Senior 2

Cluster 4: Weather Dynamics

Overview

This cluster develops an understanding of the sometimes complex relationships that influence weather and climate. An examination of the global energy budget of Earth, through water and heat transfer, provides the basis for discussion of global winds, ocean currents, and ultimately severe weather phenomena. Students gain understanding of sophisticated meteorological information, gather and analyze meteorological data related to a severe weather event, and explore the social, economic, and environmental impact of the event. Evidence that climate change occurs due to natural events and human activities is investigated and evaluated. Students apply their understanding of weather and climate in a discussion of the potential consequences of climate change.

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-4-01 Illustrate the composition and organization of the hydrosphere and the atmosphere. Include: salt water, fresh water, polar ice caps/glaciers, troposphere, stratosphere GLO: D5, E2

SUGGESTIONS FOR INSTRUCTION
(2 HOURS)

➢ Entry-Level Knowledge

In Grade 5, the study of weather was first introduced.

In Grade 8, the hydrological cycle, global distribution, and relative amounts of salt and fresh water were discussed.

➢ Notes for Instruction

A review of the hydrological cycle may be a starting point for this cluster. A Knowledge Chart or Sort and Predict activity could be used to activate prior knowledge (see *SYSTH* 9.25, 10.23).

The use of maps, diagrams, graphs, charts, and analogies will aid in student understanding of the composition and organization of the hydrosphere and atmosphere.

➢ Student Learning Activities

Visual Display/Collaborative Teamwork S2-0-1b, 4f, 4g

Student groups construct visual displays of the composition and organization of the hydrosphere and the atmosphere. Displays may include

- world maps with the oceans and continents labeled
- pie charts or graphs illustrating the distribution of water in the hydrosphere
- labeled diagrams of the layers of the Earth's atmosphere

Displays can be exhibited in the room and used for future reference.

Journal Writing S2-0-2a

Provide students with a blank world map with several latitude and longitude lines and the outlines of all the continents and oceans. Students label the oceans, continents, and major lines of latitude (Equator, Tropic of Cancer and Tropic of Capricorn, Arctic Circle and Antarctic Circle).

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-5c, 6a

Student groups present
- maps
- diagrams
- posters
- charts
- graphs

Journal Writing S2-0-2a

Students label the oceans, continents, and major lines of latitude on a world map. Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students
- compare and contrast the hydrosphere and the atmosphere (see *SYSTH* 10.24)
- label the oceans, continents, and major lines of latitude on a map of the world
- create a pie chart to illustrate the distribution of water in the hydrosphere
- draw a diagram of the Earth's atmosphere and label the troposphere and stratosphere
- discuss the implications of the unequal distribution of fresh water on the planet
- predict why so few clouds are found in the stratosphere

Suggested Learning Resources

Science 10

13.4 The Atmosphere

13.8 The Hydrosphere

BLM 13.4 The Layers of the Atmosphere

ABLM 13.4 Looking at the Atmosphere

Science Power 10

13.3 Interactions of Solar Energy with Land and Air

BLM 13-12 Levels of the Atmosphere

BLM 13-13 Atmospheric Composition

BLM 13-14 The Atmosphere

SYSTH

9.25 Knowledge Chart

10.23 Sort and Predict

10.24 Compare and Contrast

13.21 Journal Evaluation

Appendix

6.1 Rubric for the Assessment of Class Presentations

Teacher Background

While there are several layers of the atmosphere above the Earth's surface, the troposphere and stratosphere are responsible for our weather systems. The gases present in the air near the Earth's surface are nitrogen (78%), oxygen (21%), and other gases such as water vapour, argon, carbon dioxide, and others (1%). The hydrosphere is composed of salt water, fresh water, and polar icecaps and glaciers—the largest component being salt water.

Canada has an abundance of fresh water in its lakes, rivers, and glaciers. We have almost 10% of the world's freshwater supply.

Prescribed Learning Outcomes
Students will...
S2-4-02 Outline factors influencing the Earth's radiation budget. Include: solar radiation, cloud cover, surface and atmospheric reflectance (albedo), absorption, latitude GLO: D4, D5, E2, E3

Suggestions for Instruction
(2 hours)

➢ Entry-Level Knowledge

In Grade 5, the transfer of energy from the Sun was first introduced. In Grade 6, students examined how the Earth's tilt of axis and revolution cause the yearly cycle of seasons. In Grade 7, heat transfer by conduction, convection, and radiation was discussed. In Grade 8, the various types of electromagnetic radiation (e.g., ultraviolet, infrared) were compared.

➢ Notes for Instruction

Students have familiarity with many of the concepts related to this learning outcome. Activate students' knowledge of these concepts and discuss misconceptions. A KWL frame could be used (see *SYSTH* 9.24). A common misconception often held by students is that the seasons change because the Earth moves closer to or further away from the Sun. In fact, seasons change due to a combination of the Earth's revolution around the Sun and the tilt of the Earth's axis. The use of maps, diagrams, graphs, and analogies will aid in student understanding of the factors influencing the Earth's radiation budget.

➢ Student Learning Activities

Laboratory Activity S2-0-1a, 3c, 4a, 5b

Students or student groups conduct a laboratory activity. Investigations may include

- determining the relationship between the angle of sunlight and the seasons on the Earth
- comparing rates of heating and cooling of soil and water
- calculating the hours of daylight in a community on the longest and shortest days of the year
- determining the characteristics of an object that cause it to absorb or reflect solar energy

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Laboratory Report S2-0-6b, 6c, 7a, 7b

Students interpret their laboratory results and prepare a report describing their investigation findings (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Student Research S2-0-2a, 9b, 9c

Students present research findings with

- written reports
- oral presentations
- multimedia presentations
- newspaper articles

Visual Display S2-0-4f, 4g, 5c

Student groups present their visual displays of the factors influencing the Earth's energy budget with

- posters
- diagrams
- charts
- bulletin board displays
- dioramas
- cartoons

Teacher Background

The Sun's energy travels through space essentially with no interference until it reaches the Earth's atmosphere. A number of interactions then occur. Much of the Sun's energy is absorbed by gases, dust particles, clouds, and the Earth's surface, while the rest is reflected. Of 100 units of incoming solar radiation, 19 units are absorbed by the atmosphere and clouds. Fifty-one units are absorbed by the Earth's surface. The remaining 30 units are reflected and scattered by the atmosphere, clouds, and the Earth's surface.

(continued)

Suggested Learning Resources

Science 10

13.1 A Closer Look at Earth
13.2 Earth's Energy Balance
13.3 Investigation: Seasons and the Angle of Sunlight
BLM 13.1a Map of the World
BLM 13.1b What's Your Angle?
BLM 13.2 How Much Do I Know?
BLM 13.3 Mysterious Planet
BLM 16.6 Look at Frosty Go
ABLM 13.3 The Intensity of Light and the Angle of Incidence
ABLM 13.3a Changing Seasons for the Northern Hemisphere

Science Power 10

13.1 Earth's Energy Budget
13.2 Energy and Water
13.3 Interactions of Solar Energy with Land and Air
Investigation 13-A: Comparing the Properties of Soil and Water
14.1 Solar Energy and a Spherical Earth
Investigation 14-A: Hours of Daylight
BLM 13-2 Absorption or Reflection
BLM 13-7 Moisture in the Air
BLM 14-2 Hours of Daylight
BLM 14-3 Solar Energy and a Spherical Earth

(continued)

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-4-02 Outline factors influencing the Earth's radiation budget.

Include: solar radiation, cloud cover, surface and atmospheric reflectance (albedo), absorption, latitude

GLO: D4, D5, E2, E3

SUGGESTIONS FOR INSTRUCTION
(2 HOURS)

Student Research S2-0-2a, 9b, 9c

Students research the factors influencing the Earth's radiation budget. These factors include
- solar radiation
- cloud cover
- albedo
- absorption

Case studies, newspaper articles, and Internet sources may be used. See also Appendix 4.2: Sunlight and Seasonal Variations.

Visual Display/Collaborative Teamwork S2-0-4f, 4g, 5c

Student groups research and prepare visual displays of the factors influencing the Earth's radiation budget, such as
- cloud cover
- latitude
- atmospheric reflectance

Journal Writing S2-0-2c

Students prepare a glossary of new words for quick reference. A Three-Point Approach could be used (see *SYSTH* 10.22).

Suggestions for Assessment

Journal Writing S2-0-2c

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- complete a Word Cycle of terms related to this learning outcome (see *SYSTH* 10.21)
- predict the effect of melting polar ice caps on the albedo of the Earth
- describe the effect of latitude on absorption of solar radiation
- differentiate between latitude and longitude
- draw and label a diagram showing how solar radiation is distributed when it reaches the Earth
- explain the relationship between the seasons and the angle of sunlight
- describe the effect of cloud cover on reflectance of solar radiation
- differentiate between absorption and reflection

Suggested Learning Resources

SYSTH

9.24 KWL Plus
10.21 Word Cycle
10.22 Three-Point Approach
13.21 Journal Evaluation
14.12 Lab Report Format

Appendices

4.1 Earth's Energy Budget
4.2 Sunlight and Seasonal Variations
4.3 Exploring Albedo
4.4 Connecting Mathematics to the Atmosphere
6.1 Rubric for the Assessment of Class Presentations
6.2 Rubric for the Assessment of a Research Project
6.4 Lab Report Assessment

PRESCRIBED LEARNING OUTCOMES

Students will...

S2-4-03 Explain effects of heat transfer within the atmosphere and hydrosphere on the development and movement of wind and ocean currents.

Include: Coriolis effect and atmospheric convection, prevailing winds, jet streams, El Niño/La Niña

GLO: A2, D5, E1, E4

SUGGESTIONS FOR INSTRUCTION

(3 HOURS)

➢ Entry-Level Knowledge

In Grade 5, students learned how the transfer of energy from the sun affects weather conditions. In Grade 7, the concept of heat transfer was discussed. In Grade 8, the hydrological cycle, Coriolis effect, prevailing winds, ocean currents, and the heat capacity of water were introduced.

➢ Notes for Instruction

Students have familiarity with many of the concepts related to this learning outcome. Activate students' prior knowledge using a Sort and Predict activity (see *SYSTH* 10.23). Discuss misconceptions, such as the Coriolis effect, causing water to swirl in a certain direction down a drain (see Teacher Background for this learning outcome in Appendix 4.5 and Appendix 4.6). The use of maps, diagrams, graphs, analogies, and demonstrations will aid in student understanding of the effects of heat transfer within the atmosphere and hydrosphere. In particular, java applets and simulations of the Coriolis effect can be very effective in developing student understanding of this phenomenon that is unique to spinning planets with atmospheres.

Teacher Demonstration S2-0-1a, 3a, 6a, 7a

See Appendix 4.9: Convection Currents for a demonstration illustrating the formation and movement of convection currents. This demonstration can be adapted for use as a laboratory activity.

Teacher Background

As the air above Earth's surface warms, it becomes less dense and rises. Cooler and denser air tends to sink. These differences in air temperature and density initiate worldwide movements of air, and global wind patterns can develop. Having a spinning planet is also very important, with just the right rate of spin. Venus, for instance, has no wind belts because of its extremely slow rate of rotation (one rotation every 244 Earth days). Jupiter and Saturn (with rotation periods of 9h 55.5m and 10h 14m respectively) have very well-developed—and persistent—global wind belts. We observe these wind belts as coloured bands in the outer atmospheres of these large, gaseous planets).

(continued)

Suggestions for Assessment

Pencil-and-Paper Tasks

Students

- label a world map and/or map of North America with major ocean currents and the direction in which they move
- explain why a direct flight from Winnipeg to Calgary usually takes longer than a direct flight from Calgary to Winnipeg
- label a world map and/or map of North America showing the direction of prevailing winds (see Appendix 4.11–4.12 for a world map template)
- describe how solar energy causes wind currents
- suggest reasons why winters in Iceland and Norway are warmer than in Manitoba with similar latitude among these places
- distinguish between El Niño and La Niña ocean currents
- explain how the Coriolis effect influences the movement of wind and ocean currents
- differentiate between prevailing winds and jet streams

Laboratory Report S2-0-6a, 6b, 6c, 7b

Students interpret their laboratory results and prepare a report describing their investigation findings (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing.

Teacher Background

The influence of the Earth's rotation on air, or on any object moving on the Earth's surface, is called the Coriolis effect. As one moves away from the equator, each point on the Earth rotates at different speeds, depending on the latitude. For example, at the equator, the speed of rotation at the Earth's surface is 1664 km/h. At 30 degrees north latitude, the speed is 1392 km/h, and at 45 degrees north latitude, the speed drops to 1168 km/h.

The Coriolis effect is responsible for the deflection of wind and ocean currents to the right from the equator in the northern hemisphere, and to the left from the equator in the southern hemisphere. It does not cause water to swirl down the drain in the counter-clockwise direction in the northern hemisphere, and in the clockwise direction in the southern hemisphere! This is a popular, and apparently incorrect, urban legend. Try it yourself...!

(continued)

Suggested Learning Resources

Science 10

13.6 Prevailing Wind Patterns

13.7 Case Study: The First Round-the-World Balloon Flight

13.9 Major Ocean Currents

13.13 A Global Weather Model

15.12 El Niño and La Niña

BLM 13.6b How Do You Hit a Moving Target?

BLM 13.9 A Tale of Two Islands

BLM 13.13 What's the Weather Factor

BLM 16GS Trapped in Ice

ABLM 13.7 Making and Flying a Hot-Air Balloon

ABLM 15.12 El Niño's Effects on Air and Water Currents

Science Power 10

Investigation 13-B: Blowing in the Wind

14.2 Worldwide Wind Currents

Investigation 14-B: Determining the Direction of Prevailing Winds

14.3 Rivers in the Sea

Investigation 14-C: Moving Mountains of Water

BLM 14-4 The Coriolis Effect

BLM 14-5 Determining the Direction of Prevailing Winds

BLM 14-6 The Jet Stream

BLM 14-8 Ocean Gyres

BLM 14-10 Moving Mountains of Water

BLM 14-11 El Niño

BLM 14-12 El Niño

(continued)

Prescribed Learning Outcomes
Students will...
(continued) **S2-4-03** Explain effects of heat transfer within the atmosphere and hydrosphere on the development and movement of wind and ocean currents. Include: Coriolis effect and atmospheric convection, prevailing winds, jet streams, El Niño/La Niña GLO: A2, D5, E1, E4

Suggestions for Instruction

(3 hours)

➢ Student Learning Activities

Laboratory Activity S2-0-1a, 3a, 3c, 4a

Students or student groups conduct a laboratory activity. Investigations may include determining

- what happens when water of one temperature comes in contact with water of a different temperature (use coloured dyes)
- how the concentration of salt affects the motion of water
- how interactions between ground, water, and air pressure gradients result in winds
- the direction of prevailing winds on certain continents (i.e., North America)

Student Research S2-0-1b, 2b, 2c

Students or student groups research the effects of wind and ocean currents. Topics may include

- the jet stream and the race to the first "round-the-world" balloon flight
- the use of the Gulf Stream by sailing ships
- how the Horse Latitudes got their name
- the link between the location of deserts and wind/ocean currents
- how, and by whom, the jet stream was discovered
- how the Gulf Stream affects the climate of Newfoundland and western Europe
- how the "Roaring Forties" got their name

Case studies, newspaper articles, and Internet sources may be used.

Journal Writing S2-0-2a

Students label maps (world and North America) indicating major ocean currents, and the prevailing winds.On a map of North America, the location of the west-east jet stream could be plotted over a succession of days. This would make an ideal "heads-up" for later work on the association of major pressure systems with jet streams.

Suggestions for Assessment

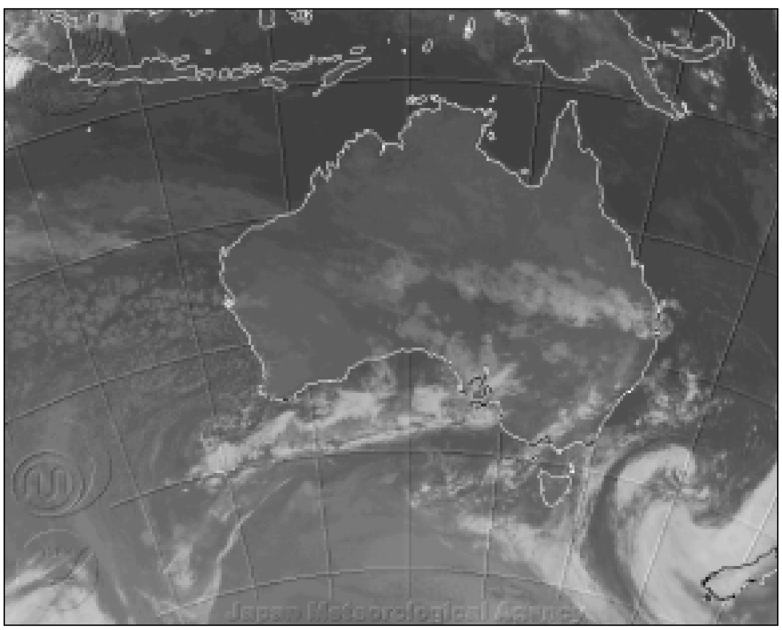
Research Report/Presentation S2-0-8c, 8e, 9a

Students or student groups present research findings with

- oral presentations
- written reports
- multimedia presentations
- posters
- bulletin board displays
- newspaper articles
- dramatic presentations

Journal Writing S2-0-2a

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).



Satellite image showing clockwise rotation (lower right) around a low pressure centre. Coriolis effect induces the “bending” as seen here in the Southern Hemisphere.

Graphic courtesy of NOAA. All rights reserved.

Suggested Learning Resources

SYSTH

10.23 Sort and Predict

13.21 Journal Evaluation

14.12 Lab Report Format

Appendices

4.5 The Coriolis Effect

4.6 Understanding the Link Between Coriolis and Weather

4.7 It Bends Because the Earth Turns

4.9 Convection Currents

4.10 The Atmosphere-Ocean Connection—El Niño and La Niña

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.4 Lab Report Assessment

PRESCRIBED LEARNING OUTCOMES
Students will...
S2-4-04 Explain the formation and dynamics of severe weather phenomena. *Examples: thunderstorms, tornadoes, blizzards, hurricanes, extreme temperature events, cyclonic storms…* GLO: A2, D5, E1, E4

SUGGESTIONS FOR INSTRUCTION
(5 HOURS)

➢ Entry-Level Knowledge

In Grade 5, the study of weather was first introduced. Topics examined included warm and cold air masses, fronts, high- and low-pressure systems, formation and types of clouds, transfer of energy from the sun, and examples of severe weather. Students will also have had real-life experiences related to severe weather, as well as exposure through the media (e.g., television, movies, newspaper).

Nevertheless, it will be important to insert an intervention related to these fundamentals of meteorology **before** consideration can be given to discussion and exploration of specific weather-related phenomena. That is, prior to addressing this student learning outcome, students will need to have in place some solid basis upon which to address the dynamics of severe weather. The following text box outlines some of the essentials of meteorology considered implicit in this specific learning outcome:

- Use the particle theory to predict how air masses will behave when placed in a **pressure gradient** (i.e., movement of air from region of high pressure to one of lower pressure)
- Be acquainted with basic meteorological symbols (weather station glyphs), the prevalent symbols used in media-type weather maps (e.g., warm and cold fronts, highs and lows, the position of the jet stream(s))
- Familiarity with terms such as air pressure, ambient temperature, dew point, isobars, surface analysis map
- The movement of frontal systems over time (accomplished through actively watching weather systems from a variety of media sources in "real-time" if possible)

➢ Notes for Instruction

This learning outcome could be introduced with a discussion and examination of warm, cold, stationary, and occluded fronts. High- and low-pressure systems should be included at this time. Diagrams, maps, and demonstrations should be used to illustrate the formation and dynamics of weather phenomena. Take advantage of current and/or local weather events to increase the level of immediate relevance to class activities. Excellent visual documentation of severe weather phenomena can be found on television, in software simulations, videotapes, and numerous websites devoted to instances of tornadoes, blizzards, and hurricanes, among others.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-2a, 5c, 8b

Students or student groups prepare and present visual displays of the development of weather phenomena. Displays may take the form of

- posters
- diagrams
- charts
- bulletin board presentations
- dioramas
- cartoons
- demonstrations

Research Report/Presentation S2-0-9b, 9c

Students or student groups research the formation and dynamics of severe weather phenomena, and present

- written reports
- oral presentations
- brochures
- pamphlets
- multimedia presentations
- newspaper articles

Teacher Background

A Colorado Low is a counter-clockwise rotating, low-pressure system, that forms over the east side of the U.S. Rocky Mountains. If the low intensifies, air from the Gulf of Mexico is drawn into the Prairies and Central Plains regions of North America. When this warm, moist air meets the cold Arctic air from the north along a frontal boundary, a mid-latitude cyclonic storm develops. Precipitation falls as rain or snow, depending on the air temperature.

As the jet stream pushes the storm from west to east, the winds shift from the southeast to the northwest as the system rotates counter-clockwise, drawing colder Arctic air to the region, and causing the temperature to plunge. Some of Manitoba's worst blizzards (March 1966, November 1986, April 1997) were the result of mid-latitude cyclonic storms. See the Appendix 4.30: The 1997 Manitoba Blizzard for a student activity.

(continued)

Suggested Learning Resources

Science 10

- 14.2 North American Weather Systems
- 15.3 Thunderstorms and Tornadoes
- 15.4 Floods and Droughts
- 15.6 Hurricanes, Typhoons, and Tropical Cyclones
- 15.7 Blizzards
- 15.9 Extreme Heat and Cold
- BLM 14.2a The Life of a Storm
- BLM 14.2b The Life of a Storm
- BLM 15.6a The Formation of Hurricanes
- BLM 15.6b The Formation of Hurricanes

Science Power 10

- 15.1 Highs, Lows, and Fronts
- 15.3 Severe Weather
- BLM 15-5 Description of a Warm Front
- BLM 15-6 Description of a Cold Front
- BLM 15-7 Cold Front
- BLM 15-8 Warm Front
- BLM 15-9 Description of an Occluded Front
- BLM 15-10 Temperature Profile of a Frontal System
- BLM 15-11 High and Low Pressure Systems
- BLM 15-12 Fronts and Winds
- BLM 15-13 Highs, Lows, and Fronts
- BLM 15-14 Thunderstorms
- BLM 15-15 Tornado in a Bottle

(continued)

PRESCRIBED LEARNING OUTCOMES

Students will...

(continued)

S2-4-04 Explain the formation and dynamics of selected severe weather phenomena.

Examples: thunderstorms, tornadoes, blizzards, hurricanes, extreme temperature events, cyclonic storms…

GLO: A2, D5, E1, E4

SUGGESTIONS FOR INSTRUCTION
(5 HOURS)

Note: The Atlantic hurricane season runs from late August to early November, averaging five to eight tropical storms of note per season. The western Pacific typhoon season runs from about March through May, while the winter months often host a number of Southern Hemisphere tropical storms and cyclones in the Indian Ocean or offshore Australia. For teachers who would benefit from automatic notification of such events, there are listserves available on the Internet, and software packages that track storms and hurricanes (e.g., *Tracking the Eye* and *Global Tracks 6.0 2003*).

➢ Student Learning Activities

Teacher Demonstration S2-0-3a, 4a, 4e

Fill a clear glass tray or shallow bowl halfway with warm water. Add a few drops of food colouring to the warm water and mix. Slowly pour in cold milk. Observe the movement and shape of the milk.

The milk represents an approaching cold air mass. A cold air mass will displace a warm air mass by pushing the warm air upwards along a cold front.

Class Discussion S2-0-7f

Generate interest in the learning outcome by having students relate their experiences with severe weather phenomena to the class. A Listen-Think-Pair-Share structure could be used (see *SYSTH* 3.10).

Visual Display S2-0-2a, 5c, 8b

Students or student groups construct visual displays illustrating the development of weather phenomena such as

- thunderstorms
- tornadoes
- blizzards
- cyclonic storms
- hurricanes

Displays can be exhibited in the room and used for future reference.

(continued)

Suggestions for Assessment

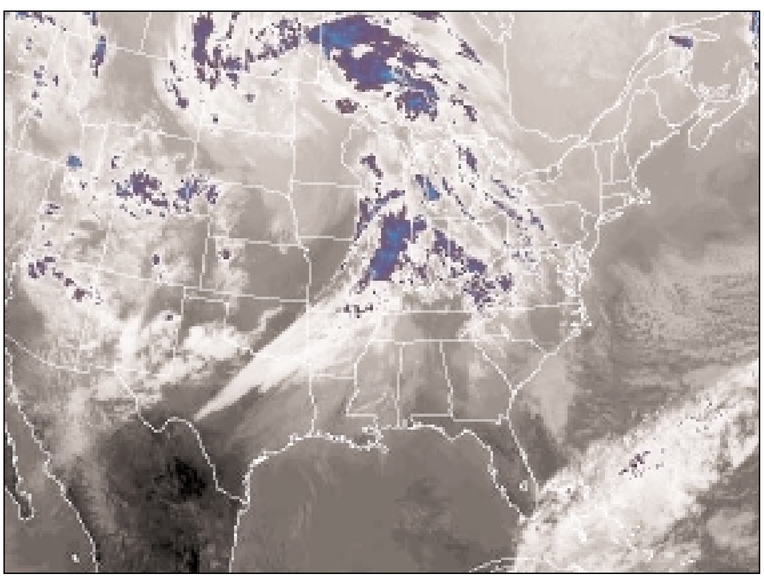
Journal Writing S2-0-2a

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students

- describe the role of the Coriolis effect in the development and movement of hurricanes
- draw and label diagrams illustrating the stages of a thunderstorm
- differentiate between cyclones and anticyclones
- explain why most tornadoes tend to occur in the Central Plains region of the United States
- list the characteristics of a blizzard
- summarize the stages of tornado formation
- predict why it is unlikely that hurricanes will form in the Arctic Ocean
- formulate a hypothesis to explain why thunderstorms seldom occur in the winter in Manitoba
- explain why a Colorado Low (a cyclonic storm) often brings severe weather (e.g., blizzards) to Manitoba



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Suggested Learning Resources

BLM 15-16 Hurricanes

BLM 15-18 Naming Hurricanes

BLM 15-19 Storm Surges

BLM 15-20 Severe Weather Quiz

BLM 15-21 Weather Events

SYSTH

3.10 Listen-Think-Pair-Share

9.24 KWL Plus

10.22 Three-Point Approach

13.21 Journal Evaluation

Appendices

4.17 Understanding Highs and Lows

4.18 Introduction to Weather Maps and Symbols

4.20 The Fujita Scale of Tornado Intensity

4.21a Canadian Tornado Frequency Data—An Applied Mathematics (20S) Approach

4.21b Canadian Tornado Frequency Data—A Consumer Mathematics (20S) Approach

4.21c Canadian Tornado Frequency Data—A Pre-Calculus Mathematics (20S) Approach

4.22a Watch Out! There May Be a Tornado in Your Backyard

4.22b Tornado Plotting Map of Canada

4.23 Tornado-Related Statistics and Graphing

4.24 Location/Place—Where in the World Can Severe Storm Events Happen?

4.25 Tracking a Killer Hurricane

(continued)

PRESCRIBED LEARNING OUTCOMES
Students will...
(continued) **S2-4-04** Explain the formation and dynamics of selected severe weather phenomena. *Examples: thunderstorms, tornadoes, blizzards, hurricanes, extreme temperature events, cyclonic storms…* GLO: A2, D5, E1, E4

SUGGESTIONS FOR INSTRUCTION
(5 HOURS)

Student Research S2-0-1b, 2c

Students or student groups research the formation and dynamics of severe weather phenomena. Topics can include

- thunderstorms
- monsoons
- extreme temperature events
- ice storms

Case studies, newspaper articles, and Internet sources may be used.

Journal Writing S2-0-2a

Students prepare a glossary of new words for quick reference. A Three-Point Approach could be used (see *SYSTH* 10.22).

Teacher Demonstration S2-0-3a, 4a, 4e

Fill a tall beaker or jar with water. Place several non-floating objects such as paper clips and thumbtacks on the bottom of the beaker. Stir the top 5 cm of water with a spoon. Observe.

The stirring simulates the wind shear that starts or intensifies the rotation of updrafts in thunderclouds, creating a vortex. As air continues to rise upward, the vortex spins faster and faster, and a funnel cloud forms. When a funnel cloud touches the ground, it is then considered to be a tornado.

Alternatively, this can be simulated as a “tornado in a bottle” demonstration. Attach two empty 2-litre plastic bottles together by gluing their lids together back-to-back. Drill a 0.5-cm hole in the lids to allow the transfer of liquid. Fill one bottle with water, a little blue food colouring, and a small handful of confetti from the copy machine. After you have re-attached the two bottles, invert the assembly, give it a few strong swirls, then watch the “tornado” develop.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

6.3 Rubric for the Assessment of a Decision-Making Process Activity

6.4 Lab Report Assessment

Hurricane/Severe Storm-Tracking Software

Global Tracks 6.0 (2003)
<http://www.jincsolutions.com/home.asp>

Tracking the Eye
<http://www.hurricanesoftware.com/>

Eye of the Storm
<http://www.starstonesoftware.com>

McHurricane (for Mac) Version 5.2.2
<http://www.mchurricane.com>

Prescribed Learning Outcomes

Students will...

S2-4-05 Collect, interpret, and analyze meteorological data related to a severe weather event.

Include: meteorological maps, satellite imagery, conditions prior to and following the event

GLO: C2, C6, C8, D5

Suggestions for Instruction

(3 hours)

➢ Entry-Level Knowledge

In Grade 5, students observed and measured local weather conditions and analyzed the data collected. Students may have had exposure to meteorological maps through television and newspaper articles, as well as discussion on personal experiences with conditions prior to and following severe storms in the previous learning outcome.

➢ Notes for Instruction

This specific learning outcome can be significantly linked to SLO S2-4-04, which deals with the dynamics of severe weather events. A more "integrative" approach would have students use the context of a particular weather event to motivate the gathering of the relevant synoptic data, such as temperature, precipitation, and cloud cover records. In addition, the readily available satellite imagery databases allow for the observational information to be correlated to space platform images (i.e., visible, infrared, water vapour wavelengths satellite images). It may be important to introduce the fundamentals of remote sensing (e.g., Doppler radar) prior to their use in analyzing particular events. See Appendices 4.17, 4.18, and 4.19 for student learning activities in these areas. Activate prior knowledge of this learning outcome with a "refresher" examination of weather maps and symbols. A Knowledge Chart could be used (see *SYSTH* 9.25).

Discuss the types of data collected by meteorologists, and the technologies used. Take advantage of current and/or local weather events available in print and electronic media. The Environment Canada website has current weather data and maps, as well as satellite and radar images for all regions of Canada (see <http://weatheroffice.ec.gc.ca/> or <www.mb.ec.gc.ca>).

(continued)

SUGGESTIONS FOR ASSESSMENT

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Visual Display S2-0-5c, 6a, 9c

Student groups present meteorological data and weather maps as

- television/radio broadcasts
- multimedia presentations
- newspaper articles
- charts
- posters
- bulletin board displays

Laboratory Report S2-0-5a, 7b, 9c, 9d

Students prepare a lab or case study report including their collected weather data, satellite imagery, issued weather advisories, their analyses and interpretation of the data, and their weather forecast for a chosen community or region over time (see *SYSTH* 14.12 for a lab report format). Word-processing software and spreadsheets can be used for report writing. At some point, individual students (or small groups) could take responsibility for tracking a weather event in order to contribute to a whole-class archive of "storm-watching."

Teacher Background

Many animals are sensitive to environmental changes that humans often cannot detect. Here are a few popularized examples:

- When air pressure drops, flying insects become more active and stay closer to the ground, so they seem to swarm before a rainstorm.
- The calls of some birds, including crows and geese, become more frequent with falling air pressure.
- Static electricity may increase the grooming activities of cats.
- Falling air pressure may affect the digestive system of cows, making them less willing to go to pasture. They then have a greater tendency to lie down and ruminate rather than graze.

(continued)

SUGGESTED LEARNING RESOURCES

Science 10

14.3 Case Study: Three Days of Canadian Weather

14.8 Weather Heritage

14.9 Weather Forecasting Technology

14.10 Investigation: The Weather Forecasting Business

14.13 Weather Records and Events

14.15 How Accurate Are Advanced Forecasts?

BLM 14.3 Map for Tracking Weather Patterns

BLM 14.8 Nature's Weather Forecasts—or Not?

BLM 15.1a Looking at the Records

BLM 15.1b A Study in Contrasts

ABLM 13.1 Looking at Weather Maps

Science Power 10

16.1 Collecting Weather Data

16.2 Weather Maps and Forecasting

16.3 Past, Present, and Future

Investigation 16-C: Forecast the Weather

BLM 16-3 Interpreting Weather Maps

BLM 16-4 Drawing Isobars

BLM 16-5 Drawing Isotherms

BLM 16-6 Forecasting the Weather

BLM 16-7 Forecasting Quiz

BLM 16-8 Thunderstorms: Myth, Folklore, and Science

BLM 16-11 Weather and Chaos

(continued)

Prescribed Learning Outcomes

Students will...

(continued)

S2-4-05 Collect, interpret, and analyze meteorological data related to a severe weather event.

Include: meteorological maps, satellite imagery, conditions prior to and following the event

GLO: C2, C6, C8, D5

Suggestions for Instruction

(3 hours)

➢ Student Learning Activities

Visual Display/Collaborative Teamwork S2-0-1b, 2a, 4f, 4g

Student groups track a storm as it moves across the country or a region, or the entire continent, and interpret and analyze the meteorological data. Students then prepare a weather map (or source the map information from available archives), using the collected data, and choose a method to showcase their results for peer review. It is recommended that this be done so that the seasonal variations in severe weather events can be highlighted. For instance, fall constitutes an excellent time to track Atlantic hurricanes; winter offers classic “Colorado Lows” that can bring blizzards to the Prairies; transition to spring often brings benevolent weather to Manitoba, but eastern Canada often has spectacular events such as ice storms (e.g., January 1998), early season thunderstorms and tornadoes (central US), and unanticipated spring snowstorms. For an archive of significant weather events, see: <http://www.osei.noaa.gov/>; for significant events as they happen, see <http://Earthobservatory.nasa.gov/Newsroom/Headlines/>. NASA operates an automatic updates page on important natural developments around the world, accessible at <http://Earthobservatory.nasa.gov/>.

Laboratory Activity S2-0-1b, 2b, 3a, 4e

Students or student groups collect North American weather data daily for several consecutive days. Prior to this activity, students could benefit from the mapping sequence activity found in Appendix 4.16: Introduction to Weather Maps. The data for a particular community are analyzed, and a weather forecast is prepared. Meteorological data should be collected from a variety of sources, such as the Internet, television, radio, or newspaper. Case studies may be used for this approach, and it may be useful to have groups of students work in different regions of the world, and then compare/contrast inter-hemisphere phenomena.

(continued)

SUGGESTIONS FOR ASSESSMENT

Research Report/Presentation S2-0-3e, 8e, 9a, 9d

Students or student groups present research findings with
- written reports
- oral presentations
- newspaper articles
- posters
- bulletin board displays
- brochures
- pamphlets
- multimedia presentations

Journal Writing S2-0-7f, 8d

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students
- discuss the importance of satellite imagery in weather forecasting, and make use of actual satellite image products as a component of this discussion
- describe how weather balloons are used to gather weather-related data
- discuss the advantages/difficulties of using Doppler radar in weather forecasting
- identify symbols used on weather maps (e.g., warm front, isobars, low pressure, et cetera)
- interpret and analyze meteorological data related to a severe weather event
- compare and contrast isotherms and isobars (all examples of *isopleths*) (see *SYSTH* 10.24)
- differentiate among a visible wavelengths satellite image, an infrared (IR) image, a water vapour image, and a radar image as these are used in weather forecasting and analysis of conditions

SUGGESTED LEARNING RESOURCES

SYSTH

9.25 Knowledge Chart

10.24 Compare and Contrast

13.21 Journal Evaluation

14.12 Lab Report Format

Appendices

4.17 Understanding Highs and Lows

4.18 Introduction to Weather Maps and Symbols

4.19 Using Satellites to Track Weather

4.20 The Fujita Scale of Tornado Intensity

4.21a Canadian Tornado Frequency Data—An Applied Mathematics (20S) Approach

4.21b Canadian Tornado Frequency Data—A Consumer Mathematics (20S) Approach

4.21c Canadian Tornado Frequency Data—A Pre-Calculus (20S) Approach

4.22a Watch Out! There May be a Tornado in Your Backyard!

4.22b Tornado Plotting Map of Canada

4.23 Tornado-Related Statistics and Graphing

4.24 Location/Place—Where in the World Can Severe Storm Events Happen?

4.25 Tracking a Killer Hurricane

4.26a East Pacific Hurricane Tracking Chart

4.26b Atlantic Hurricane Track Chart

(continued)

Prescribed Learning Outcomes
Students will...
(continued) **S2-4-05** Collect, interpret, and analyze meteorological data related to a severe weather event. Include: meteorological maps, satellite imagery, conditions prior to and following the event GLO: C2, C6, C8, D5

Suggestions for Instruction
(3 hours)

Student Research S2-0-1b, 2b, 8e, 9a

Students or student groups research the origin or veracity of folkloric sayings/observations with respect to weather. Examples include

- "Red sky at night, sailor's delight,
  Red sky in the morning, sailors take warning"
- "The dog days of summer"
- the number of stripes on a woolly bear caterpillar and the length/cold of the coming winter
- the correlation between a groundhog's seeing its shadow and the arrival of spring
- arthritic joint pain foretelling a change in the weather
- the thickness of the mud on a beaver lodge and the length/cold of the upcoming winter
- "a three dog night"

Students may wish to interview or invite community elders to the class to share their knowledge.

Journal Writing S2-0-7f, 8c

Students reflect and respond to the following questions:

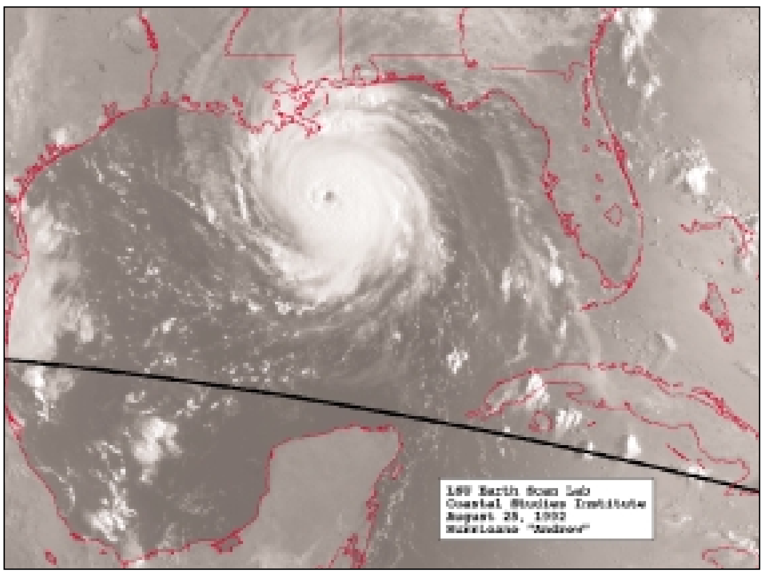
- How has your understanding of weather changed since the start of the unit?
- What new questions do you have about weather?
- What new information in this cluster surprises you?
- How has technology played a role in our understanding of weather?

Community/Career Connection S2-0-8c, 8d, 8f , 9b

Invite a community member such as a pilot, weather announcer, or meteorologist to come into the classroom and answer students' questions. The questions may be prepared in advance so that appropriate topics are covered. Questions may include:

- What special training in weather forecasting have you received?
- Where do you get your meteorological data?
- What sciences are involved in meteorology, both academic and applied?
- How does meteorological technology assist you in your job?

Suggestions for Assessment



Suggested Learning Resources

- 4.27 The Saffir-Simpson Hurricane Scale and Fujita Tornado Scale
- 4.28 Weather Map Symbols
- 4.29 Weather Map Symbols—A Student’s Guide
- 4.30 The 1997 Manitoba Blizzard
- 6.1 Rubric for the Assessment of Class Presentations
- 6.2 Rubric for the Assessment of a Research Project
- 6.3 Rubric for Assessment of a Decision-Making Process Activity
- 6.4 Lab Report Assessment

Prescribed Learning Outcomes
Students will...
S2-4-06 Investigate the social, economic, and environmental impact of a recent severe weather event. Include: related consequences on personal and societal decision-making GLO: B2, B4, C6

Suggestions for Instruction
(3 hours)

➢ Entry-Level Knowledge

In Grade 5, students described how weather may affect the activities of humans and animals. Severe weather forecasts and preparations for ensuring personal safety were also discussed. Students may have personal experience with the impact of a severe weather event, or familiarity from the media and other sources.

➢ Notes for Instruction

Activate prior knowledge of this learning outcome by having students relate ways severe weather events have affected their lives. A Rotational Cooperative Graffiti structure could be used (see *SYSTH* 3.15).

Take advantage of current and/or local weather events. Excellent visual documentation of severe weather phenomena can be found on television or videotape footage, and numerous websites devoted to instances of tornadoes, blizzards, and hurricanes.

➢ Student Learning Activities

Student Research/Collaborative Teamwork
S2-0-1b, 1d, 4f, 4g

Student groups examine case studies, or research the effects of a severe weather event. Research may include interviewing

- survivors of a tornado
- homeowners affected by a flood
- trappers, elders, or conservation officers about the impact of extreme cold on wildlife populations
- motorists stranded by a snowstorm
- boaters caught by a windstorm

The social, economic, and/or environmental impact of a severe weather event should be included.

(continued)

SUGGESTIONS FOR ASSESSMENT

Pencil-and-Paper Tasks

Students

- discuss how severe weather phenomena can disrupt our everyday lives
- differentiate between a severe weather watch and a severe weather warning
- formulate a plan to ensure personal safety if a thunderstorm develops during a canoe trip or golf game
- calculate the distance between themselves and a lightning bolt, using the time between seeing the lightning and hearing the thunder
- describe survival techniques for stranded motorists or snowmobile operators
- predict the potential consequences of an extended hot and dry spell on Manitoba forests or farms
- compare and contrast the humidex scale with the wind chill factor or Environment Canada's new "Chilldex/Froidex" at <http://www.msc.ec.gc.ca/education/windchill/index_e.cfm> (see *SYSTH* 10.24)

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Research Report/Presentation S2-0-5a, 9b, 9c

Student groups present their research on the social, economic, and/or environmental impact of a severe weather event with

- oral presentations
- written reports
- dramatic presentations
- newspaper articles
- multimedia presentations

(continued)

SUGGESTED LEARNING RESOURCES

Science 10

15.1 Weather Records and Events
15.2 Weather in the News
15.8 Case Study: Surviving the 1998 Ice Storm
15.9 Extreme Heat and Cold
15.10 Explore an Issue: Winter Shelters for the Homeless
15.11 Reporting an Extreme Weather Event
BLM 13.10 Weather or Not!
BLM 14.11 How Vital Is It?
BLM 15.2 We Interrupt This Program…
BLM 15.3 Tornadoes in Canada
BLM 15.6c Hurricanes in Canada

Science Power 10

16.3 Past, Present, and Future
Unit 4 Project: Preparing for a Really Rainy Day
BLM 15-17 Hurricane Evacuation Game
BLM G-29 Scientific Research Planner
BLM G-30 Research Worksheet
BLM G-31 Internet Research Tips

SYSTH

3.15 Rotational Cooperative Graffiti
10.24 Compare and Contrast
11.40 Issue-Based Article Analysis
11.41 Fact-Based Article Analysis
13.21 Journal Evaluation

(continued)

Prescribed Learning Outcomes

Students will...

(continued)

S2-4-06 Investigate the social, economic, and environmental impact of a recent severe weather event.

Include: related consequences on personal and societal decision making

GLO: B2, B4, C6

Suggestions for Instruction
(3 hours)

Visual Display S2-0- 1c, 2a, 7c, 7d

Students or student groups develop an advertising campaign to increase knowledge of

- winter emergency kits for cars and trucks
- community flood preparation
- the role of EMO (Emergency Measures Organization)
- tornado safety
- thunderstorm safety
- recognizing and treating frostbite/hypothermia
- recognizing and treating heat exhaustion/stroke
- winter driving techniques
- emergency measures for boaters

Journal Writing S2-0-9b

Students complete a fact- or issue-based article analysis of a current newspaper or magazine article related to the impact of a severe weather event (see *SYSTH* 11.40, 11.41).

Collaborative Teamwork S2-0-4f, 8b, 9b

Student groups create severe weather haiku poetry, such as

Snowflakes fall and drift
as the north wind howls—blizzard
No school tomorrow!

Haiku poems typically contain 17 syllables in a 5-7-5 arrangement and a seasonal reference.

Community/Career Connection S2-0-8e, 8f, 9a

Invite guests such as construction workers, resort operators, hunters, fishers, trappers, or farmers to speak to the class about how the weather affects their work and/or how their knowledge of weather helps them in their jobs. Students could also interview community members in their homes or workplaces.

Suggestions for Assessment

Visual Display S2-0-3f, 7d, 7e, 9f

Students or student groups present visual displays of their advertising campaigns such as

- posters
- radio commercials
- bulletin board displays
- television commercials
- pamphlets
- brochures
- newspaper/magazine advertisements

Journal Writing S2-0-9b

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Suggested Learning Resources

Appendices

4.24 Location/Place—Where in the World Can Severe Storm Events Happen?

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

Teacher Background

Significant Canadian Severe Weather Events

Tornadoes
Regina — June 1912
Portage la Prairie — June 1922
Windsor — June 1946
Barrie, Ontario — May 1985
Edmonton — July 1987
Pine Lake, Alberta — July 2000

Blizzards/Snowstorms
Southern Saskatchewan — February 1947
St. John's — February 1959
Southern Manitoba — March 1966, November 1968, April 1997
Victoria — December 1996
Toronto — December 1998 to January 1999

Hailstorms
Calgary — July 1981
Southern Manitoba (Morden, Pilot Mound) — June 1992
Winnipeg — July 1996
Okanagan — July 1997

Floods
Fraser River — spring 1948
Red River — spring 1950, spring 1997
Saguenay River — July 1996

Hurricanes
Hazel — Southern Ontario, October 1954
Freda — British Columbia, October 1962
Beth — Nova Scotia, August 1971

Ice Storms
Quebec/Eastern Ontario — January 1998

Drought & Extreme Heat
Prairies — 1933–1937: "Dustbowl Era"
Manitoba and Ontario — July 5–17, 1936: heat wave in which temperatures exceeded 44°C
Midale and Yellowgrass, Saskatchewan — July 5, 1937: hottest temperature ever recorded in Canada (45°C)
Prairies — 1961

Extreme Cold
Snag, Yukon — February 3, 1947: coldest temperature ever recorded in North America (–63°C)
Pelly Bay, NWT — January 28, 1989: record wind chill made the –51°C temperature feel like it was –91°C

Adapted from The Green Line [Fact Sheet] Top Weather Events of the 20th Century at: <www.ec.gc.ca/press/vote20_f_e.htm>

Data Source: Environment Canada, 2001.

Prescribed Learning Outcomes
Students will...
S2-4-07 Investigate and evaluate evidence that climate change occurs naturally and can be influenced by human activities. Include: the use of technology in gathering and interpreting data GLO: A1, A4, D5, E3

Suggestions for Instruction
(4 hours)

➢ Entry-Level Knowledge

In Grade 5, students were introduced to the concept that climate can change. They also identified possible explanations for climate change such as the greenhouse effect and volcanic activity. In Grade 7, fossil fuel formation and use by humans as a source of energy was discussed. Students may have familiarity with the enhancement of the greenhouse effect and global warming from the media and other sources.

➢ Notes for Instruction

In Senior 2, Cluster 1: Dynamics of Ecosystems, the carbon cycle and factors that disturb the cycling of matter are examined. Explain the difference between weather and climate.

While students will have heard of the greenhouse effect, they may be unfamiliar with the process by which the Earth's temperature is maintained. A discussion of the mechanism of the greenhouse effect, greenhouse gases, and the effects of human activities on greenhouse gases would be appropriate at this time. Take advantage of current information available in print and electronic media. The Natural Resources Canada website <http://climatechange.gc.ca> contains up-to-date information.

Teacher Background

Even though accurate records of precipitation, temperature, and other weather patterns have been kept for only about 150 years, humans in general tend to judge events in history on the same time scale as their lifespan. When a weather pattern exists for two or three years, it is seen as a trend. Meteorologists, however, generally accept that a 30-year period is the minimum required to assess what is termed "normal trends."

The Little Ice Age (1550–1850) was a time of cooler global temperatures. Evidence of this colder than average period is illustrated in paintings by the Flemish artist, Pieter Bruegel, which show skaters on canals that do not freeze to this extent today. In China, warm weather crops, such as oranges, were abandoned in the Kiangsi Province, where they had been grown for centuries. In England, the Thames River froze over so regularly that it became a common sight to see people crossing by foot during winter. Permanent snow was found on mountain peaks in Ethiopia at levels where it does not occur today.

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Research Report/Presentation S2-0-8c, 8g, 9a, 9e

Students or student groups evaluate evidence that would indicate climate change occurs naturally, and/or can be influenced by human activities, and present

- written reports
- oral presentations
- newspaper articles
- multimedia presentations
- posters
- bulletin board displays
- dramatic presentations

Journal Writing S2-0-3d, 7f

Encourage reflection on the debate (see following page). Have students summarize the arguments given by each team and ask the following questions:

- What surprising points were raised during the debate?
- What is your opinion, based on the evidence presented in the debate?

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Teacher Background

The natural greenhouse effect results from the presence of certain gases (particularly water vapour, $H_2O(g)$, and including CO_2) in the atmosphere that absorb solar radiation and re-emit it in the infrared. As the concentration of these greenhouse gases increases, the average temperature of the Earth and its atmosphere could also increase, giving rise to global warming. The combustion of fossil fuels has been a primary source of increased CO_2 emissions since the beginning of the industrial age in the early 19th century. Record-keeping atop Hawaii's Mauna Loa volcano has clearly demonstrated that the atmospheric concentration of CO_2 has increased **exponentially** since about 1950.

(continued)

Suggested Learning Resources

Science 10

7.8 Debate: The Sale and Use of Cars Should be Restricted

16.1 Evidence of Change

16.2 The Greenhouse Effect and Ozone Depletion

16.3 Investigation: Observing Pollution

16.4 Microclimates

16.7 Our Disappearing Forests

BLM 15.12 El Niño Visits Canada

BLM 16.1 The Trees Can Talk

Science Power 10

Investigation 2-B: Carbon Cycle and Climate

13.3 Interactions of Solar Energy with Land and Air

16.3 Past, Present, and Future

Unit 4 Issue Analysis: Cooling the Driving Habit

BLM G-29 Scientific Research Planner

BLM G-30 Research Worksheet

BLM G-31 Internet Research Tips

SYSTH

13.21 Journal Evaluation

Appendices

4.1 Earth's Energy Budget

4.4 Connecting Mathematics to the Atmosphere

4.31 Climates Do Change Naturally

4.32 Canadian Climatology Datasets

4.33 Annual Regional Temperature and Precipitation Datasets

(continued)

Prescribed Learning Outcomes

Students will...

(continued)

S2-4-07 Investigate and evaluate evidence that climate change occurs naturally and can be influenced by human activities.

Include: the use of technology in gathering and interpreting data

GLO: A1, A4, D5, E3

Suggestions for Instruction

(4 hours)

➢ Student Learning Activities

Student Research S2-0-1b, 2b, 3d, 8c

Students or student groups research evidence of climate change. Some projects may

- comment on human activities that may have an influence on greenhouse gases
- describe how dendrochronology (study of tree rings) can provide evidence of regional weather in the past
- discuss El Niño's or La Niña's effects on air and water currents and their impact on Canada's economy, society, and environment
- assess evidence that civilizations have vanished due to climate change (e.g., Vikings in Greenland)
- investigate how ice core sampling is used to determine the climate of the past
- explore the evidence for the "Snowball Earth" hypothesis, which claims that our planet has completely frozen over as much as four times in Earth's past, followed by rapid warming to tropical extremes
- describe how Manitoba's landscape provides evidence of glaciation
- discuss how microclimates can be modified by humans
- compare Manitoba's current climate with the climate of the past

Case studies, newspaper articles, and Internet sources may be used.

Class Debate S2-0-1d, 3d, 3e, 7c

Students research and then debate the pros and cons of a government-imposed carbon tax to reduce fossil fuel consumption. Environmental implications, cost of buying fuel, and issues of public health may be considered.

Suggestions for Assessment

Pencil-and-Paper Tasks

Students

- differentiate between weather and climate
- list the atmospheric gases that absorb electromagnetic radiation from the Sun and re-emit infrared radiation
- identify human activities that have an influence on greenhouse gases
- describe the mechanism of the greenhouse effect
- explain how tree rings can provide evidence of past weather
- describe the technique of ice core sampling and how it is used to determine the gas and aerosol chemistry of ancient atmospheres
- interpret graphs to determine average world temperatures in past centuries
- evaluate evidence that suggests climate change occurs naturally
- explain why deforestation may contribute to the enhancement of the greenhouse effect
- predict how a major volcanic eruption or meteorite impact may affect global temperatures
- discuss how urban microclimates differ from the climate in a city's outer suburbs
- evaluate the evidence for climate change as seen through traditional environment knowledge (TEK) of Canada's northern Aboriginal peoples

Suggested Learning Resources

4.34 Greenhouse Gases and Climate Change

4.35 Plotting CO_2 and Temperature

4.36 Ozone—What Is It, and Why Do We Care About It?

4.37 Volcanoes and Global Cooling

6.1 Rubric for the Assessment of Class Presentations

6.2 Rubric for the Assessment of a Research Project

Multimedia

Sila Alangotok: Inuit Observations on Climate Change

Prescribed Learning Outcomes
Students will...
S2-4-08 Discuss potential consequences of climate change. *Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change…* GLO: A1, A2, C5, C8

Suggestions for Instruction
(3-1/2 hours)

➢ Entry-Level Knowledge

In Grade 5, students were introduced to the concept that climate can change. They also identified possible explanations for climate change, such as the greenhouse effect and volcanic activity. Students may have familiarity with the potential consequences of climate change from the media and other sources.

➢ Notes for Instruction

The scientific debate over the nature and degree of global warming due to the enhanced greenhouse effect is ongoing. Some computer models forecast increased temperatures, while others predict global cooling. Take advantage of current information available in print and electronic media. The Natural Resources Canada website <http://climatechange.gc.ca> contains up-to-date information.

➢ Student Learning Activities

Class Discussion S2-0-1c, 4e, 4f, 9b

Generate interest in the learning outcome by having students predict the potential consequences of climate change (especially due to global warming perceptions). Since the science of climate change is in a state of flux, be cautious about the extremism on both sides of the debate (e.g., both global warming and cooling should be discussed in relation to a higher CO_2 future for the atmosphere). This situation is advantageous in that it highlights important considerations about the nature of scientific debate. A Rotational Cooperative Graffiti structure could be used (see *SYSTH* 3.15).

(continued)

Suggestions for Assessment

Rubrics/Checklists

See Appendix 6 for a variety of rubrics and checklists that can be used for self-, peer-, and teacher-assessment.

Research Report/Presentation S2-0-8c, 8g, 9b, 9d

Students or student groups present research findings with
- written reports
- oral presentations
- posters
- bulletin board displays
- dramatic presentations
- newspaper articles
- multimedia presentations

Journal Writing S2-0-9b

Assess journal entries using a Journal Evaluation form (see *SYSTH* 13.21).

Pencil-and-Paper Tasks

Students
- describe the consequences of thin or absent sea ice for polar bear populations in the Arctic
- predict the effect of hotter and drier summers on agriculture in Manitoba
- discuss the effect of El Niño on the winter sport industry (e.g., ski hills, snowmobile trails, equipment sales)
- explain how an increase in greenhouse gases may affect extreme weather events
- assess the impact of the movement of the Gulf Stream to a more southerly course and its effect on the climate of northern Europe
- suggest reasons why there are more concerns about global warming today than in the past
- discuss potential economic, social, and environmental consequences of both the warming and cooling of Manitoba's climate
- discuss the effect of the 2003 European heat wave on the healthcare systems of affected countries

Suggested Learning Resources

Science 10

16.8 Canada's Fragile North

16.9 Case Study: Monsoons in Bangladesh

16.10 Weather of the Future

16.11 Explore an Issue: The Human Impact on Global Temperatures

ABLM 16.2 A Model of the Greenhouse Effect

ABLM 16.8 Building on Permafrost

ABLM 16.10 Water Levels—Up or Down?

Science Power 10

Investigation 13-C: Weather After Global Warming

16.3 Past, Present, and Future

BLM G-29 Scientific Research Planner

BLM G-30 Research Worksheet

BLM G-31 Internet Research Tips

SYSTH

3.15 Rotational Cooperative Graffiti

11.40 Issue-Based Article Analysis

11.41 Fact-Based Article Analysis

13.21 Journal Evaluation

Appendices

4.36 Ozone—What Is It, and Why Do We Care About It?

4.37 Volcanoes and Global Cooling

6.1 Rubric for the Assessment of Class Presentations

(continued)

Prescribed Learning Outcomes
Students will...
(continued) **S2-4-08** Discuss potential consequences of climate change. *Examples: changes in ocean temperature may affect aquatic populations, higher frequency of severe weather events influencing social and economic activities, scientific debate over nature and degree of change…* GLO: A1, A2, C5, C8

Suggestions for Instruction
(3-1/2 hours)

Student Research S2-0-1d, 2b, 3d, 6d

Students or student groups research the potential consequences of climate change. Topics may include

- melting of permafrost in northern Manitoba
- decreased rainfall and hotter summers in southwestern Manitoba
- thin or absent sea ice in Hudson Bay and its effect on polar bear populations
- increased number of thunderstorms and tornadoes in southern Manitoba
- increased snowfall in the western Arctic
- movement of the Gulf Stream to a more southerly course
- flooding of low-lying coastal plains (e.g., Florida, Bangladesh, the Netherlands)

Case studies, newspaper articles, and Internet sources may be used.

Journal Writing S2-0-2d, 8c

Students complete a fact- or issue-based article analysis of a current newspaper or magazine article related to the potential consequences of climate change (see *SYSTH* 11.40, 11.41).

Collaborative Teamwork S2-0-9d, 9e, 9f

Students list the activities they do and the resources they use that produce CO_2. They then reflect on the question “How could I change my lifestyle to help reverse the increasing production of CO_2?”

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

6.2 Rubric for the Assessment of a Research Project

6.3 Rubric for the Assessment of a Decision-Making Process Activity

Teacher Background

Climate Change Websites:

Climate Change in Canada—Climate Change in the Prairie Provinces: <http://www.adaptation.nrcan.gc.ca/posters/reg_en.asp?Region=pr>

Climatology Links: <http://www.uwinnipeg.ca/~blair/climlink.htm>

Apple Learning Interchange-Global Warming Activities: <http://ali.apple.com/ali/uops_display.php?findunit=51>

Atmospheric Greenhouse Gases: <http://vathena.arc.nasa.gov/curric/land/global/greenhou.html>

Canadian Climate and Water Information—Links and Downloads (Meteorological Service of Canada—The Green Lane): <http://www.msc-smc.ec.gc.ca/climate/links/climate_outlook_e.cfm>

Canadian Climate and Water Information: <http://www.msc-smc.ec.gc.ca/climate/index_e.cfm>

Climate Change Connection—Manitoba: <http://www.web.ca/~climate/>

Climate Change in Canada—Futures Wheel Teacher's Guide: <http://www.adaptation.nrcan.gc.ca/posters/teachers/wheel_e.asp>

Climate Change in Canada—Home Page: <http://adaptation.nrcan.gc.ca/posters/wel_en.asp?Language=en>

Climate Change in Canada—Le changement climatique au Canada: <http://www.adaptation.nrcan.gc.ca/posters/>

Climate Change in Canada Poster—Le changement climatique au Canada: <http://www.adaptation.nrcan.gc.ca/posters/>

Climate Timeline Tool: <http://www.ngdc.noaa.gov/paleo/ctl/>

Climate Trends and Variations Bulletin for Canada—Climate Trends and Variations Bulletin (Meteorological Service of Canada): <http://www.msc-smc.ec.gc.ca/ccrm/bulletin/annual98/page2_e.html>

CPC Products—Stratosphere SBUV-2 Total Ozone: <http://www.cpc.noaa.gov/products/stratosphere/sbuv2to/>

Encyclopedia of the Atmospheric Environment: <http://www.doc.mmu.ac.uk/aric/eae/english.html>

Global Climate Change Student Guide: <http://www.docm.mmu.ac.uk/aric/gccsg/>

Ice Core Research Global Warming and Cooling Studying the Ice Sheet: <http://www.secretsoftheice.org/icecore/studies.html>

Large-Scale Climate Change Linked to Simultaneous Population Fluctuations in Arctic Mammals: <http://earthobservatory.nasa.gov/Newsroom/MediaAlerts/2002/2002111410899.html>

Manitoba Climate Change Task Force—Home: <http://www.iisd.org/taskforce/>

Manitoba Conservation, Climate Change Branch Home Page: <http://www.gov.mb.ca/conservation/climatechange/>

NASA Goddard Institute Datasets and Images: <http://www.giss.nasa.gov/data/>

New Evidence that El Niño Influences Global Climate Conditions on a 2,000-Year Cycle—November: <http://earthobservatory.nasa.gov/Newsroom/MediaAlerts/2002/2002111410898.html>

New Scientist Environment Report Climate Change: <http://www.newscientist.com/hottopics/climate/>

NOAA Paleoclimatology Global Warming—The Story: <http://www.ngdc.noaa.gov/paleo/globalwarming/what.html>

NOAA Paleoclimatology Program—Vostok Ice Core: <http://www.ngdc.noaa.gov/paleo/icecore/antarctica/vostok/vostok.html>

NOVA Online Warnings from the Ice Stories in the Ice: <http://www.pbs.org/wgbh/nova/warnings/stories/nojs.html>

Pacific Ocean Temperature Changes Point to Natural Climate Variability—November 13, 2002: <http://earthobservatory.nasa.gov/Newsroom/MediaAlerts/2002/2002111310900.html>

Past Climate From Antarctic Ice Cores: <http://www.agu.org/sci_soc/vostok.html>

Science of Ozone: <http://www.sprl.umich.edu/GCL/Notes-1999-Fall/Ozone.pdf>

Skywatchers Environment Canada: <http://weatheroffice.ec.gc.ca/skywatchers/national/information_e.html>

The Methane Budget (May 1992): <http://www.globalchange.org/gccd/gcc-digest/1992/d92may13.htm>

Twin Ice Cores From Greenland Reveal History of Climate Change, More U.S. Tornadoes 1953-2001: <http://www.agu.org/sci_soc/eismayewski.html#stadial/interstadial%20oscillations>

The Snowball Earth Hypothesis—Earth Freezes Over from Pole to Pole in the Past: <http://www-eps.harvard.edu/people/faculty/hoffman/snowball_paper.html>

<http://www-eps.harvard.edu/people/faculty/hoffman/TerraNova.PDF>