

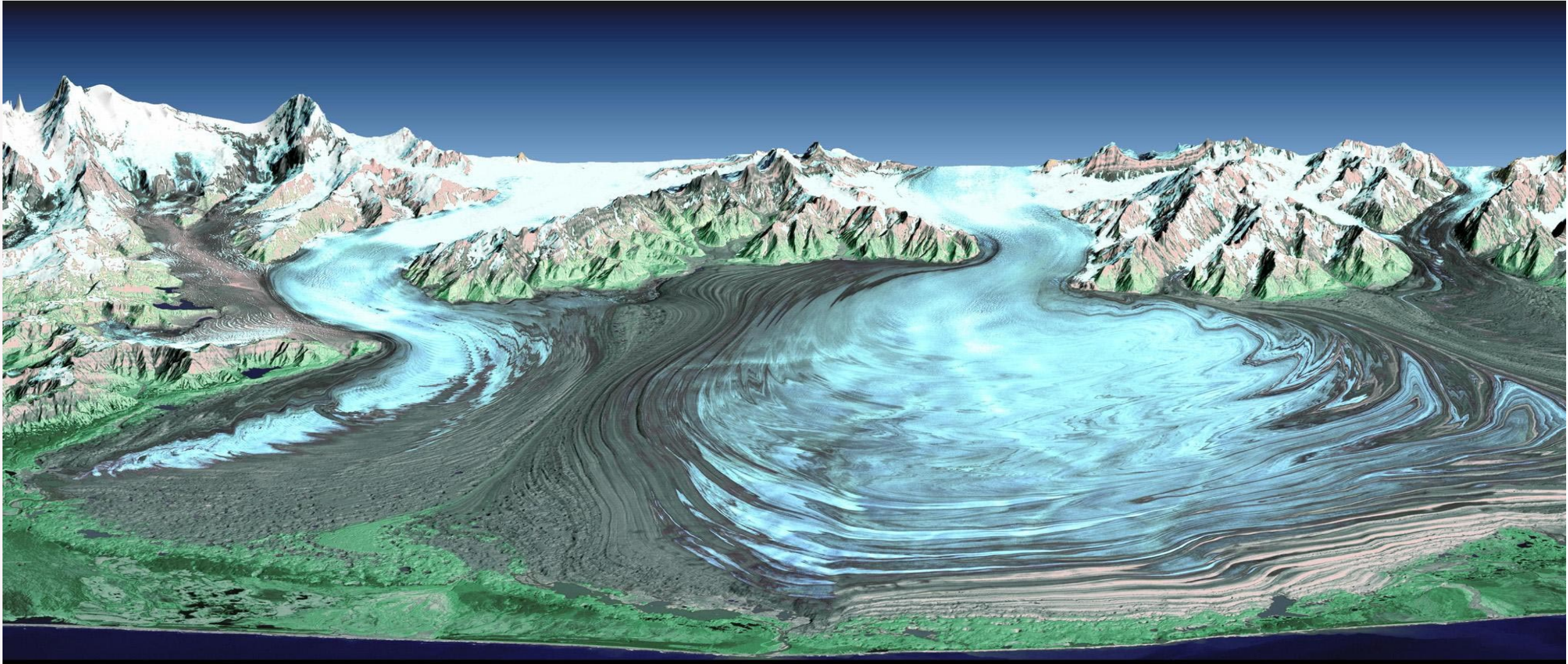
GEOGRAPHY BULLETIN

Edition 52, No 3, 2020

EXPLORING THE CRYOSPHERE

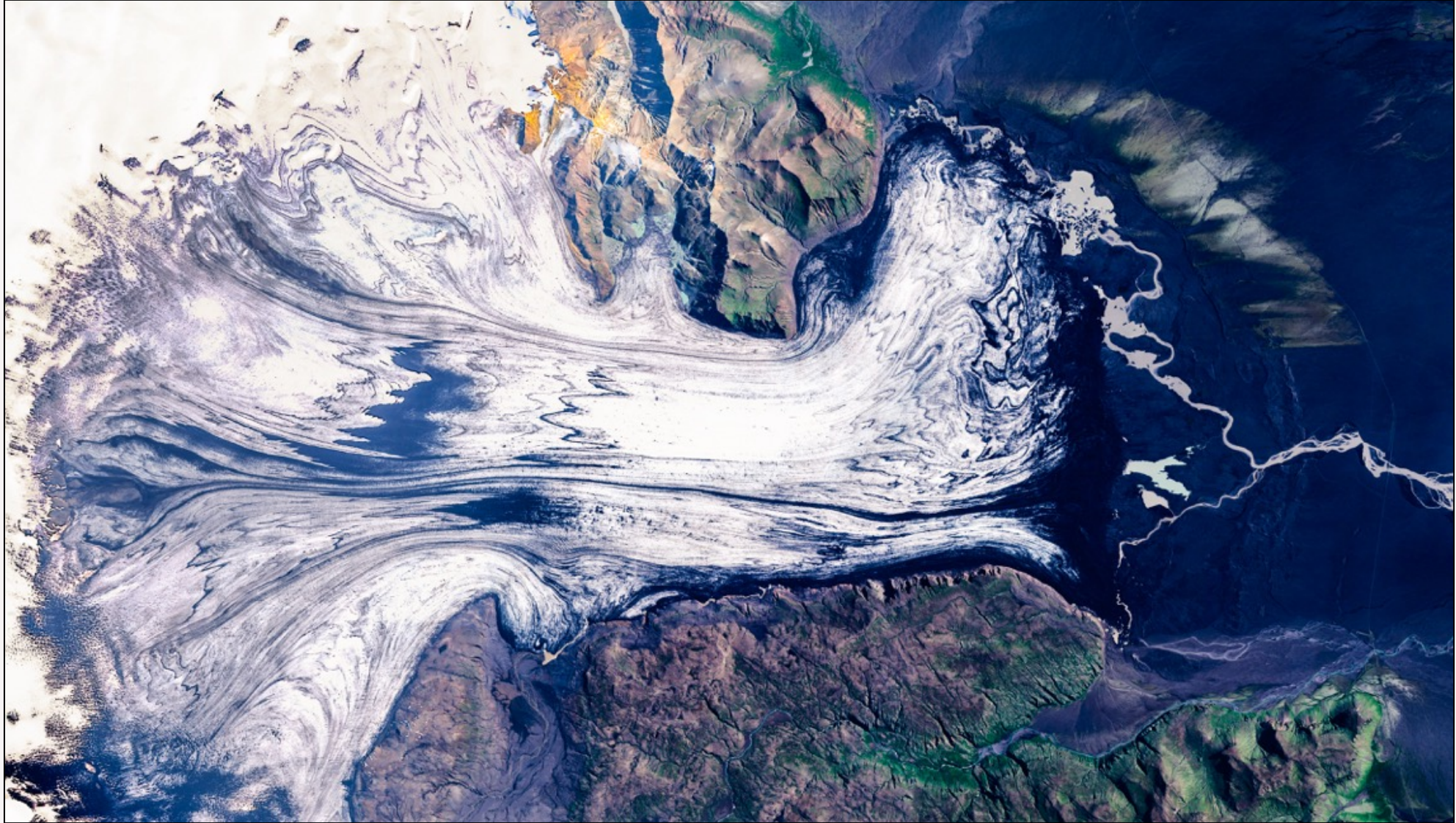
Created by L Chaffer for GTANSW & ACT Edition 52, No 3, 2020

What is the cryosphere?



<https://scitechdaily.com/ice-in-motion-incredible-time-lapse-satellite-footage-captures-decades-of-change/>

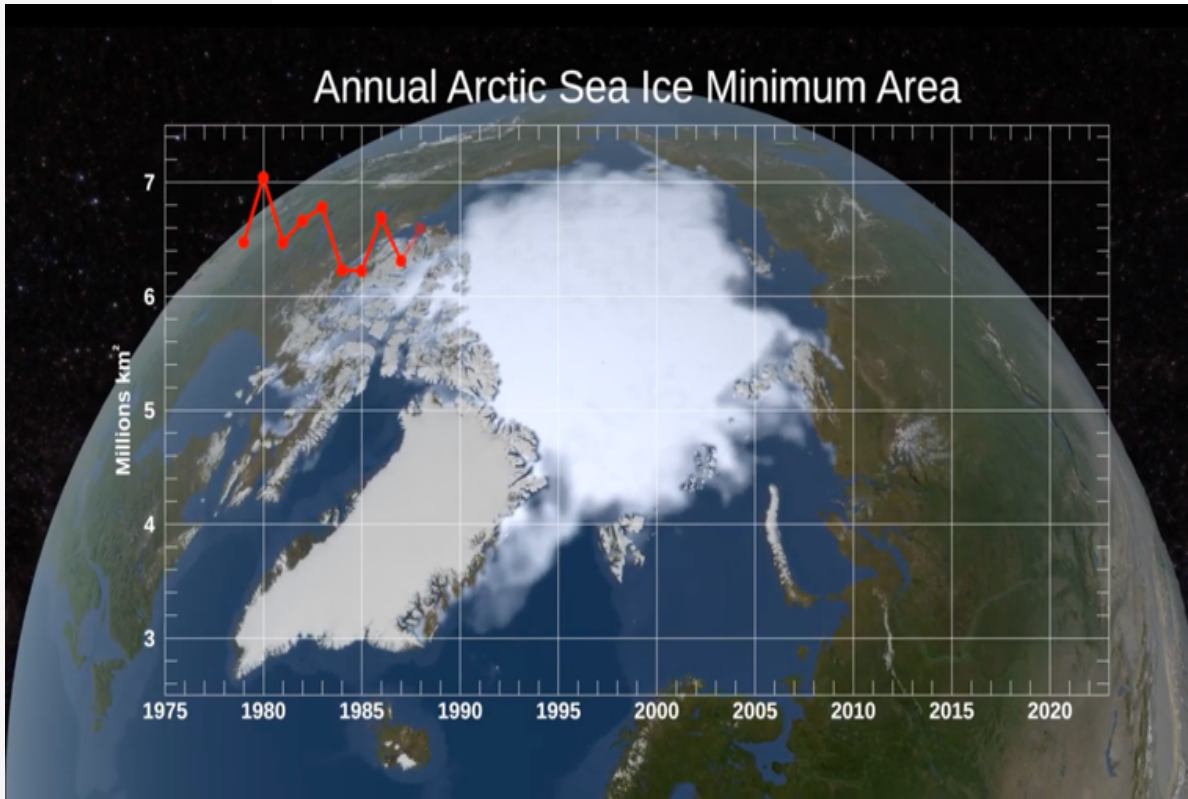
What is the cryosphere?



Source A [Shutterstock](#)

What is the cryosphere?

Source B: Arctic Ocean simulation

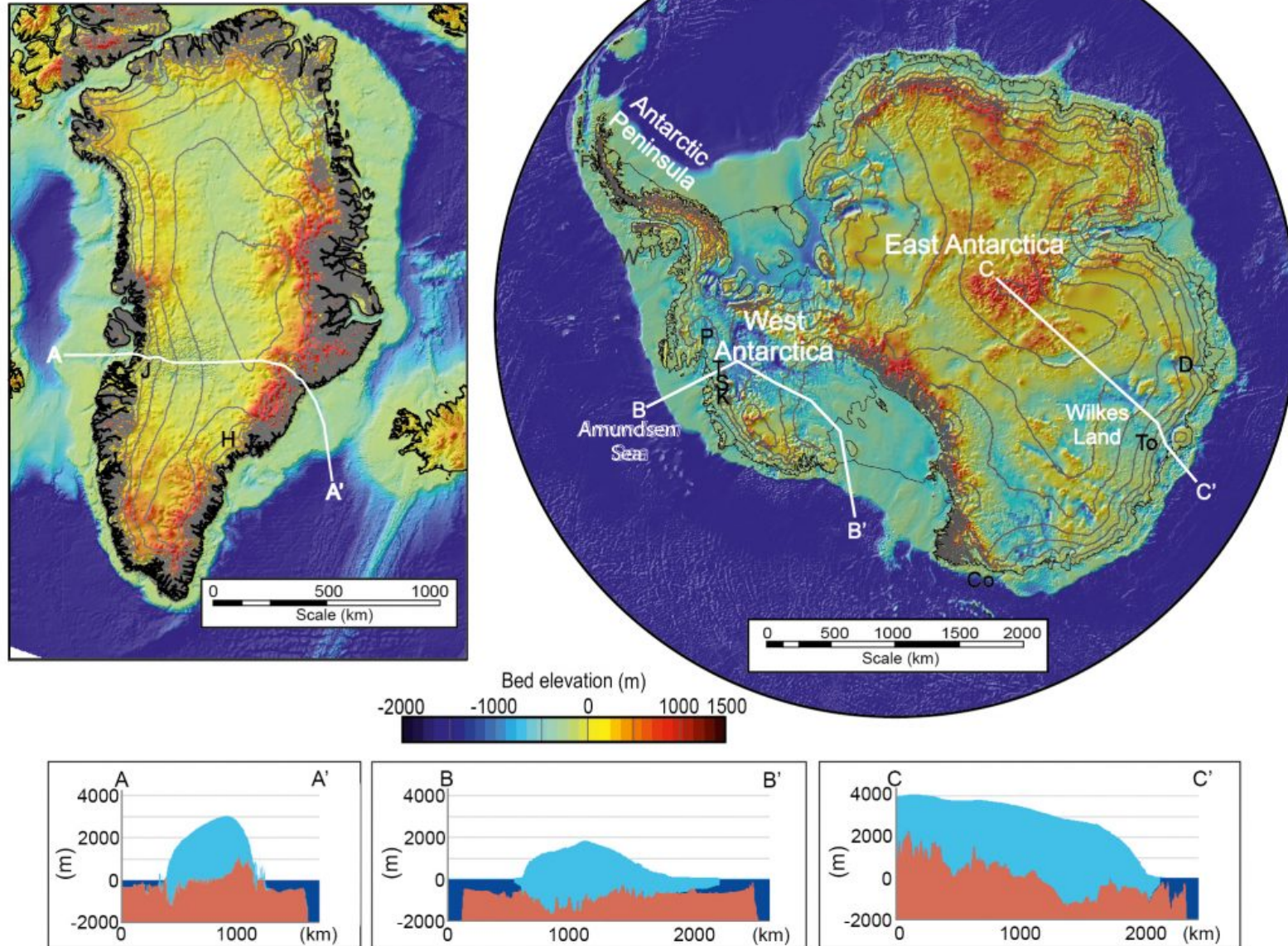


https://climate.nasa.gov/climate_resources/155/video-annual-arctic-sea-ice-minimum-1979-2019-with-area-graph/



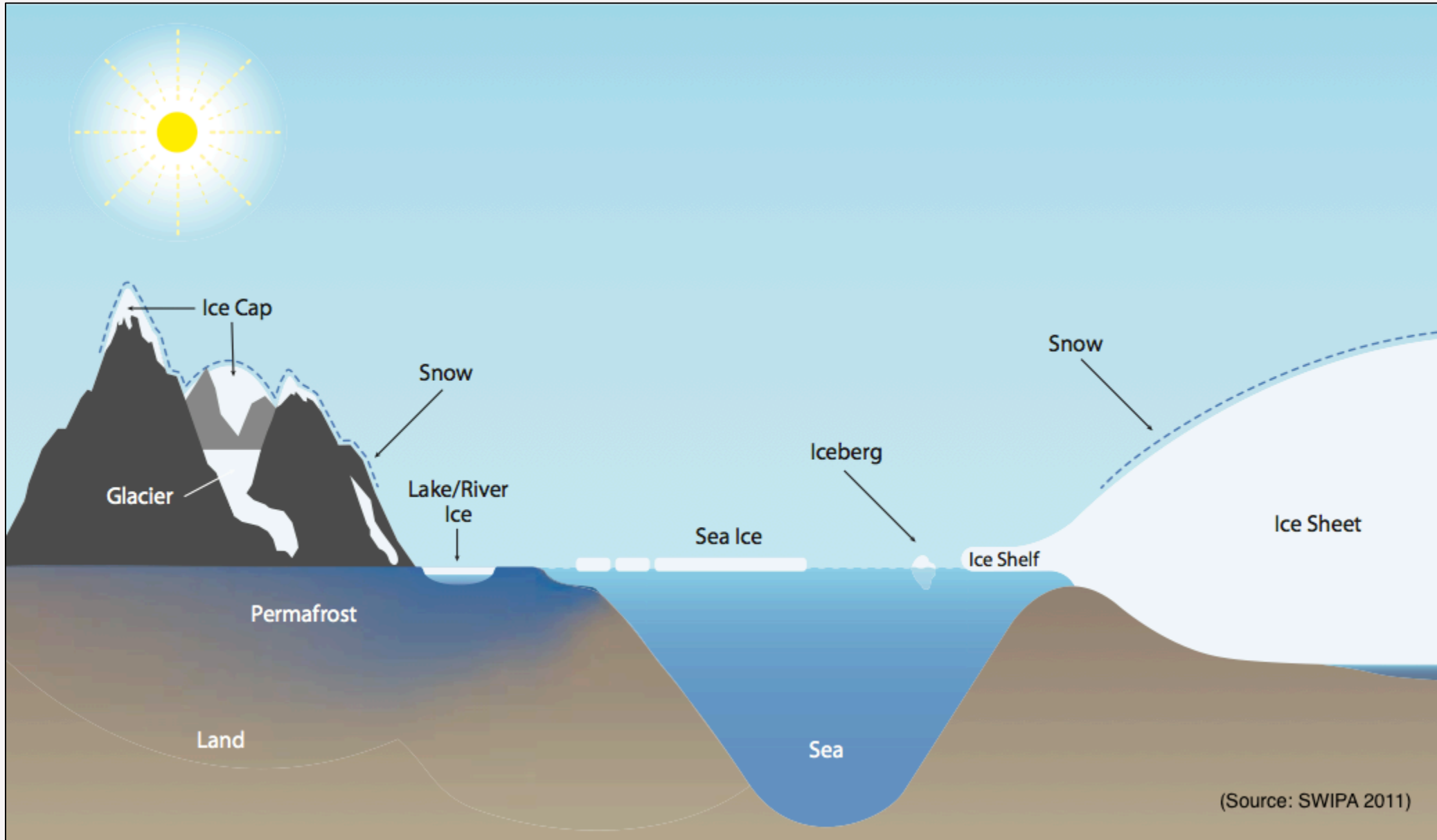
https://climate.nasa.gov/climate_resources/155/video-annual-arctic-sea-ice-minimum-1979-2019-with-area-graph/

What is the cryosphere?



Source C: Antarctica

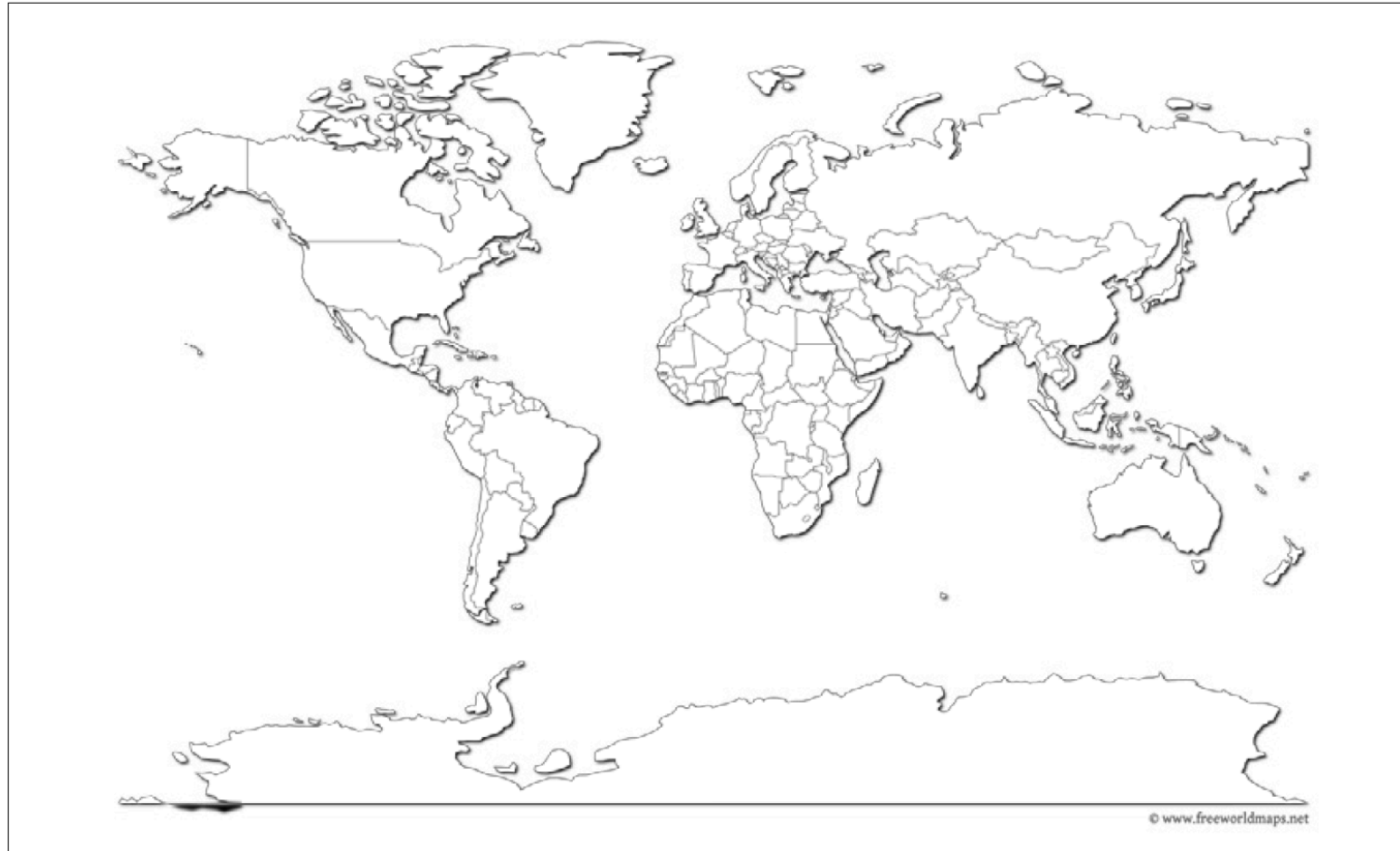
Features of the cryosphere



(Source: SWIPA 2011)

Source: <https://globalcryospherewatch.org/about/cryosphere.html>

Activity 2a. World map 1



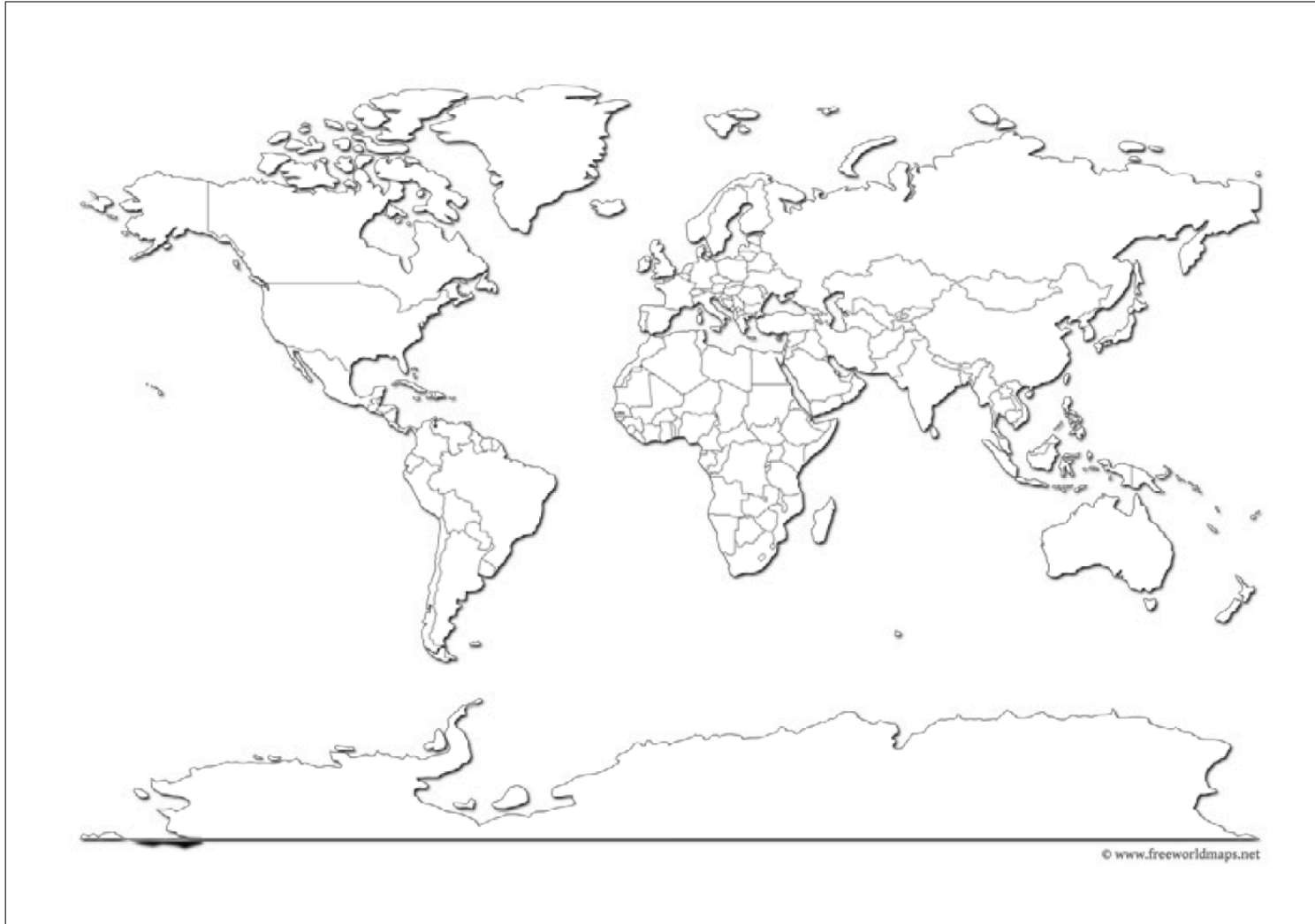
Can you map
the cryosphere?

Ice caps
Ice shelves
Sea ice
Glaciers
Permafrost

Source: <https://www.freeworldmaps.net/pdf/maps.html>

<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>

Activity 2b. World map 2



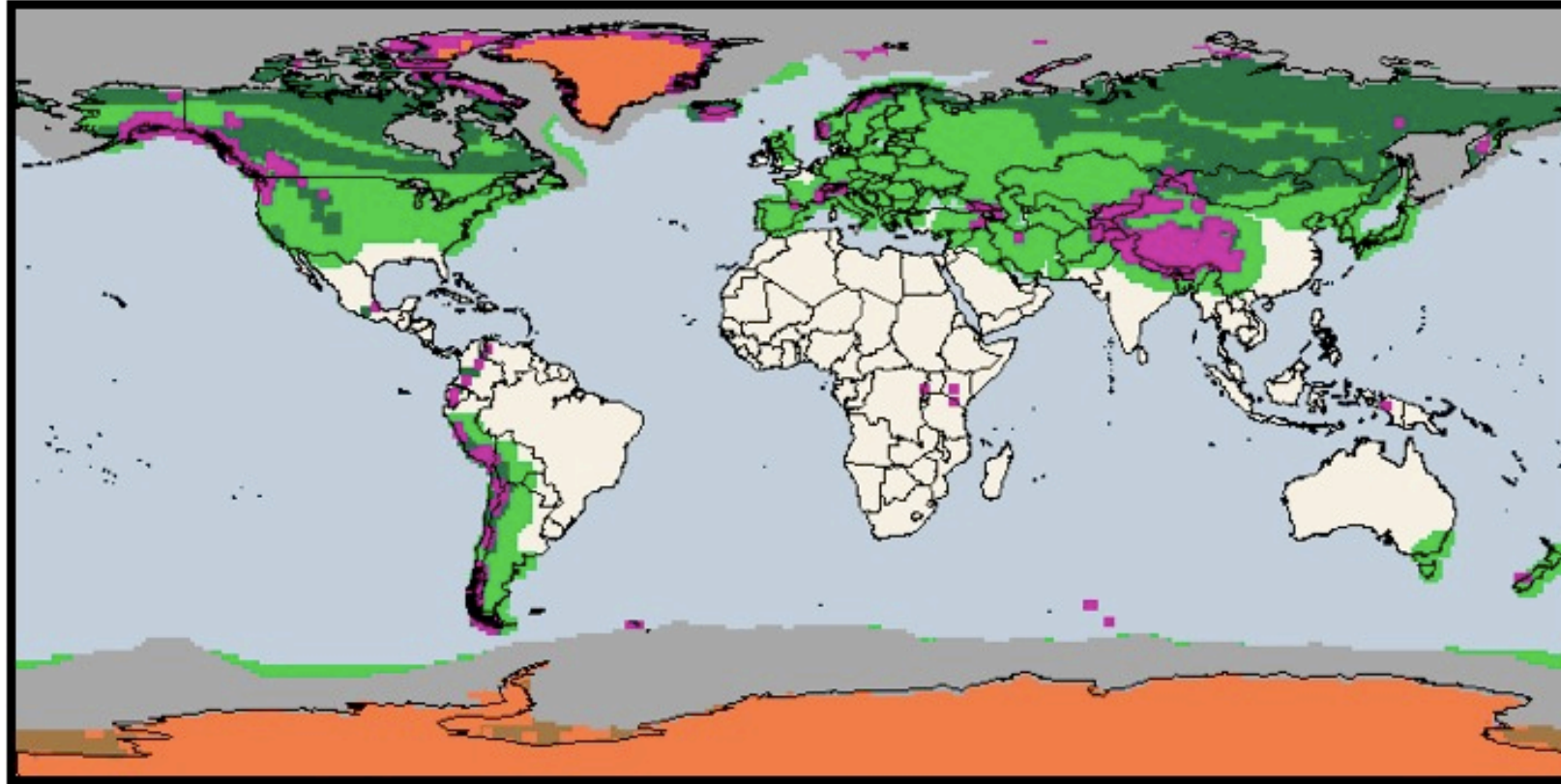
Can you map
the cryosphere?

Snow

Source: <https://www.freeworldmaps.net/pdf/maps.html>



Spatial distribution of the cryosphere



Glacier



Ice Sheets



Ice Shelves



Sea Ice



Permafrost



Snow Cover

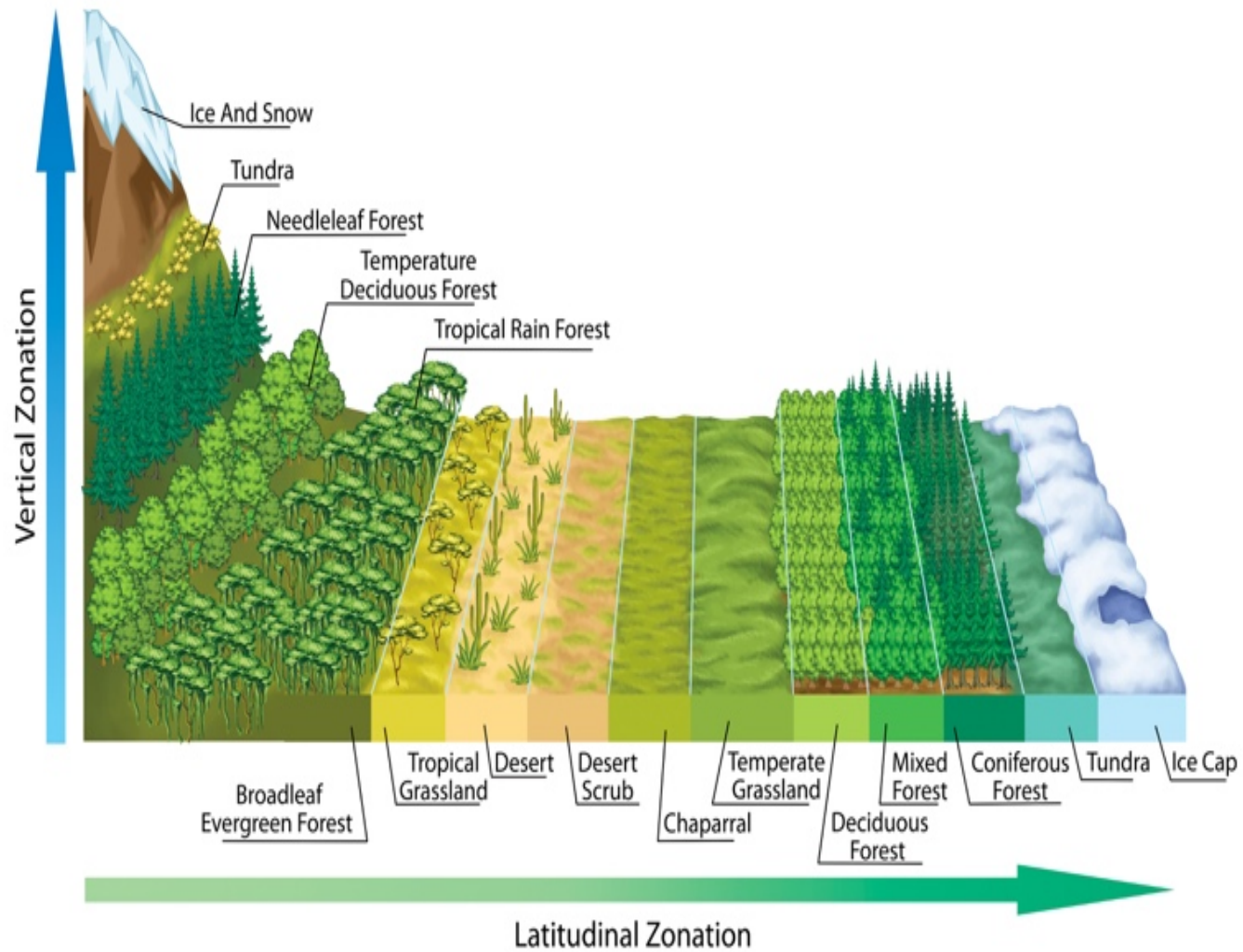


Peer assessment

1 mark for each correct location of a feature (by continent)

Maximum
20 marks

Factors influencing the location of the cryosphere



Source: Shutterstock

EARTH'S WATER CYCLE

● Storage ● Flow

● Freshwater in glaciers and snow

● Surface runoff

● Groundwater storage

● Soil moisture

● Precipitation

● Evaporation

● Freshwater in lakes and rivers

● Ice sheets

● Water storage in oceans

● Sea level

Cryosphere and Hydrosphere

Knowledge check

Where Is Earth's Water?



is in the oceans



is in lakes, rivers, streams and soil



is in polar ice caps, glaciers and permanent snow



is in water vapor in Earth's atmosphere

Select answers from : 0.001%; 1.7 %; 1.7%; 96.5%.

Check your answers

Where Is Earth's Water?



~96.5% is in
the oceans



~1.7% is in lakes,
rivers, streams
and soil



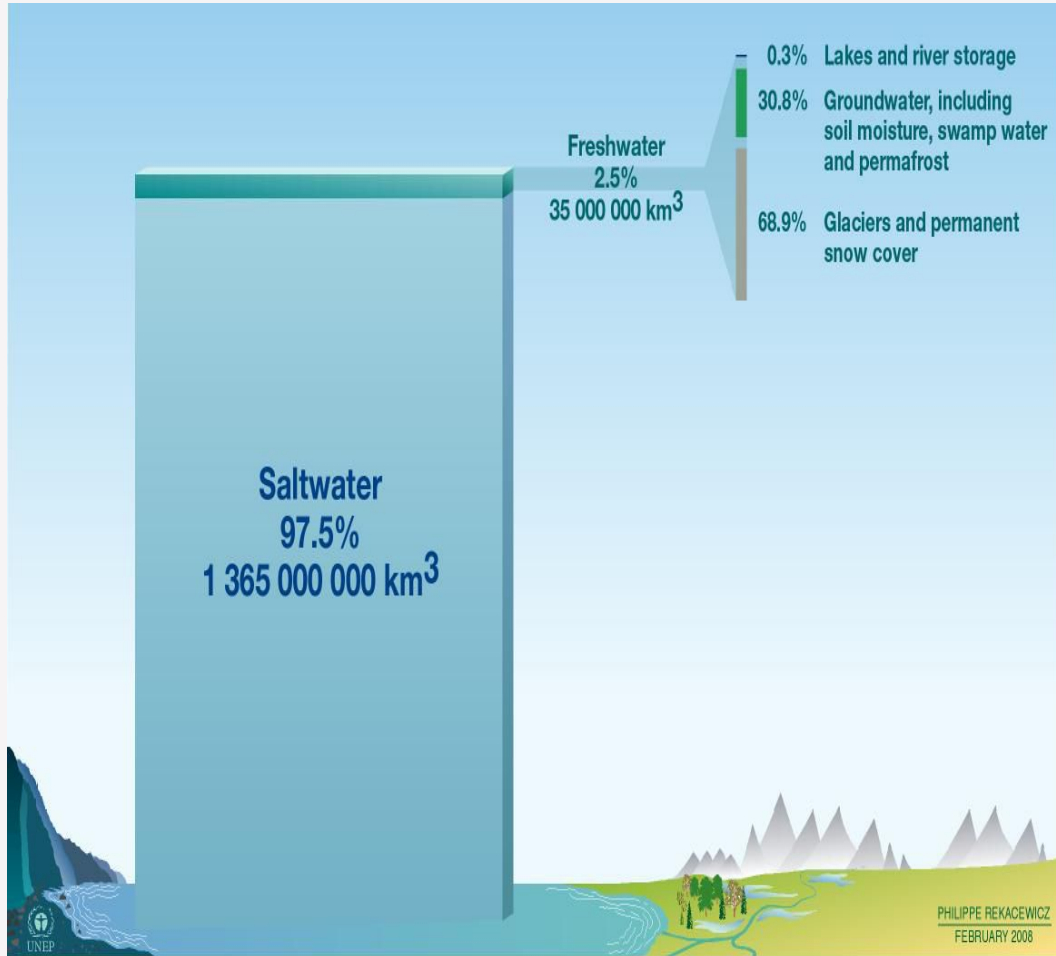
~1.7% is in polar
ice caps, glaciers
and permanent
snow



~.001% is in water
vapor in Earth's
atmosphere

Source: NASA Climate Kids – <https://climatekids.nasa.gov/water-cycle/>

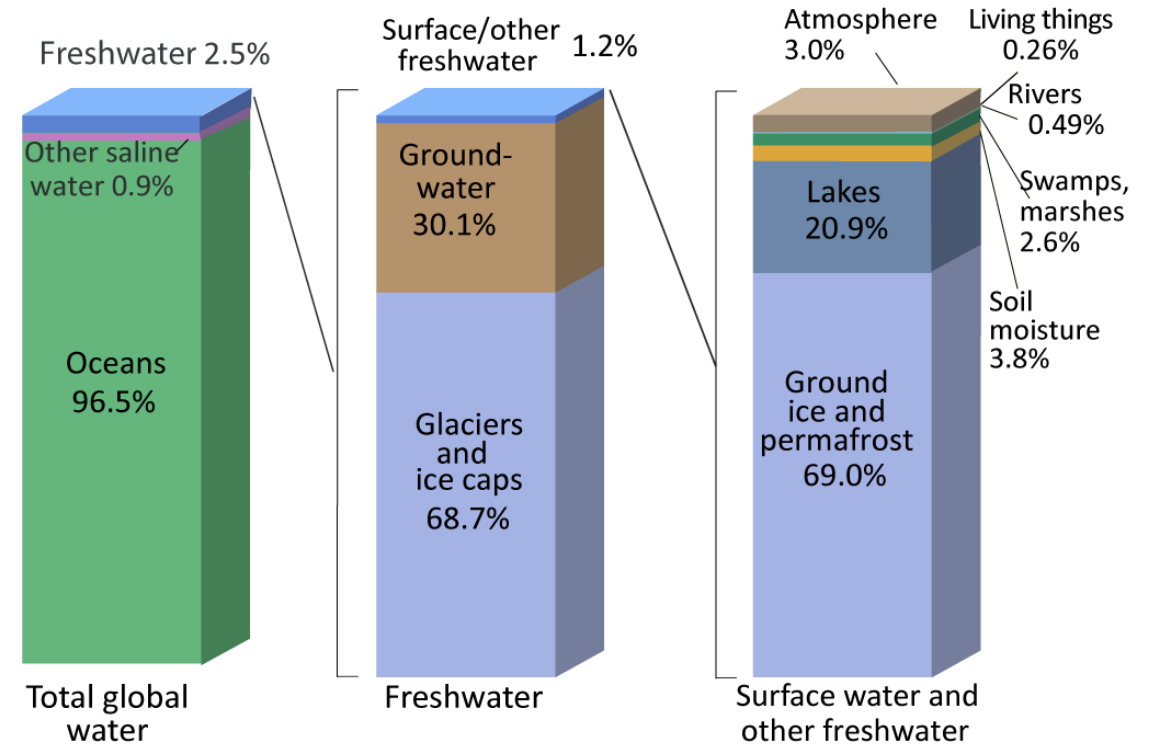
Visualising the location of the world's water



Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.

<https://www.nationalgeographic.org/media/water-distribution-earth/>

Where is Earth's Water?

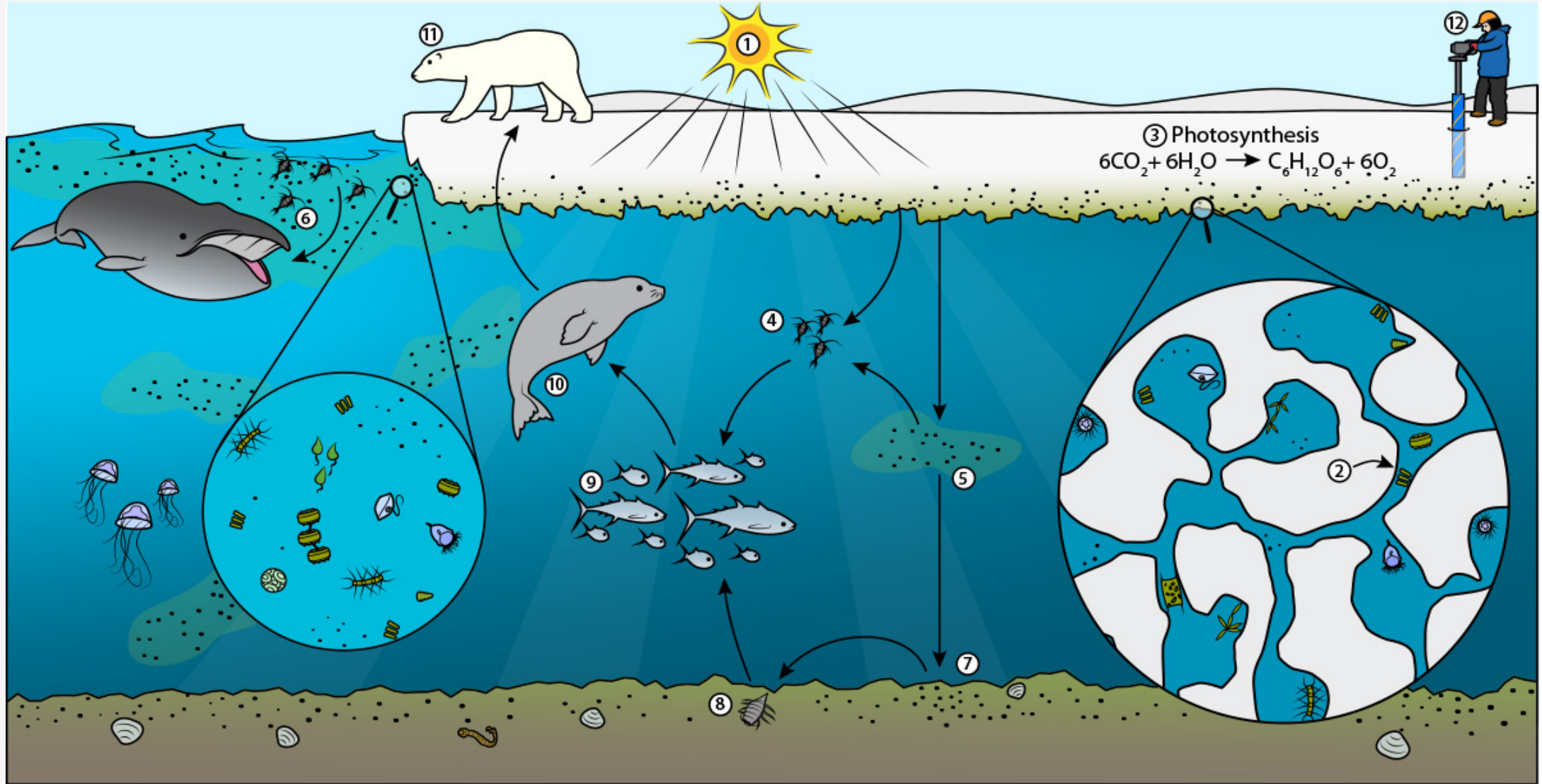


Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources*. (Numbers are rounded).

<https://www.usgs.gov/media/images/distribution-water-and-above-earth>

Cryosphere - Biosphere

Arctic sea-ice ecosystem



Source <https://askabiologist.asu.edu/explore/frozen-life>

Biophysical interactions

Components	Interactions	Your examples	Issues
Cryosphere ⇕ Hydrosphere	Glacier meltwater and runoff contributes to water flows, affecting freshwater availability for irrigation, hydropower, and ecosystems. The runoff is seasonal, with a minimum in the snow-accumulation season, and a maximum in the melt season.		
Cryosphere ⇕ Atmosphere	The cryosphere plays an important role in the Earth's climate. Snow and ice reflect heat from the sun, helping to regulate Earth's temperature. The cryosphere is one of the first places that scientist study to identify global changes in climate.		
Cryosphere ⇕ Biosphere	Ice provides a habitat for animals and plants and supports marine and terrestrial ecosystems such the arctic ocean, tundra and mountain ecosystems. People		
Cryosphere ⇕ Lithosphere	Glaciers transport material as they move and sculpt land into distinctive landforms. A glacier's weight and gradual movement reshape landscapes over time. Permafrost frozen ground, soil, sediment, or rock up to 1,000 metres thick that remains at or below 0°C for at least two years. Some permafrost thaws seasonally releasing water into the environment.		

Cryosphere change

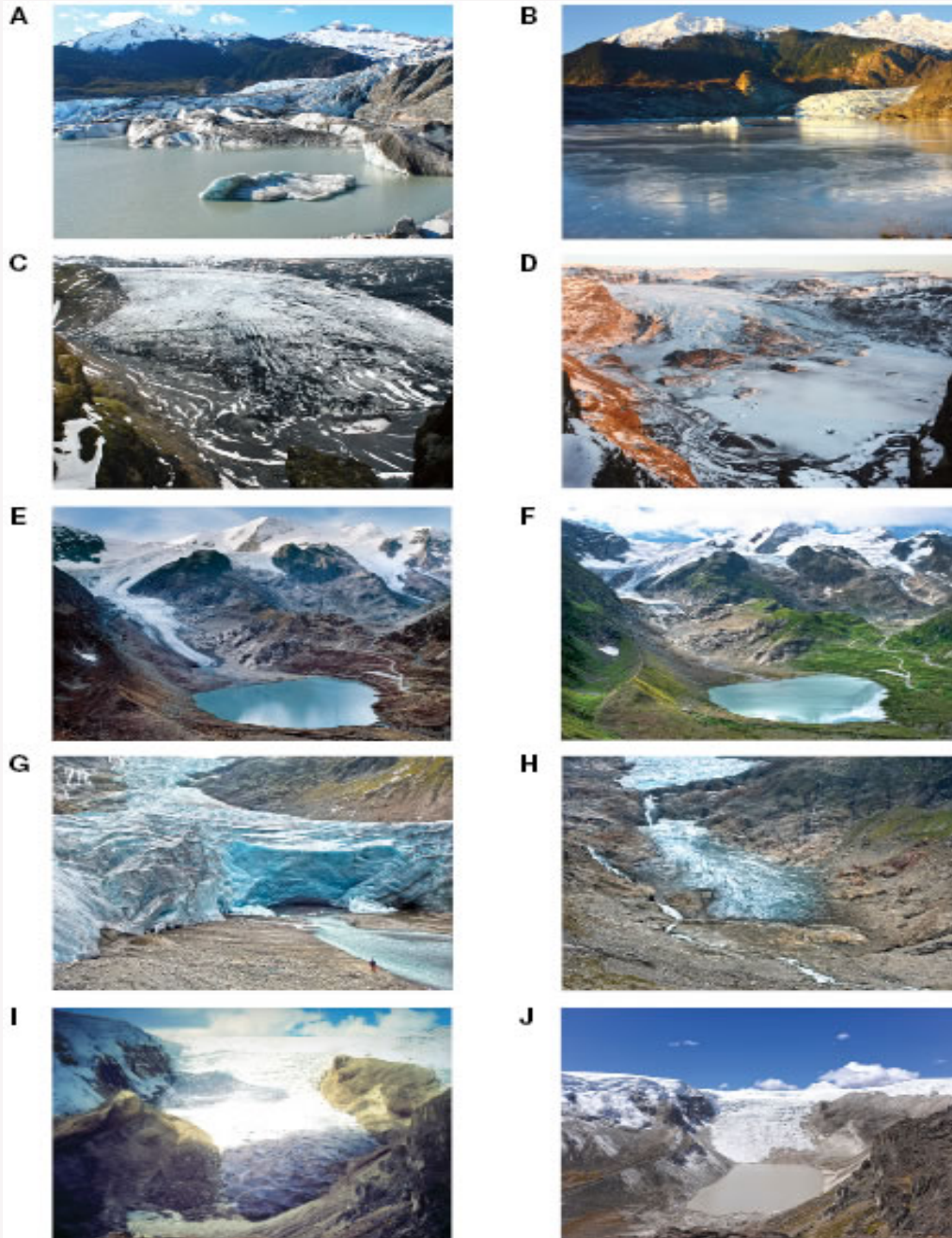
Time lapse photographs of melting glaciers

Composite image

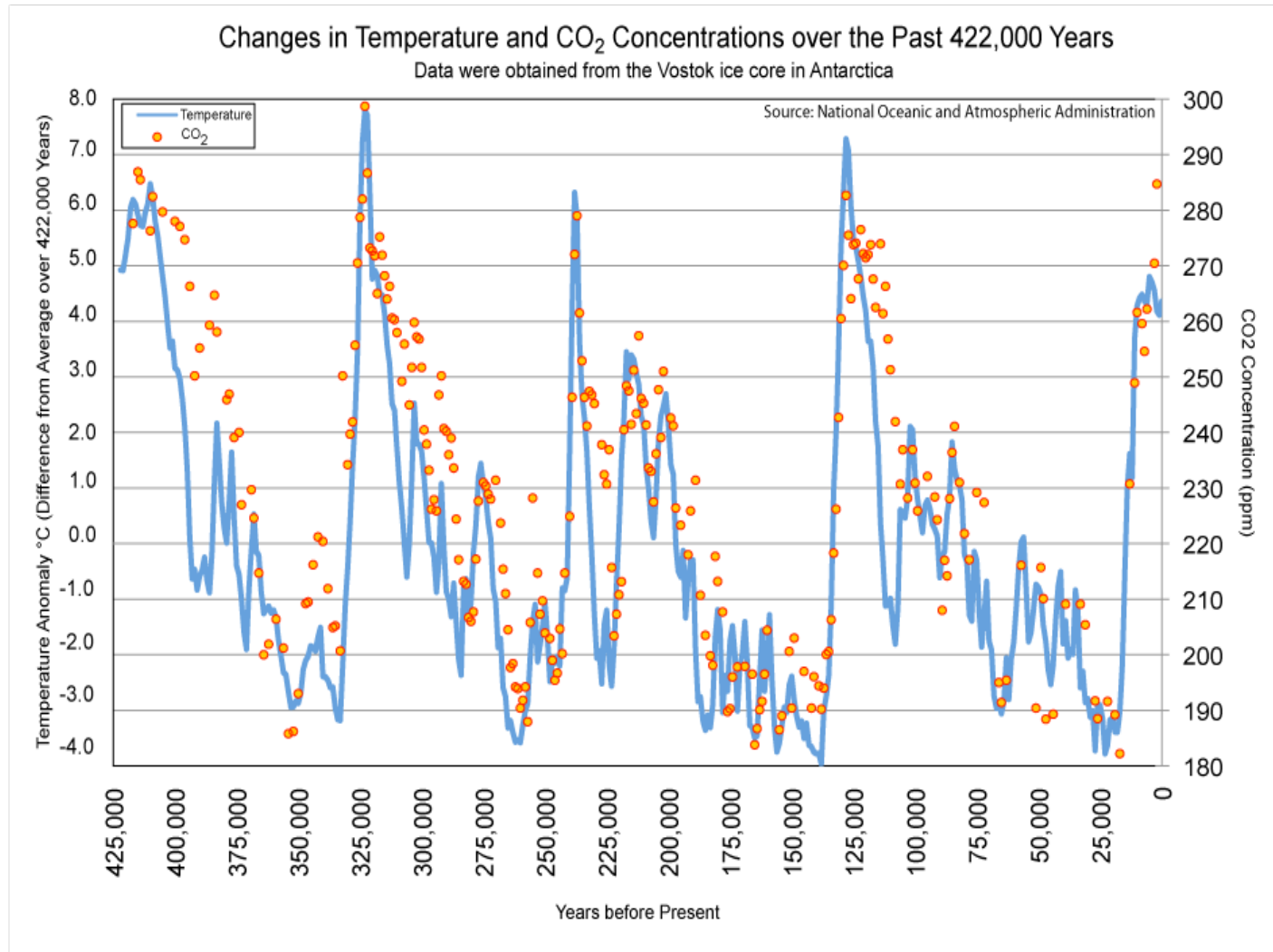
<https://desdemonadespair.net/2017/04/these-stunning-timelapse-photos-may.html>

Original individual images

<https://www.washingtonpost.com/news/energy-environment/wp/2017/04/03/you-cant-deny-climate-change-once-you-see-these-images/>

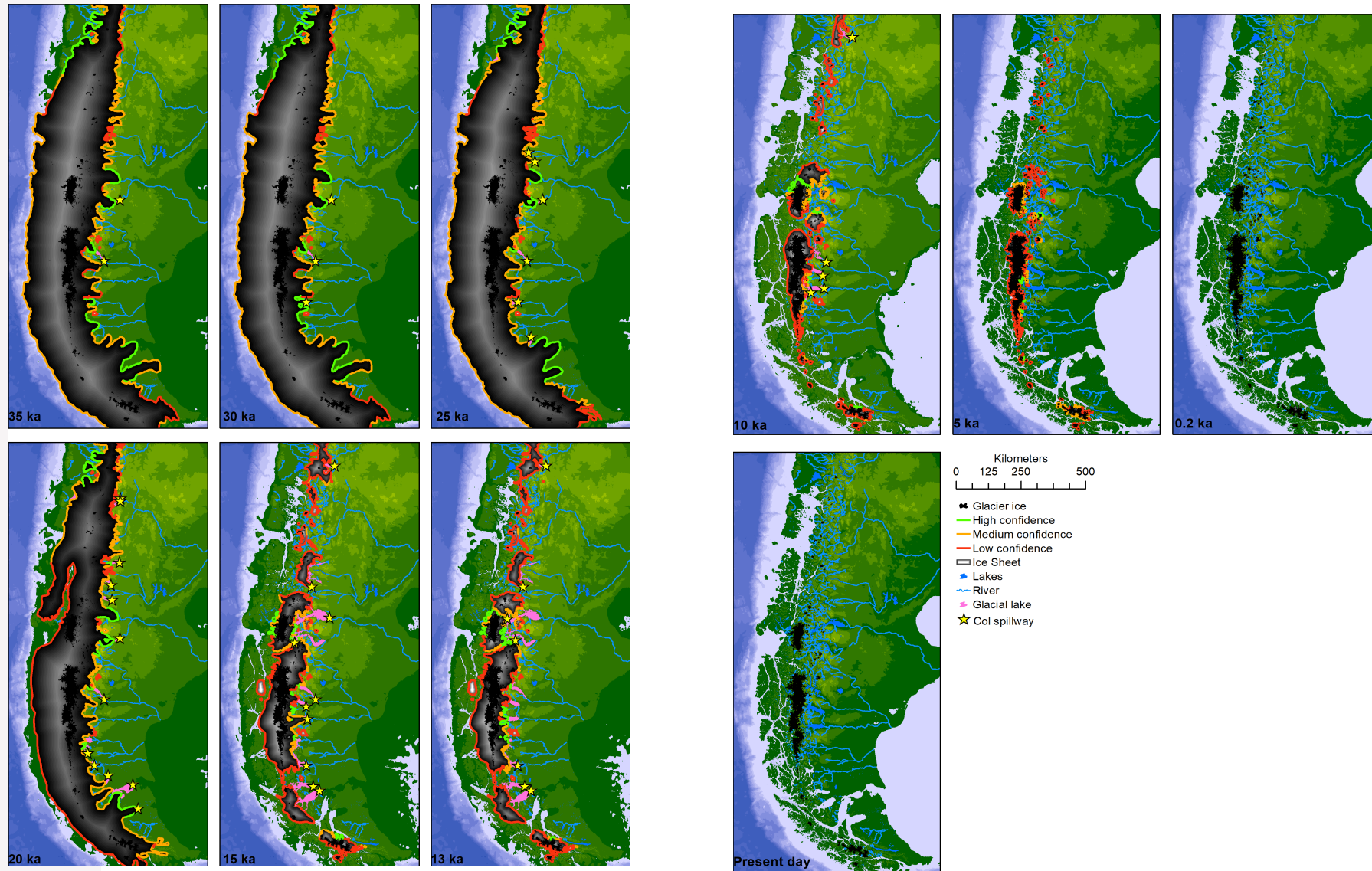


Cryosphere change: Glacial and Interglacial cycles



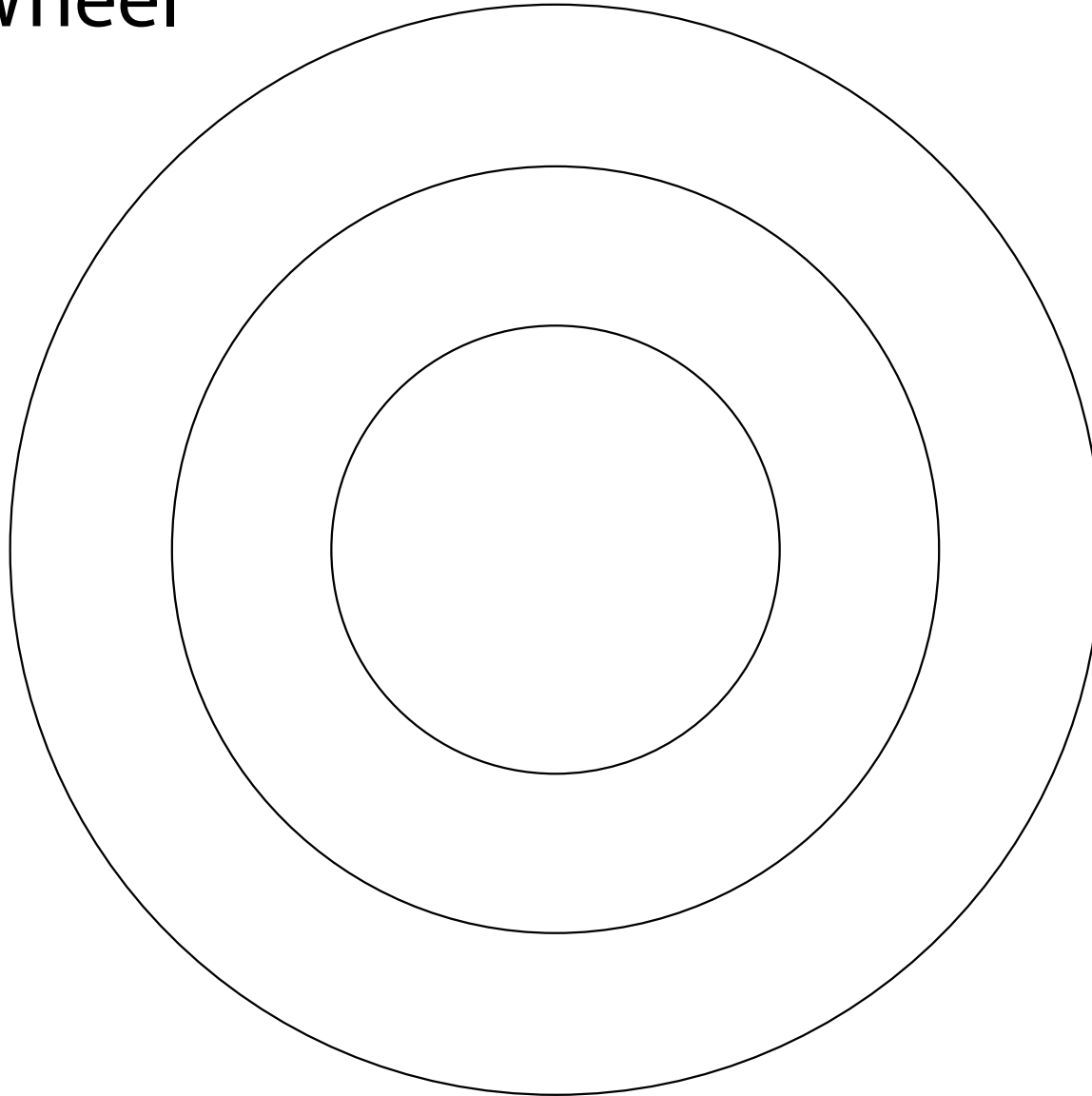
Source: Georgia State University School of Geosciences – <http://sites.gsu.edu/geog1112/lab-6-part-5/>

Cryosphere change: Recession of Patagonian glaciers and ice-dammed lakes



Source: <http://www.antarcticglaciers.org/glacial-geology/patagonian-icesheet/patice/patice> 2020 02 28 1000-2/

Futures Wheel



Complete a Futures Wheel / Consequence Chart with the statement 'If all Earth's ice melted?' in the centre.

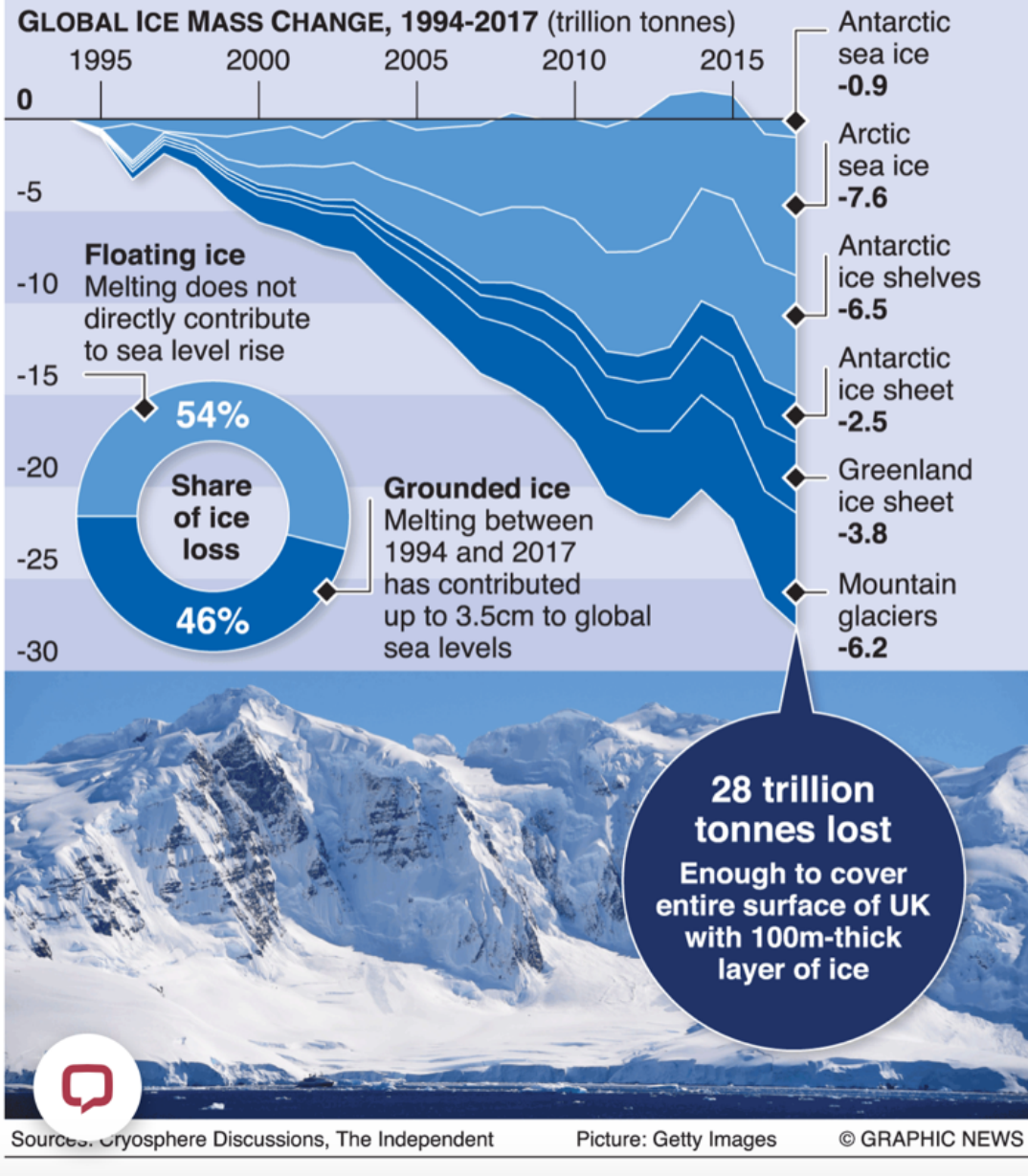
Biophysical Interactions

Stage 6 Skills: Cryosphere

Refer to SOURCES H, I and J: (Bulletin 52, Edition 3 p106-107)

- i. Complete a PQE for the graph line graph in Source I.
- ii. Calculate the total weight of ice loss in 2000 and 2015.
- iii. Calculate the % change in ice loss between 2000 and 2015.
- iv. Define ‘grounded ice’ and ‘floating ice’ using your understanding of the cryosphere.
- v. Why is the loss of grounded ice seen as a greater threat than the loss of floating ice?

The Earth has lost 28 trillion tonnes of ice from its surface since 1994, according to a study by UK scientists who warn that sea level rises could reach a metre by the end of the century



SOURCE I

Earth has lost 28 trillion tonnes of ice since 1994

August 26, 2020 - The Earth lost 28 trillion tonnes of ice between 1994 and 2017 with 60 percent of melting occurring in the northern hemisphere, according to data published in the online journal Cryosphere Discussions.

A group of researchers describe the ice loss as “staggering” and warn that melting glaciers and ice sheets could cause sea levels to reach a meter by the end of the century.

The analysis showed that the rate of ice loss has risen by 57 percent since the 1990s

The majority of all ice losses were driven by atmospheric melting, with 68 percent from Arctic sea ice, mountain glaciers, ice shelf calving and ice sheet surface mass balance. The remaining 32 percent of the losses were from ice sheet discharge and ice shelf thinning, driven by oceanic melting.

Source: Graphic News

<https://www.graphicnews.com/en/pages/40501/environment-global-ice-loss>

Refer to SOURCES H, I and J: (Bulletin 52, Edition 3 p107)

- vi. Describe the impacts of ice losses on glaciers with specific reference O Sources H and J
- vii. Explain the processes contributing to changes in Thwaite glacier.
- viii. Explain why Thwaite Glacier is called the “doomsday glacier”
- ix. Identify similarities between Mont Blanc glacier and Thwaite glacier.
- x. Identify differences between Mont Blanc glacier and Thwaite glacier. Are these differences significant?
- xi. Explain the connection between Source I and Sources H and J



SOURCE H

Mont Blanc glacier on brink of collapse

September 25, 2019 - Part of a glacier on a mountain in the Mont Blanc range is at risk of collapse, prompting Italian authorities to close roads and evacuate Alpine hamlets.

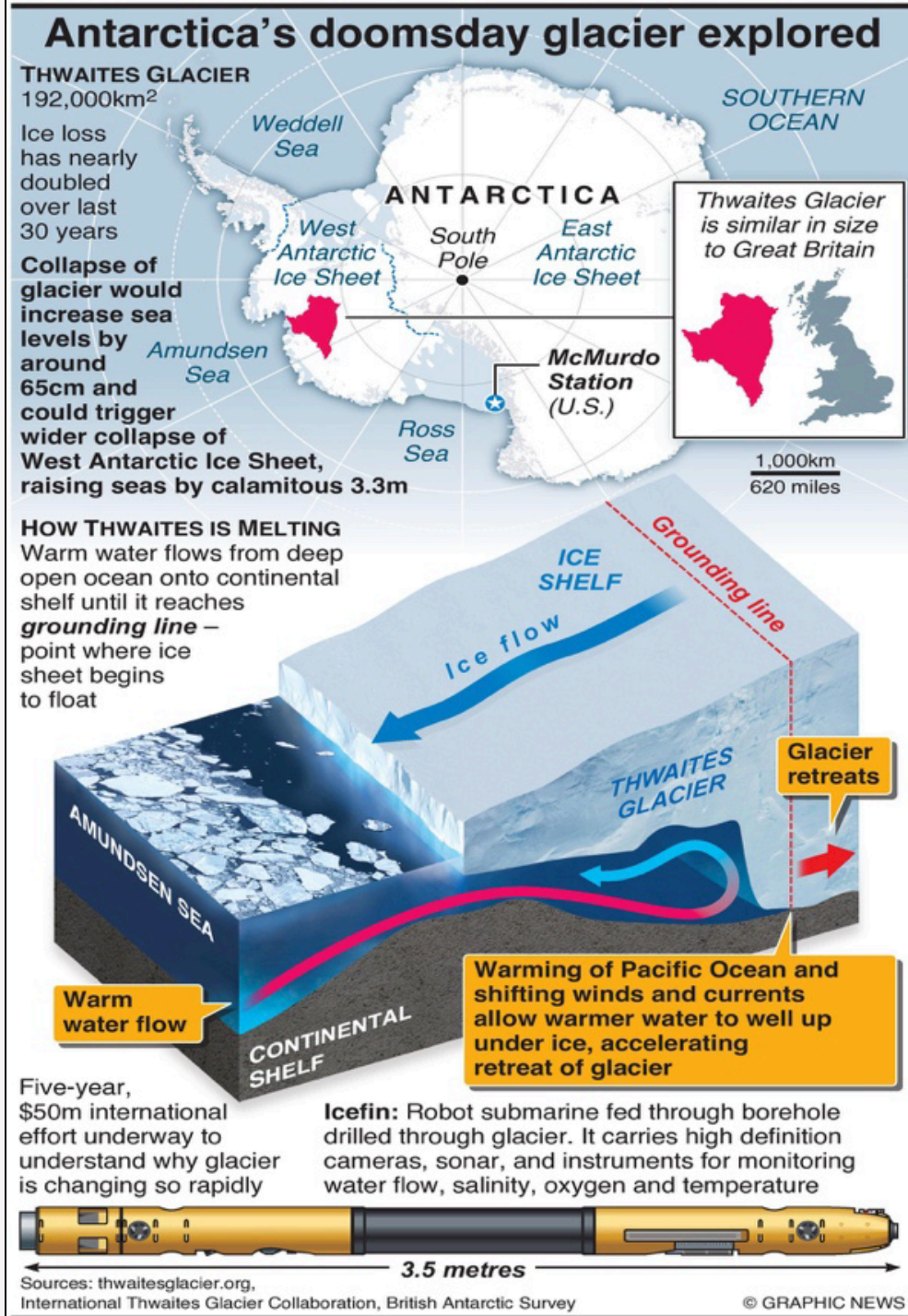
A section estimated to contain up to 250,000 cubic metres of ice could fall down the mountain, the mayor of the nearby town of Courmayeur has warned.

Roads on the Italian side of Mont Blanc have been closed, after experts warned that a section of the glacier was sliding at speeds of 50-60cm per day.

Rising global temperatures are causing the melting of mountain glaciers and the retreat of polar ice sheets.

Source: Graphic News

<https://www.graphicnews.com/en/pages/39543/climate-changemont-blanc-glacier-collapse>



SOURCE J

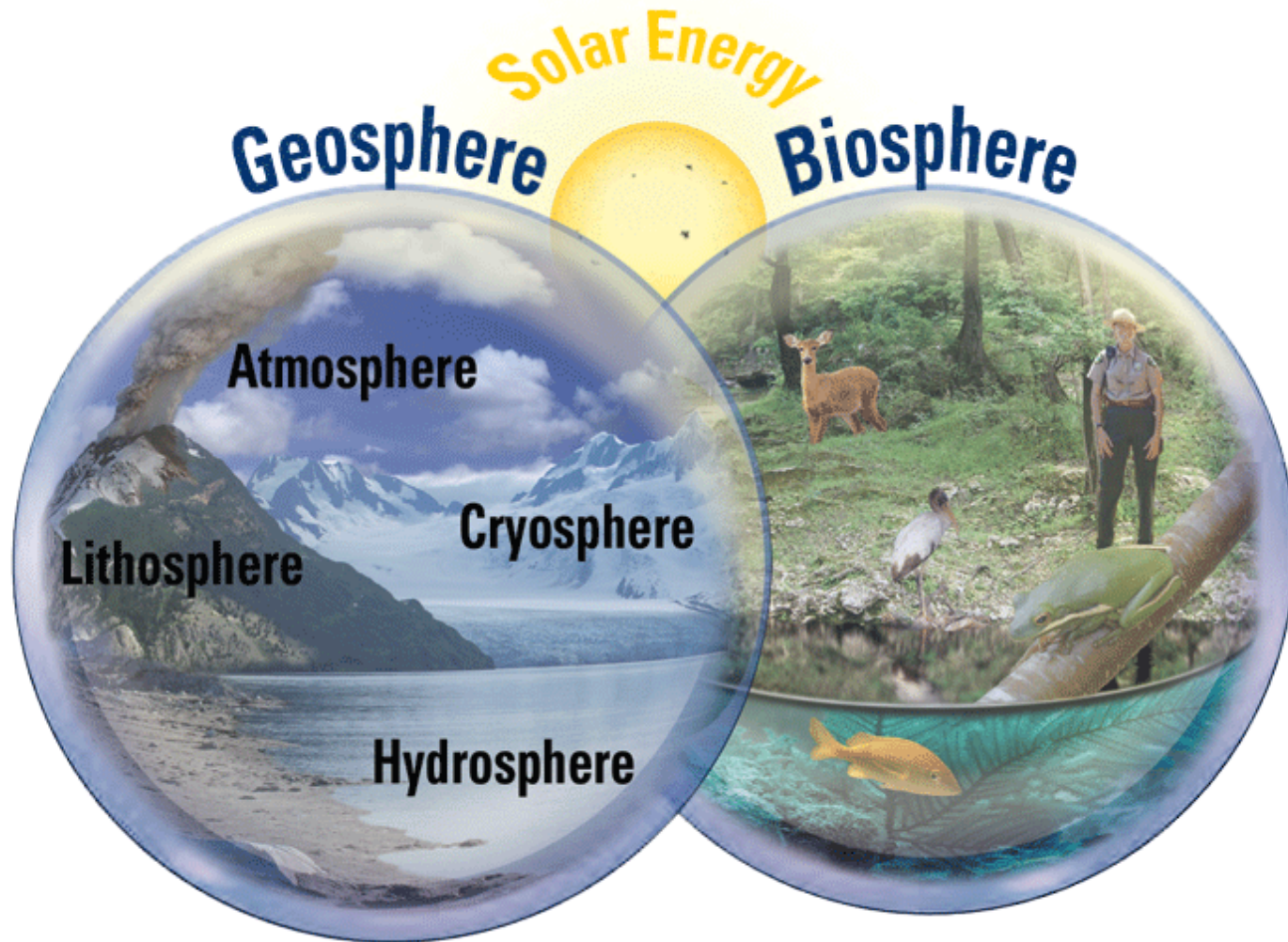
Antarctica's doomsday glacier melting fast

January 29, 2020 - A massive research effort is underway to understand why the Thwaites glacier is melting so fast. If it collapses, it could trigger catastrophic sea level rise, putting coastal cities around the world at risk.

Thwaites glacier, covering 192,000 square kilometres – an area the size of Great Britain – is particularly susceptible to climate and ocean changes. Over the past 30 years, the amount of ice flowing out of the region has nearly doubled.

*Source: Graphic News

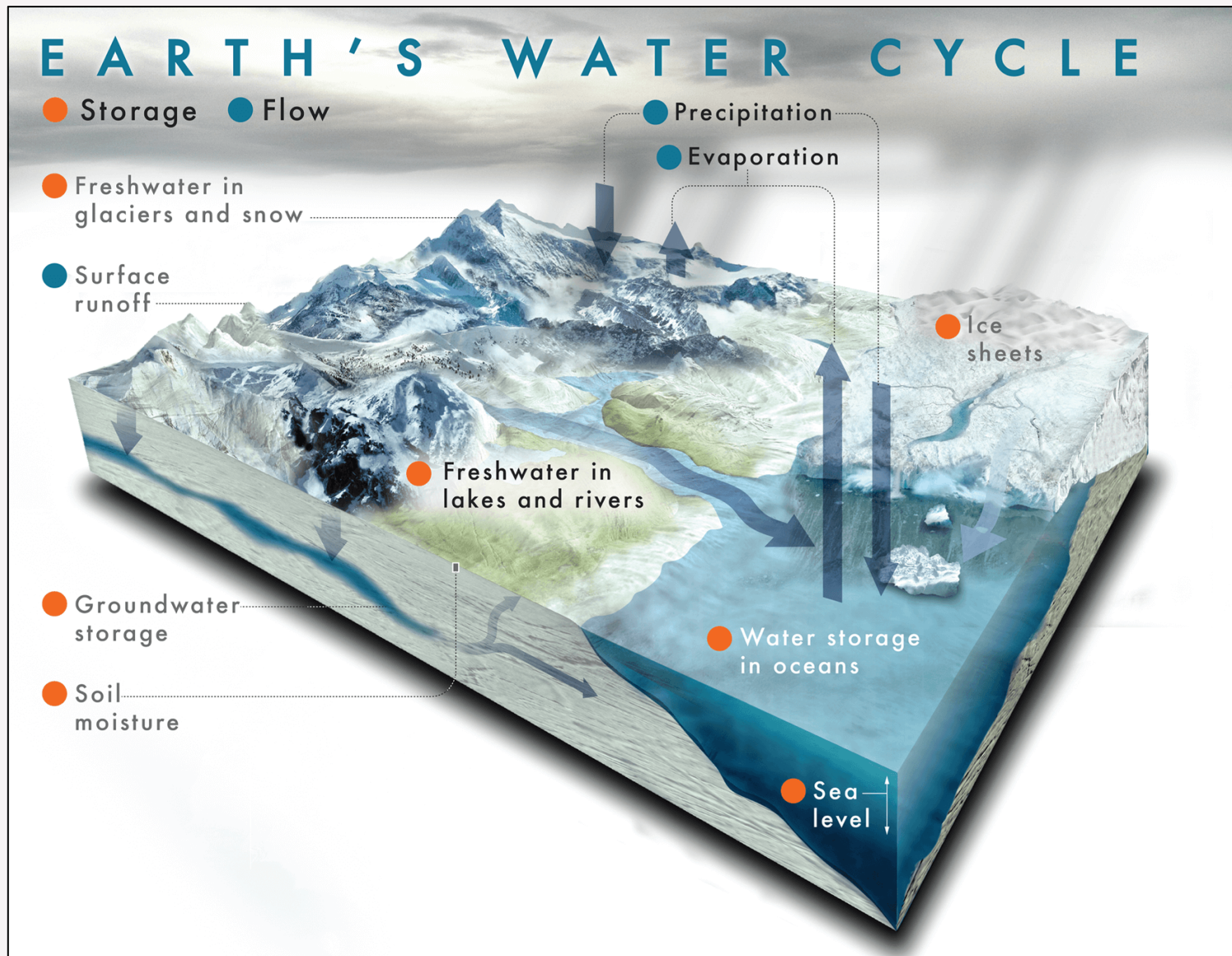
<https://www.graphicnews.com/en/pages/39917/climate-change-antarcticas-doomsday-glacier-1>



BIOPHYSICAL INTERACTIONS

Knowledge retrieval
activities

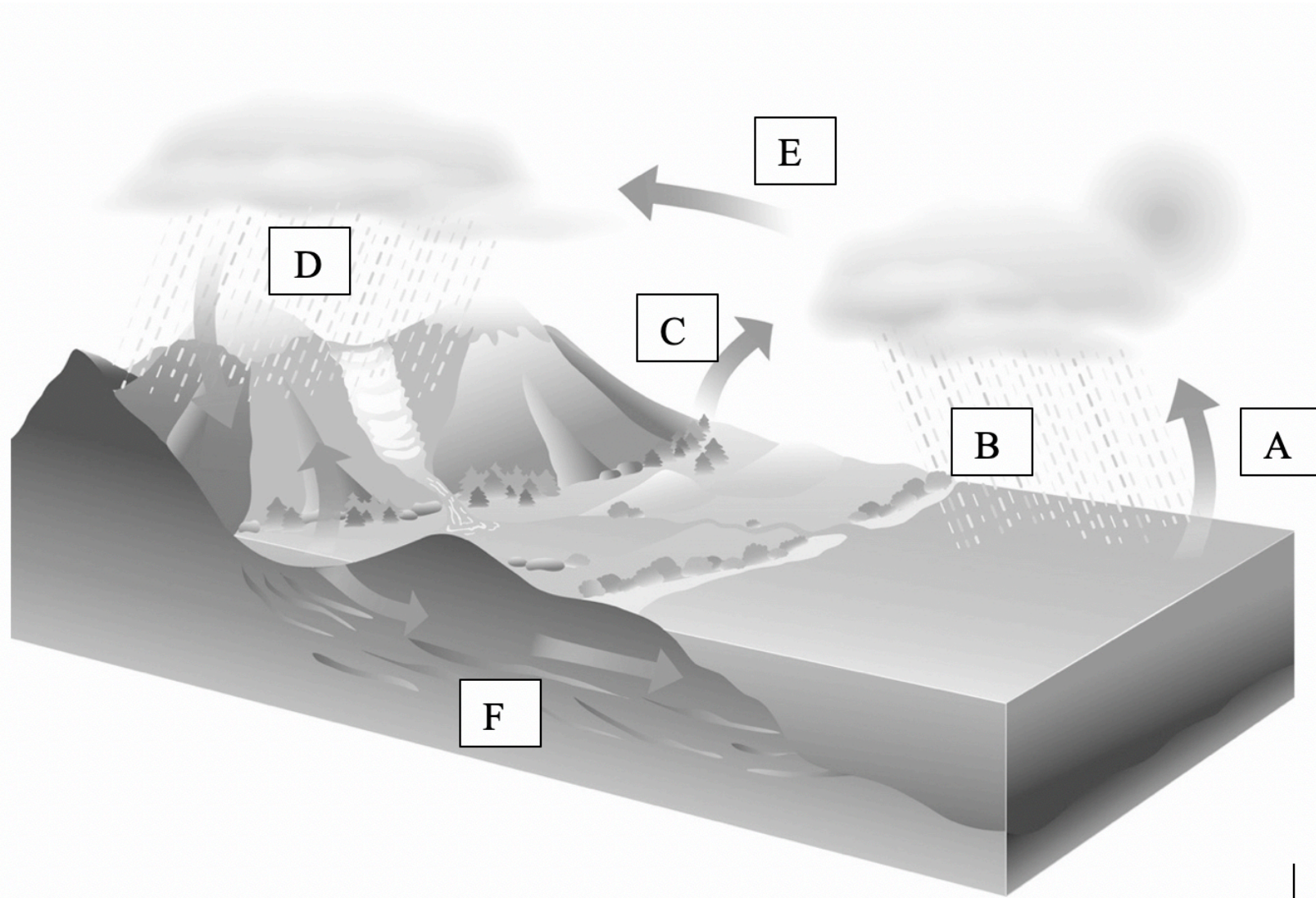
Source: <https://www.geographyrealm.com/what-are-the-earths-systems/>



HYDROSPHERE RECALL ACTIVITY

Worksheet
Bulletin Supplement pp 32

A. Transfer of water through the hydrological cycle



A. Transfer of water through the hydrological cycle

WATER transferred through the water cycle	LETTER	WATER CYCLE process and location
40,000 km ³		
40,000 km ³		
70,000 km ³		
110,000 km ³		
390,000 km ³		
430,000 km ³		

LITHOSPHERE RECALL ACTIVITY

Complete 'Its wrong Can you Fix it'
Worksheet

Bulletin Supplement P36

AND

The following investigation
TO

Retrieve your knowledge and
understanding of the biosphere.

Where in the world can you scuba
dive and walk between earth's
tectonic plates?

* Must be a country



Source A [Shutterstock](#)



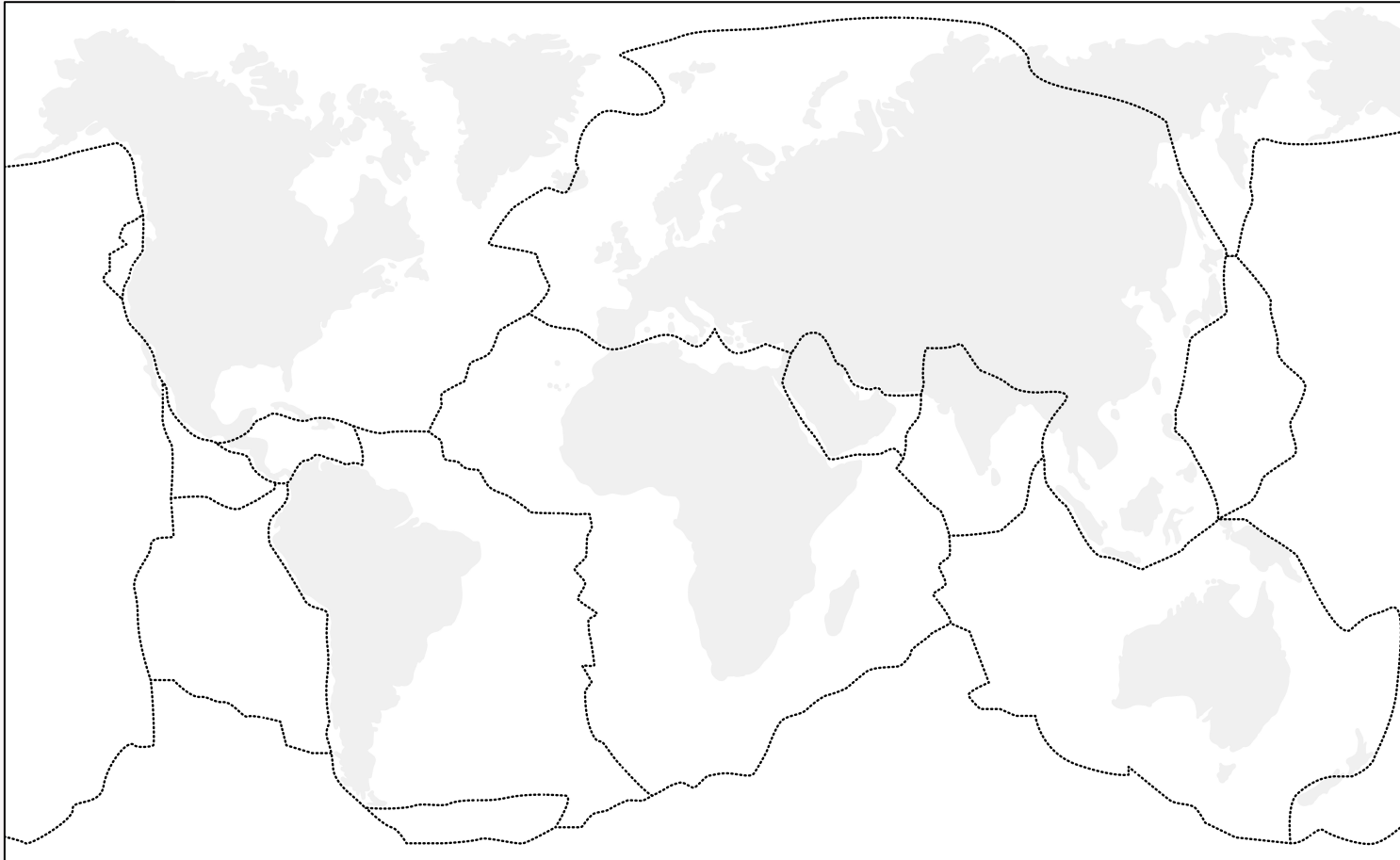
Photo : L Chaffer




Source A [Shutterstock](#)




Source A [Shutterstock](#)



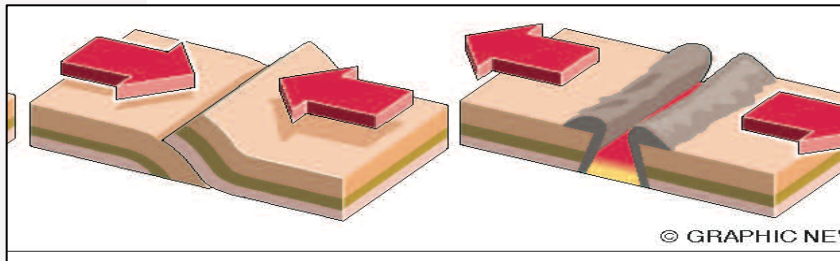
Can you name these tectonic plates?
Pacific, Eurasian, North American,
Australian, African

Show the location of converging plates
using 

Show the location of diverging plates
using 

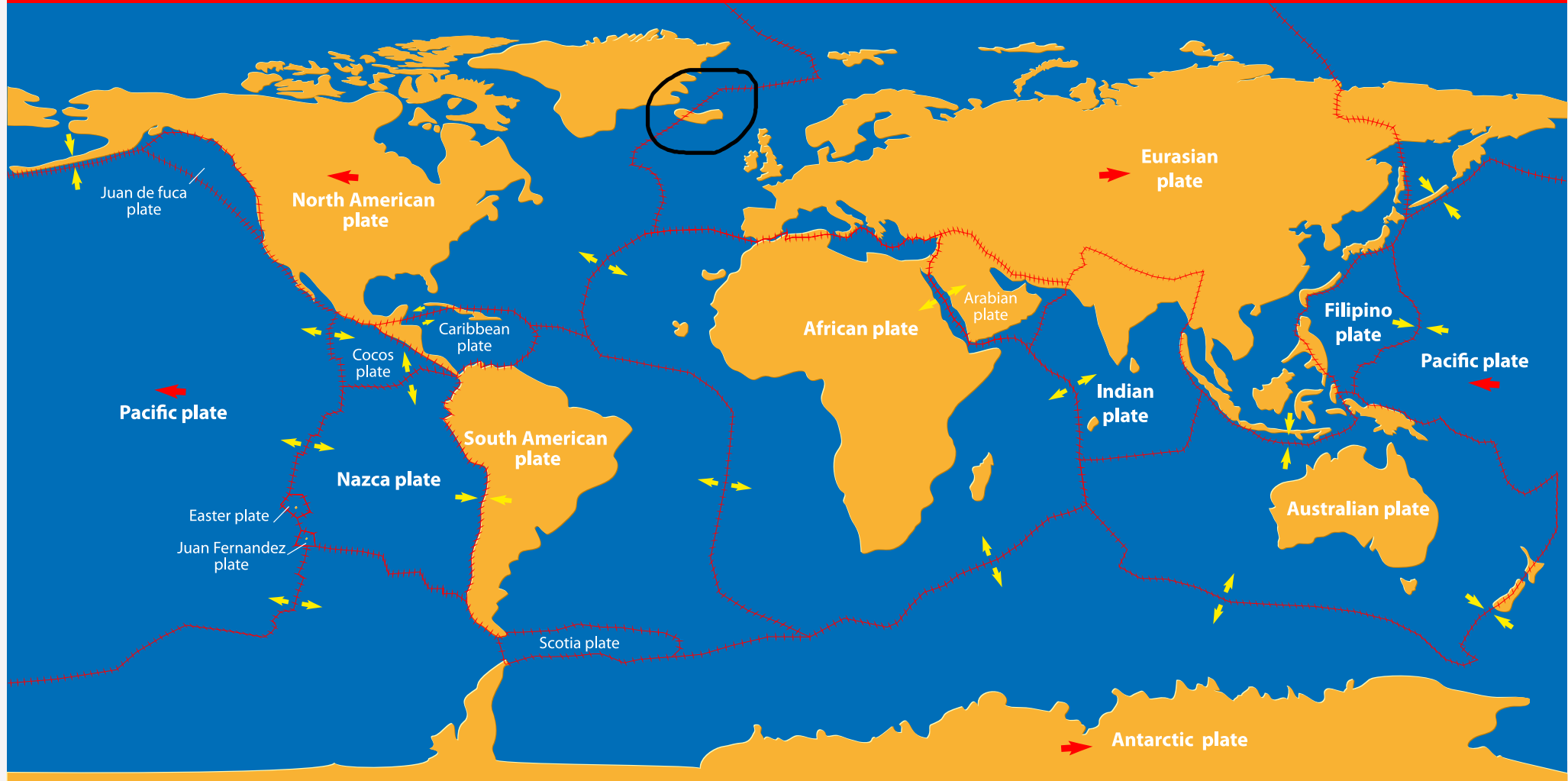
Where could people potentially dive
and walk between plates (look for clues
in the previous images

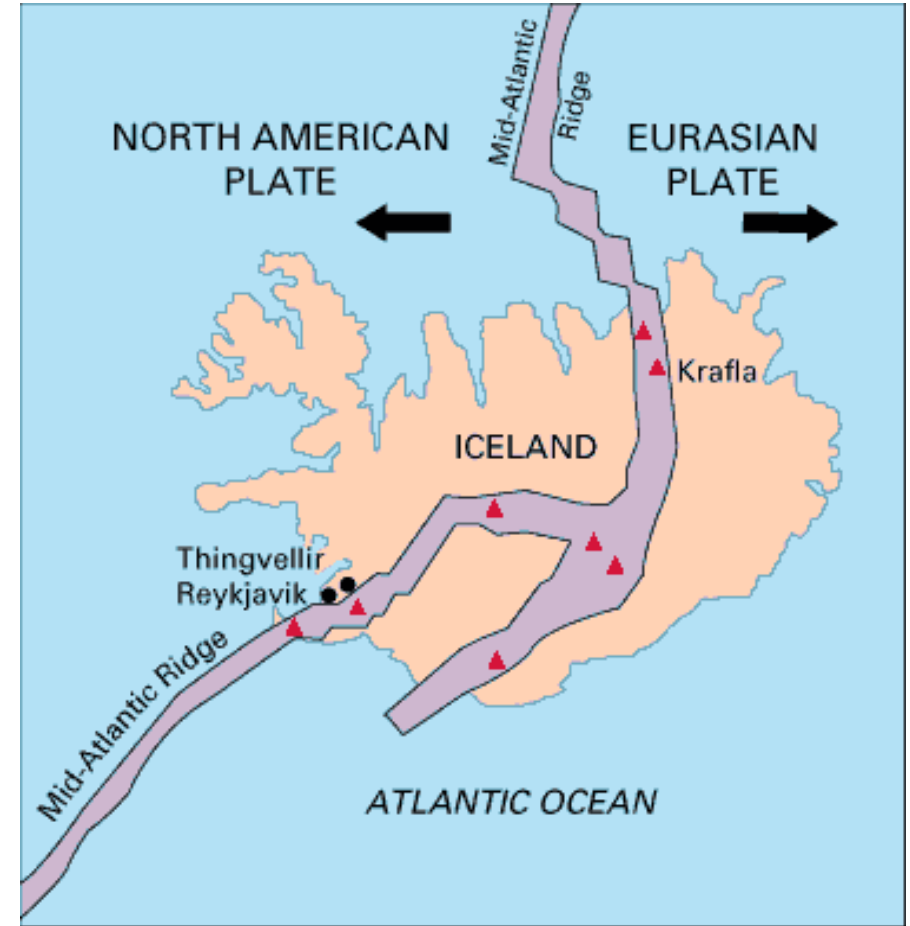
YOUR ANSWER?



THE ANSWER IS ?

TECTONIC PLATES





Snorkeler in famous fissure Silfra between two tectonic plates in the national park Thingvellirin Iceland.

Diving Silfra <https://www.youtube.com/watch?v=YHcRAa4bz2U>

Iceland is an island created by volcanic activity caused by the drifting apart of the N American and Eurasian tectonic plates.

Pingvellir National Park is the place where the North American and the Eurasian continent are slowly being driven apart for about 1-2 cm per year.

The national park has been on the UNESCO World Heritage List since 2004.

In the Þingvallavatn lake lies the **Silfra fissure** where you can dive or snorkel between 2 continents: America and Europe.

Because of the low temperature (read: 2-4 degrees) and the fact that the water has been filtered by porous old lava for 30-100 years, the water is crystal clear and you can look up to 100 meters under water.

<https://www.justgo.travel/en/route-golden-circle-iceland/>

BIOSPHERE RECALL ACTIVITY



Complete “Risk & Reward”
Activity Bulletin Supplement p.35
AND
Investigate Madagascar as a
biodiversity hotspot
TO
Retrieve your knowledge and
understanding of the biosphere.



Photo source: Shutterstock.

Map retrieved from <https://sites.google.com/a/lincoln.edu.gh/biodiversityhotspots/lesson/madagascarindian-ocean-islands>



ATMOSPHERE RECALL ACTIVITY

Use 'Miracle in a storm' as a stimulus to retrieve your knowledge and understanding of the atmosphere and weather events.

Worksheet P33 Bulletin 3 Supplement

Illustration retrieved from

<https://www.telegraph.co.uk/news/worldnews/1542962/Paraglider-survived-in-storm-at-32000-ft.html>