

## Teachers' Guidelines

### Title of the package: Sea ice in the Arctic

#### Information about the package:

**Brief Description:** The warming trend in the Arctic is at least twice as large as the global average in recent decades. The loss of sea ice amplifies the warming trend because the ocean surface absorbs more sun heat than the surface of snow and ice. How does that affect the planet?

**How does the package relate to STEAM education:** Students learn about differences between sea ice and icebergs. Next, they learn about albedo and the melting sea ice positive feedback loop and the likely results of reduced snow and ice cover on global temperatures. The package contains multidisciplinary concepts, like albedo (useful for Physics, Geography), feedback loops (useful for Biology, Chemistry and Geography) and demonstrates how some factors are affecting other factors in the environment and how they are inter-connected. The main emphasis is put on Science.

**Keywords:** sea ice, icebergs, albedo, positive feedback loop, Arctic amplification.

**Age Range:** 14-18

**Didactical Hours:** 2 hours.

#### Learning objectives:

The student will:

- know what sea ice is and how it forms;
- understand the difference between sea ice and icebergs;
- know how climate change affects sea ice extent;
- know what is albedo and how it changes in case sea ice melts more than usually;
- understand that increase of sea ice melting accelerates the process and that is a positive feedback loop;
- understand why sea ice is important for the climate of whole planet;
- understand how reduced snow and ice cover in the Arctic may affect global temperatures.

#### Content of the package and guidelines for teachers:

Link to the package: <https://graasp.eu/spaces/61a0f0e837367e95afe8e80b>

We encourage teachers to copy the graasp package to their own graasp space in order to become "owner" and be able to modify the content, hide or unhide some materials, add quizzes etc. Moreover, teachers may share the package with their students and check the progress of each student.

A short video tutorial on how to do it is available at:

<https://view.genial.ly/5f7ef81f1b2b330d2efa3411/video-presentation-tutorial-graasp>

If you don't have access to the graasp package, contact us: [edukacja@igf.edu.pl](mailto:edukacja@igf.edu.pl)

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EDU-ARCTIC 2: from polar research to scientific passion – innovative nature education in Poland and Norway receives a grant of ca. 240 000 EUR received from Iceland, Liechtenstein and Norway under EEA funds. The purpose of the EDU-ARCTIC 2 project is to: enhance the knowledge about nature, geography, natural resources, political specificities concerning polar regions and increase awareness of environmental issues and climate change, increase of interest in pursuing STEM education and careers due to enhancement of knowledge about scientific research, and their place in the modern world, familiarizing young people with scientific career opportunities; introduce innovative tools by way of an e-learning portal and effective methods of teaching science in schools.

The package consists of 6 sections described in detail below:

### 1. Let's start!

In this section students will find out, what sea ice is and why it is so important. They will learn, how scientists monitor the Arctic sea ice and if Antarctic sea ice is equally important.

#### Suggested resources:

- Sea ice ppt presentation (slides 1-6)
- Video on YouTube: <https://youtu.be/9BDbEZdB7PU>
- NASA video on YouTube: <https://youtu.be/YIFvpdewY10>
- Worksheet for students – task 1.
- Section “Let's start!” on graasp.eu platform

**Estimated time: 15 minutes**

### 2. Icebergs

Sea ice is frozen sea or ocean water. In contrast, icebergs float in the ocean but originate on land. In this section students will find out more about icebergs - their shapes and sizes, how they form and how long they live.

First, they watch animation about the differences between sea ice and icebergs. They learn how icebergs form and what shapes and sizes they may have. Next, they may play with drawing their own icebergs and see how they float. They may try to draw such shapes, which are most dangerous for ships (underwater parts extends widely behind the visible parts).

#### Suggested resources:

- Sea ice ppt presentation (slides 7-10)
- Animation “Sea ice vs. icebergs” on YouTube: <https://youtu.be/2neNRBnYq3w>
- Application for drawing icebergs: <https://joshdata.me/iceberger.html>
- Worksheet for students – task 2.
- Section “Icebergs” on graasp.eu platform

**Estimated time: 15 minutes**

### 3. Sea ice

In this section students will learn, how sea ice forms and if it is salty. They will learn about MOSAIC expedition on the vessel, which freezes into sea ice to be carried around by ice. They will learn about multiyear ice and how ice is carried around the Arctic with ocean currents. Next, they will focus on loss of sea ice, especially the multiyear ice. Finally, they will watch the visualisation of the ice age and how it changed from 1984 to 2016. Additionally, they may follow the transcript and fill in the blanks. It may be necessary to watch the video twice.

#### Suggested resources:

- Sea ice ppt presentation (slides 11-15)
- video about MOSAIC expedition on YouTube: [https://youtu.be/bDUp3Eno\\_Uw](https://youtu.be/bDUp3Eno_Uw)

- video about ice age on YouTube: <https://youtu.be/hlVXOC6a3ME>
- transcript for the video: <https://svs.gsfc.nasa.gov/vis/a000000/a004600/a004616/narration.txt>
- Section “Sea ice” on graasp.eu platform

**Estimated time: 15 minutes**

#### 4. Disappearing ice

Students will learn that sea ice extent changes over seasons, but also over years due to climate change. First, they watch animation about changes in the sea ice extent in the period 1984-2018. The sea ice extent differs over seasons. It varies from ca. 6.3 to 15.5 million km<sup>2</sup> on average. Ask students, when they expect the lowest sea ice extent and why. Quite probably they will answer that the lowest sea ice extent occurs in July, as July is the warmest month in the Arctic. You may show them the climate graph of Longyearbyen – the capital of Svalbard Archipelago. The sea ice minimum occurs at the end of the summer melting season, when the average daily air temperature falls below 0°C.

Next, students may play with the interactive sea ice chart. They may check the sea ice extent in various years, starting from 1979, where satellite observations of the sea ice started. They may choose the year by simply clicking on it in the right menu. Their task is to check the minimum sea ice extent for September, 16, 2012 (the record minimum) and compare it to 1981-2010 median. Then, they compare the difference to area of their country.

**Suggested resources:**

- Sea ice ppt presentation (slides 16-21)
- video on YouTube: <https://youtu.be/dlQI64EudeA>
- Interactive sea ice graph: <https://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/>
- Worksheet for students – tasks 3 and 4.
- Section “Disappearing ice” on graasp.eu platform

**Estimated time: 20 minutes**

#### 5. Arctic amplification

In this section students will learn about albedo, positive feedback loop and Arctic amplification. Ask your students, what they think will happen if ice in the Arctic melts more than usually in terms of the albedo effect? How it may affect the rate of melting ice? Does it accelerate or slow down the process?

Albedo represents percentage of reflected sun radiation in relation to the various surfaces of the Earth. It may range from 0 to 1. Surfaces with very low albedo: asphalt, open ocean; surfaces with high albedo: ocean ice and fresh snow. Ask students to think, how melting of sea ice affects the albedo and how it affects the rate of melting. They fill in the gaps in the task 5.

Finally, they watch a lesson by William Chapman, who explains positive and negative feedback loops occurring in the Arctic due to more intense sea ice melting.

**Suggested resources:**

- Sea ice ppt presentation (slides 22-27)
- Animation “Why the Arctic is a canary in the coal mine”: <https://youtu.be/lrEM3LHvjI0>
- Worksheet for students – task 5.
- Section “Arctic amplification” on graasp.eu platform

**Estimated time: 15 minutes****6. Check yourself**

Students will solve two tasks. The first task is to indicate the differences between sea ice and icebergs (where they form, their shapes, salty or fresh water, melting and ships).

Second task is to do the quiz with 5 questions (true-false, multiple choice and definition) dedicated to albedo and Arctic amplification.

**Suggested resources:**

- Sea ice ppt presentation (slides 28-31)
- Worksheet for students – tasks 6 and 7.
- Section “Check yourself” on graasp.eu platform

**Estimated time: 10 minutes**

Answer key:

### Task 1.

Sea ice is frozen sea or ocean water. It forms in the ocean and may grow or melt over seasons and years.

### Task 2.

Icebergs are dangerous for ships, because their underwater part is huge in comparison to the part above the sea level and may not be visible for navigators. Icebreakers easily break sea ice, but icebergs are usually thicker and may destroy ships.

### Task 3

The sea ice minimum occurs in mid September – this is the end of the summer melting season, when the average daily air temperature falls below 0°C.

### Task 5.

negative decreases smaller slows down less

Ice has **higher** albedo than water. It means that ice reflects **more** sun radiation than water.

When sea ice melts more than usually, there is more open water and **more** sun radiation is absorbed. The temperature of the ocean **increases**. It **accelerates** melting of ice.

Therefore, we call it a **positive** feedback loop.

### Task 6.

Sea ice	Iceberg
It forms on the sea surface.	It forms on land and reaches the sea as a result of the calving of glaciers.
It is usually flat.	It has various shapes and sizes.
It forms from salty ocean water.	It forms from snow.
It may survive many years.	It usually melts within summer.
It may carry ships around.	It is dangerous for ships.

## Task 7

1. Water has much higher albedo than ice, therefore it warms up quickly.



True

False



You are right. Ice has higher albedo than water and reflects more sun radiation.

2. Indicate surface with the highest albedo



open ocean

ice

ice with snow

3. Positive feedback loop



amplifies changes

slows down changes

4. When sea ice melts faster than usually, there is more open water, which has



lower albedo and absorbs more sun radiation

lower albedo and reflects more sun radiation

higher albedo and absorbs more sun radiation

higher albedo and reflects more sun radiation

5. Arctic amplification means that...

temperature rise in polar regions is large in comparison to the temperature rise in lower latitudes, and may further accelerate climate warming well beyond the Arctic.