A Century of Glacier Change

From the Center for Science Education

<https://scied.ucar.edu/activity/century-glacier-change>

Grade Level: Middle and High School

Time: Preparation 15 minutes, activity 25 minutes, and discussion 25 minutes

Students compare photographs of glaciers to observe how Alaskan glaciers have changed over the 20th century.

## Learning Objectives

* Students will understand how alpine glaciers changed over the 20th century.
* Students will understand possible reasons for glacier retreat over long and short periods of time.
* Students will consider the possible impacts of global glacier retreat.

## Materials

* For each group of 2-4 students: An envelope containing the 16 glacier photos printed from the [A Century of Glacier Change - Image Pairs](https://scied.ucar.edu/sites/default/files/documents/A-Century-of-Glacier-Change_image-pairs.pdf)

## Preparation

1. Print enough copies of [A Century of Glacier Change - Image Pairs](https://scied.ucar.edu/sites/default/files/documents/A-Century-of-Glacier-Change_image-pairs.pdf) (pdf) to have one for each student group.
2. Cut each sheet of paper in half to separate the glacier photos.
3. Optional: Laminate all photos to make the sets more durable for repeated use.
4. Note: Do not share the first page with students until they have matched the pairs of photographs.

## Directions

1. Explain what glaciers are, how glaciers grow and retreat, and the two types of glaciers: continental and valley (or alpine) glaciers. Discuss the climate conditions that are necessary for a glacier to grow (snowy winters and cool summers). Discuss the climate conditions that are necessary for a glacier to shrink (warmer).
2. Introduce students to the photographs.
   1. These photos were taken in locations with valley (or alpine) glaciers in Alaska.
   2. Explain that each photo has a year in the lower left corner indicating when it was taken.
   3. There are two photos taken at each location. Students’ goal is to match photos from the same location.
   4. Typically one was taken near the start of the 20th century and the other was taken near the end of the 20th century. (You may need to remind students that the 20th century includes the years 1900 to 1999 and that color photography didn’t become common until later in the century.)
3. In groups of three or four, have students try to match the glacier images from the past and present. Give them approximately 10 minutes to accomplish the task. (Note: Do not share the key with students until they have matched pairs.)
4. Give students 5 minutes to compare their matches to those made by the other groups.
5. Discuss the images and reveal the correct matches.
6. Have students take notes about what is similar and different about pair of images.
7. Discuss as a class how the older photos were similar and different to the ones from the end of the century, and hypothesize about the reason for change in glaciers.
   1. What stayed the same? What changed? (the rocks stay the same, the ice changes and often the plants in the photos change too)
   2. Do all the glaciers in this sample follow the same pattern? Are they growing, retreating, or staying the same? (all glaciers in these photos are retreating)
   3. What climate conditions encourage glacier growth and glacier retreat? (growth due to cold climate and lots of snowfall, which adds to the glacier; retreat due to warmer climate and less snow)
   4. What might account for glacier retreat today? (climate change, warming)
   5. As glaciers get smaller, how might this affect the Earth? How might it affect humans? (melting ice causes sea level to rise, which affects coastal communities; people who live near glaciers often rely on the meltwater as a source of drinking water, so when the glaciers retreat, this becomes a less reliable water source)
   6. Given that the glaciers in this activity shrunk over the 20th century, what do you think has happened to the remaining glacial ice in the years since the latter photos were taken? (continued retreat)

## Background

Glaciers are either one of two types: a continental glacier, also called an ice sheet, such as those that occur on Antarctica, or an alpine or valley glacier found in mountain valleys. The photographs in this activity are all alpine glaciers from Alaska, US. Alpine glaciers occur all over the world, yet require specific climate conditions to survive. This usually includes a location that has high snowfall in the winter and cool temperatures in the summer to prevent snow from melting.

If a glacier is to form in a given location, snow must accumulate over time, turn to ice, and begin to flow under the pressure caused by its own weight and gravity. As more and more snow accumulates over years, decades, centuries, and longer periods of time, the glacier continues to move. In areas with little snowfall or low slope conditions, the glacier will flow downward and outward very slowly. If the ice is on a steep slope, if basal conditions are smooth and soft, and if there is high snowfall, then the glacier will flow faster. Often this rapid motion creates crevasses on the glacier's surface.

Glacier retreat occurs as a result of sublimation (transition of ice to vapor), snow evaporation (evaporation of liquid water in the snow), strong scouring winds, and ice melt. The process of a glacier getting smaller is called ablation. Over the 20th century almost all glaciers worldwide experienced ablation, particularly during the latter decades of the century.  In most cases, there is strong evidence that glacier retreat has been due to our warming climate. This is most evident for alpine glaciers in the Arctic, which is warming quickly compared with other regions, and for alpine glaciers at high elevations in tropical latitudes.