Dynamic Planet
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Students will use process skills to complete tasks related to:

- glaciers,
- glaciation, and
- long-term climate change.
Dynamic Planet – What you can bring

• Four 8.5” x 11” sheets of paper
• Containing information on both sides
• Sheets may be laminated or in sheet protector without annotations affixed
• Two stand-alone non-programmable, non-graphing calculators
This event may be in the form of:

• a Test
• Station Rotations
• a combination of both
What must students do?

Participants will be presented with tasks, many requiring the use of process skills (e.g., observing, classifying, measuring, inferring, predicting, communicating, and using number relationships) from the following topics:
Glacier Formation

• Thus the ice molecule is regular tetrahedron with positive charges in two corners and negative charges in the other two. Each negative corner attracts a positive corner in a neighboring molecule, joining the molecules together by hydrogen bonds. Thus four other molecules surround each molecule in a regular tetrahedral arrangement. The spacing between molecules in ice is 0.276 nm. A substance in which every atom has four neighbors in regular tetrahedral arrangement can crystallize hexagonally or cubically. Molecules or rather, the oxygen atoms are arranged in layers of hexagonal rings. The atoms in rings are not in one plane but in two: alternate atoms are in the upper and lower planes. The spacing between these two planes is much less than the spacing between layers. Adjacent layers are mirror images of each other.
Glacier Formation

Firn?

Wetted snow that has survived one summer without being transformed to ice.

How does it form a glacier?
Glacial mass-balance and flow

Dry Snow Zone
  Peculation Zone
  Wet-Snow Zone
  Superimposed –ice zone
  Ablation Zone
  Accumulation Zone
  Equilibrium Line
  Influence of bed
Glacier/ice sheet types and forms
Glacial features

cirque, tor, U-shaped valley, hanging valleys, aretes, horns, striations & grooves, and Rôche moutonnée

moraines (end/terminal, recessional, lateral, medial, ground), kettles, kames, drumlins, eskers, and erratics
Glacial features
Moulin
Jökulhlaups (an Icelandic word pronounced yo-KOOL-la hp) are glacial outburst floods
Global connections of glaciation: Atmosphere, Oceans, & Lithosphere
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What Happens in the Arctic Doesn’t Stay in the Arctic

- Temperatures are rising
- Sea ice is melting
- Land ice is melting
- Permafrost is thawing
- Arctic ecosystems are changing
- Life is changing for the people of the Arctic
Global connections of glaciation: Atmosphere, Oceans, & Lithosphere

GLOBAL IMPACTS
• Melting land ice causes sea levels to rise
• Arctic changes ripple through the oceans and atmosphere
• Which way does the wind blow?
• Side effects of a large dose of fresh water
• The Arctic’s living resources affect global health and well-being
• Feedback loops accelerate the pace of change
History of ice on Earth:
Greenhouse? Icehouse? Snowball?

- Snowball Earth - 2.4 to 2.1 billion years ago
- Deep freeze - 850 to 630 million years ago
- Mass extinction - 460 to 430 million years ago
- Plants invade the land - 360 to 260 million years ago
- Antarctica freezes over - 14 million years ago
- Latest advance of the ice - 2.58 million years ago
- Our ice age - 110,000 to 12,000 years ago
Ice cores as archives

See

the Greenland Ice Core Records.
Sedimentary sequences produced in glaciers

Foraminiferans are constantly sampling the oceans' oxygen by building it into their CaCO$_3$ shells. When they die and fall to the bottom, they create a record of oceanic oxygen isotopes during their lives.

We can reconstruct the ocean's isotopic history by looking at the ratio of oxygen isotopes present in foraminiferan shells deposited at different times. That ratio, in turn, tells us how much water was locked up as continental ice.
Milankovitch cycles’, climate, & dating

Earth's eccentricity, axial tilt, and precession comprise the three dominant cycles, collectively known as the Milankovitch Cycles for Milutin Milankovitch, the Serbian astronomer and mathematician who is generally credited with calculating their magnitude.

Taken in unison, variations in these three cycles creates alterations in the seasonality of solar radiation reaching the Earth's surface. These times of increased or decreased solar radiation directly influence the Earth's climate system, thus impacting the advance and retreat of Earth's glaciers.
Laurentide Ice Sheet retreat
Modeling rates and size of ice sheet changes
Methods of studying glaciers
Cryospheric change

Rates of observed surface elevation change for Greenland and Antarctica.

Red hues indicate a rising surface and blue hues a falling surface, which typically indicate an increase or loss in ice mass at a site.
See everything on these sites:
NOAA
USGS
National Park Service
There is a glacier in Iceland, Solheimar, which has retreated a great deal, and every time I go back there and see what's not there any more, it does something to the heart. It makes you realise it's possible for a gigantic natural element to just disappear.

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