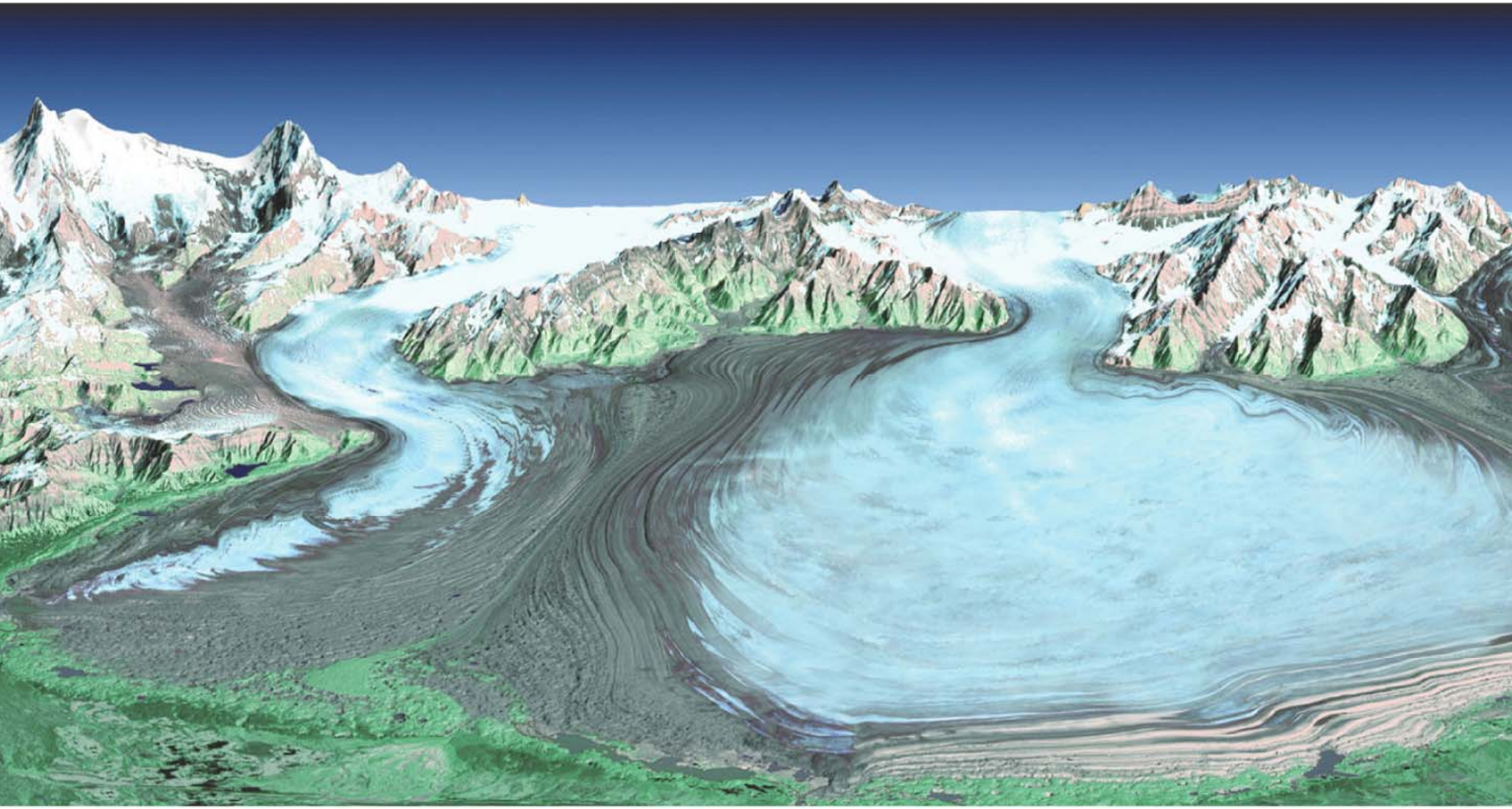
click here for 9/page to print

Glaciers

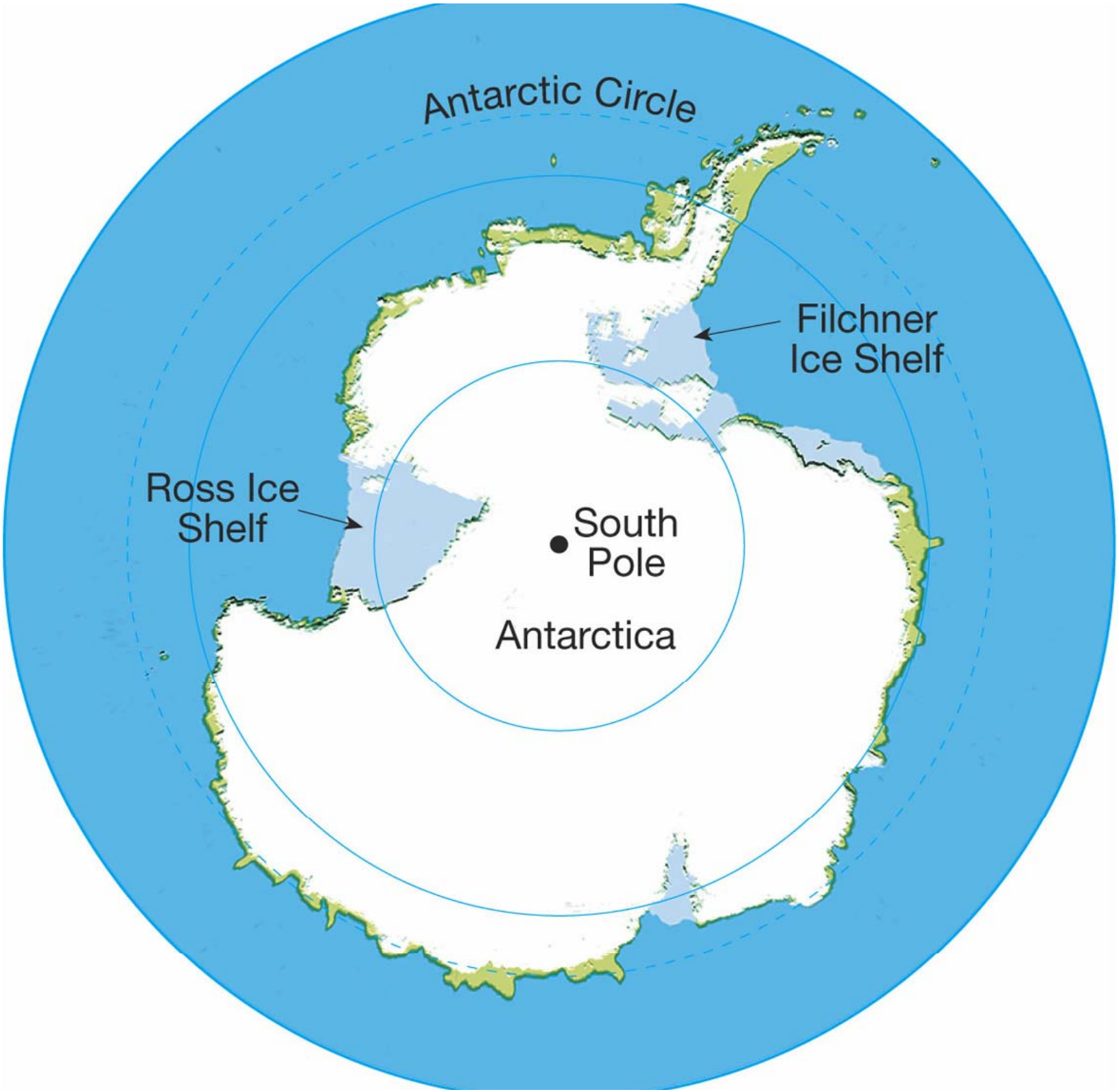
Earth Science

Chapter 6

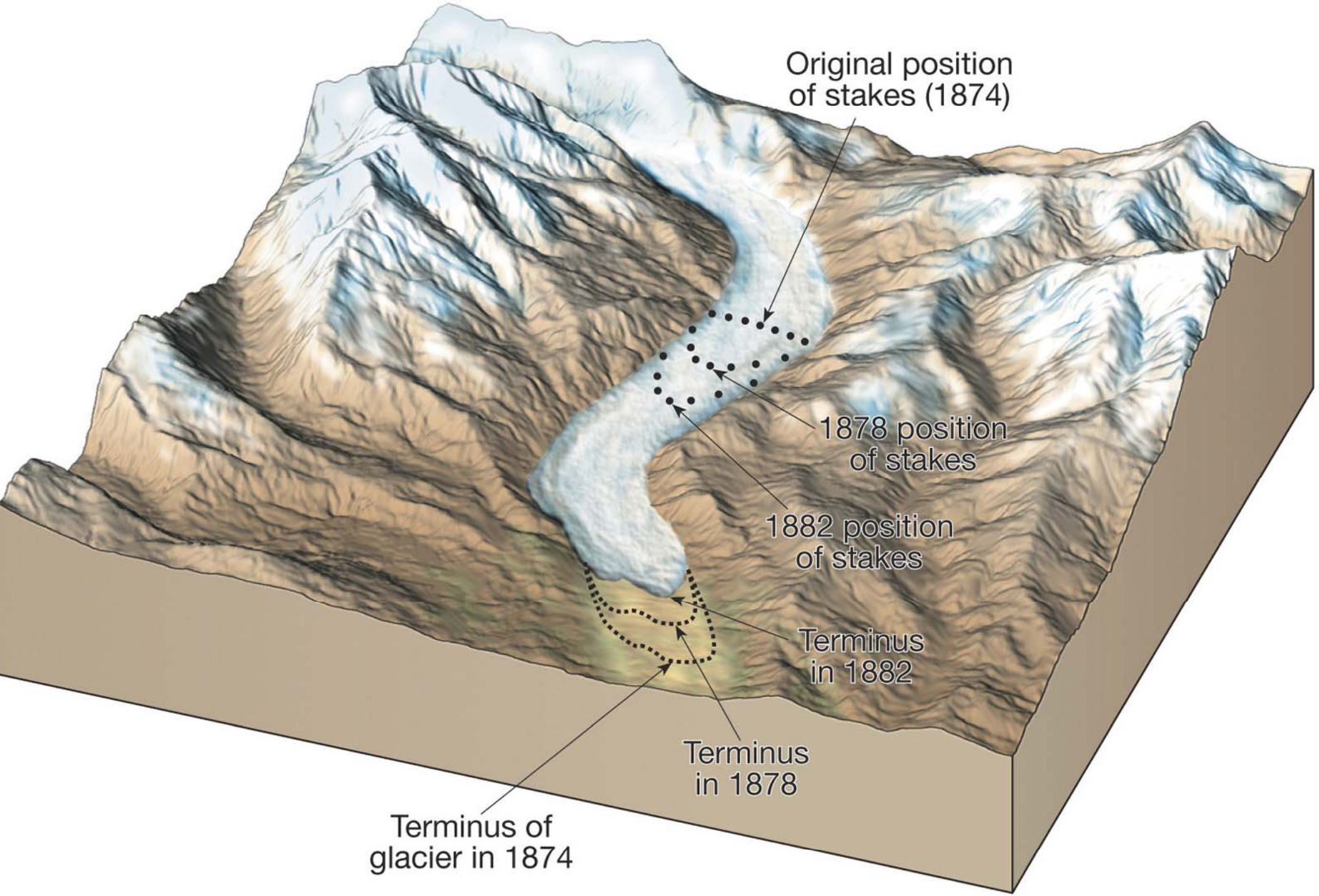
p. 154-159, 168-173

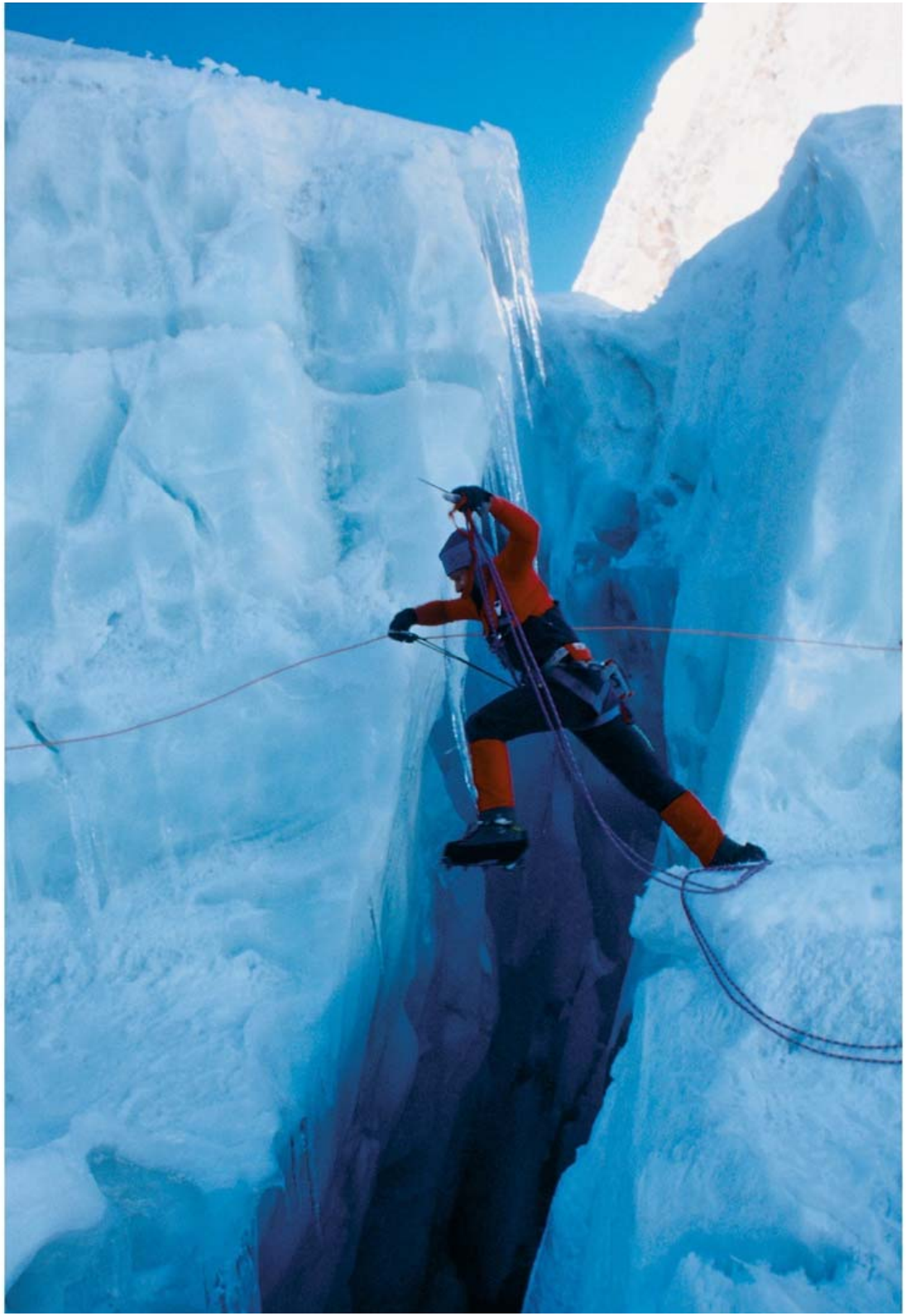


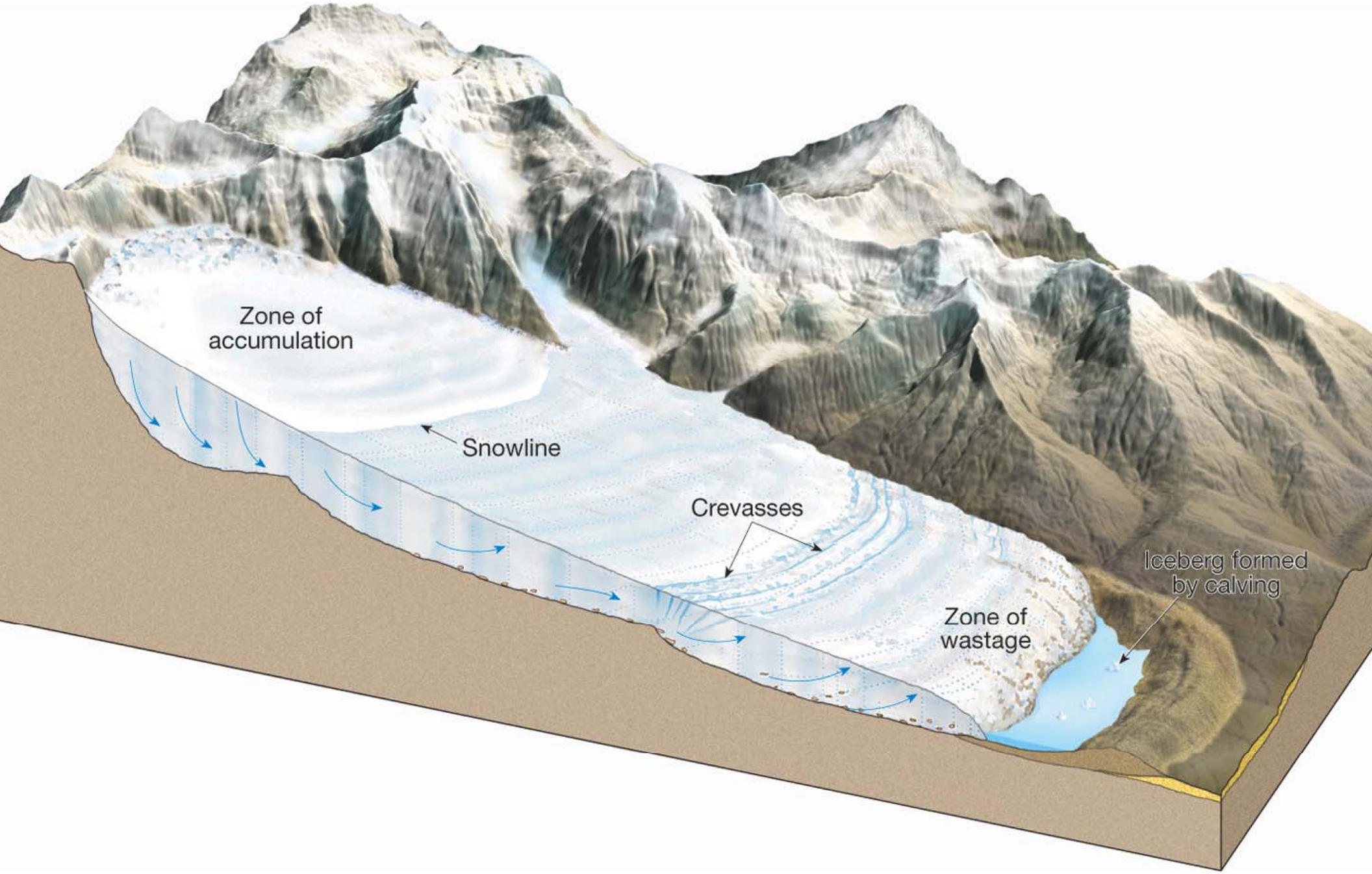
- Malaspina Glacier, Alaska


Antarctic Circle
Filchner
Ice Shelf
Ross Ice
Shelf
South
Pole
Antarctica

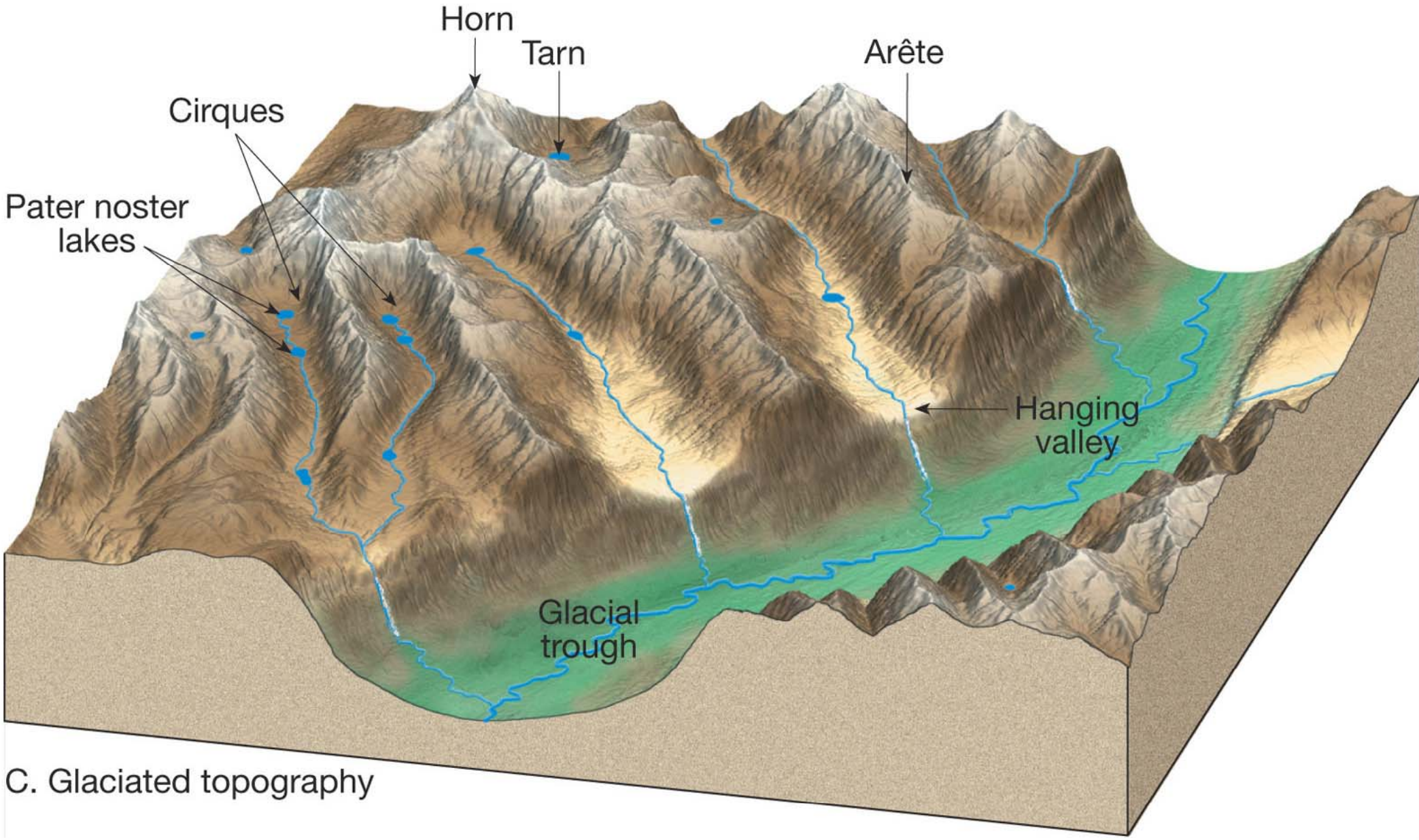

Arctic Circle
North Pole
Greenland



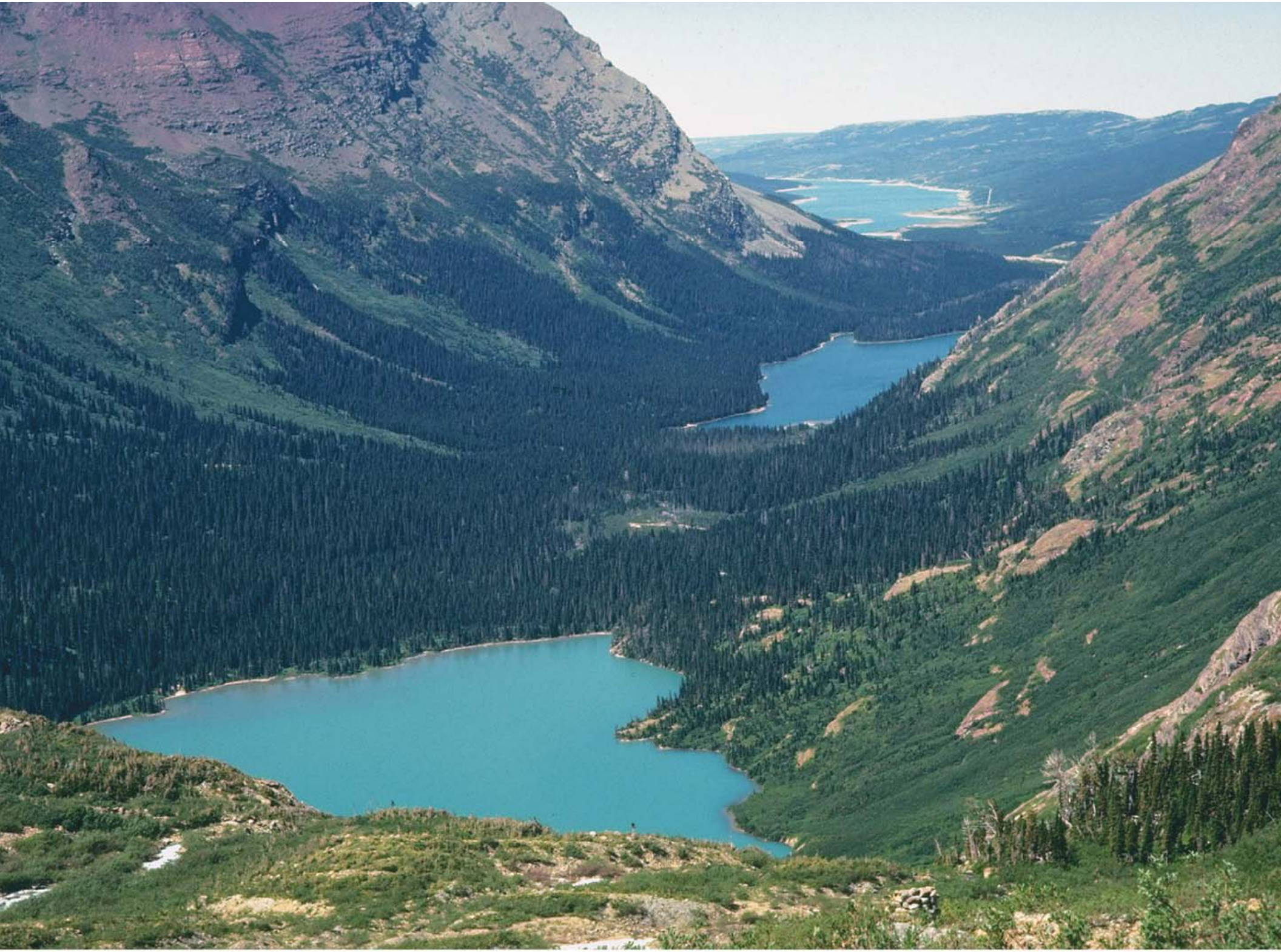




A.



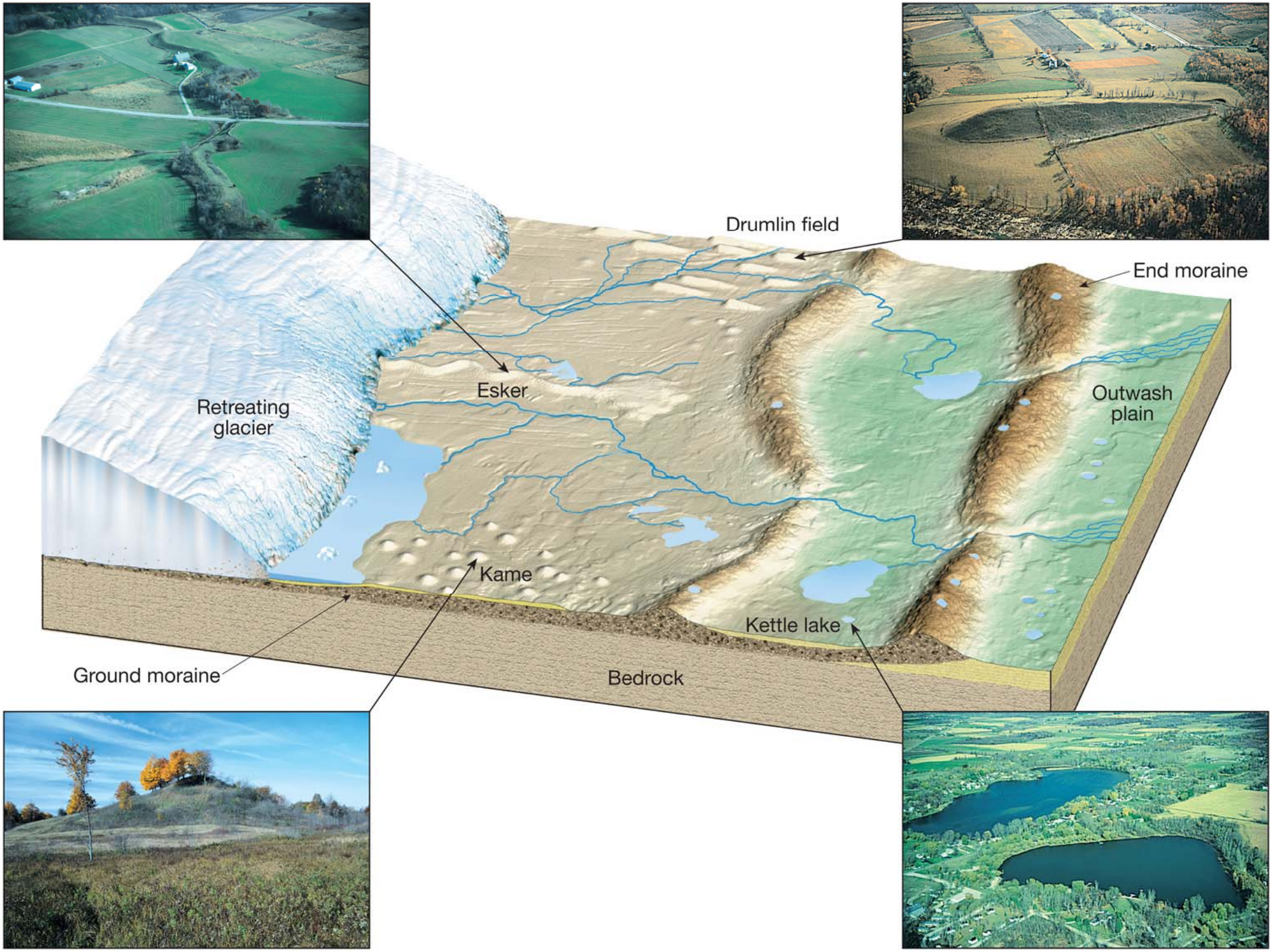
C. Glaciated topography

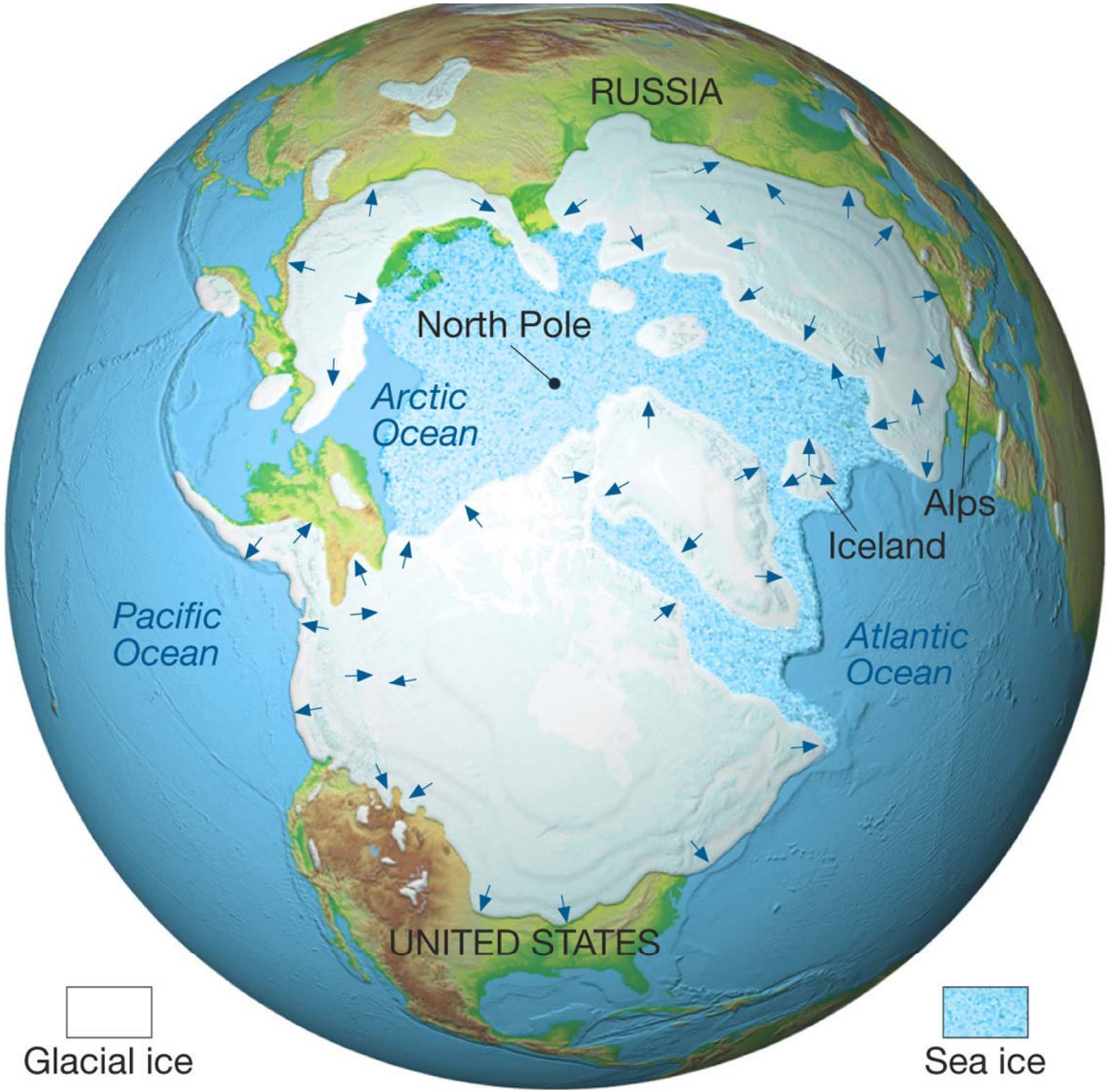



Hanging
valley

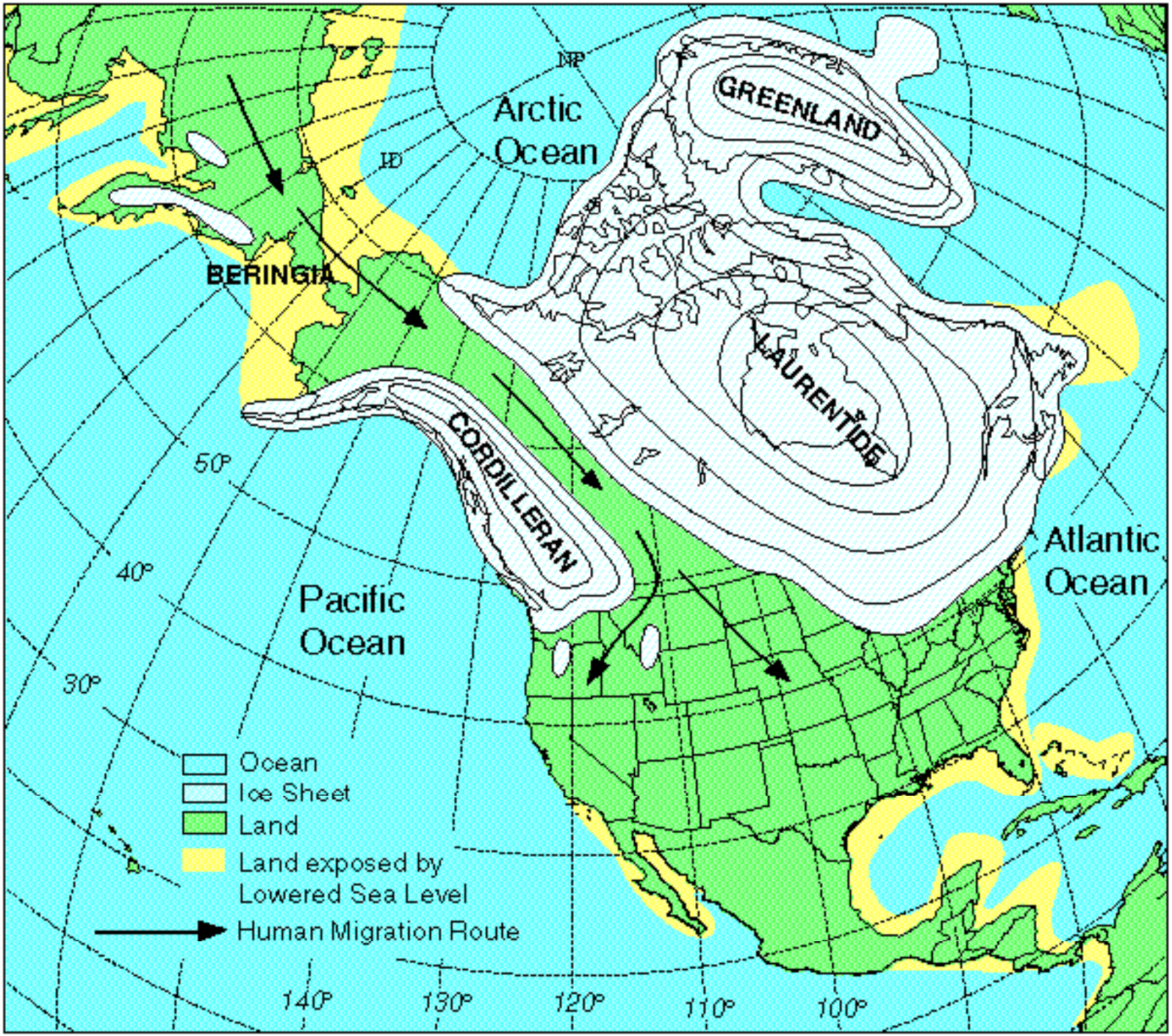
http://jesse.usra.edu/articles/iceagemodule/iceagemodule-paper.html


http://ns.geo.edu.ro/~paleomag/

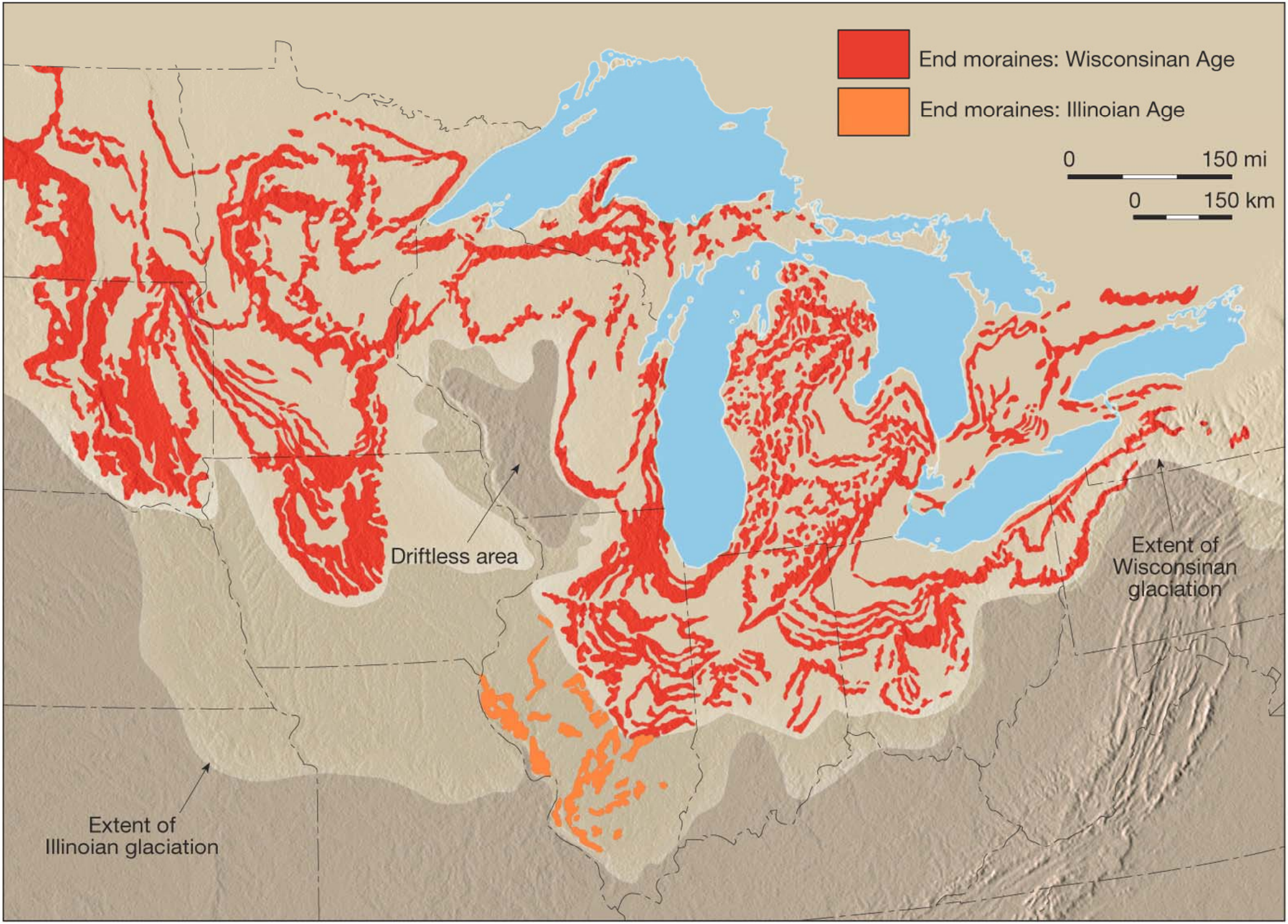

Drumlin field
End moraine
Retreating glacier
Esker
Outwash plain
Kame
Kettle lake
Ground moraine
Bedrock

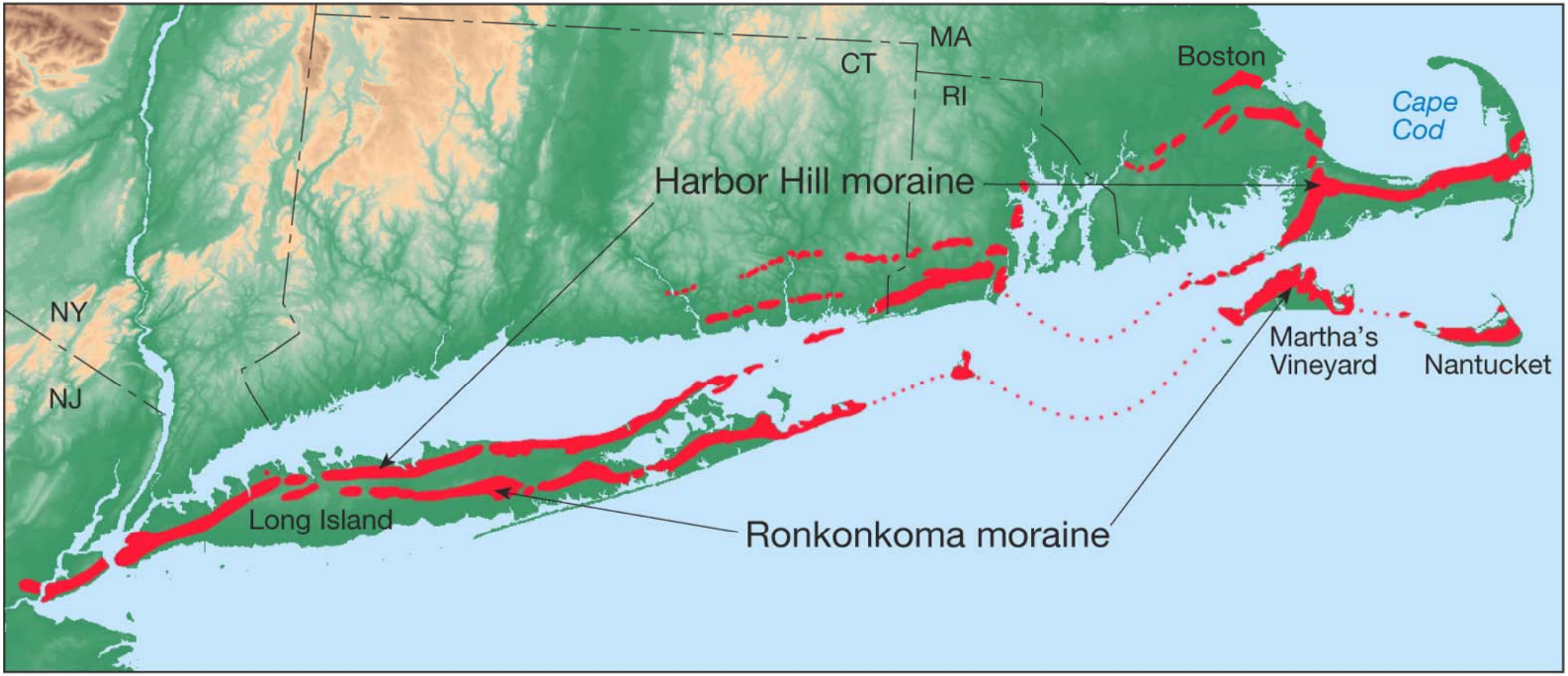

RUSSIA
North Pole
Arctic Ocean
Alps
Iceland
Pacific Ocean
Atlantic Ocean
UNITED STATES
Glacial ice
Sea ice

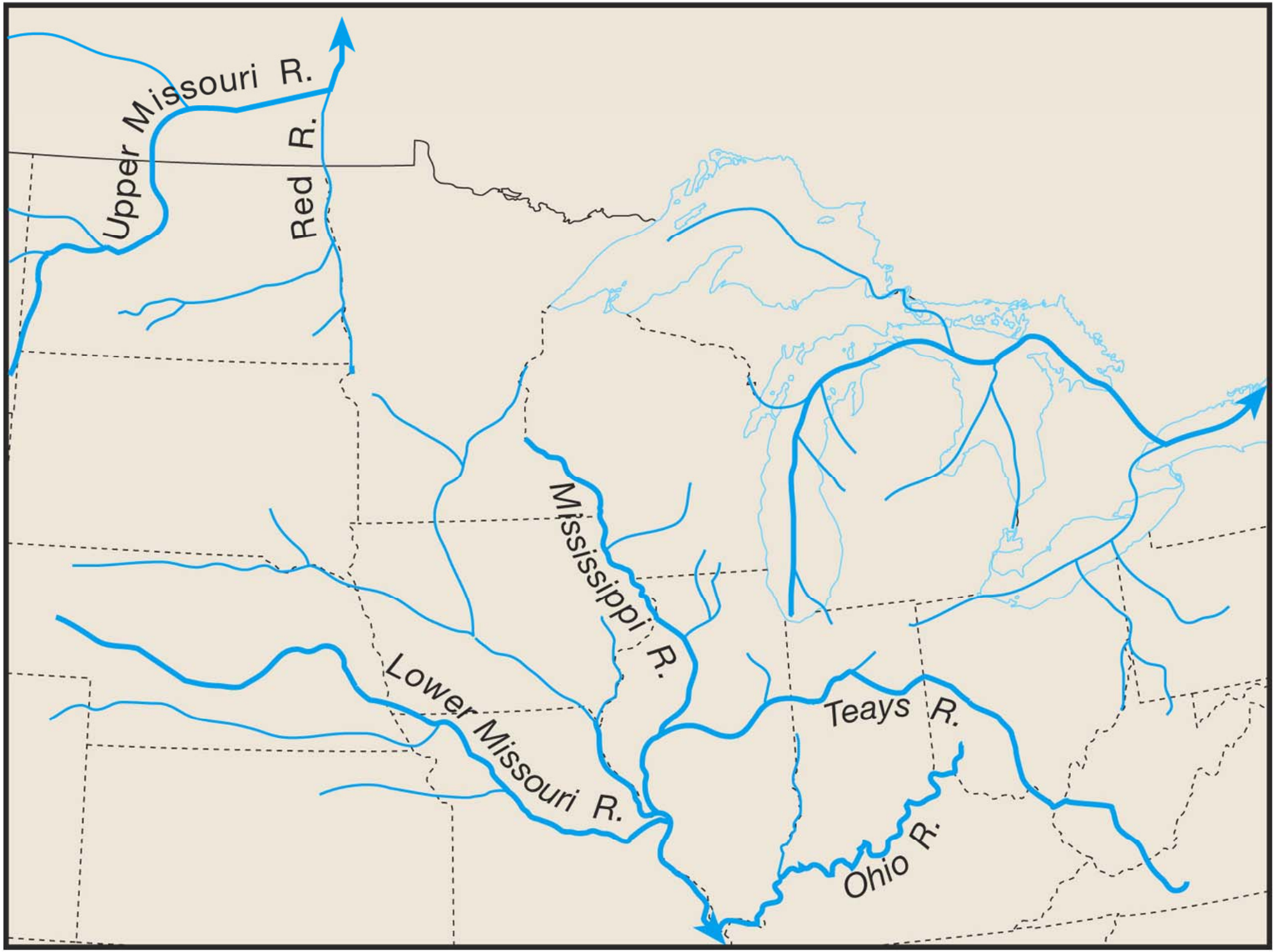
AMERICA DURING LAST ICE AGE



http://www.atmos.washington.edu/~dennis/Our_Changing_Climate.html

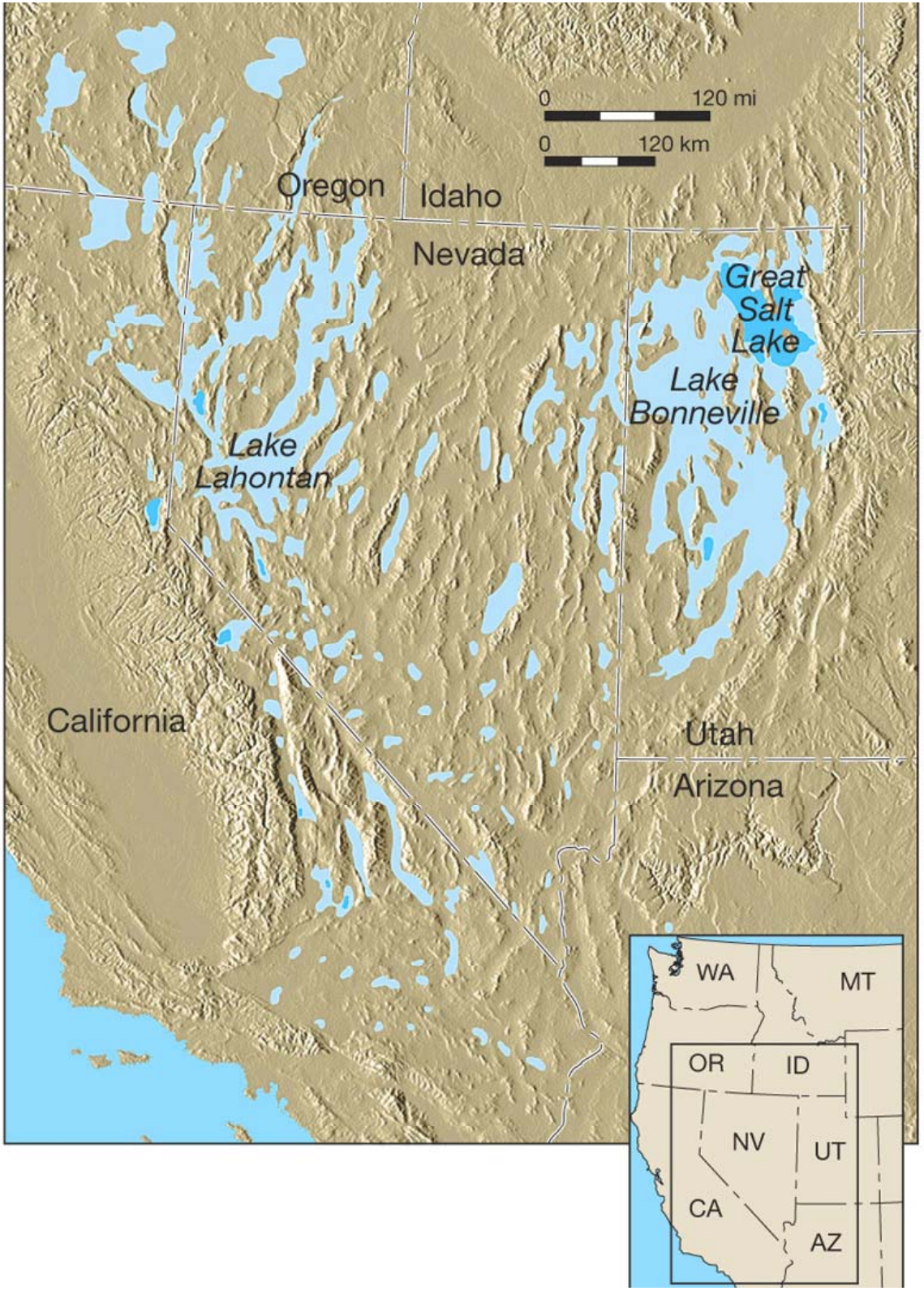





Upper Missouri R.
Red R.
Mississippi R.
Lower Missouri R.
Teays R.
Ohio R.

- Deranged drainage after ice melts

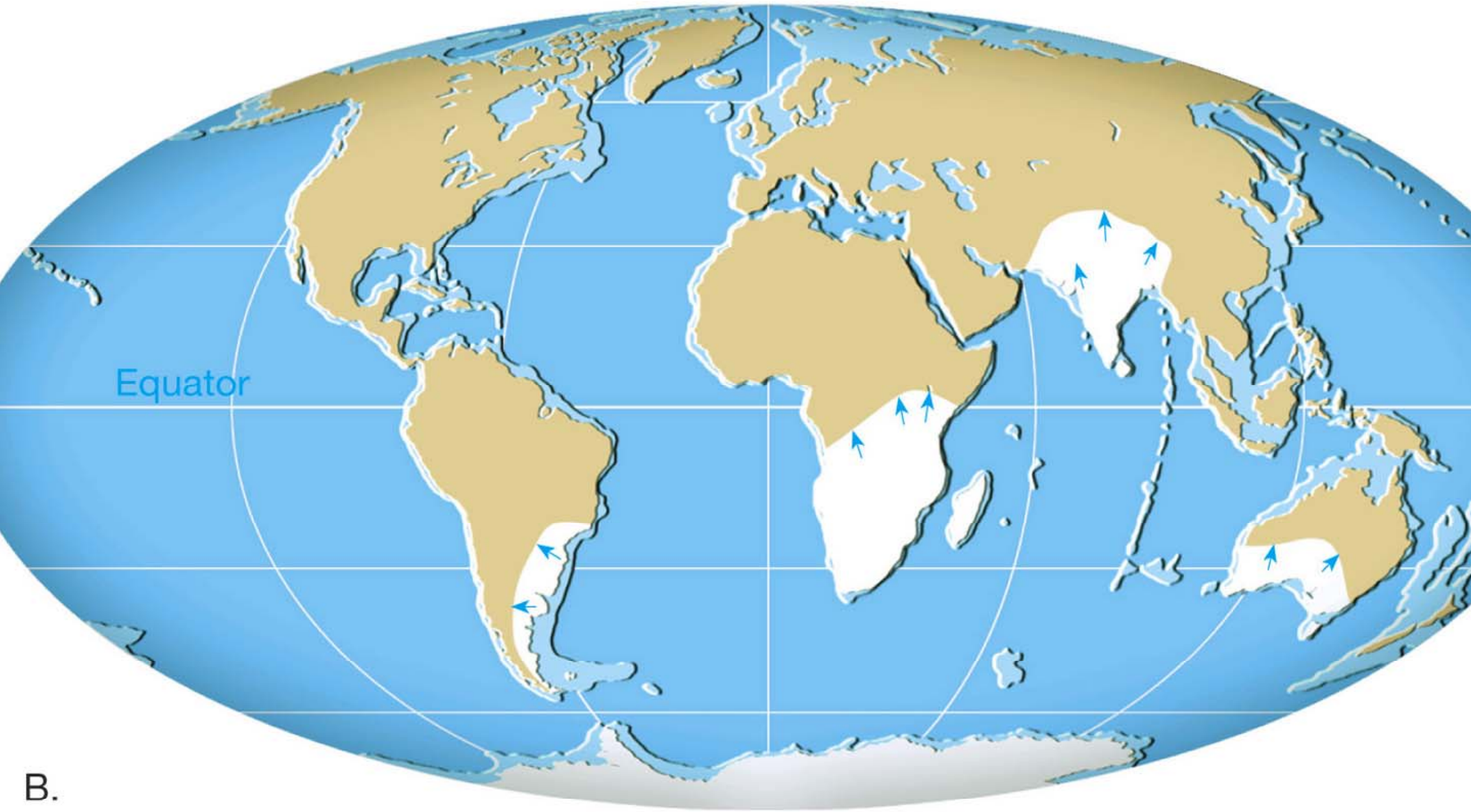
Pluvial Lakes of Southwest



Past Glacial Ages

- Pliocene-Pleistocene
  - Ice in Antarctica starting about 40 m.y.a.
  - Widespread N. Hemisphere ice about 3 mya
  - Advances every 40,000 to 100,000 years
- Karoo Ice Ages
  - 260 to 350 mya
  - Lasted 90 million years
  - Wegener’s evidence of continental movement

Location of 300 MY Continental Glaciation



B.

Location of 300 MY Continental Glaciation with continents located 300 mya

Past Glacial Ages

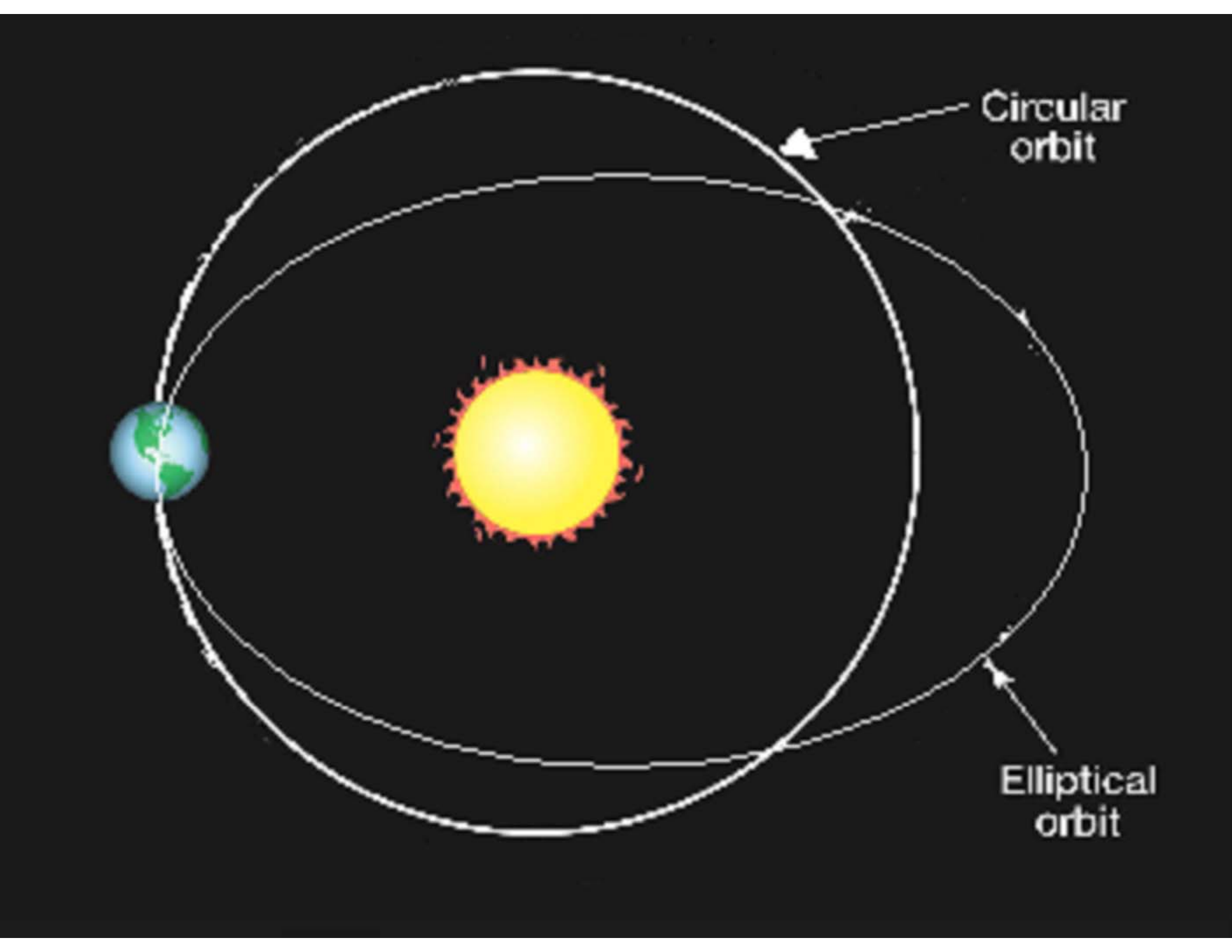
- Andean-Saharan Ice Ages
  - 430 to 460 mya
  - Lasted 30 million years
- Cryogenian
  - 630 to 850 mya
  - Lasted 200 million years
  - Periods of all Earth covered with glacier
- Huronian
  - Over 2 billion years ago
  - Lasted 300 to 400 million years

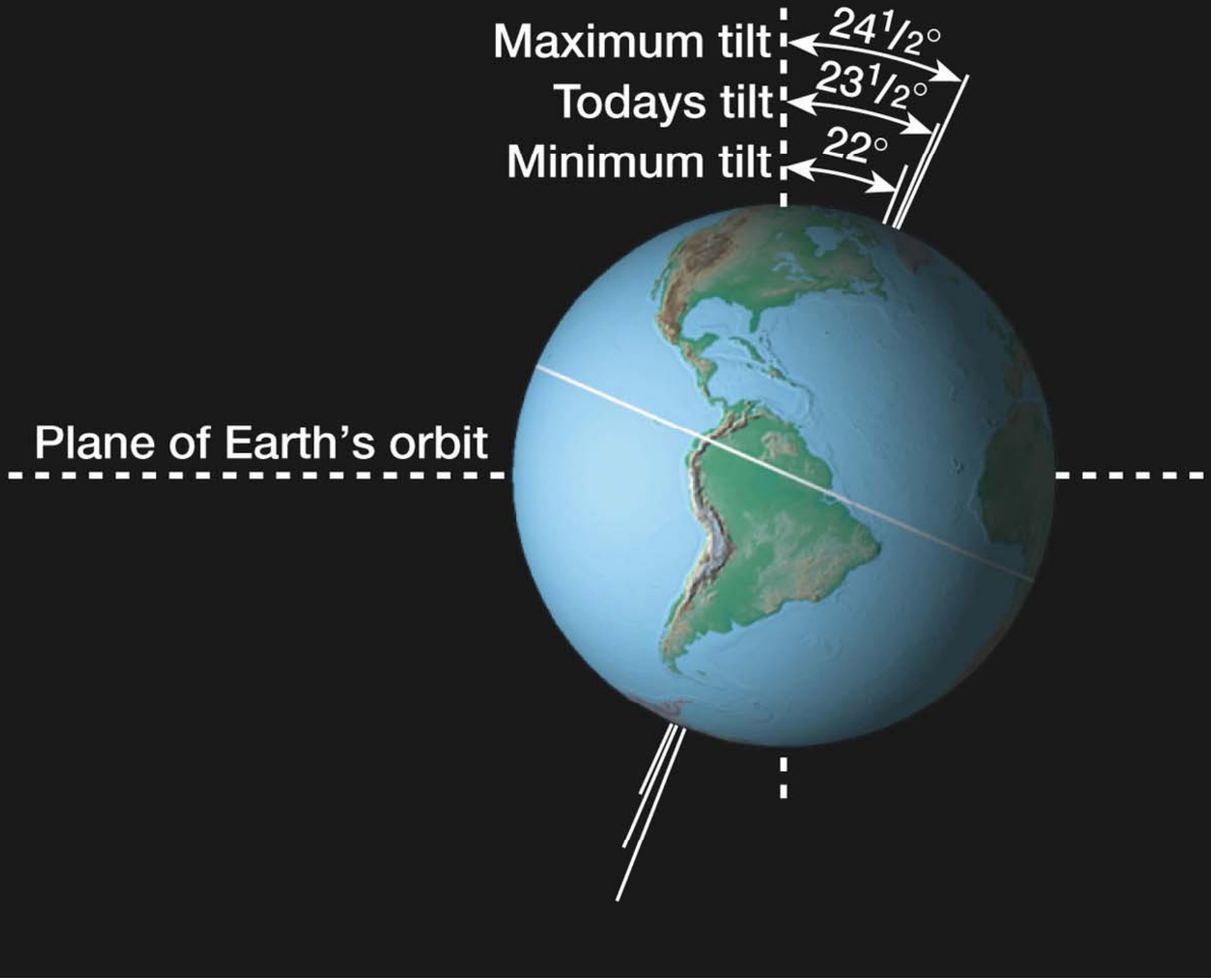
Documentation

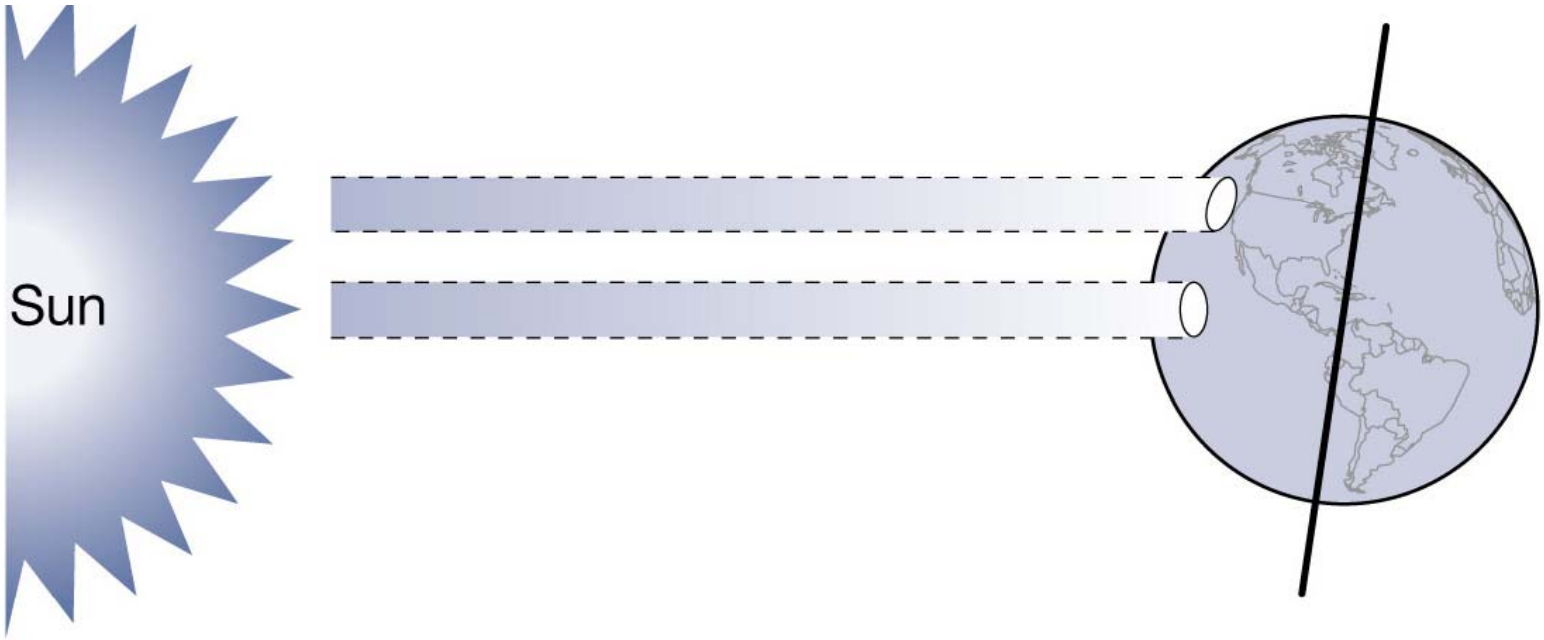
- Drift
- Loess and marine deposits
- Oxygen isotope ratio in shells
- Air trapped in ice—CO_2 levels

Causes

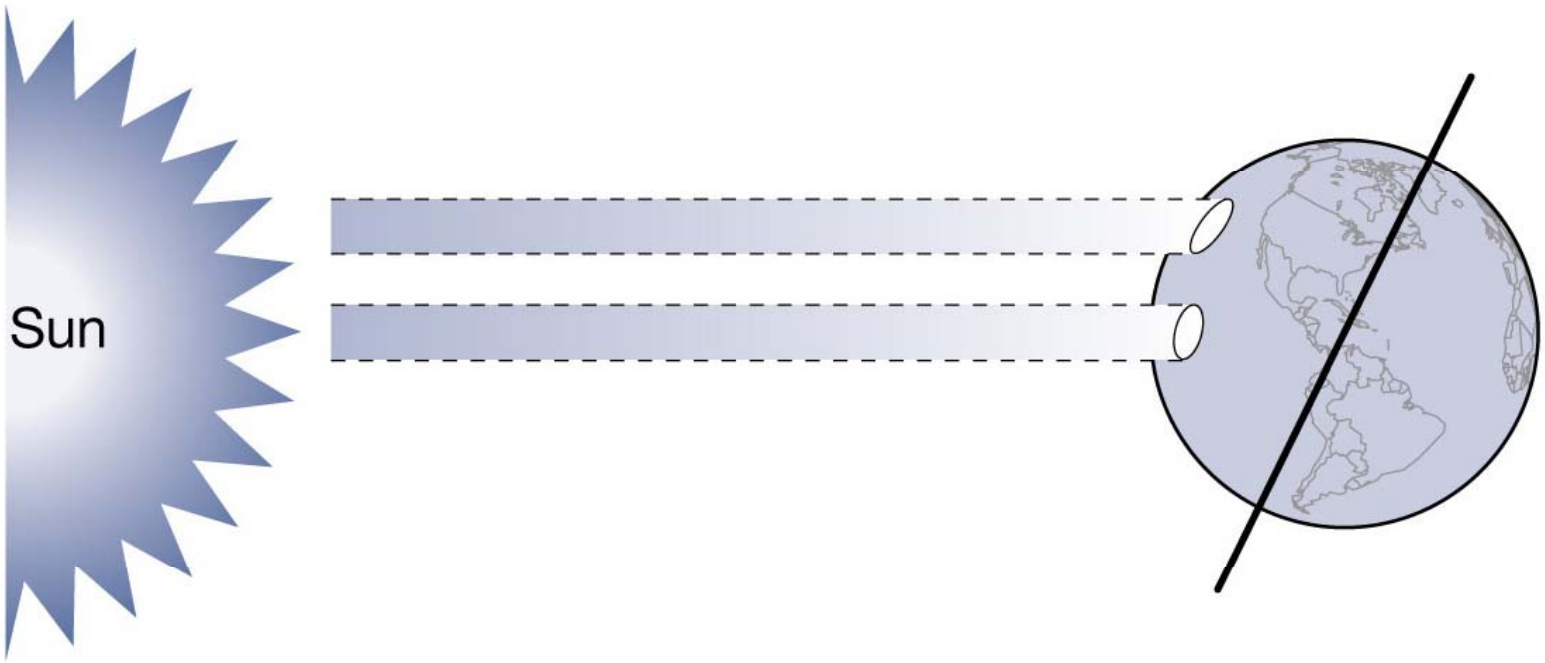
- Land mass configuration
  - High latitude land mass—Antarctica
  - High elevation in westerlies—Andes, Cascades
- Coincidence of astronomical variations of Earth in relation to Sun
  - Orbit shape: eccentricity
  - Axial tilt amount: obliquity
  - Tilt direction superimposed on orbit shape: progression of the equinox
- CO_2 levels—may be effect and not cause


Circular orbit
Elliptical orbit

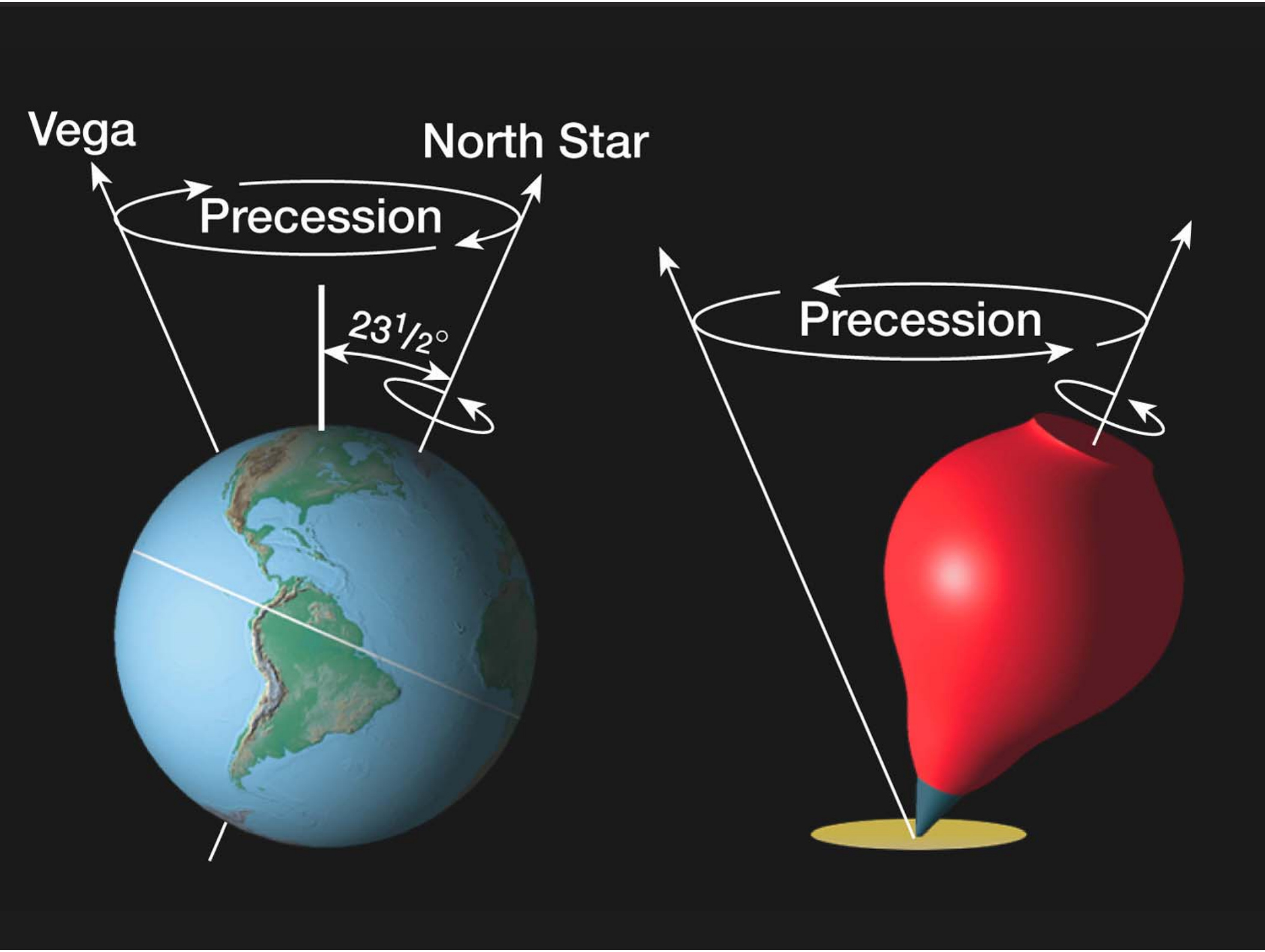

Maximum tilt
24 1/2°
Todays tilt
23 1/2°
Minimum tilt
22°
Plane of Earth's orbit



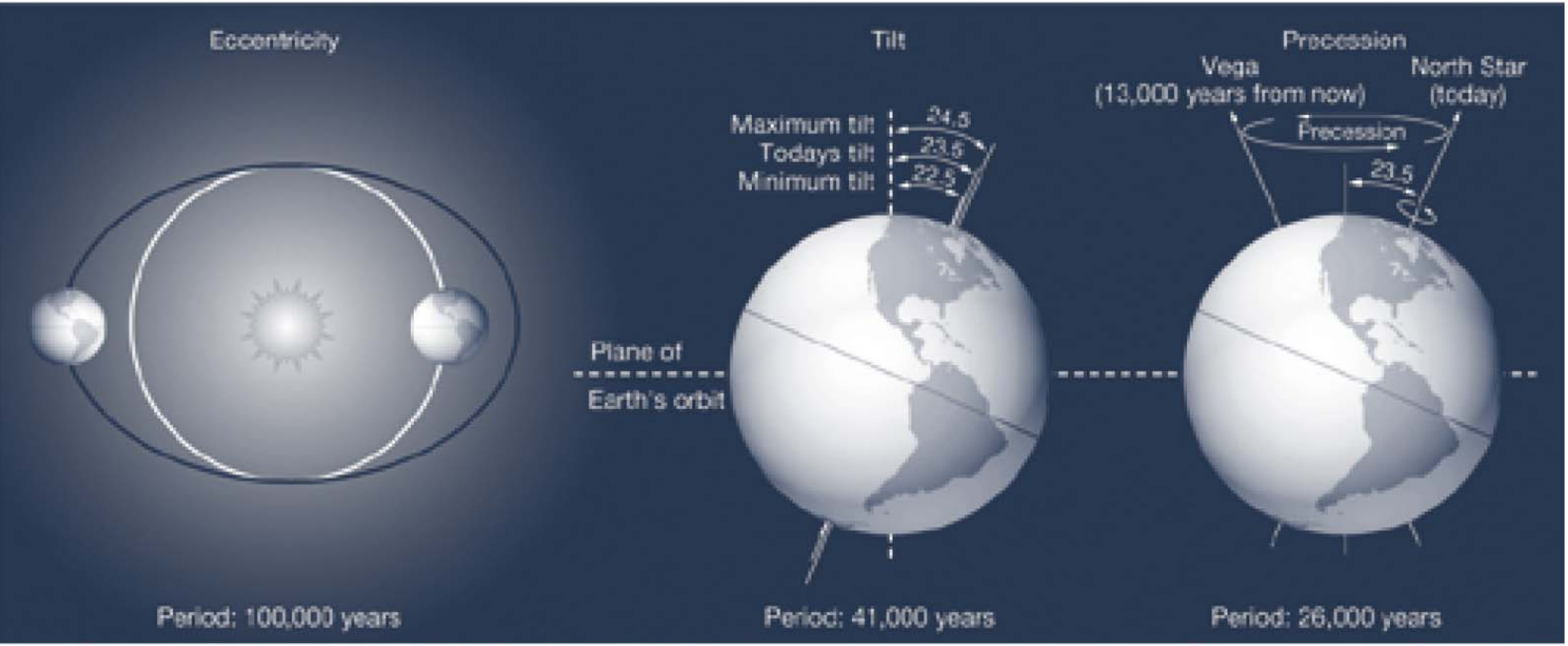
(a) Low obliquity



(b) High obliquity

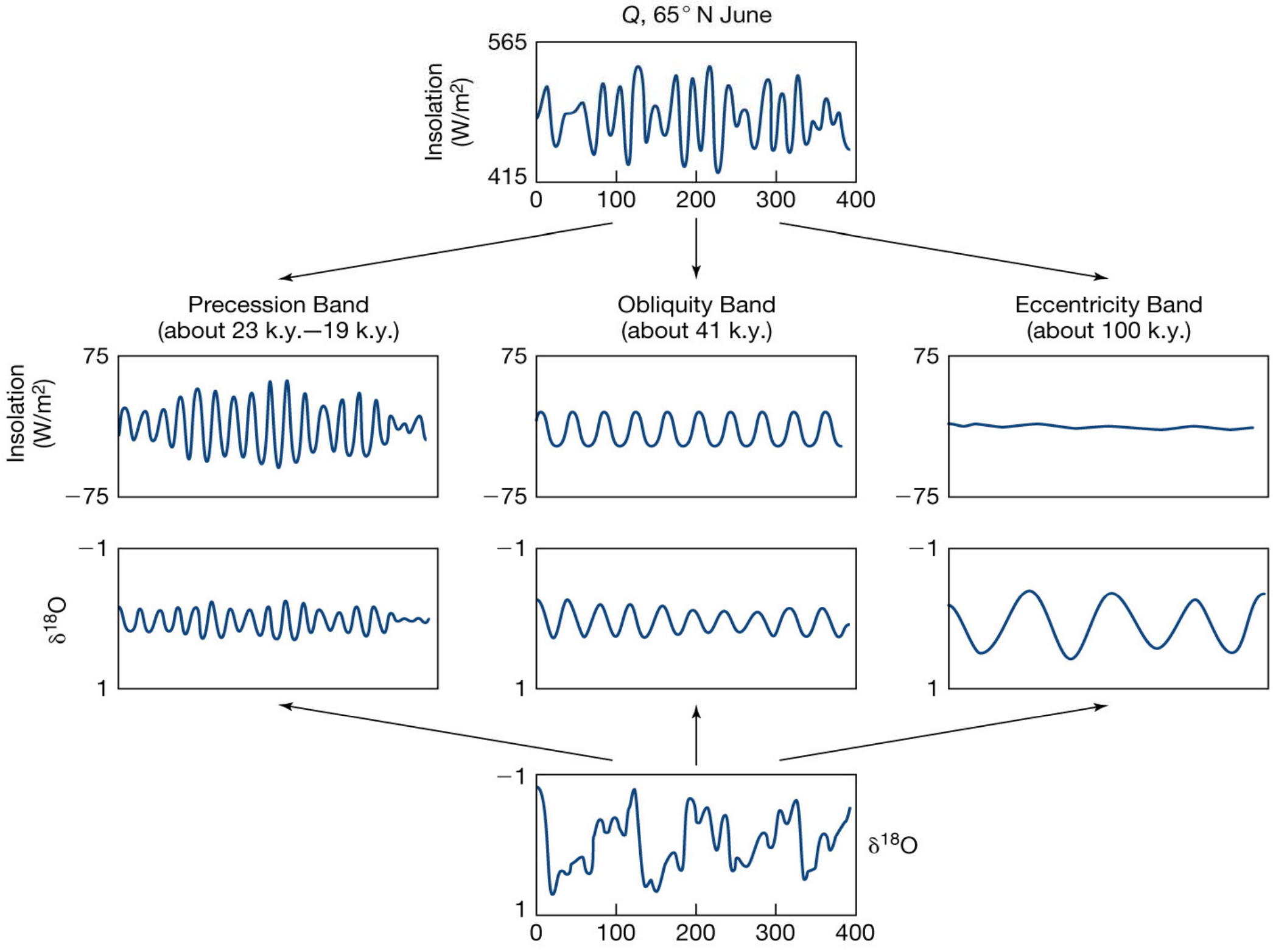

Vega
North Star
Precession
23 1/2°
Precession

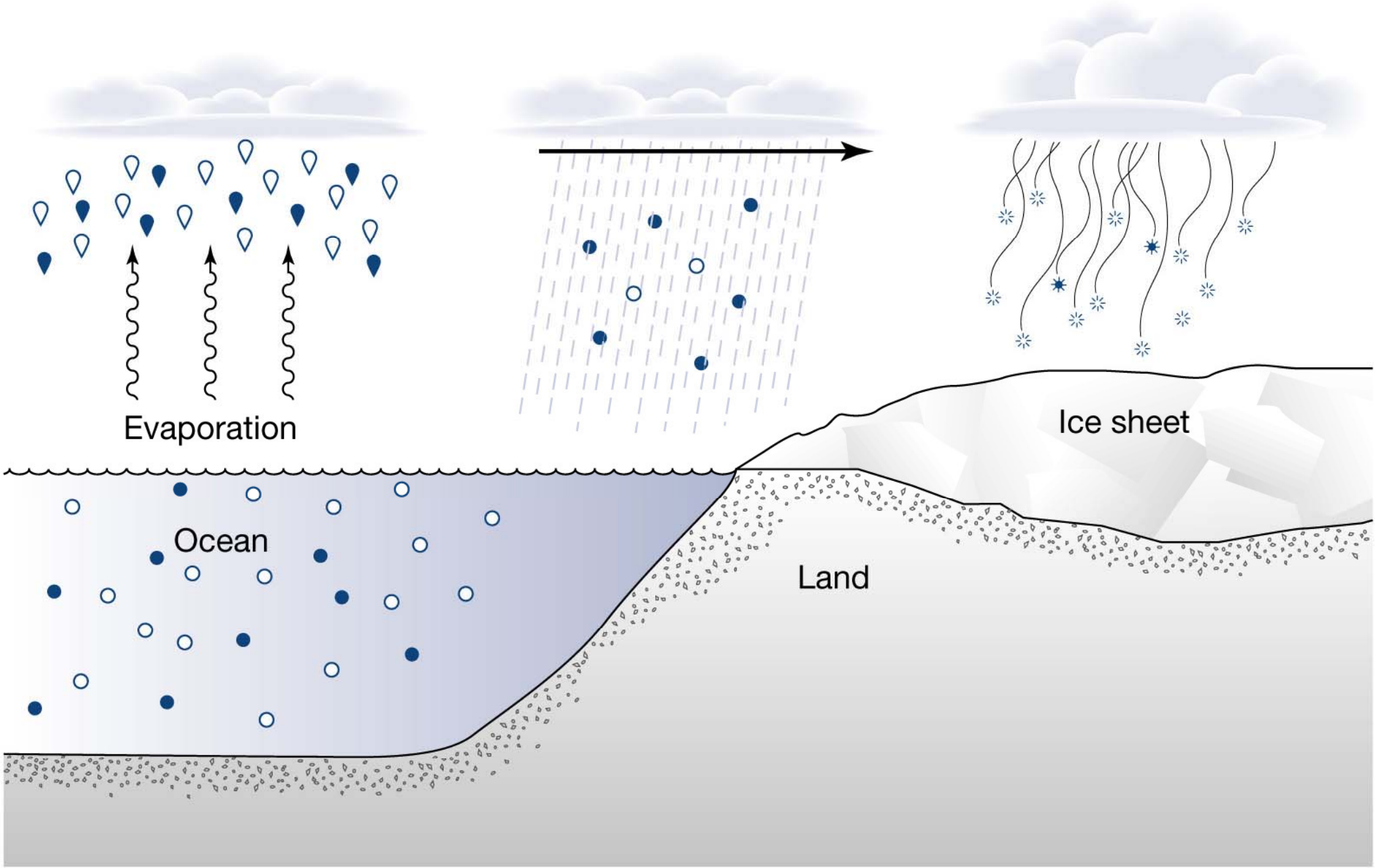
Milankovitch cycles



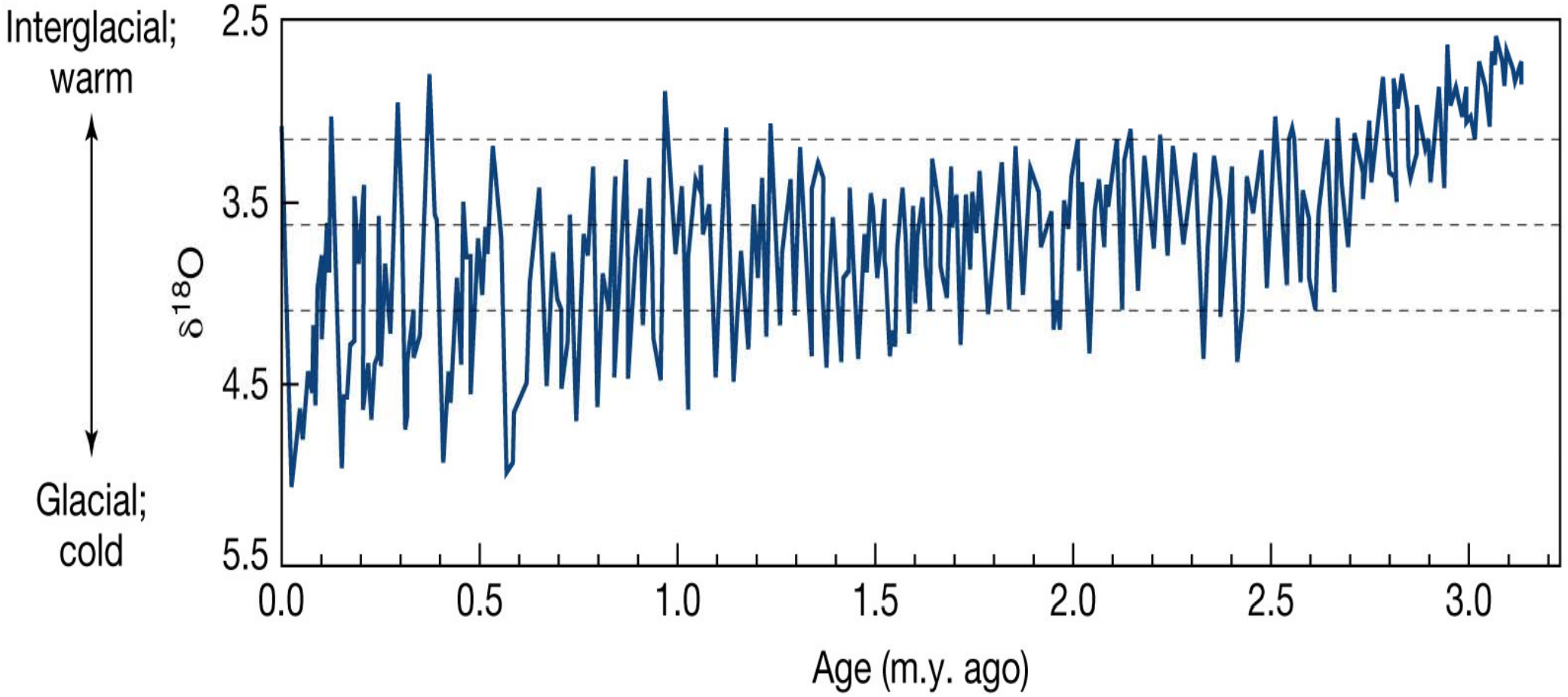
- Link to a lovely explanation of these cycles

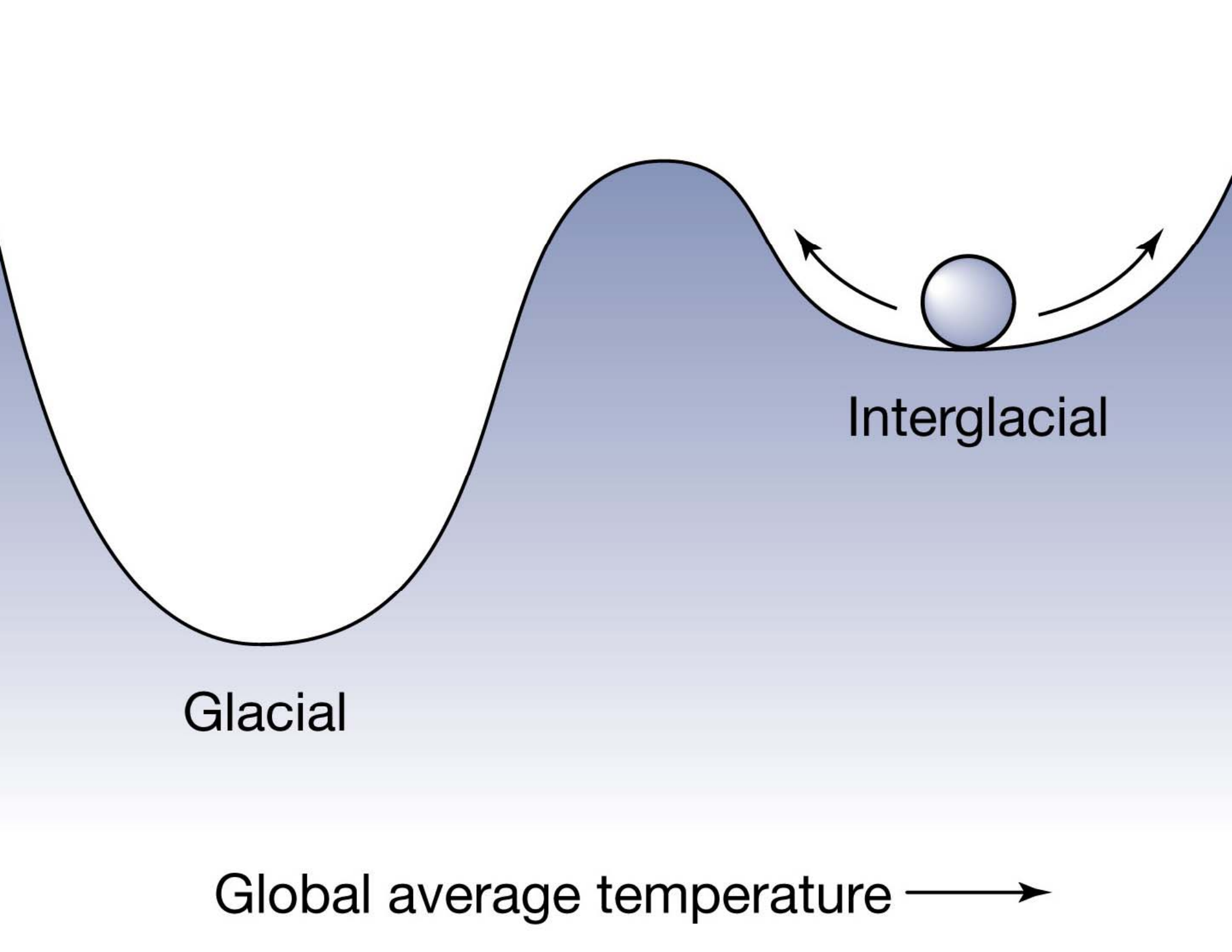
http://skepticsplay.blogspot.com/2008/12/axial-tilt-milankovitch-cycles.html


Q, 65° N June
565
415
Insolation (W/m²)
0
100
200
300
400
Precession Band
(about 23 k.y.—19 k.y.)
Obliquity Band
(about 41 k.y.)
Eccentricity Band
(about 100 k.y.)
75
−75
Insolation (W/m²)
−1
1
δ18O
δ18O



Temperature record from O-18

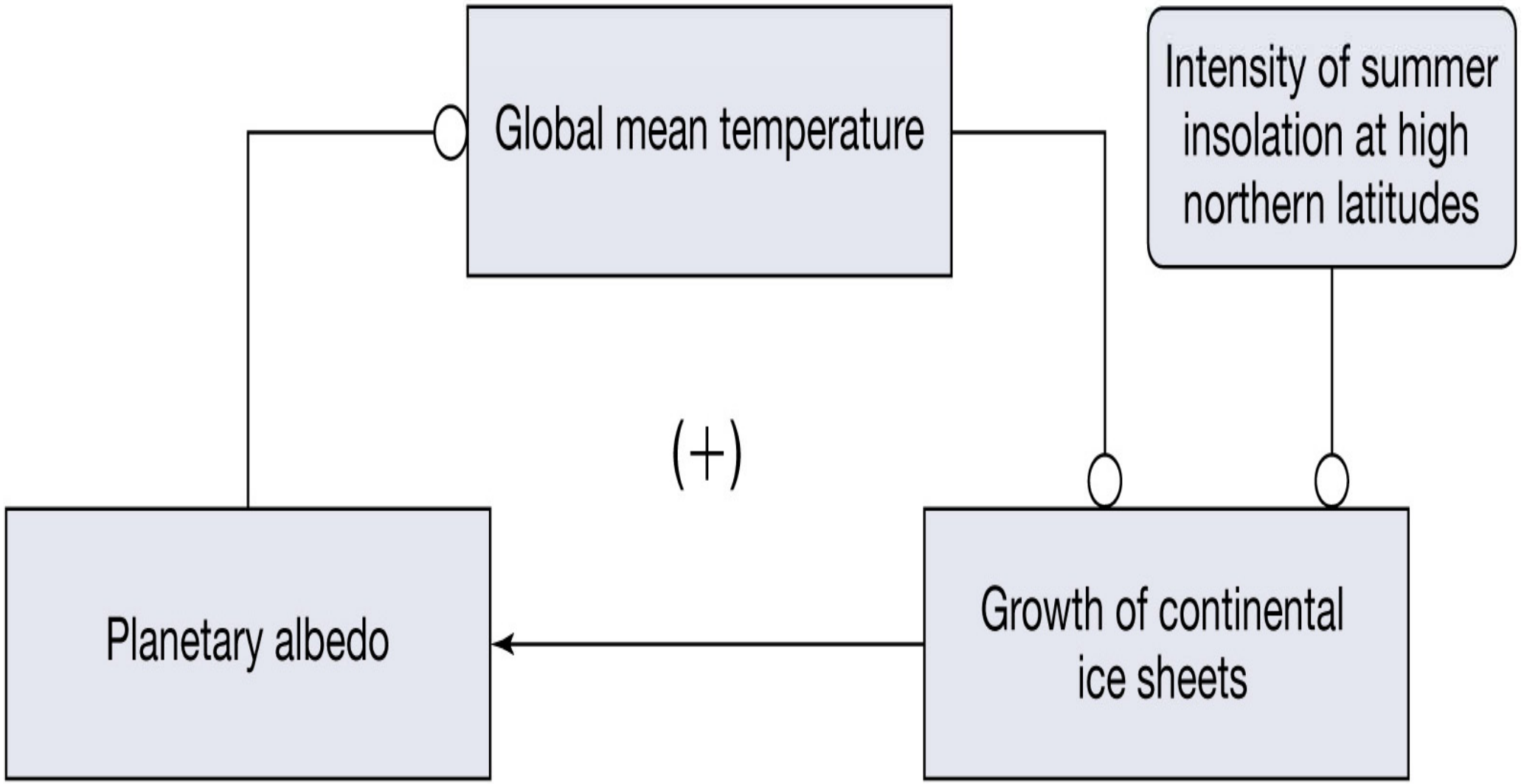



Interglacial
Glacial
Global average temperature

Positive Climate Feedback Loops

- Ice albedo decreases temperature, increases ice. Reduced ice increases temperature

Ice-albedo feedback loop

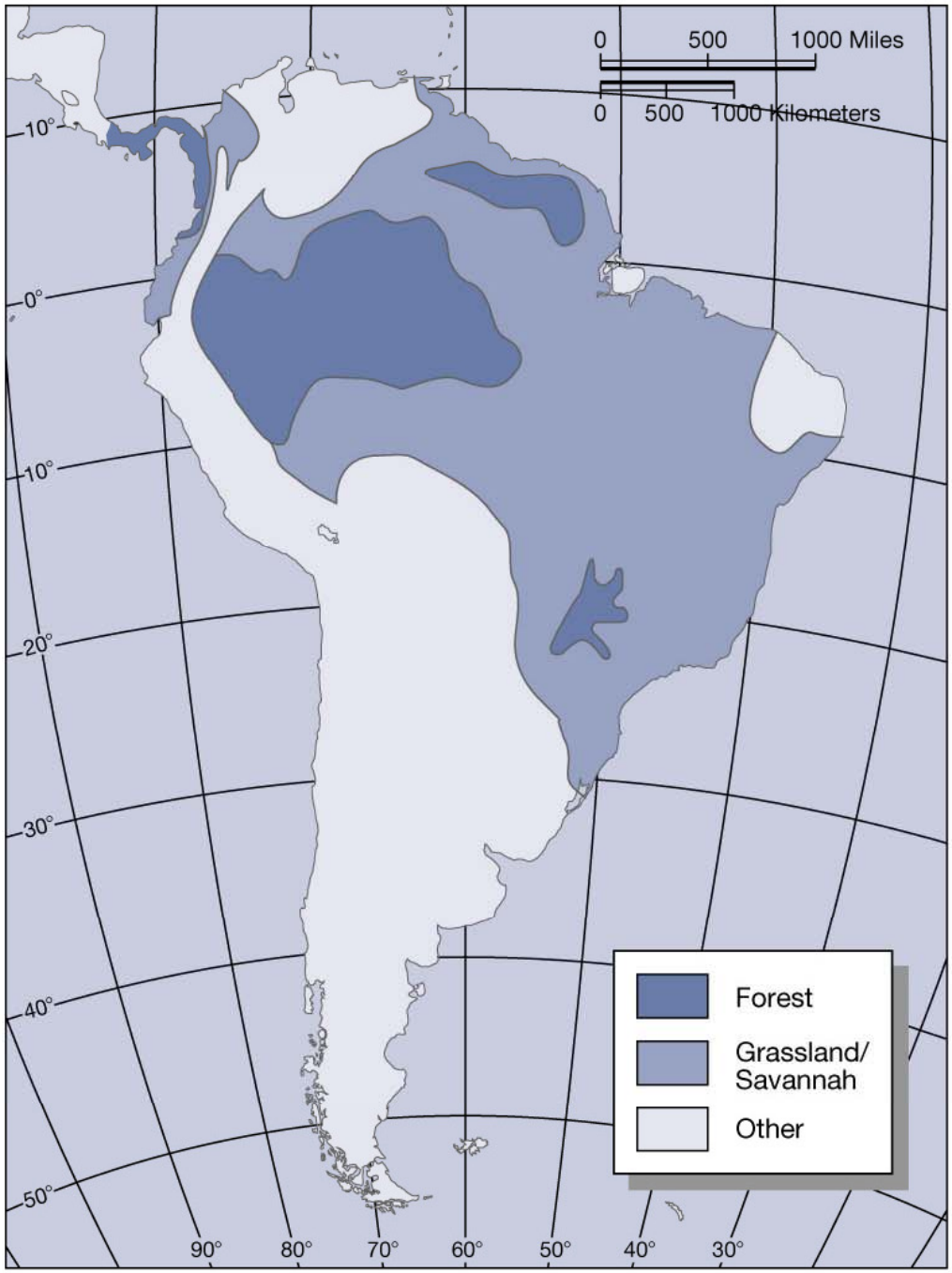


Positive Climate Feedback Loops

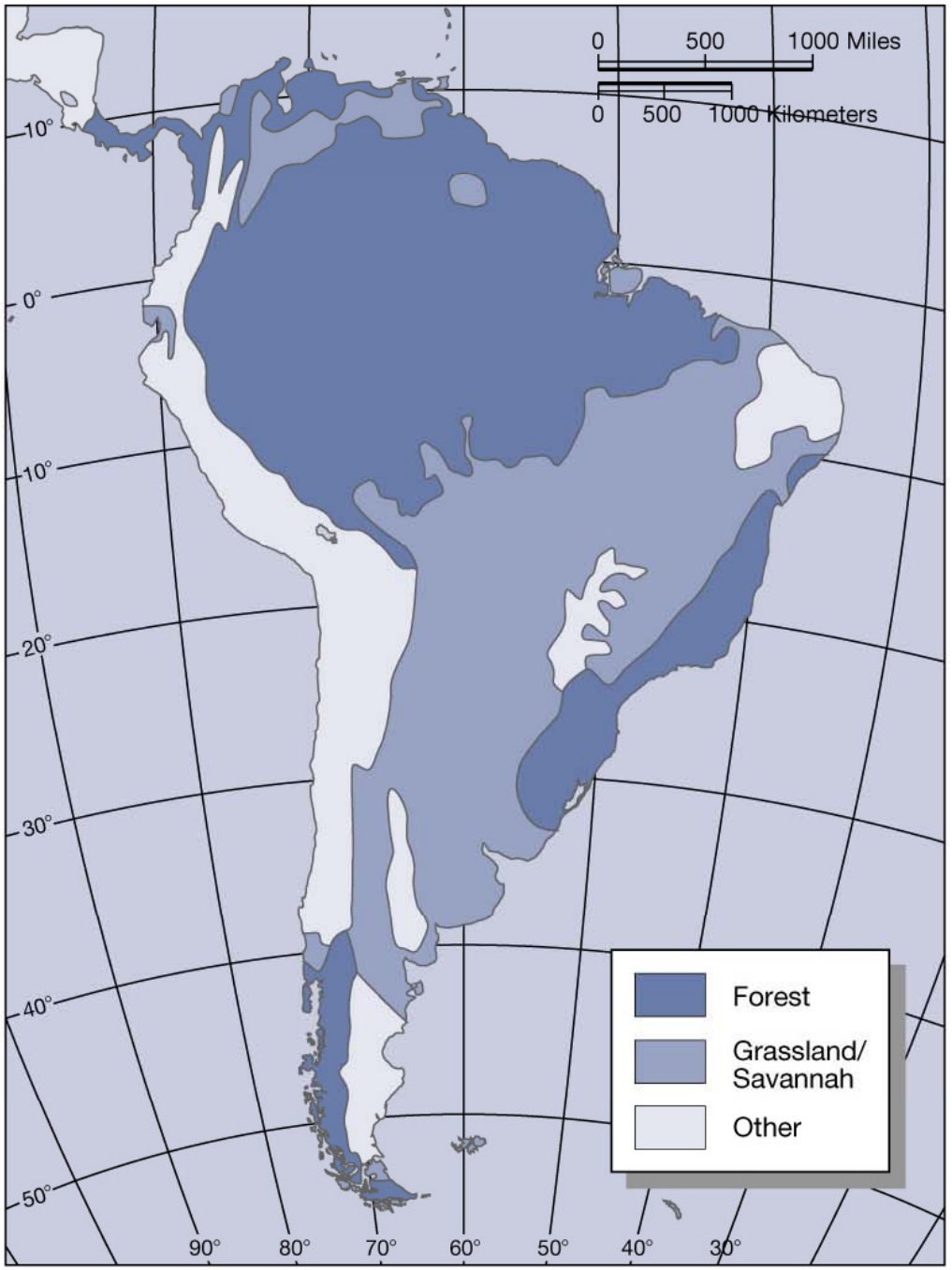
- Ice albedo decreases temperature, increases ice. Reduced ice increases temperature
- Glacial periods result in larger arid areas, increasing delivery of iron nutrients to sea, increasing algae productivity, lowering CO_2 levels, and temperature
- Lowering sea level will expose reefs to weathering. Reaction consumes CO_2 , lowering temperature. Rising sea level has opposite effect: reef preserved, does not consume CO_2

Negative Climate Feedback Loop

- Forest die out during glacial ages, reducing mechanism to remove CO_2 from atmosphere, increasing CO_2, allowing temperature to increase

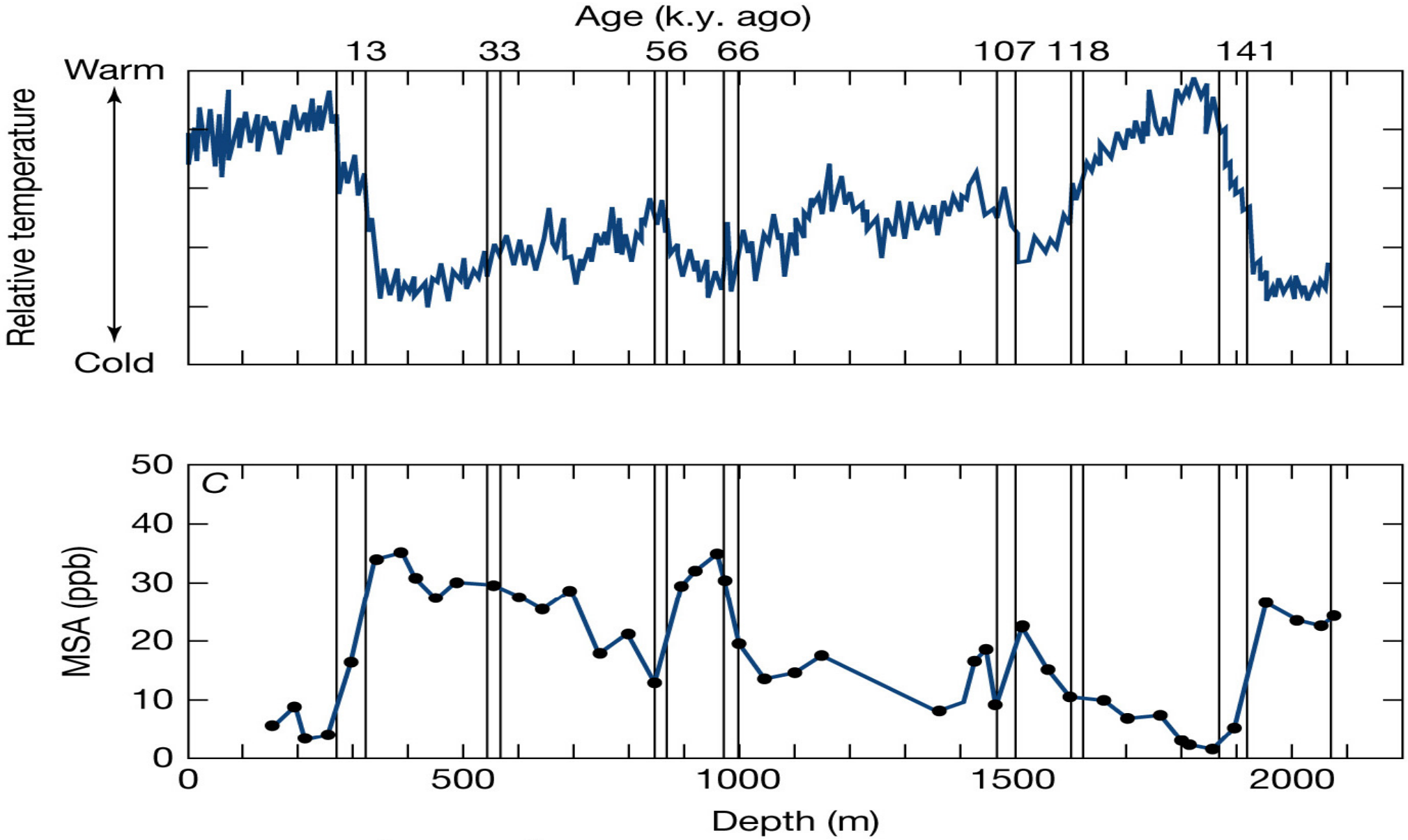


(a) Reconstructed vegetation cover, 18 k.y. ago

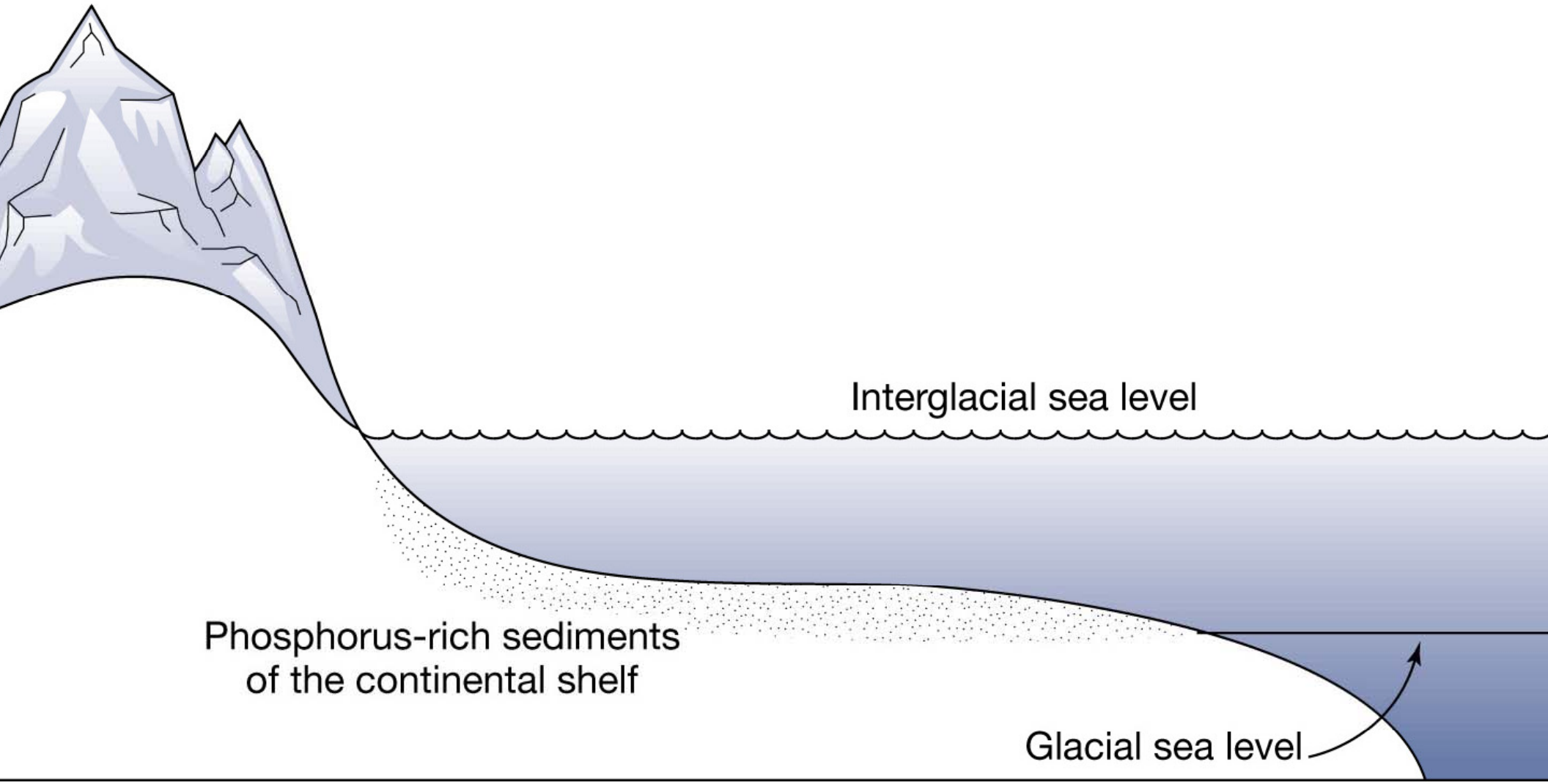


(b) Present-day "potential" vegetation cover.

Temperature compared to sulfur aerosol concentration



Nutrients related to sea level change



Nutrient cycle