

Resources for Glaciers:

The National Snow and Ice Data Center has a set of educational web pages giving an excellent overview of Glaciers and other cryosphere phenomena: <https://nsidc.org/cryosphere/>

- How glaciers form and move
- How glaciers erode and deposit sediment and create landforms
- Background and explanation of permafrost and sea ice
- Repeat photograph collection of many glaciers—showing record of modern changes
- Data showing modern changes occurring in glaciers, sea ice, snow, and permafrost

[AntarcticGlaciers.org](http://AntarcticGlaciers.org) is another excellent resource for many aspects of glaciers and climate. Some items are presented in more detail than the NSDIC provide, including

- Glacier mass balance: <http://www.antarcticglaciers.org/modern-glaciers/introduction-glacier-mass-balance/>  
Explanations of both annual mass balance versus cumulative mass balance over time
- Ice Shelves and ice shelf stability: <http://www.antarcticglaciers.org/glaciers-and-climate/shrinking-ice-shelves/ice-shelves/>  
Explains the causes of ice shelf collapse and gives data and records of known ice shelf collapses in Antarctica
- [Glacial Hydrology](#): Surface melt, englacial drainage (moulins, etc.) subglacial lakes, proglacial melt
- [Ice cores and climate analysis](#)—accumulation rate, melt layers, temperature (O-18), greenhouse gases (CO<sub>2</sub>, etc.), dust, and volcanic ash

Glacial landforms (and many other types) on topographic maps. The features are highlighted on these maps: <https://www.csus.edu/indiv/s/slaymaker/archives/geol10l/landforms.htm#Glaciers>

The following two resources are available from Earth Labs. They come with educator resources, background science, and lab-based activities—no better substitute for learning! Resources include photos of sediment cores demonstrating different types of sediment deposits, such as dropstone. Good explanations of why and how O-18 and O-16 amounts vary in the oceans and in glacial ice are available. Milankovitch cycles are described, and records of past glacial cycles are explained (including Pleistocene glacial and interglacial cycles, and Tertiary climate characteristics).

Analysis of glacial sediments:

<https://serc.carleton.edu/eslabs/climatedetectives/index.html>

Climate Cycles, Ice Cores (including O-18/O-16 analysis), Modern glacier and sea ice changes:

<https://serc.carleton.edu/eslabs/cryosphere/index.html>

The National Snow and Ice Data Center (NSIDC) publishes daily analysis of satellite observations of Arctic and Antarctic Sea Ice and of the Greenland Ice Sheet. These satellite records are highly effective at tracking a time series of modern changes in the distribution of ice. Hallmarks of these records include the concepts of: Seasonal patterns between summer and winter, natural interannual variability, and anomalies (difference between short-term values compared to a long-term average).

- Sea Ice Extent: The graph overlays the current daily extent against the mean extent between 1979-2010. The map shows the current extent of the Arctic region covered by sea ice in contrast to the mean extent: <https://nsidc.org/arcticseaicenews/>
- Greenland Ice Sheet Melt: Satellite reflection data detects meltwater on the surface of the ice sheet and is analyzed daily. A) One map shows current melt extent and the second map shows the total number of days with surface melt for the year. B) The graph tracks daily melt extent against the mean melt extent <https://nsidc.org/greenland-today/>