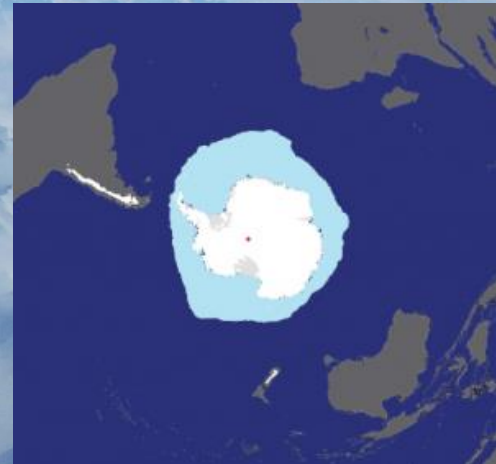


CRYOSPHERE

THE FROZEN EARTH



About **2/3** of the world's freshwater is **frozen** in ice sheets, glaciers, permafrost and sea ice.

Cryosphere Components

ICE SHEETS

(permanent ice caps of Antarctica and Greenland)

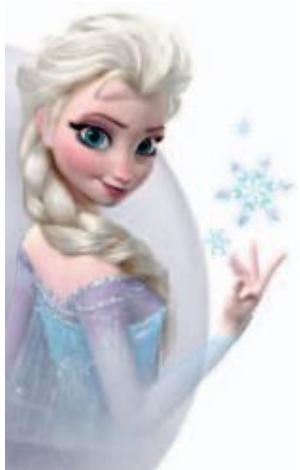
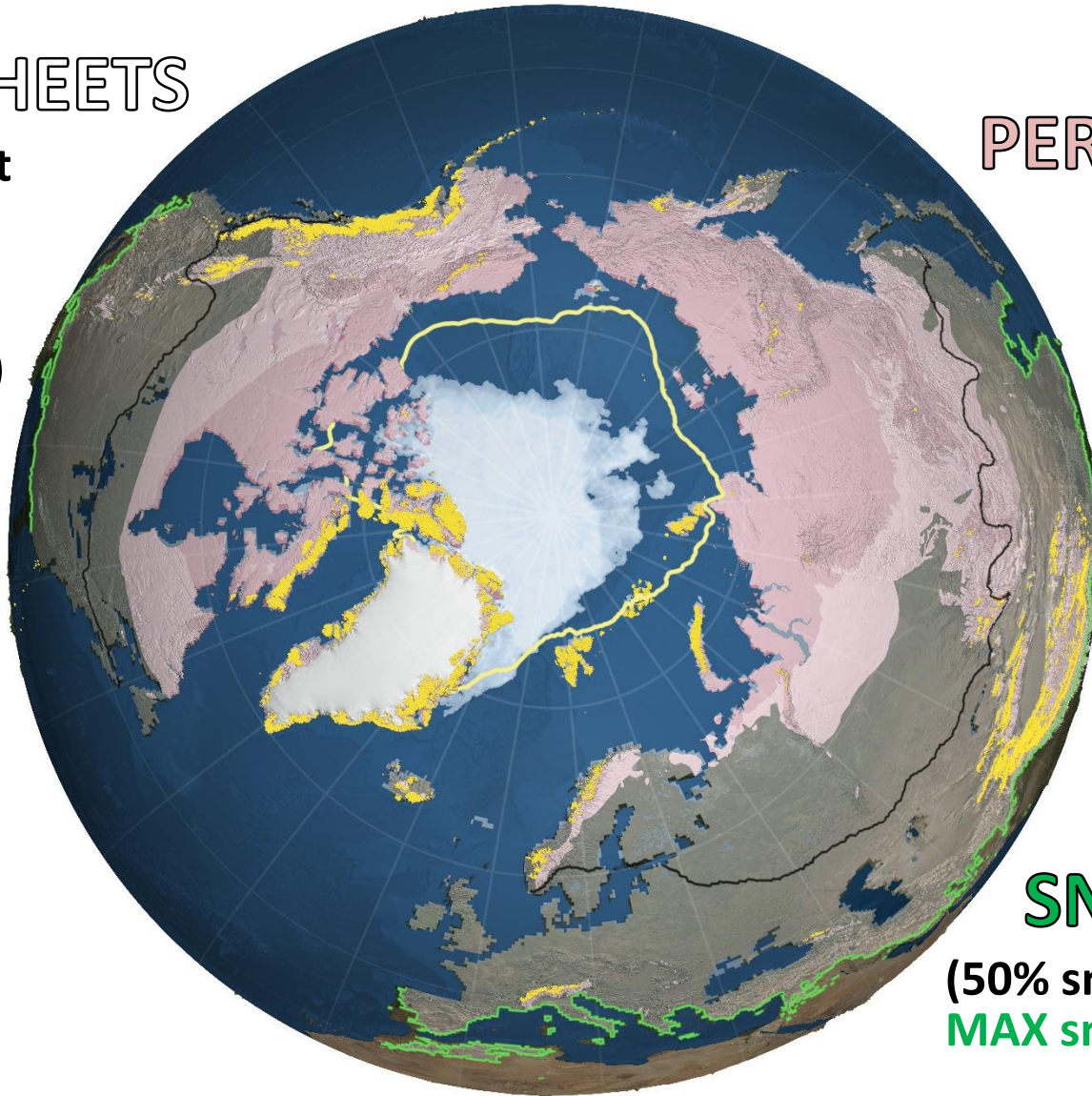
PERMAFROST
(frozen ground)

SEA ICE

ALPINE
GLACIERS

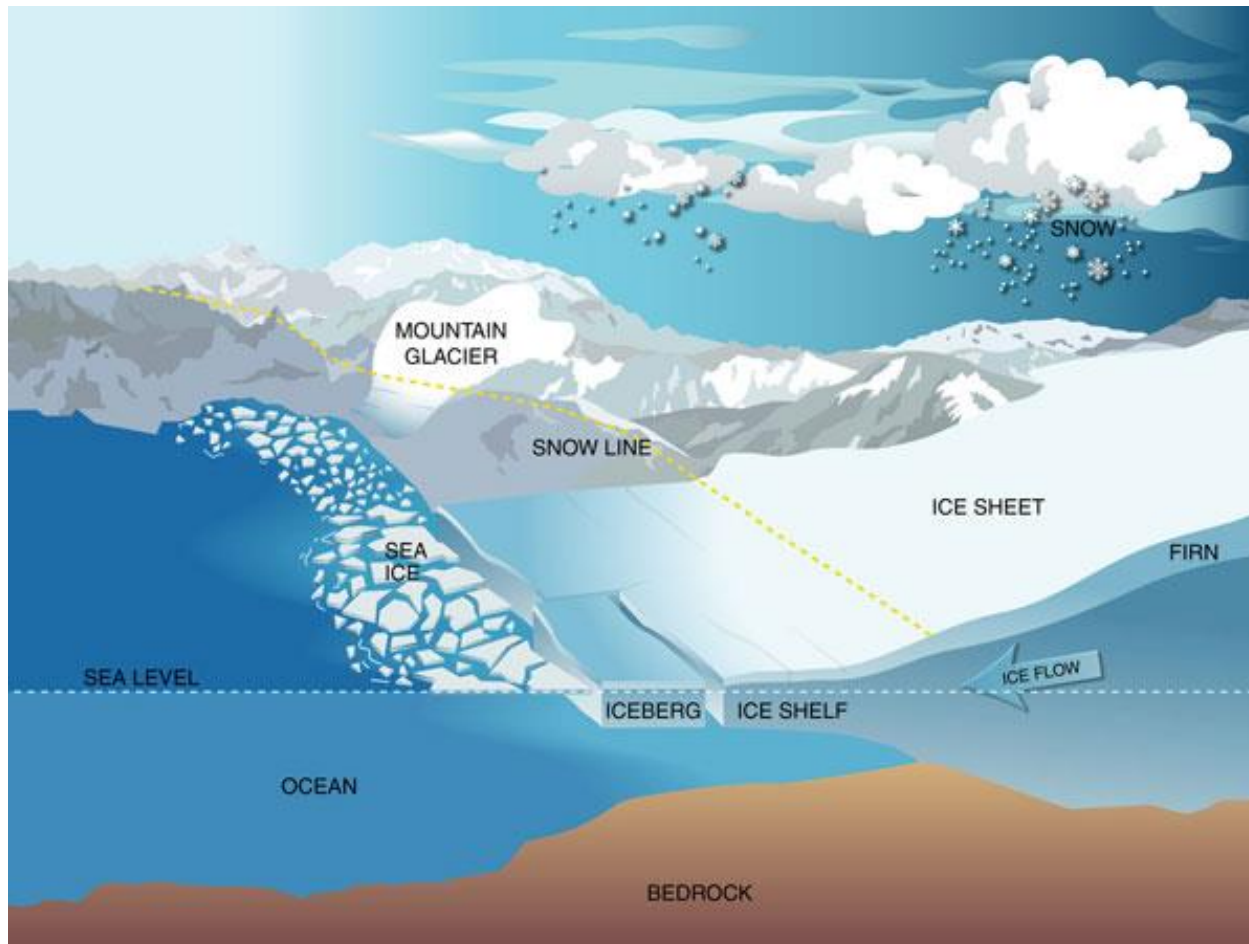
SNOW

(50% snow extent line
MAX snow extent line)



Glaciers

A glacier is any large mass of ice that forms on land and moves (flows) slowly due to gravity and the internal deformation of ice.



On Earth,
~99% of glaciers
are **ice sheets**
in the polar
regions
(Antarctica
and Greenland)
and
~1% is found
in **mountain**
ranges on
every continent
except
Australia.

Ice Sheets of Greenland and Antarctica

~3 million km³ of ice

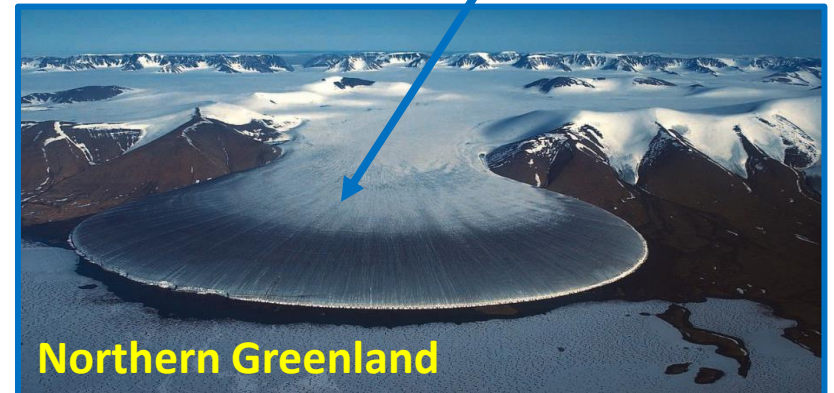
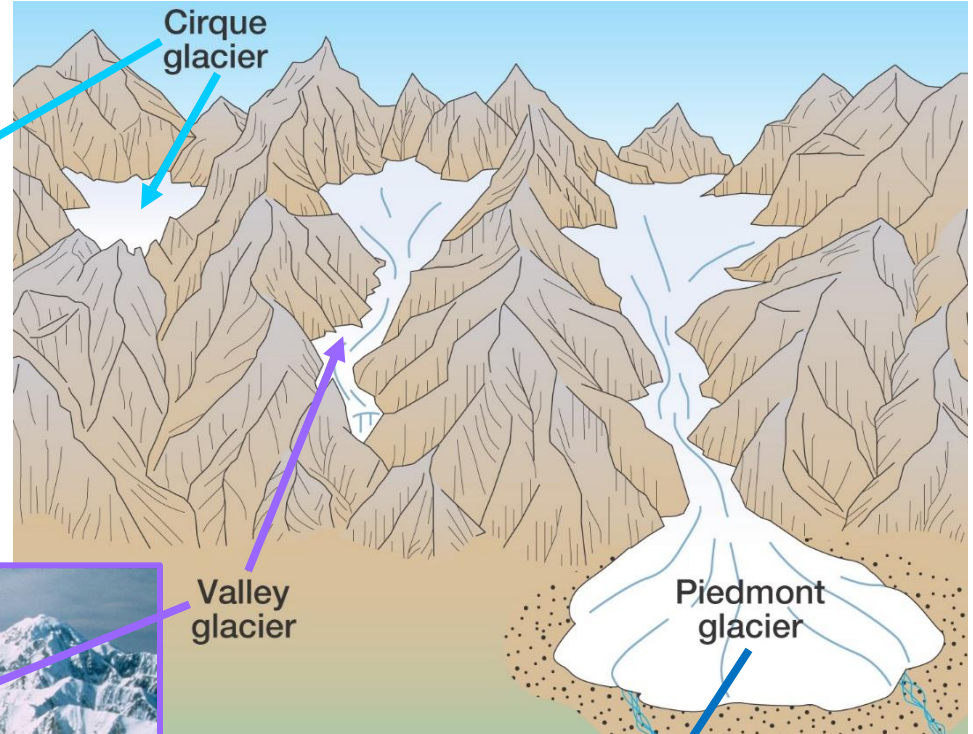
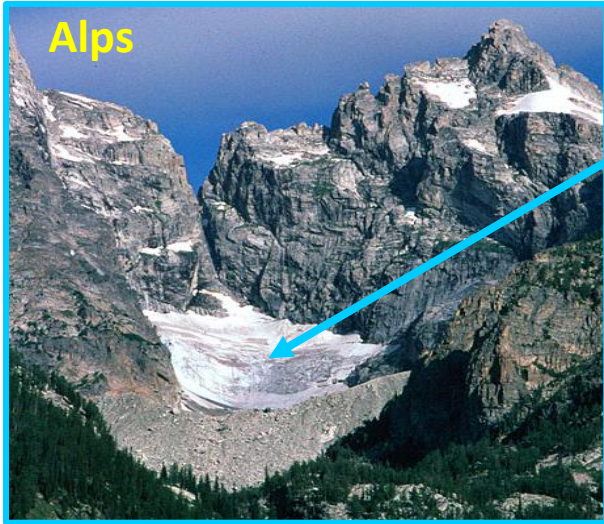


~30 million km³ of ice



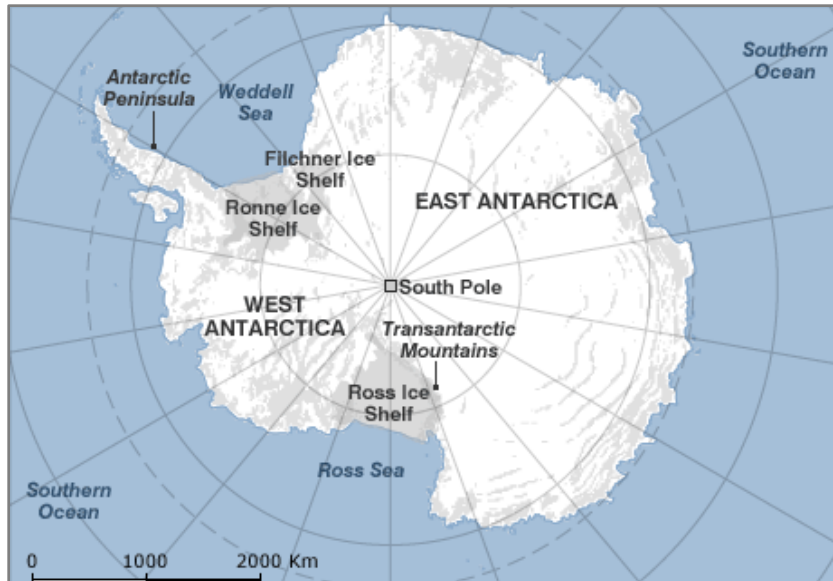
ice thickness in meters

Mountain (Alpine) Glaciers



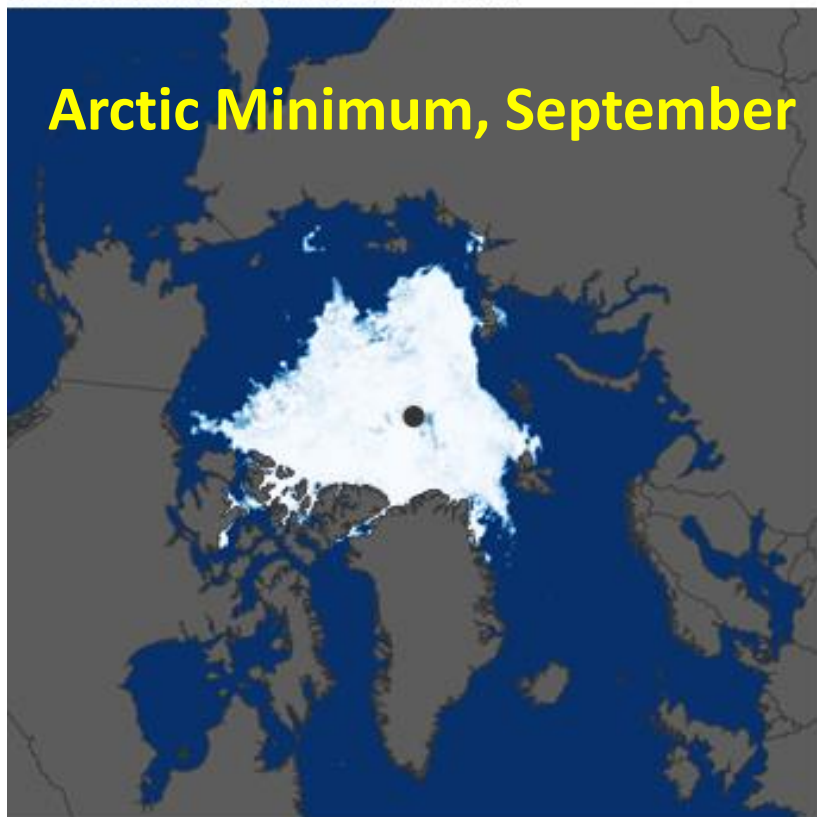
Permafrost in Land Areas

- Land areas in polar regions, such as Antarctica and Greenland, and the northern parts of Alaska and Siberia, have zones below their surfaces in which **ground water remains frozen year-round**.
- Those regions are known as **permafrost areas**.



Arctic Sea Ice: shrinking

Arctic Minimum (September 14, 2008)



**Before 1990: ~7 million km²
or ~2.7 million square miles**
**2009-2018: ~5 million km²
or ~2 million square miles**
2024: ~4.3 mil km²

Arctic Maximum (February 28, 2009)



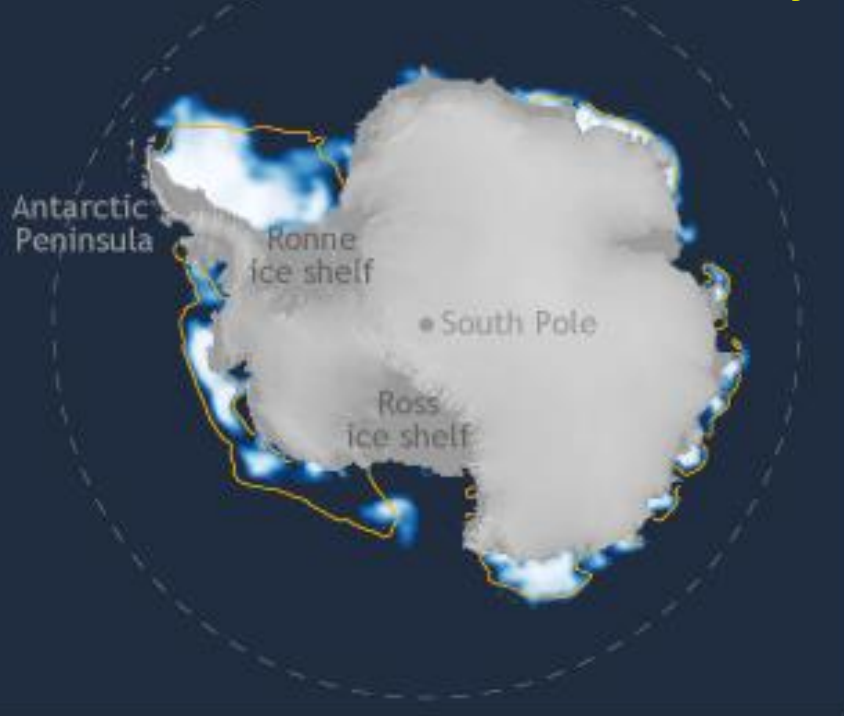
**Before 1990: ~16 million km²
or ~6 million square miles**
**2009-2018: ~14.5 million km²
or ~5.5 million square miles**
2024: ~15 mil km²

Antarctic Sea Ice: declining

2020 Antarctic sea ice minimum and 2019 maximum

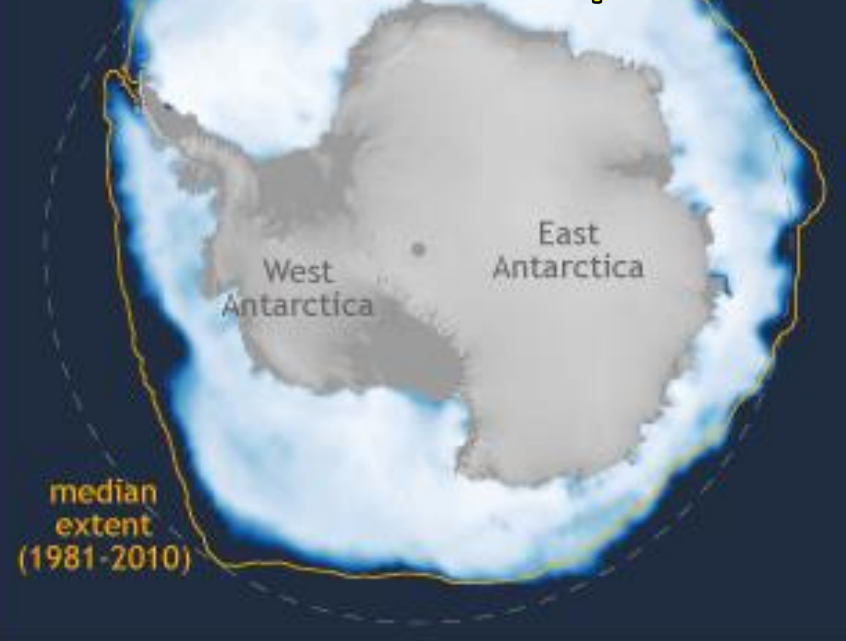
Feb 2020

Antarctic Minimum, February



Sep 2019

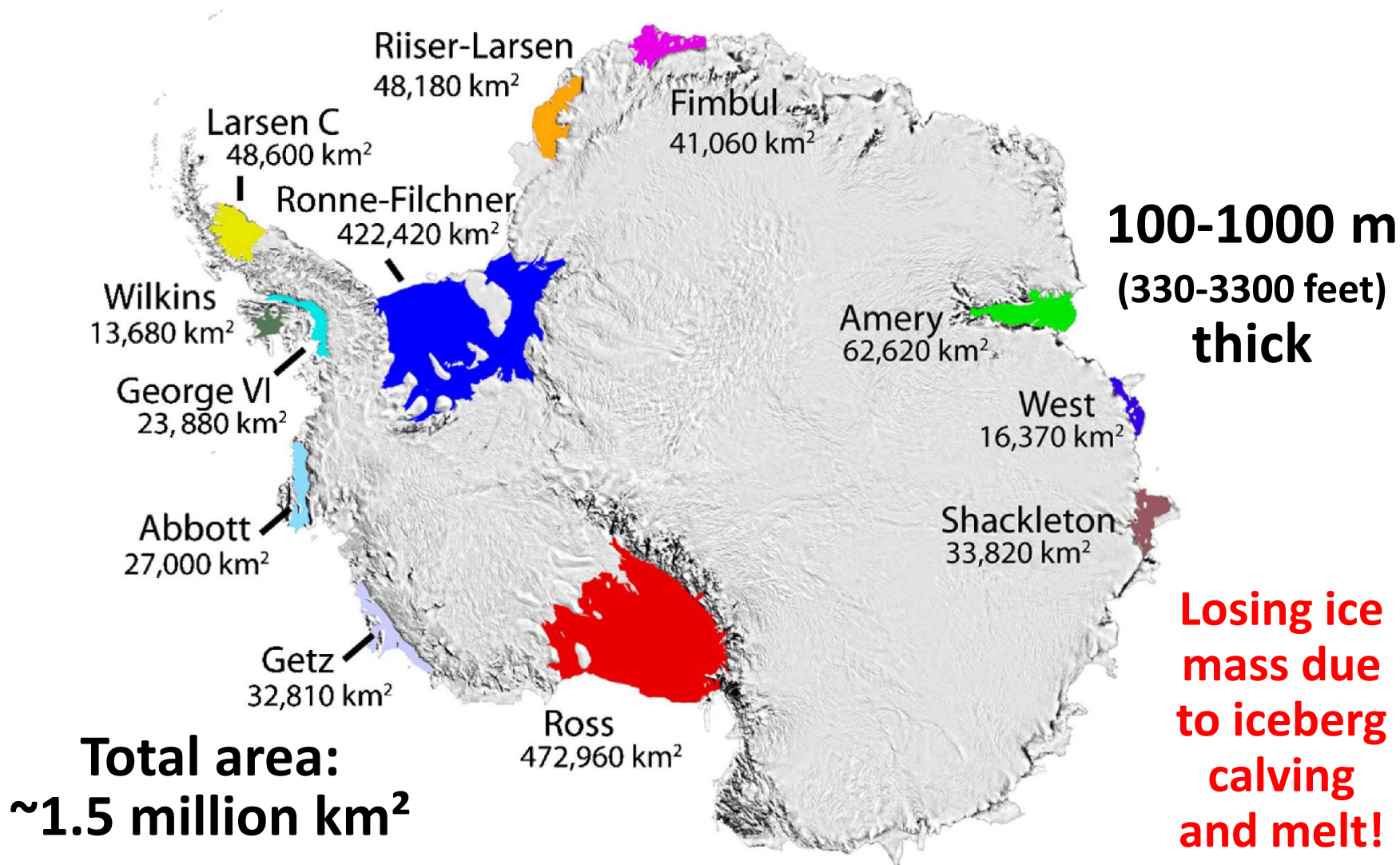
Antarctic Maximum, September



Approximately mid-September, **Antarctic sea ice** reaches its **maximum extent of ~18 million square kilometers** or **~7 million square miles** (averaged over past ~40 years); **It was second lowest at ~6.6 million sq mi in 2024.**

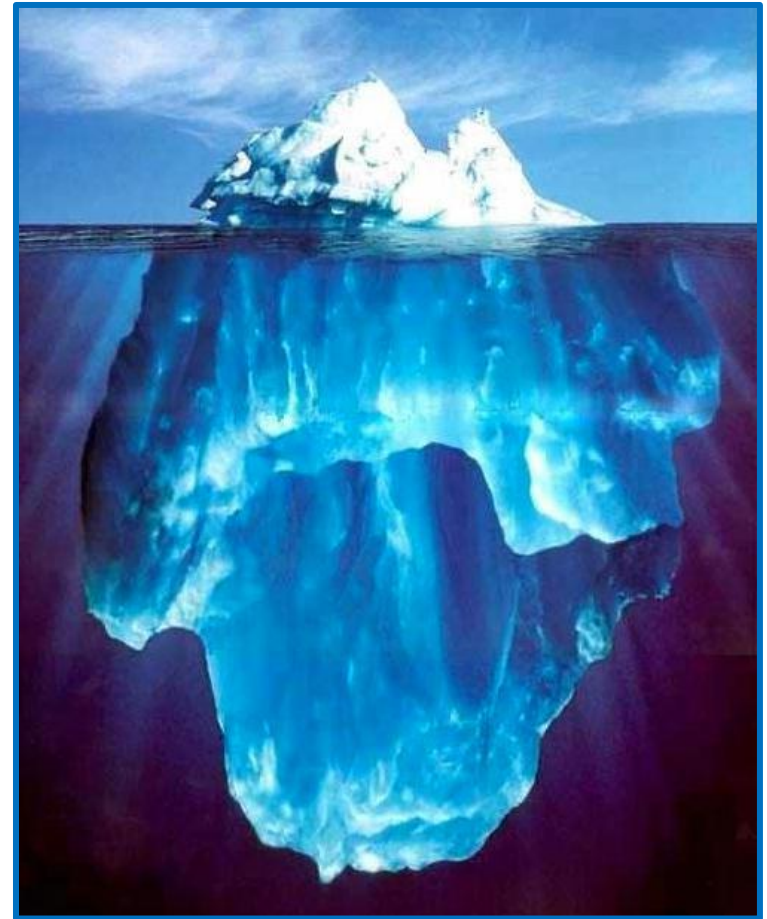
Antarctic Ice Shelves

Ice shelves are attached to ~44% of the Antarctic coastline.



An iceberg (Dutch for “ice mountain”)

is a large piece of freshwater ice that has broken off a glacier or an ice shelf and is floating freely in open water.

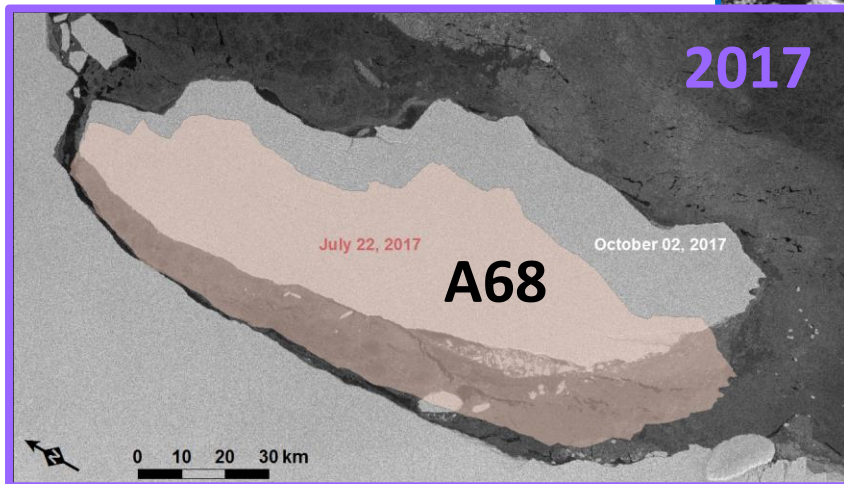
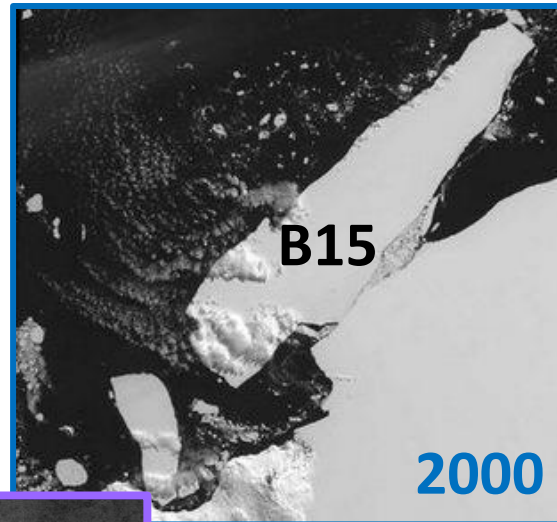


Typically, only **one-tenth** of the volume of an iceberg is **above water**.

How large can an iceberg be?

Formation of an iceberg, as it separates from an ice shelf or a glacier, is termed “calving”. The largest icebergs recorded have been calved from the Ross Ice Shelf of Antarctica.

- **B15**, calved in March 2000, holds an **absolute record ever** with an area of 11,000 sq km (4,200 sq mi, about **the size of Connecticut**). B15 has since broken up, but small parts of it still exist around the Antarctic today.



- The most recently formed major iceberg is **A68**, measuring about 2,400 square miles (about **the size of Delaware**) and weighing over one trillion tons. It calved from the Larsen C Ice Shelf in **July 2017**, and has since completely disintegrated.

Tracking Iceberg A-68

This video clip was created using real satellite observations.

www.youtube.com/watch?v=7I1fbm-DDjQ