

Overview

As humans witness the increased melting of ice in the arctic, the natural questions that arise are: so what? And, how will this impact the rest of the globe? In this scientific article, researchers use a climate model to predict the corresponding weather changes around the world. In particular, scientists examined the changes in the number of wet, dry, warm,

and cold days different regions of the world would likely see. In this lesson, students will learn the scientific background behind Arctic sea ice, its role in the environment and climate regulation, and have discussions centered around the future impacts the study predicts.

Key Concepts

- ♦ **The differences between weather and climate, in the short and long run.**
- ♦ **The loss of sea ice leads to increased absorption of solar radiation, a form of energy from the sun, by the ocean. This is known as the albedo effect.**
- ♦ **Increased absorption of energy by the oceans will warm them, causing knock-on effects on the climate in other parts of the world.**
- ♦ **Sea ice in the arctic melting does not contribute to sea-level rise, while the melting of land-based ice sheets in Greenland and the Antarctic would increase sea level.**
- ♦ **Scientific research methods discussed:**
 - Scientific models, including input and output variables.
 - Statistical analysis, error, and probability
 - Positive/negative feedback loops

Key Terms

Climate change, extreme weather, Arctic ice, sea ice, feedback loop, scientific model, albedo effect, energy, absorption, heat capacity, IPCC

Learning Objectives:

By the end of this lesson, students will be able to...

- Describe the feedback loops in weather, climate, and ecosystems created by melting arctic ice.
- Summarize the methods used by scientists to test predictions in a scientific model.
- Analyze the results produced by the scientists' model and draw conclusions about how weather in different areas of the world will change.

Extension for higher-level thinking:

- Research, develop and debate policy plans to mitigate the consequences of arctic ice melting

Curriculum Connections

| Curriculum | Section |
|--|---|
| College Board AP Environmental Science Topics | I. Earth Systems and Resources A. Earth Science Concepts B. Atmosphere VII. Global Change B. Global Warming |
| International Baccalaureate (IB) Environmental Systems and Societies | Topic 1: Systems and models Topic 6: The issue of global warming |
| Next Generation Science Standards (NGSS) | Earth Systems, Human Impact, Ecological Change HS-ESS2-2, HS-ESS2-4, HS-ESS3-1, HS-ESS3-5 |
| Common Core Literacy for Science and Technical Subjects | Grades 9-12 Standard #1, #4, #8 (Scientific Literacy) |
| Texas Essential Knowledge and Skills (TEKS) Environmental Systems | 6B, 9L, 14A |

Textbook Correlations:

| Text & Author | Chapter |
|--|--|
| Living in the Environment by Miller and Spoolman (18th ed) | Chapter 7 - Climate and Biodiversity Chapter 19 - Climate Disruption |
| Environmental Science for AP by Friedland and Reylea (2nd ed) | Chapter 4: Global climate and biomes Chapter 19 - Global change |
| Environment: the Science Behind the Stories by Withgott & Brennan (4th ed) | Chapter 6: Environmental Ethics and Economics Chapter 18: Global Climate Change |

Prior knowledge

Ecosystems and food webs
Ocean currents and impact on climate
Basic understanding of energy and radiation

Reading level

6 - 10th grade (Flesch-Kincaid Readability Index: 63.5)

Time requirements

Minimum one 45-min class period
Possible extensions for up to 10 class periods

Teacher materials/preparation

Internet connectivity
Capability to project audio/video to the class
Access to PowerPoint or OpenOffice

Students materials

Each student/each group of students will need:
Science article "The Arctic is melting - so what?"
Graphic organizer handout
Computer access with internet connectivity

Lesson

BELLRINGER/WARM-UP

(~3 minutes)

Have students complete the attached "Know, Want to Know, Learned" (KWL) chart on arctic ice. This serves to activate student thinking about sea ice, melting, and climate change. Students may have difficulty articulating what they want to know, depending on their level of exposure. As you circulate for the first several minutes of class, provoke questions based on what they have written down under the "Know" column. At this point, they should leave the "Learned" column empty until after the lesson.

INTRODUCTION

(~5 minutes)

Have students complete the attached "Know, Want to Know, Learned" (KWL) chart on arctic ice. This serves to activate student thinking about sea ice, melting, and climate change. Students may have difficulty articulating what they want to know, depending on their level of exposure. As you circulate for the first several minutes of class, provoke questions based on what they have written down under the "Know" column. At this point, they should leave the "Learned" column empty until after the lesson.

READ THE ADAPTED PAPER

(~25 minutes)

Have students work through the science article independently. This can be scaffolded by asking them to complete the accompanying graphic organizer, highlight key terms they recognize, or by stopping after each section (Introduction, Methods, Results, Conclusion) to summarize the information presented depending on how familiar students are with scientific texts.

POST-ASSESSMENT

(~10 minutes)

Have students complete the "What I Learned" column on their KWL chart from the beginning of the lesson. This can be open ended, or you can prompt them by putting specific discussion questions on the board (see "Discussion Questions" on page 4 of the article).

Math Extension (2 Class Periods to Complete and Discuss)

Students can dig further into the albedo effect and the idea of conservation of energy in the Earth system using this activity from the University of Colorado

Student Activity:

[http://cires.colorado.edu/outreach/sites/default/files/curriculum/Student%20Worksheet%20\(Activity%203\)_0.pdf](http://cires.colorado.edu/outreach/sites/default/files/curriculum/Student%20Worksheet%20(Activity%203)_0.pdf)

Teacher's Guide & Answer Key:

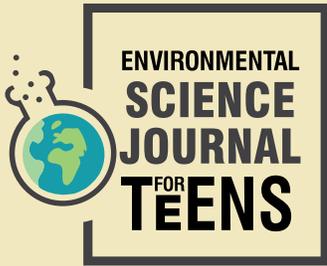
http://cires.colorado.edu/outreach/sites/default/files/curriculum/ACC_website.pdf

Data and Modeling Extension (1 Class Period)

The students can use the article to record data and manipulate the model themselves. They will be asked to use the data to draw conclusions, as well as identify what additional data could be collected to further the study.

Student Activity and Teacher's Guide & Answer Key:

<http://datanuggets.org/2016/06/the-arctic-is-melting-so-what/>



Laws Review Section (1 Class Period)

Have student groups review or research the follow international climate agreements and laws and prepare a summary of how they address (or don't address) the melting Arctic adequately.

Kyoto Agreement
Paris Agreement

Antarctic Treaty System
Montreal Protoco

Policy Extension (3 - 4 Class Periods)

Activity 4 from this worksheet prepared by the Canadian Museum of Nature will ask students to read provided background information on either the Oil & Gas Industry, Inuits, or Conservation Groups and to draft policy position papers on on-going human activity that has been the subject of international law disputes and contributions to arctic melting.

Student Activity and Teacher's Guide & Answer Key:

http://www.nature.ca/education/pdf/lpdsisw_e.pdf

Critical Thinking Extension (1 Class Period)

Discussion about credibility of sources of information

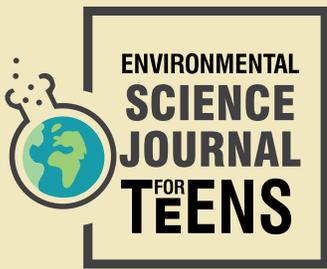
Have students Google search "Climate Change" and choose an article or website to read on climate change. Feel free to encourage them to dig deeper into pages 2 or 3 of the search results. Just be sure that everyone in each group has a different article. Provide a source credibility evaluation rubric, such as the one found here

<https://www.mchenry.edu/library/tutorial/PDF/EvaluatingSourcesRubric.pdf>

for them to score their source. Use this to begin a conversation about the credibility of sources, motives behind sources, and how to find credible information on current scientific events.

Writing Extension

- 1** Ask students to write their own version of the abstract. Explain that an abstract is a brief summary of the entire paper. To write a good abstract, they should summarize each section in one or two sentences and connect them in a cohesive paragraph.
- 2** According to the climate model experiments, what types of extreme (cold, warm, wet, dry) are expected where you live? Think of one way that this change(s) would be a good thing and one way it would be a bad thing.
- 3** The melting of Arctic sea ice is bad news for polar bears and Santa! What about any other ways the loss of ice may affect human and animals in the Arctic, for good or bad? Explain your opinion. (Hint: think about shipping routes or industries such as mining and oil extraction.)
- 4** The planet is getting warmer - and sea ice is melting - because of human activities. What can you and your family and friends do to reduce their greenhouse gases emissions. Use evidence from the article and try to think of 3 additional things not mentioned in the articles.
- 5** Temperature and precipitation extremes can have devastating impacts on people's lives. Explain one way your life, or that of someone you know, has been affected by extreme weather.



Labs/Hands-On Extensions

Mapping Activity

The Arctic Ocean is made up of different seas. Have students use an online map to locate and to name 3 of them. Use evidence from the article to understand whether these areas were covered by sea ice in March 2000 and September 2000. What about in March 2100 and September 2100, according to the model?

Sea-Ice vs. Land-Ice Demonstration

At the start of class, place a glass filled to the rim with water with ice cubes floating in it. Ask the students if they think that as the ice melts, the water level will rise and the glass will overflow. Revisit at the end of class. This simulates sea-ice melting, which is already contributing to sea-level even as ice. Ask what will happen to the water level, if you add more ice from outside of the cup. This simulates the melting of land-based ice masses, which are not currently accounted for in the present sea level.

FRQ Extension

2010 AP Environmental Science Exam Free Response Question 4 (Sea Level)
2007 AP Environmental Science Exam Question 4 (Albedo Effect and Reflectivity)

Animation

Interactive animation on sea ice formation:

<https://nature.ca/en/teacher-zone/teacher-resources/animations-videos/sea-ice-formation>

Online Games Extension

Go to Kahoot! Games for brief pre-assessment and post assessment quizzes:

Prior to reading:

<https://play.kahoot.it/#/k/8ce89b37-ce70-4c12-9aea-788ebc850f02>

After reading:

<https://play.kahoot.it/#/k/1a6e339f-68fa-461a-a977-281acac7754e>

About The Author

Nick Messenger is the science curriculum lead and teaches at Canton Preparatory High School in Canton, Michigan. He has worked to develop data driven, hands on lessons in environmental science, physics, and chemistry to engage students and relate learning to the real world. He spends his summers working for a local organic farm focused on sustainable agriculture.