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

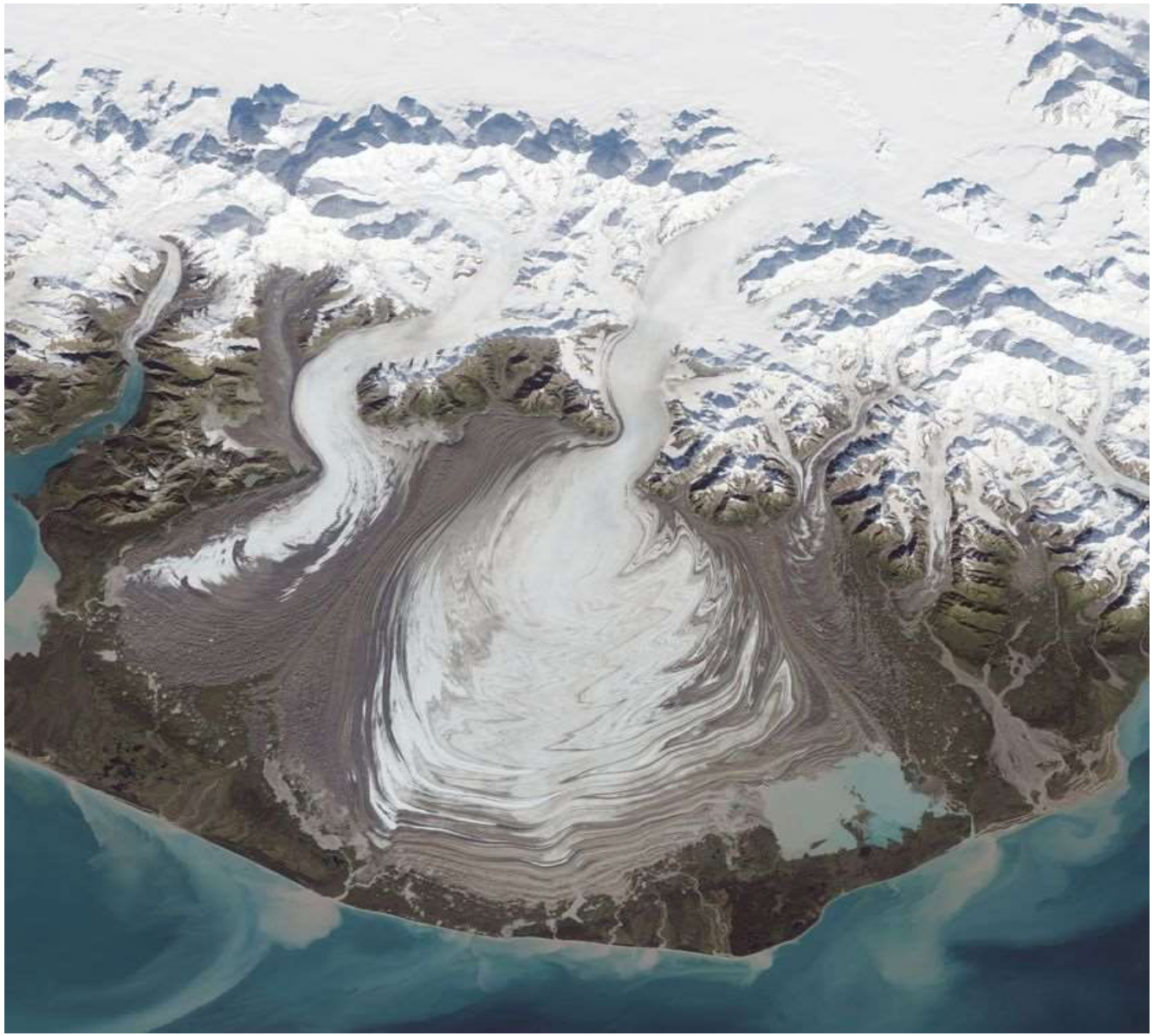
Ablation Zone

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

https://youtu.be/cQ1JahJ7LFI?list=UUS07a1P4LLh4oep941lxTKQ

Moulin

Jökulhlaups (an Icelandic word pronounced yo-KOOL-lahp) 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.

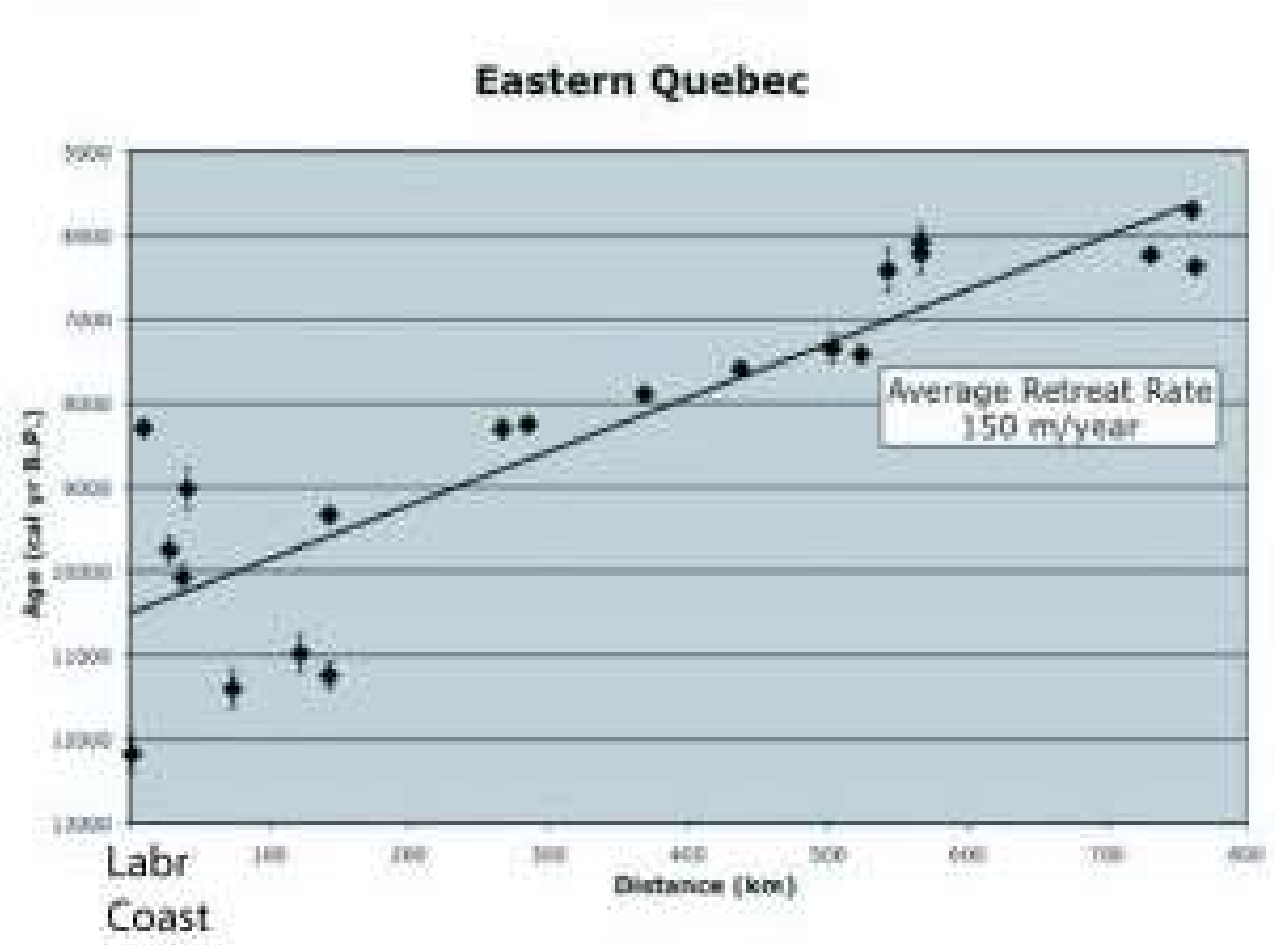
We can reconstruct the ocean's **isotopic history** by looking at the ratio of oxygen isotopes present in foraminiferan shells deposited at different times. **That ratio**, in turn, tells us how much water was locked up as continental ice.

Milankovitch cycles', climate, & dating

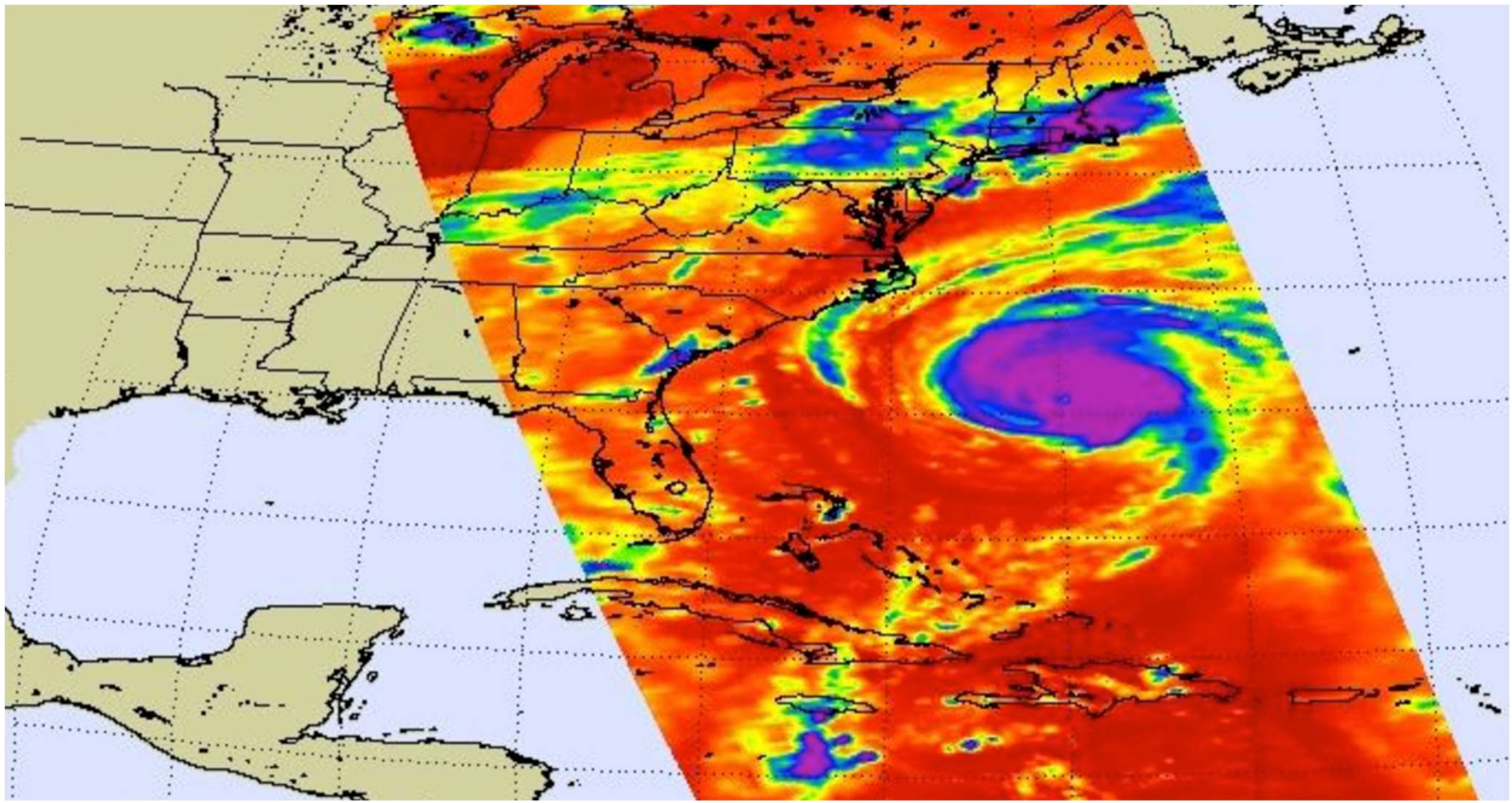
Earth's eccentricity, axial tilt, and precession comprise the three dominant cycles, collectively known as the Milankovitch Cycles for Milutin Milankovitch, the Serbian astronomer and mathematician who is generally credited with calculating their magnitude.

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

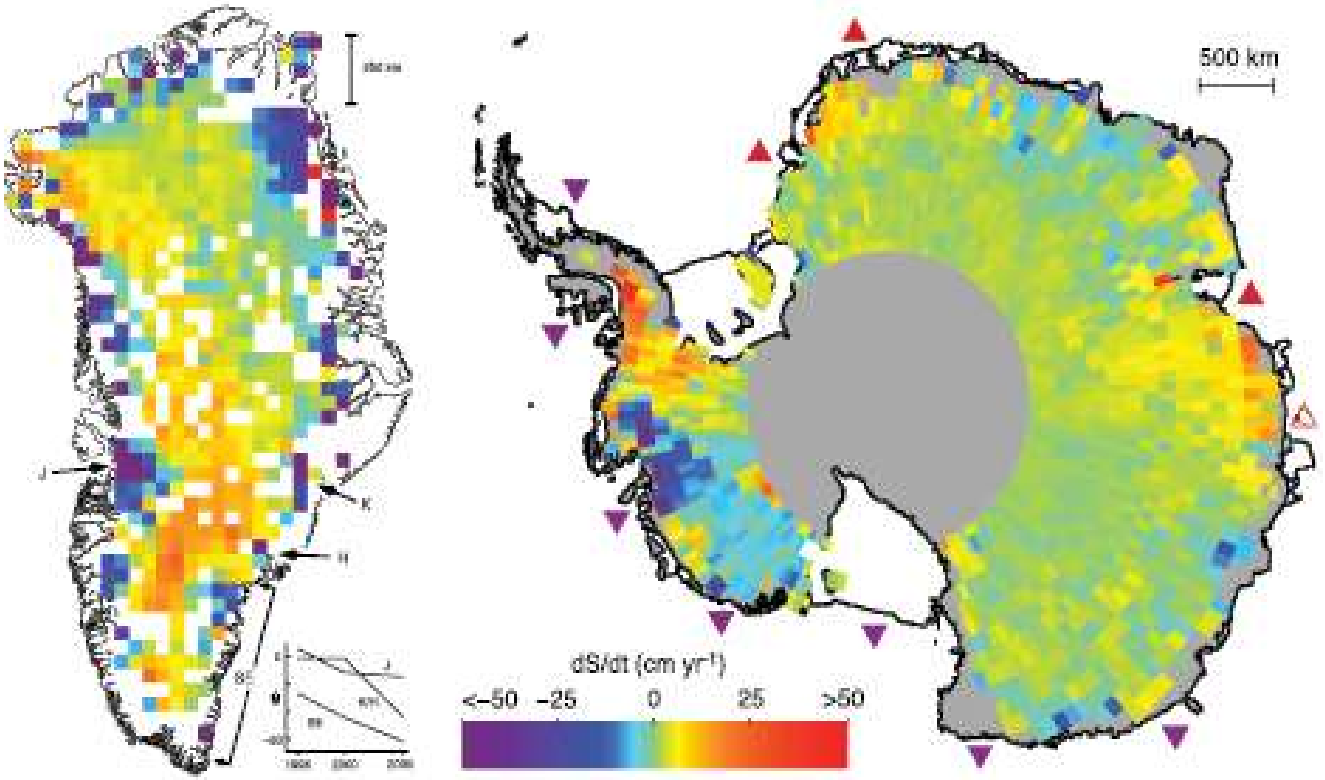


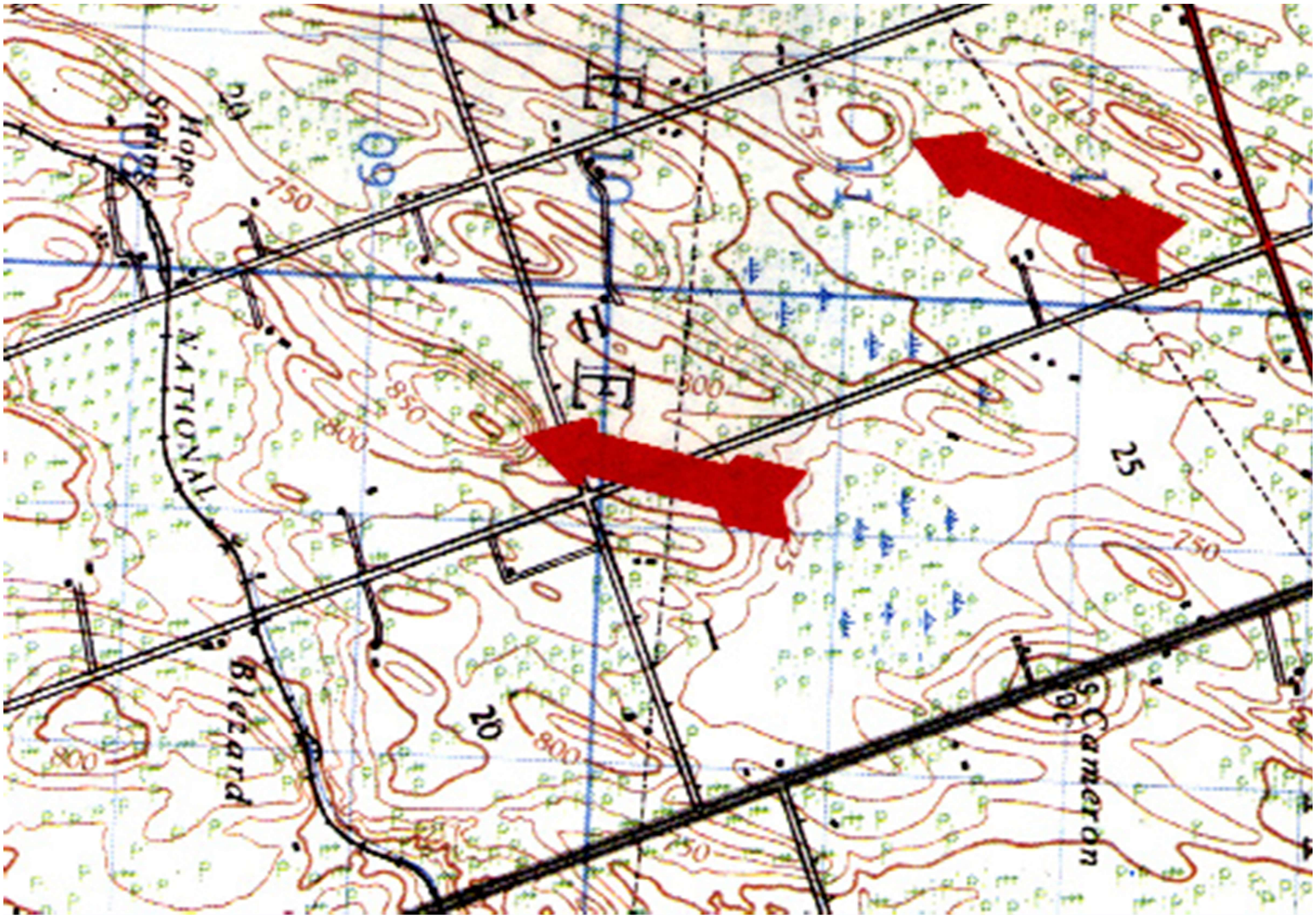
Methods of studying glaciers

Cryospheric change

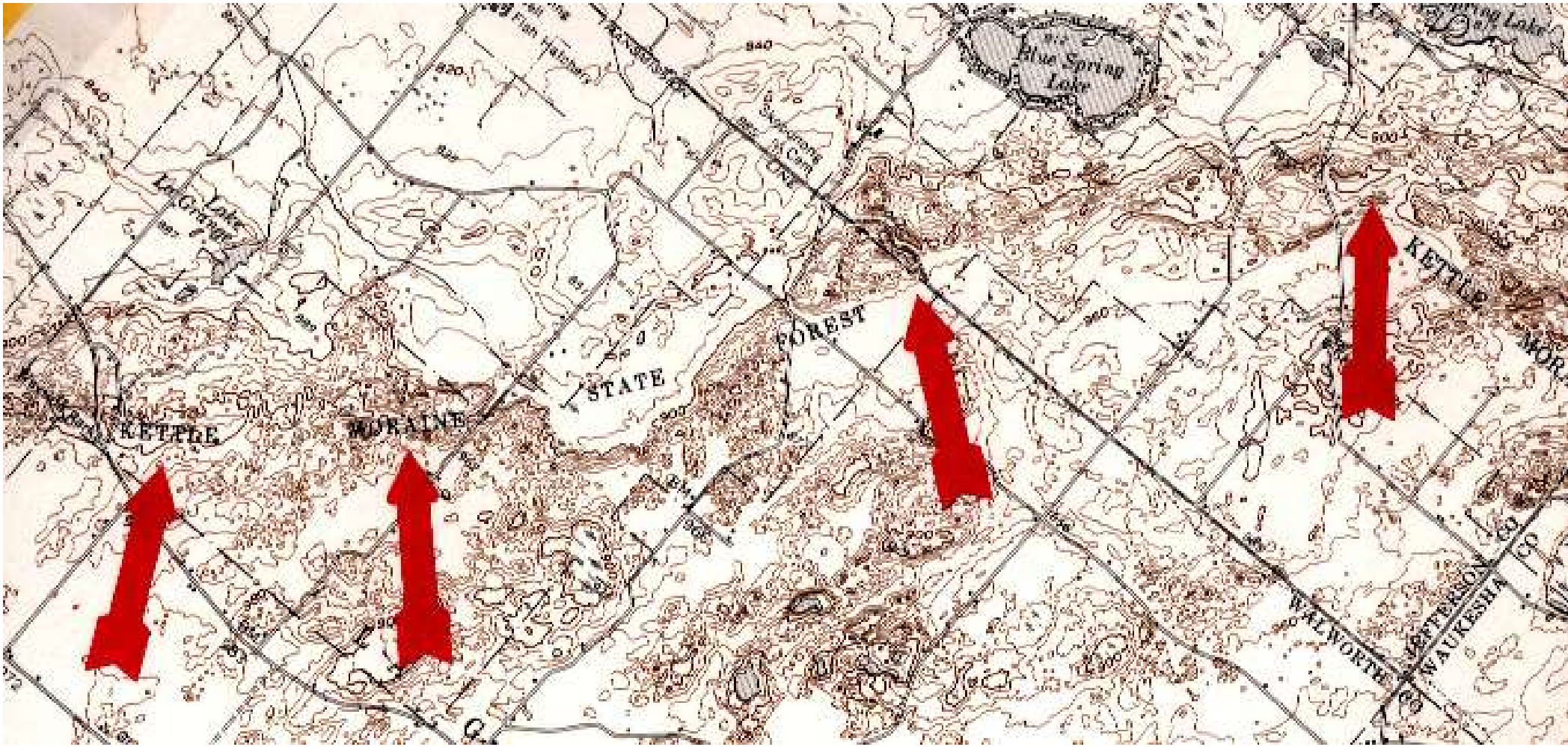
Rates of observed surface elevation change for Greenland and Antarctica.

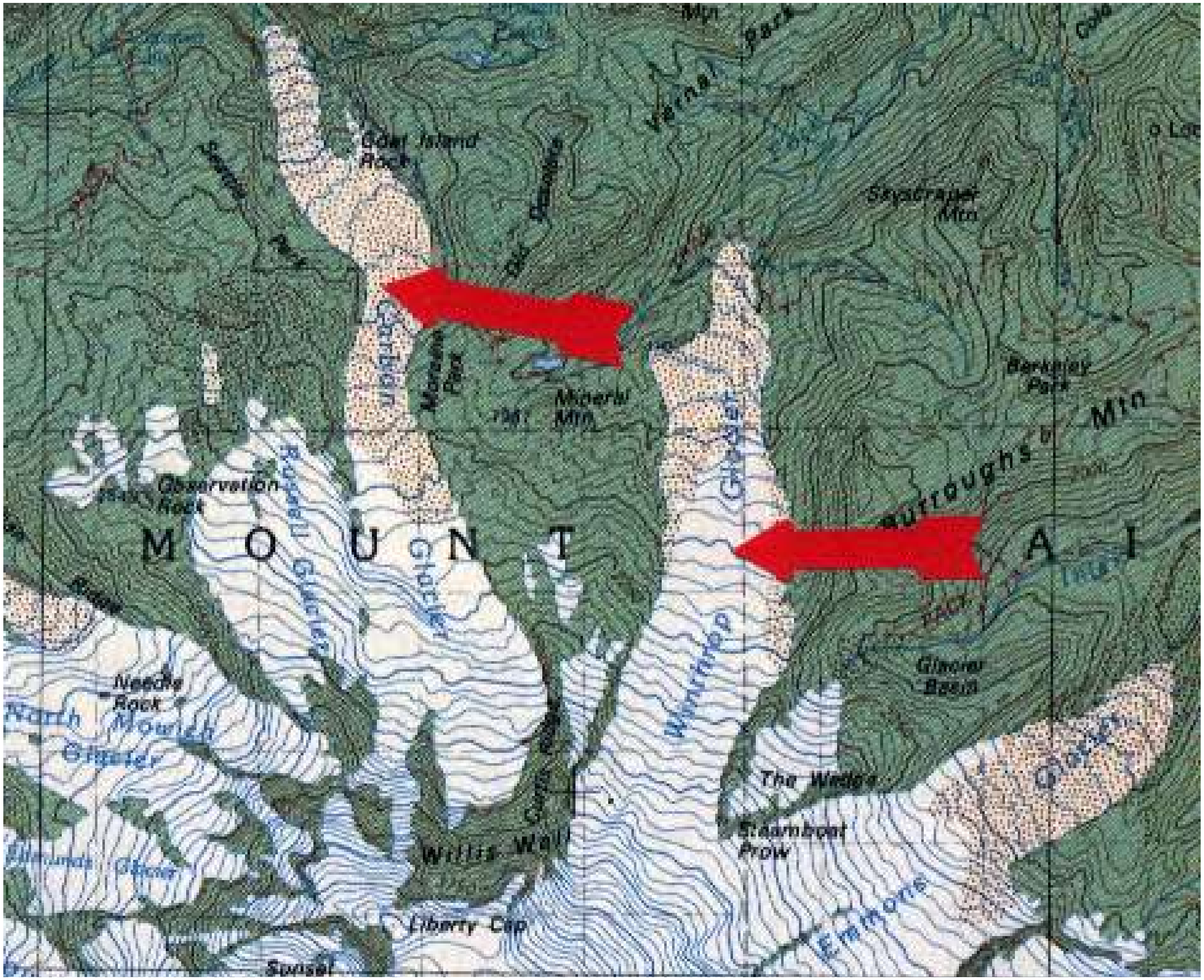
Red hues indicate a rising surface and blue hues a falling surface, which typically indicate an increase or loss in ice mass at a site.

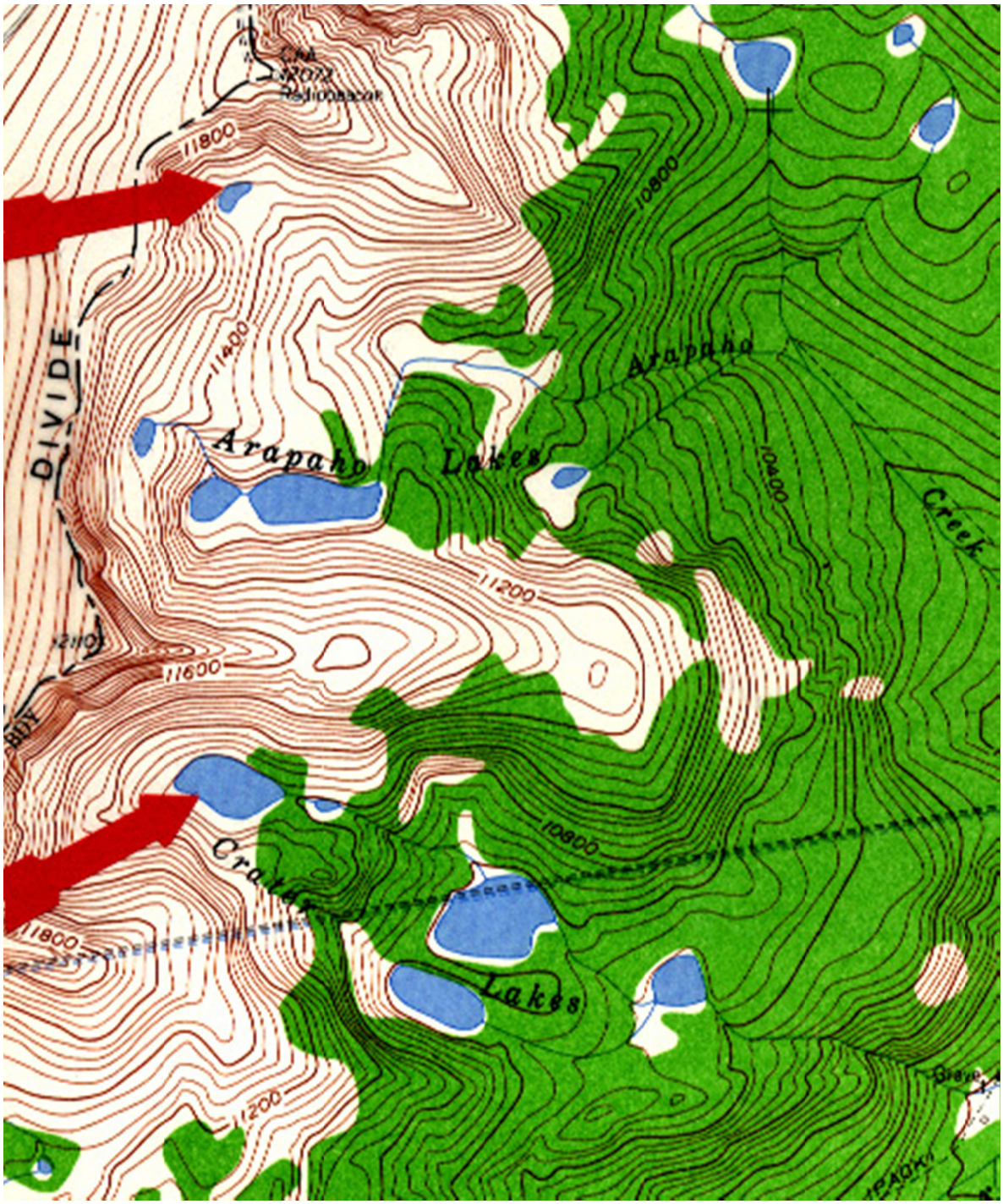


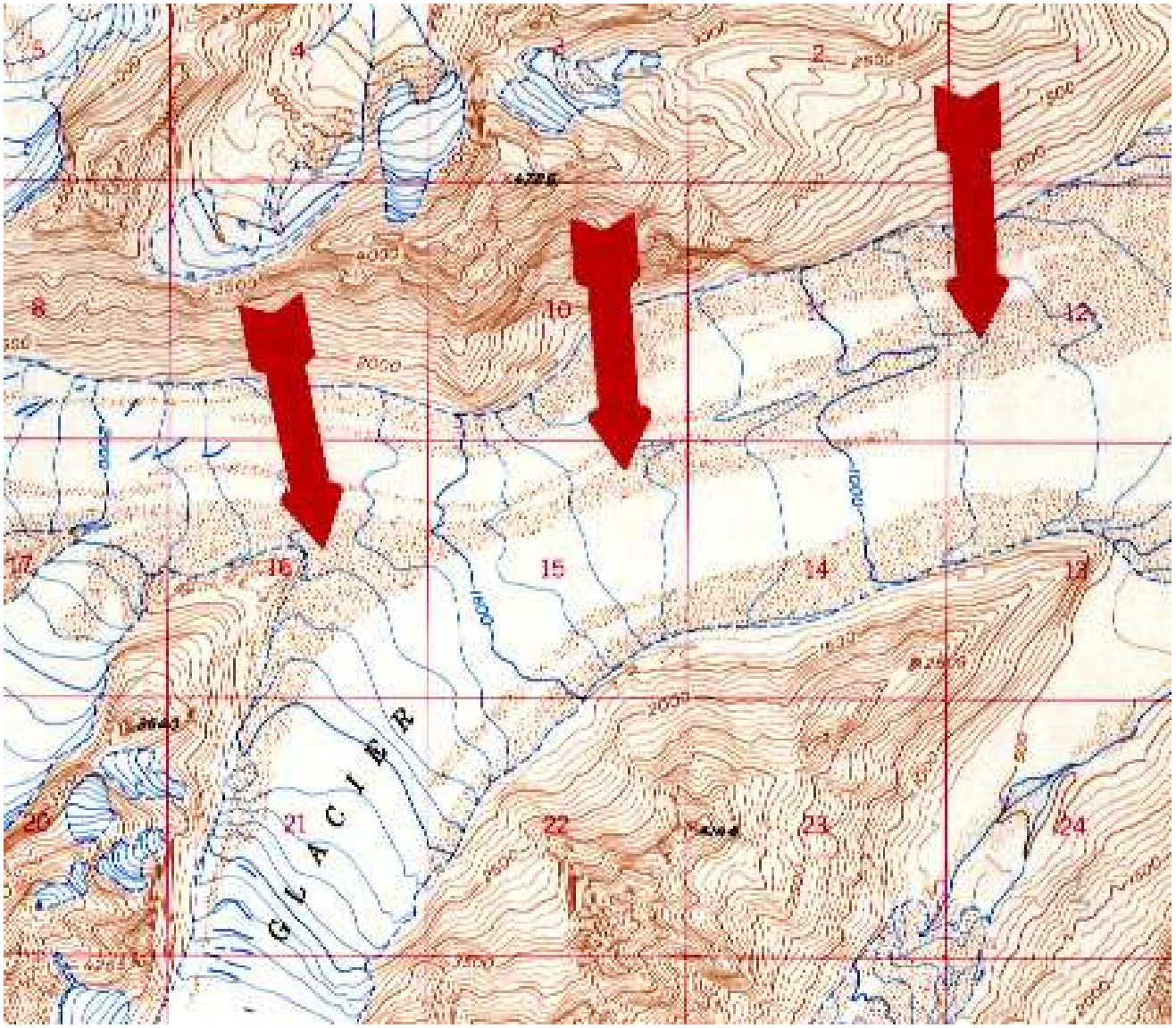

Hope
Siding
NATIONAL
Blezard
Cameron
750
850
800
25
20


Little
North Basin
N W Plateau
North Basin
Hamlin Pk
Hamlin Ridge
Great Basin
Chimney Pond Campground
Chimney Pk
South Basin
Pamola
Keep Ridge
Baxter Pk
BM 5287
MOUNT KATAHDIN
South Peak
T 3 R 9


Blue Spring Lake
Fish Hatchery
STATE
FOREST
KETTLE
MORAINE
KETTLE
WALWORTH CO
JEFFERSON CO
WAUKESHA CO


Goat Island Rock
Vernal Park
Skyscraper Mtn
Berkeley Park
Mineral Mtn
Burroughs Mtn
Observation Rock
M O U N T
A I
Russell Glacier
Carbon Glacier
Winthrop Glacier
Glacier Basin
Needle Rock
North Mowich Glacier
The Wedge
Steamboat Prow
Willis Wall
Liberty Cap
Emmons
Sunset


DIVIDE
Arapaho Lakes
Arapaho Creek
Crater Lakes
11800
11400
11200
11600
10800
10400
10800
11800
11200

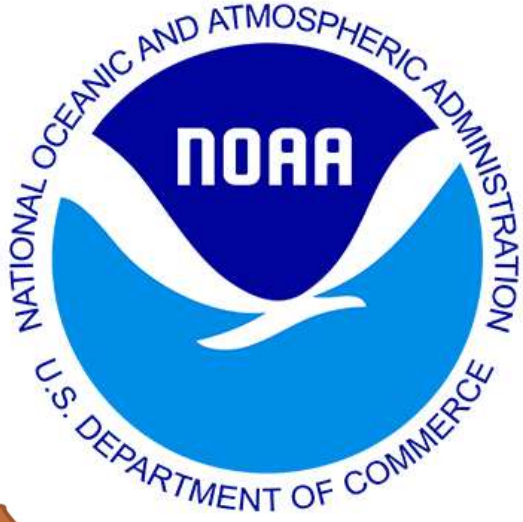

GLACIER

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.

James Balog

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