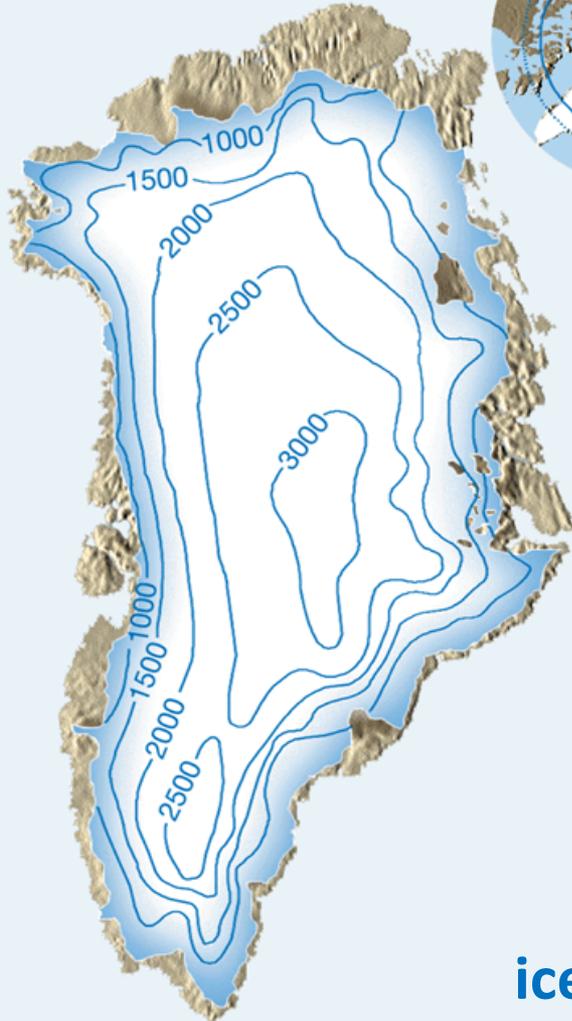
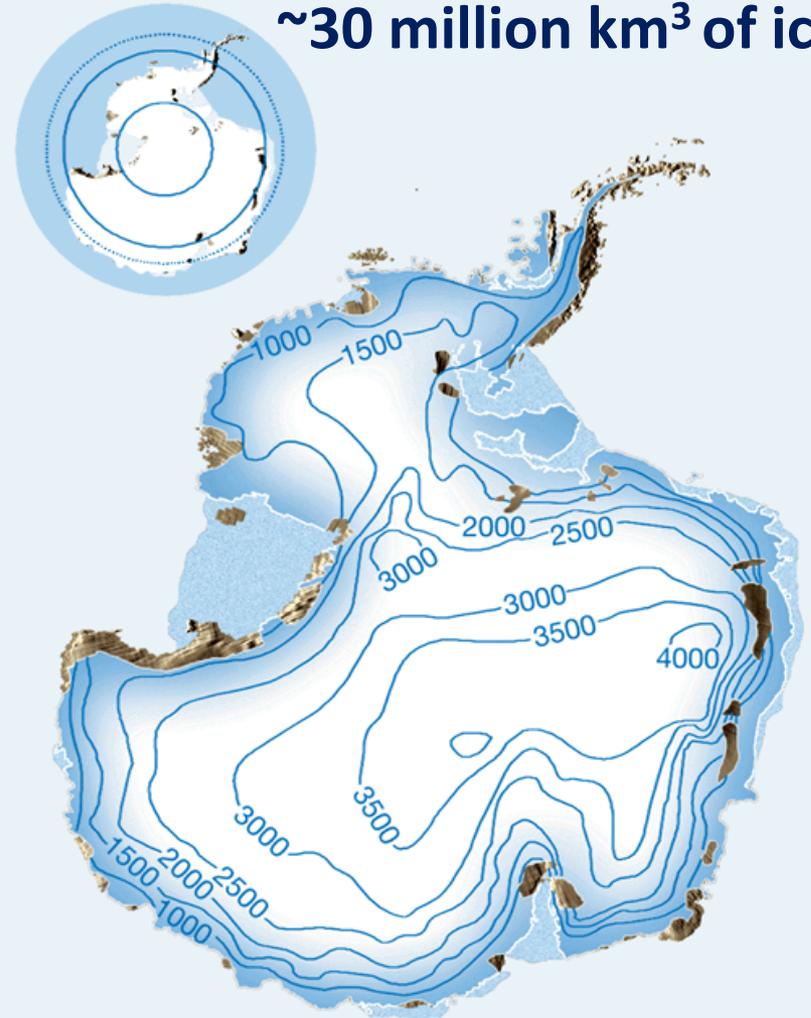


Ice Cover of Greenland and Antarctica

~3 million km³ of ice



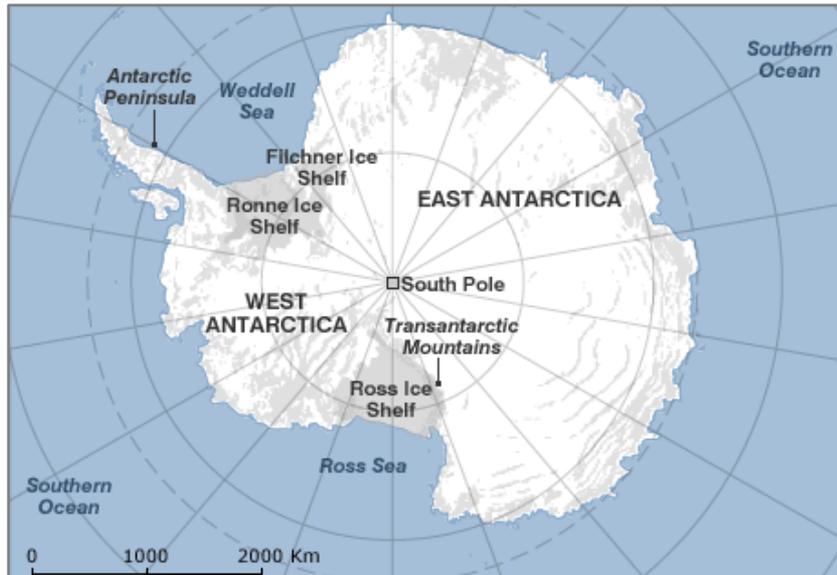
~30 million km³ of ice



ice thickness in meters

Permafrost in Land Areas

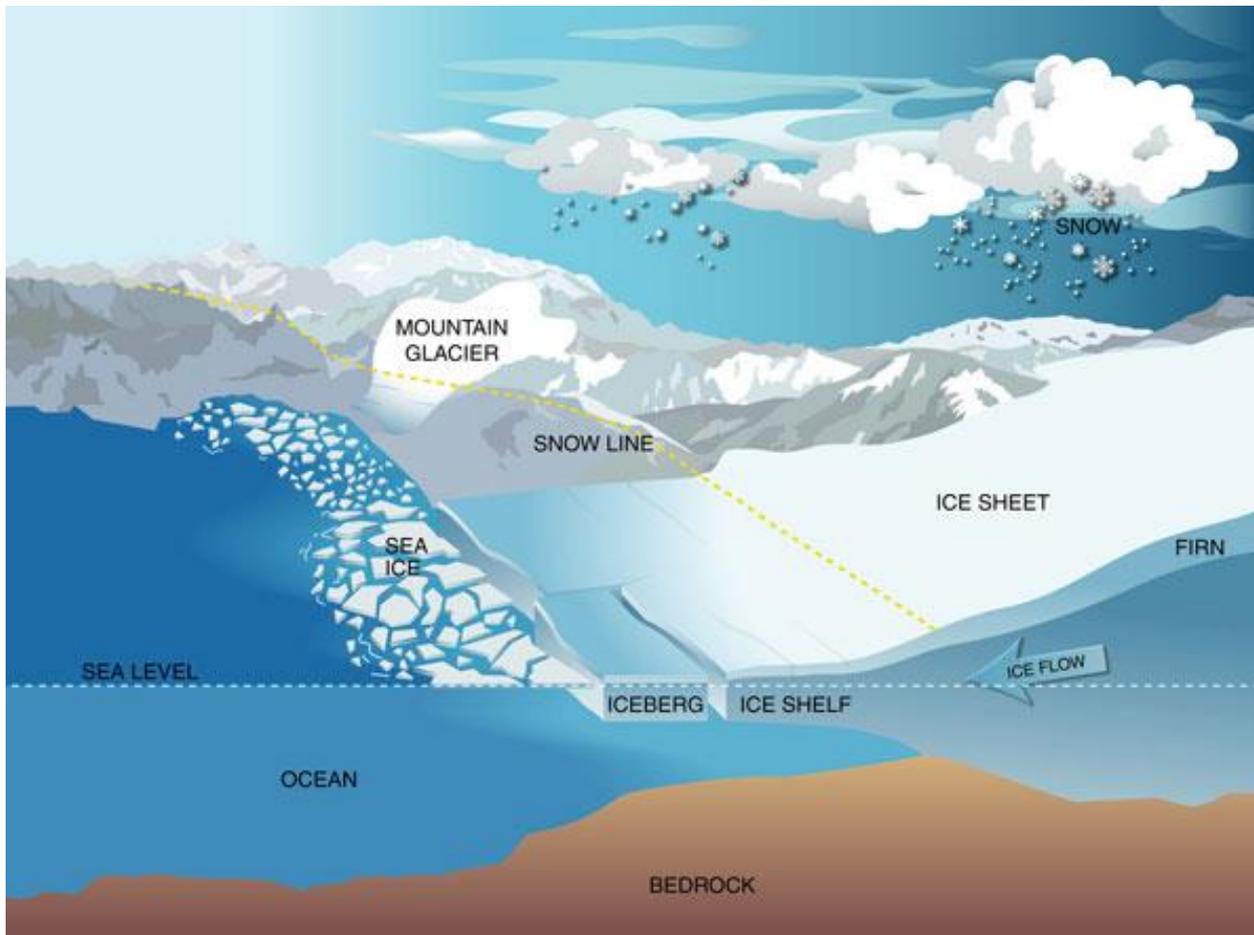
- Land areas in polar regions, such as Antarctica and Greenland, and the northern parts of Alaska and Siberia, have zones below their surfaces in which **ground water remains frozen year-round**.
- Those regions are known as **permafrost areas**.



Continuous zone Discontinuous zone

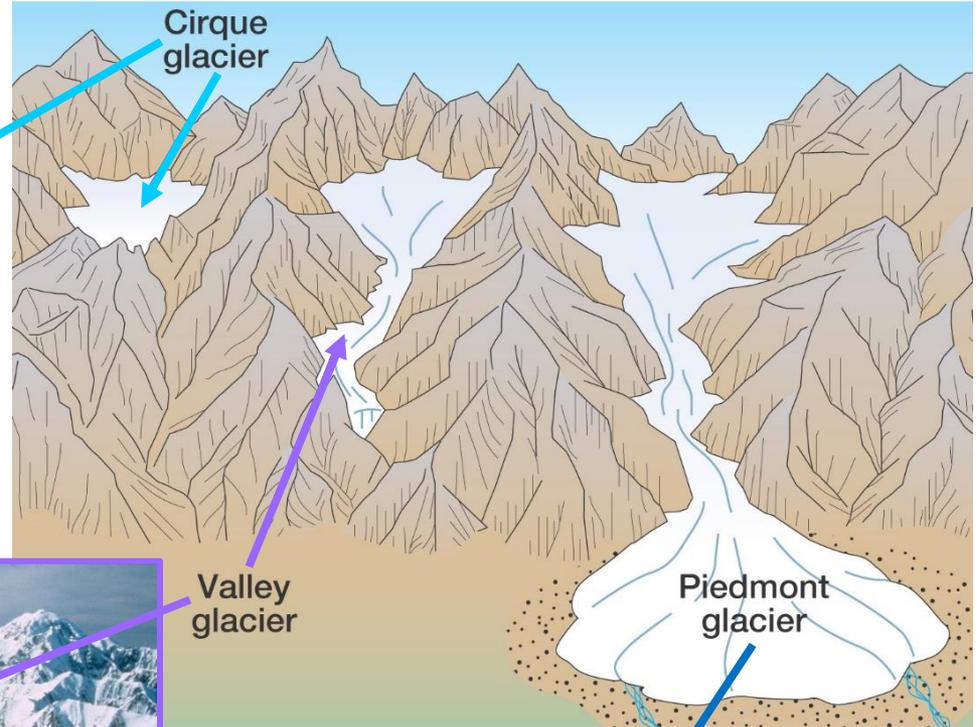
Glaciers

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.

Mountain (Alpine) Glaciers



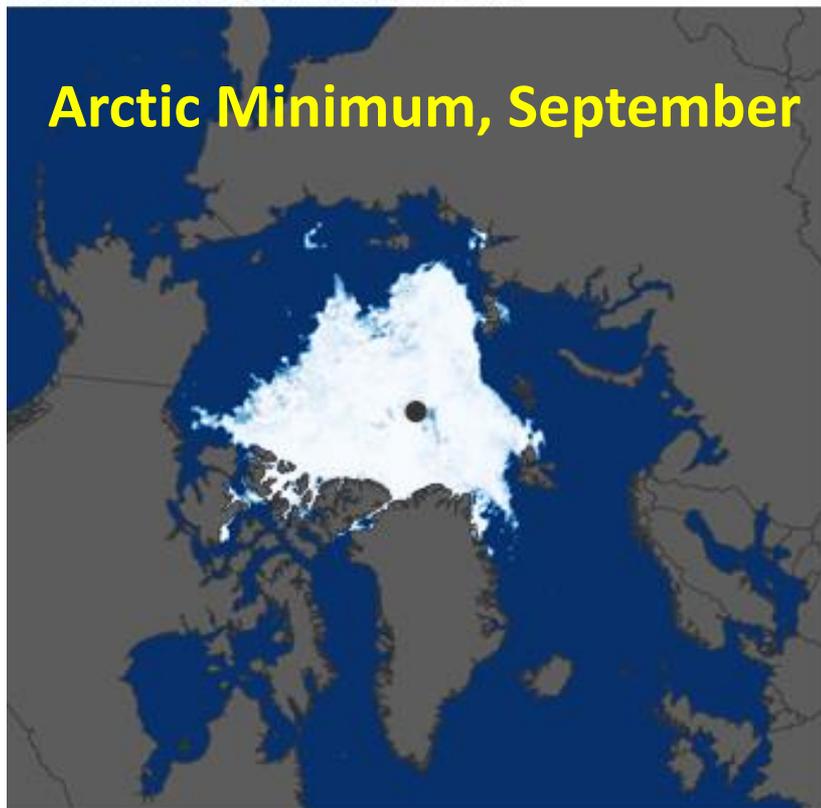
**Black Rapids
Glacier, Alaska**



Northern Greenland

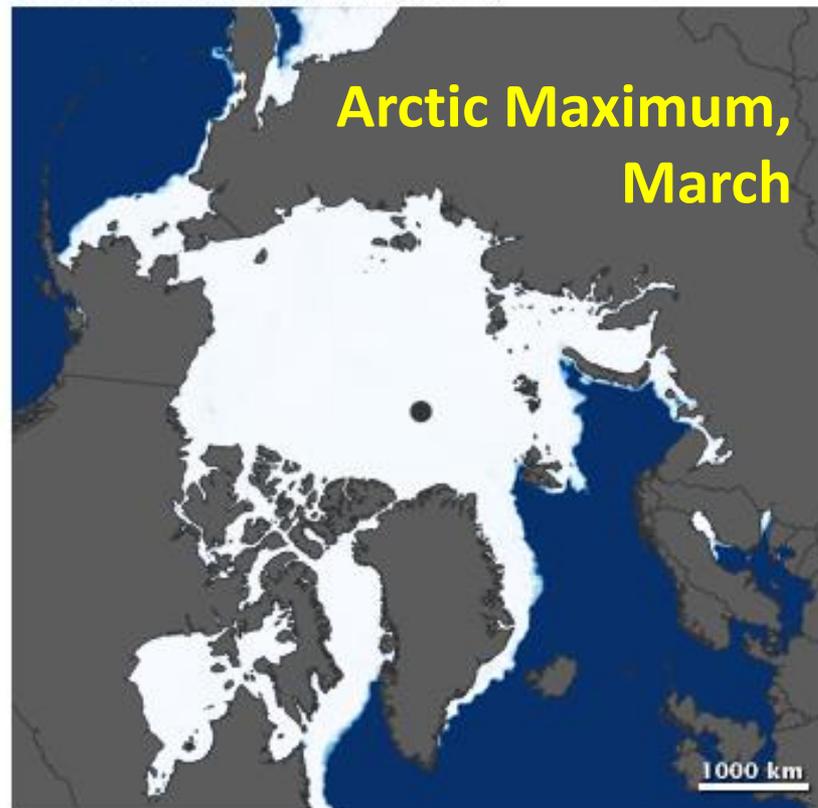
Arctic Sea Ice: rapidly shrinking

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**

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**

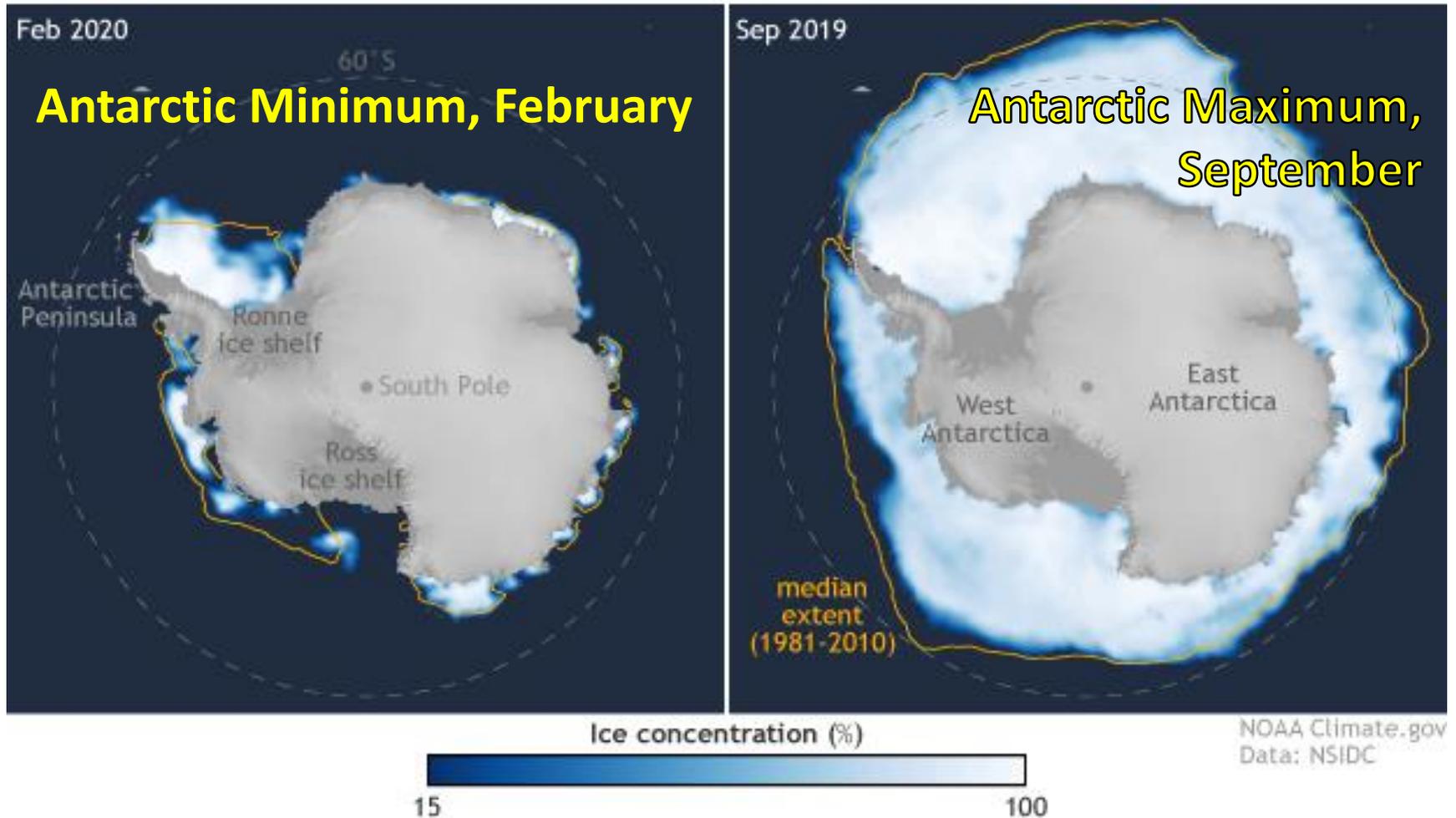
Arctic sea ice drift



Typically,
sea ice is
<3 m (<10 feet) thick.

Antarctic Sea Ice

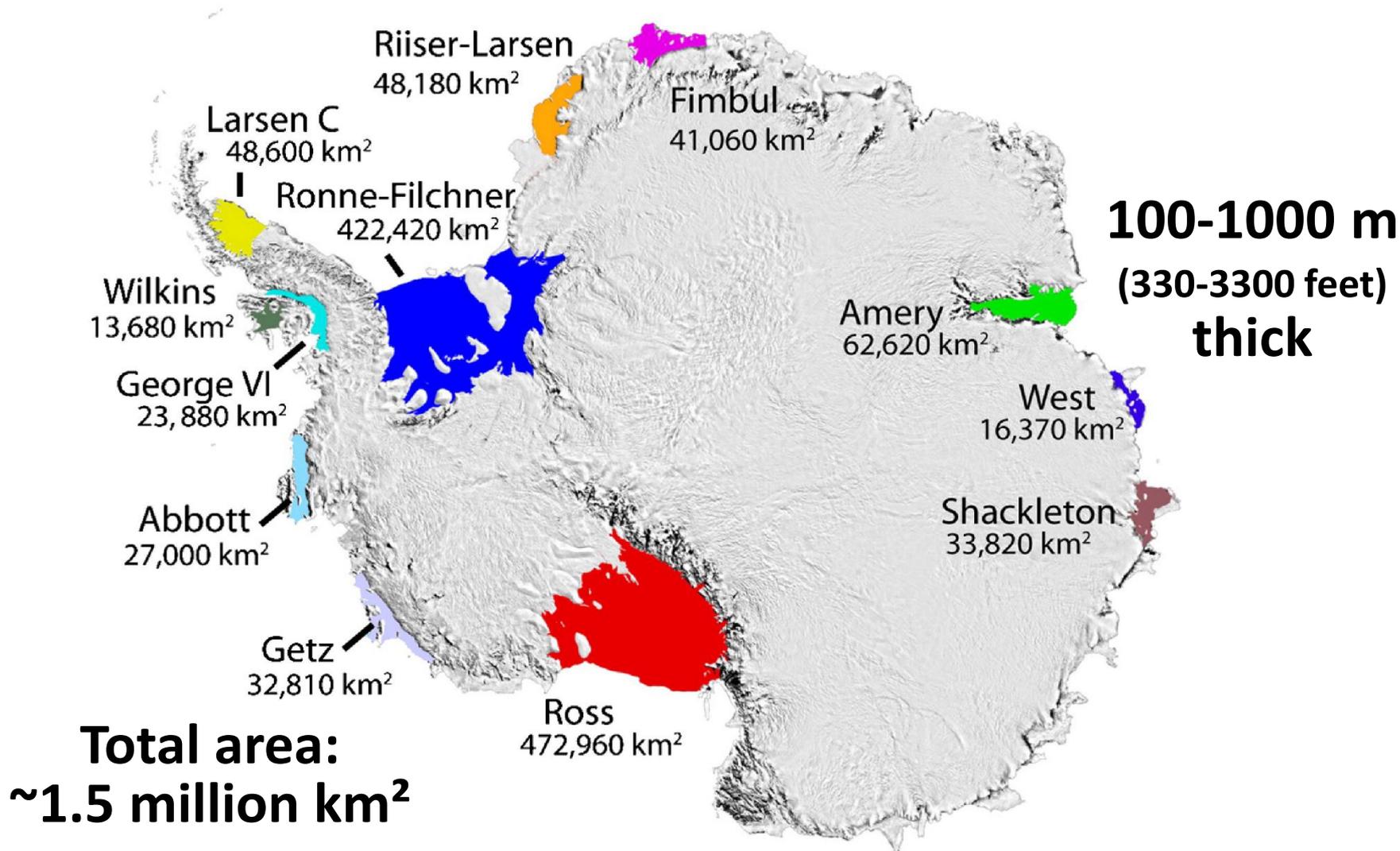
2020 Antarctic sea ice minimum and 2019 maximum



Antarctic sea ice reaches its **maximum extent each September** of **~18 million square kilometers** or **~7 million square miles**.

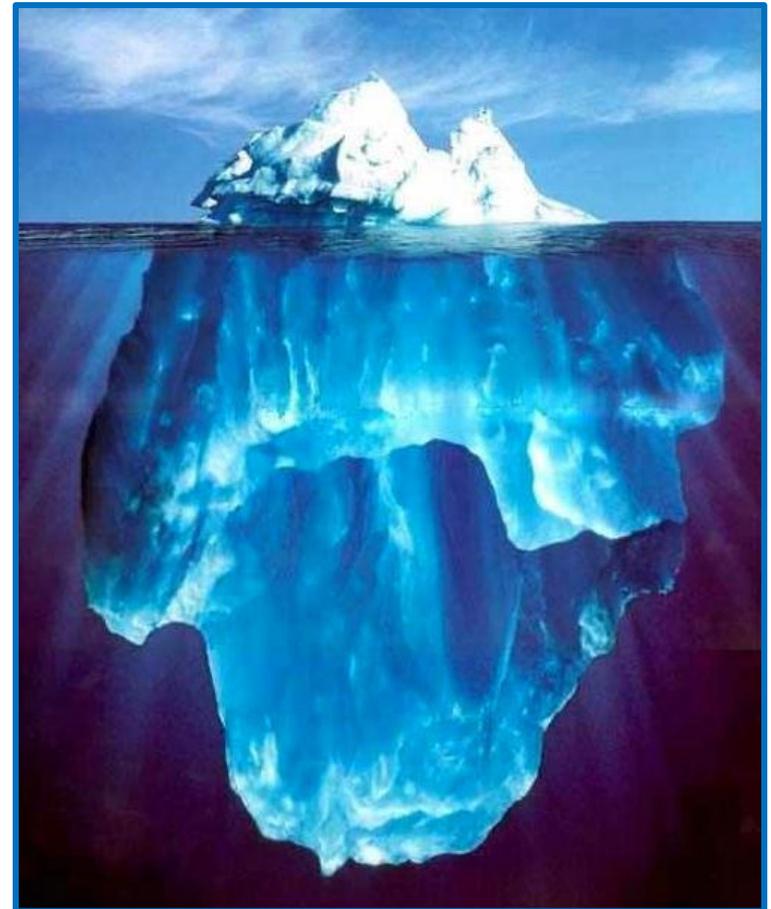
Antarctic Ice Shelves

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.

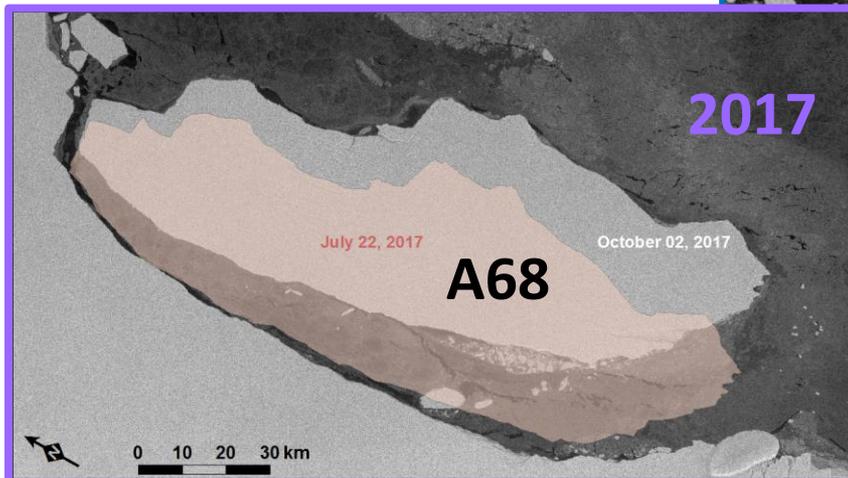
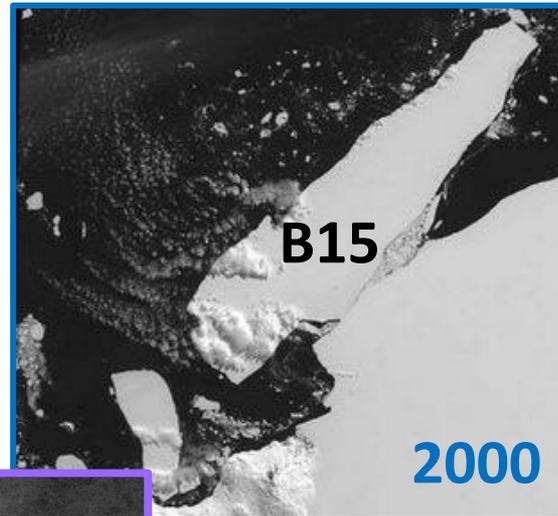


Typically, only **one-tenth** of the volume of an iceberg is **above water**.

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**.

Cryosphere and Climate Change

Major changes in sea level can occur during times of global climate change (*ice ages* and *global warming*), due to associated changes in the water content of the cryosphere.

IF ALL ICE MELTS...

Global warming could potentially result in melting of the polar ice caps, which would raise the water level of the oceans by more than 200 feet and cause flooding of coastal areas of the continents.

