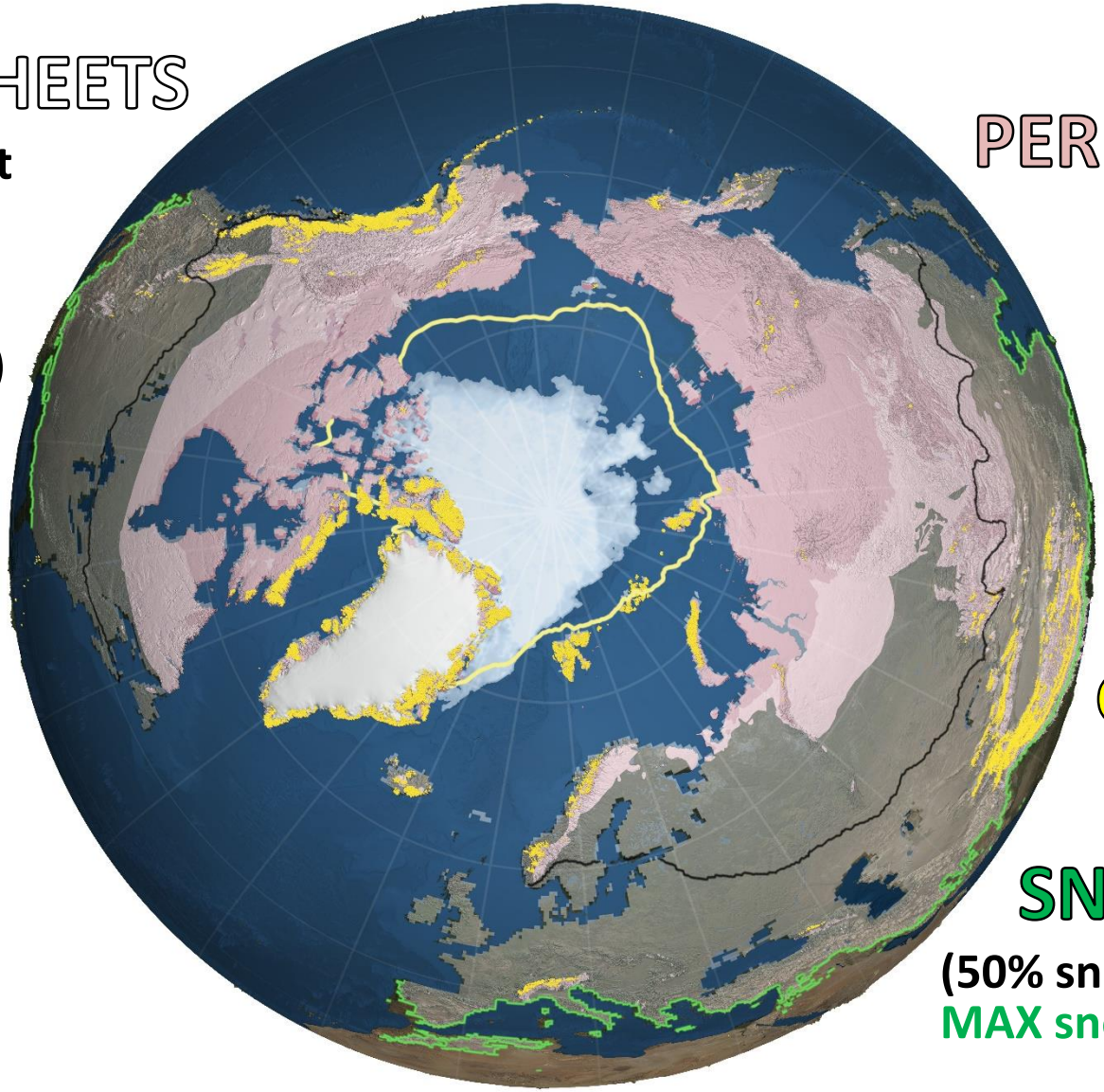

About 2/3 of the world's freshwater is frozen in ice sheets, glaciers permafrost and sea ice.

# Cryosphere Components

ICE SHEETS

(permanent ice caps of Antarctica and Greenland)



PERMAFROST

(frozen ground)

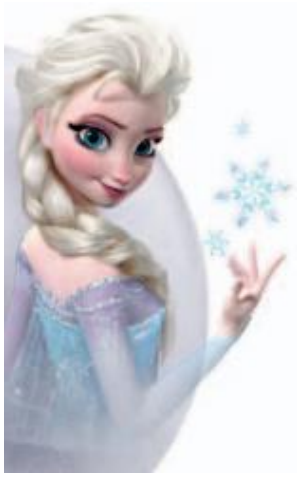
SEA ICE

ALPINE GLACIERS

SNOW

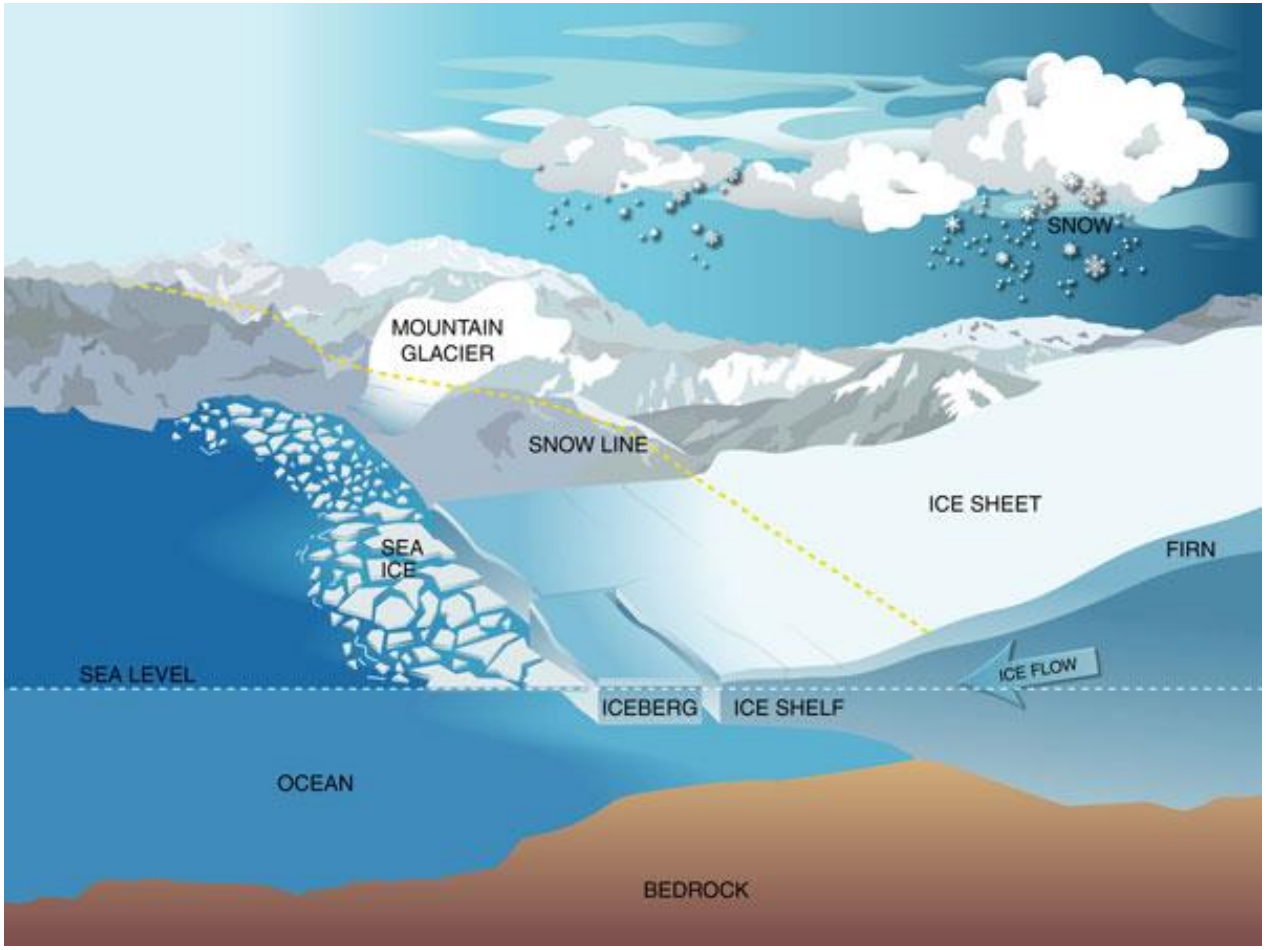
(50% snow extent line

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.**

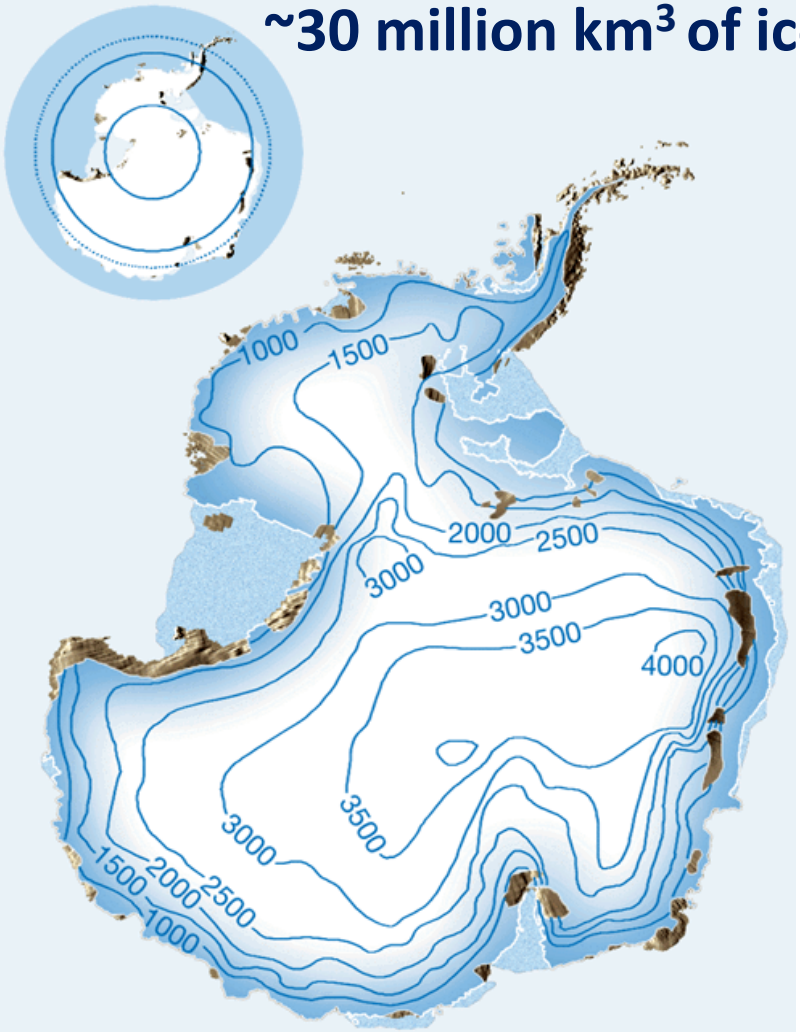



**On Earth, ~99% of glaciers are ice sheets in the polar regions (Antarctica and Greenland) and ~1% is found in mountain ranges on every continent except Australia.**

# Ice Cover of Greenland and Antarctica

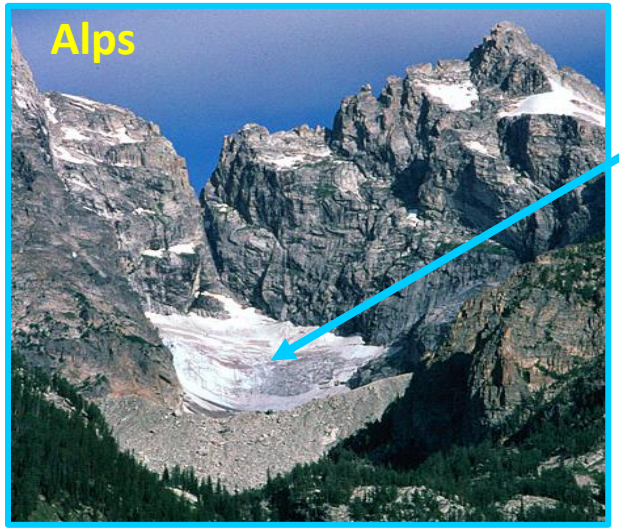
~3 million km$^3$ of ice

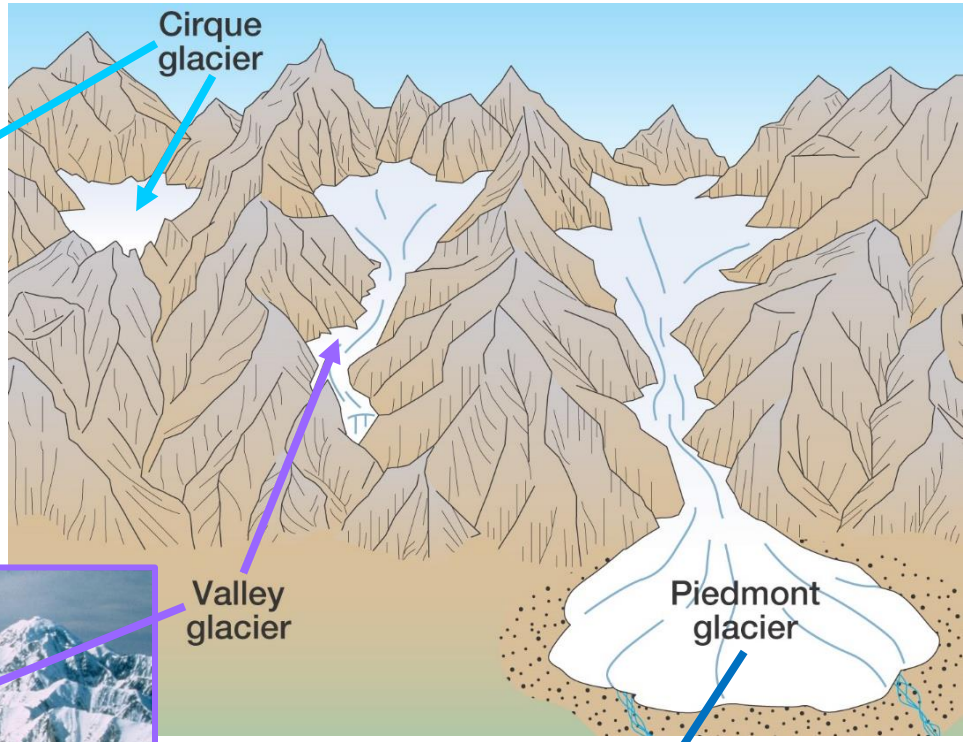

~30 million km$^3$ of ice



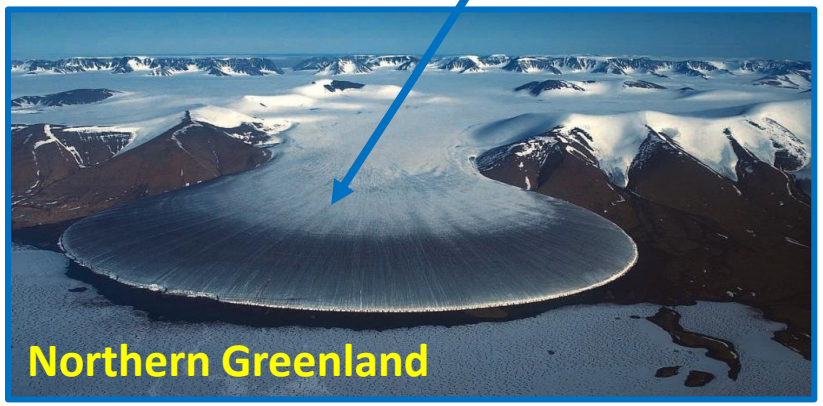

ice thickness in meters

# Mountain (Alpine) Glaciers



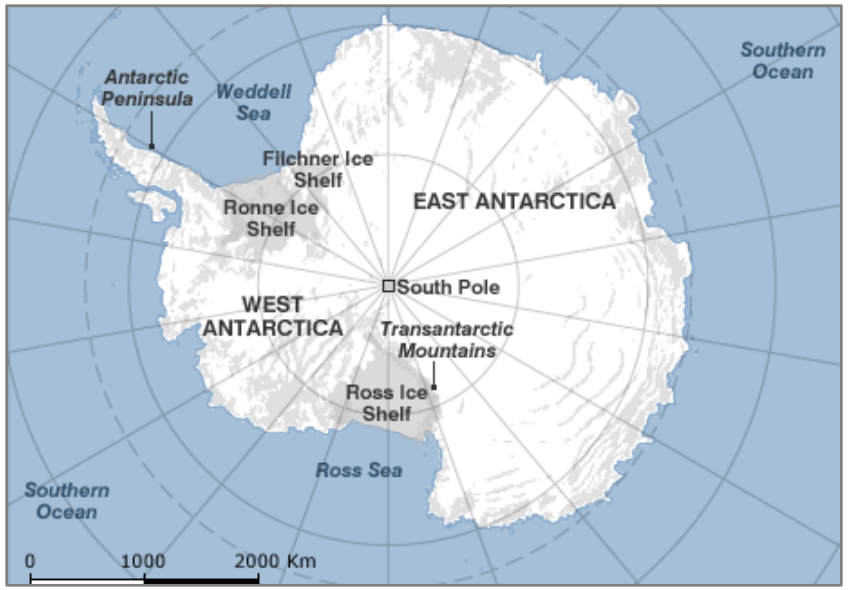



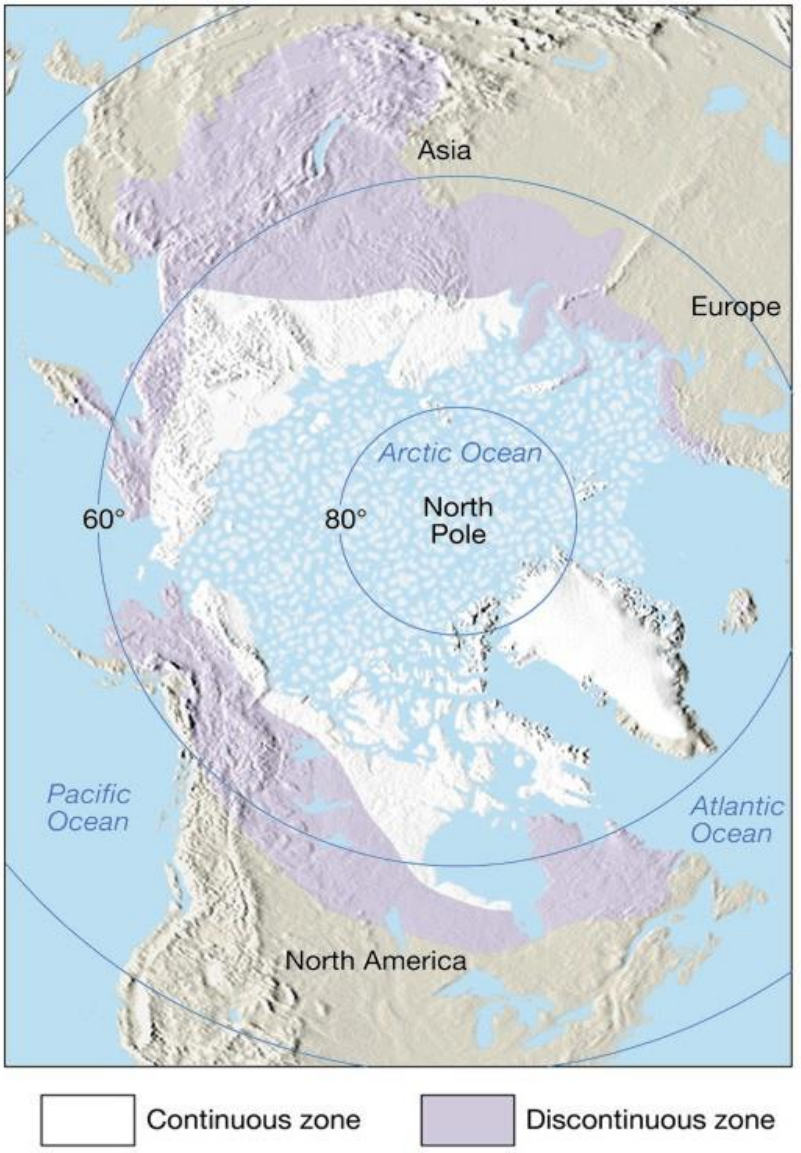




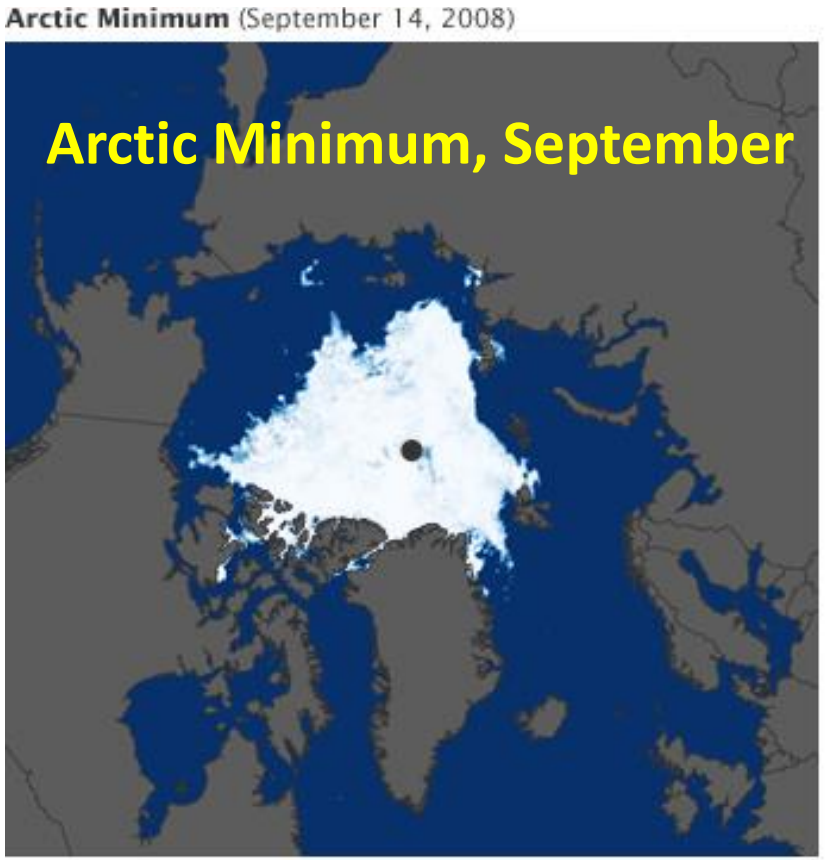
# Permafrost in Land Areas

- **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: rapidly shrinking



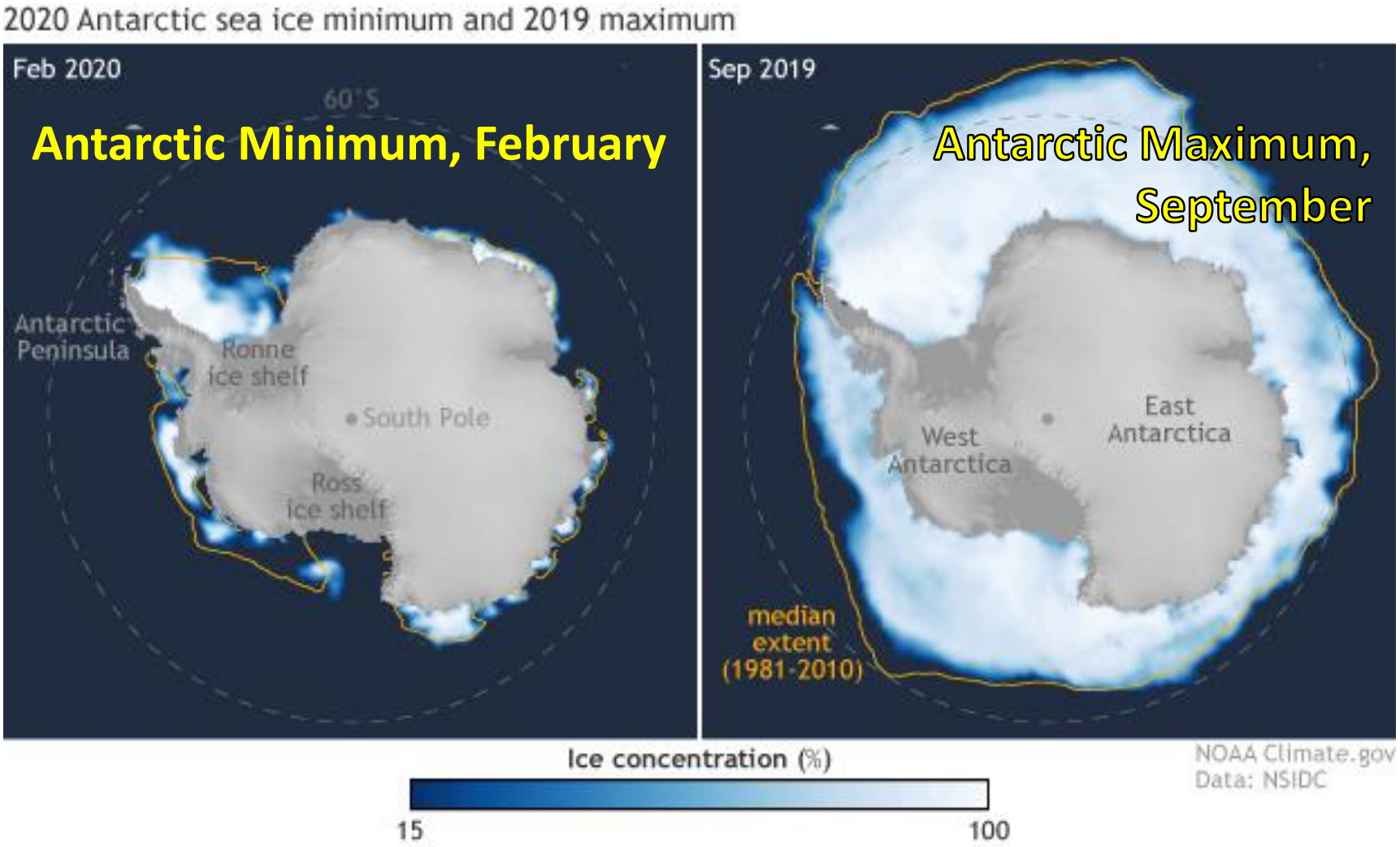

**Before 1990:** ~7 million km²
or ~2.7 million square miles

**2009-2018:** ~5 million km²
or ~2 million square miles


**Before 1990:** ~16 million km²
or ~6 million square miles

**2009-2018:** ~14.5 million km²
or ~5.5 million square miles

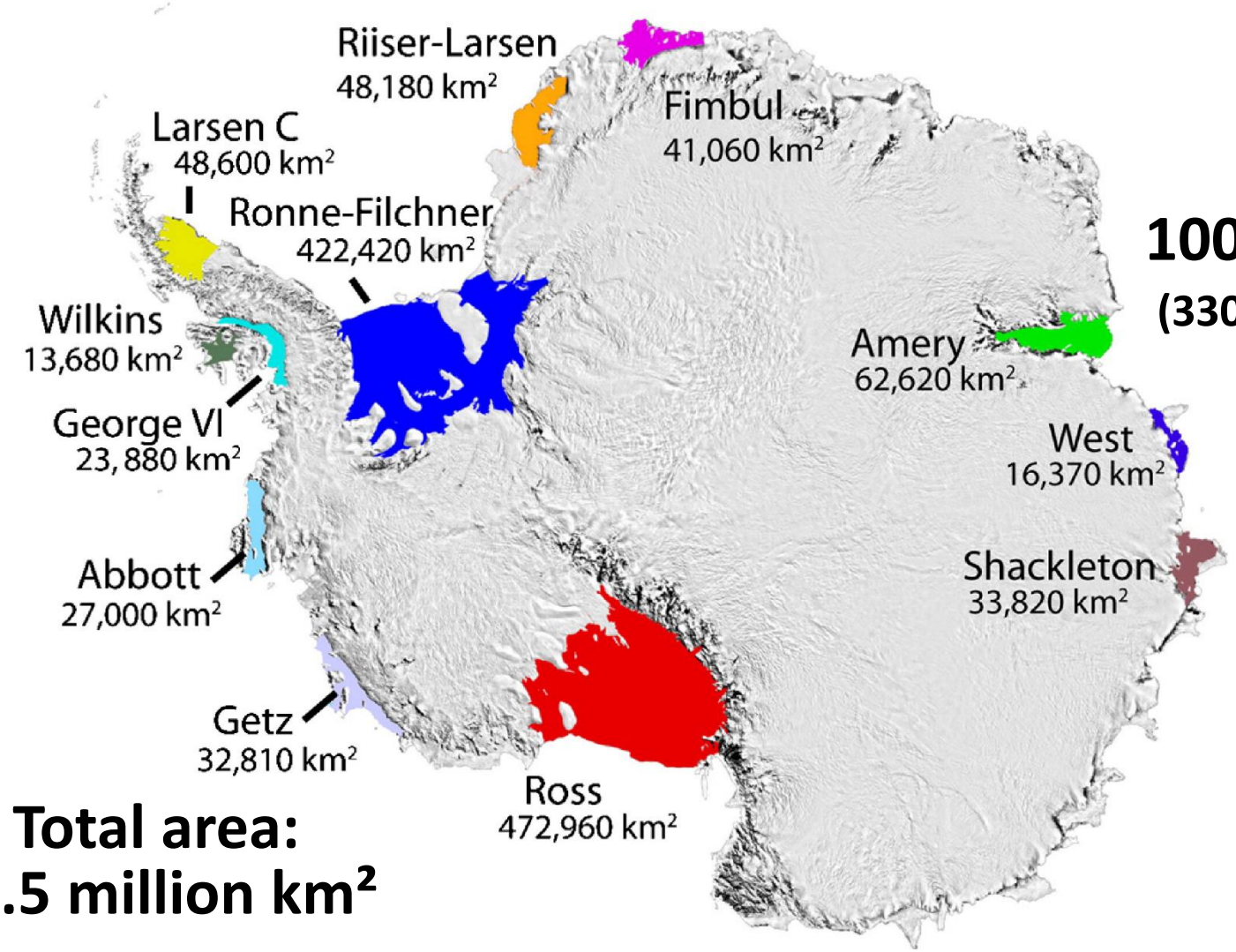
# Antarctic Sea Ice




**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.**

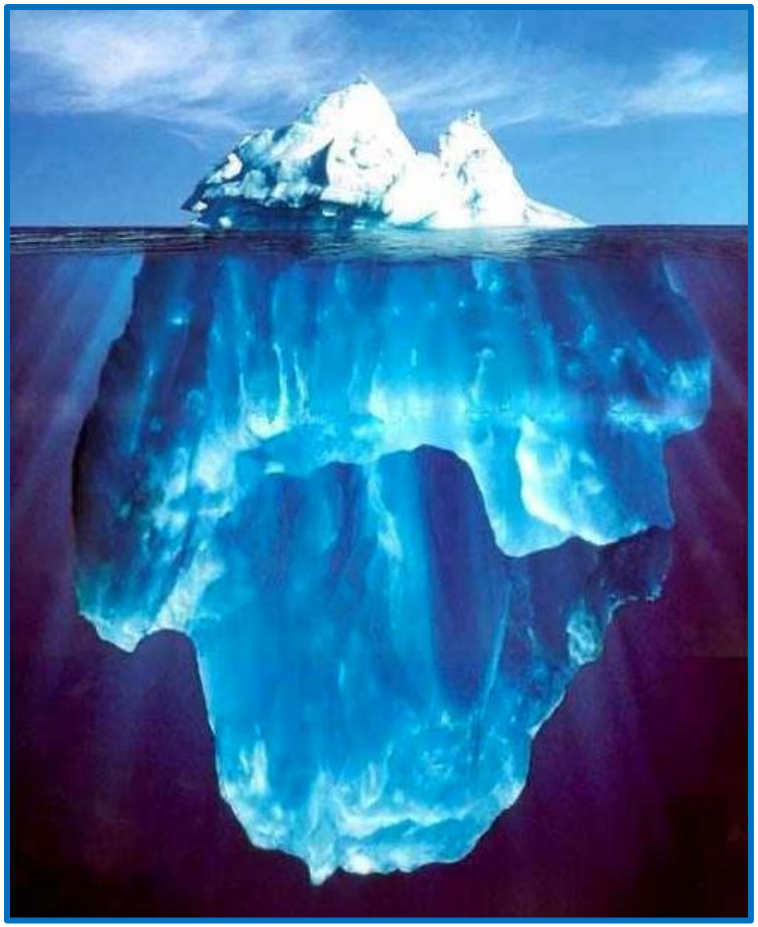



**100-1000 m**
**(330-3300 feet)**
**thick**

**Total area:**
**~1.5 million km²**

# 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.**

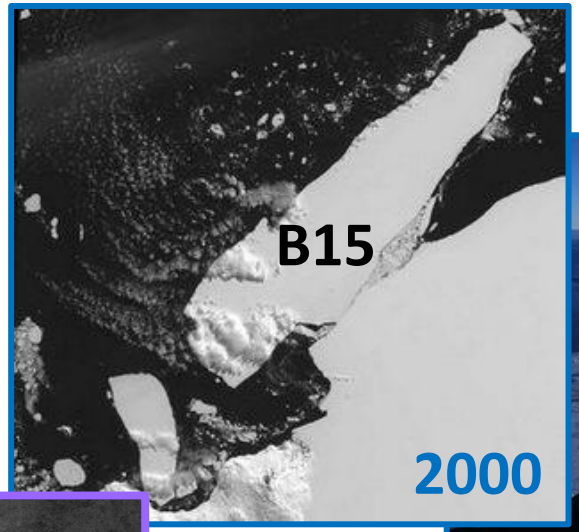


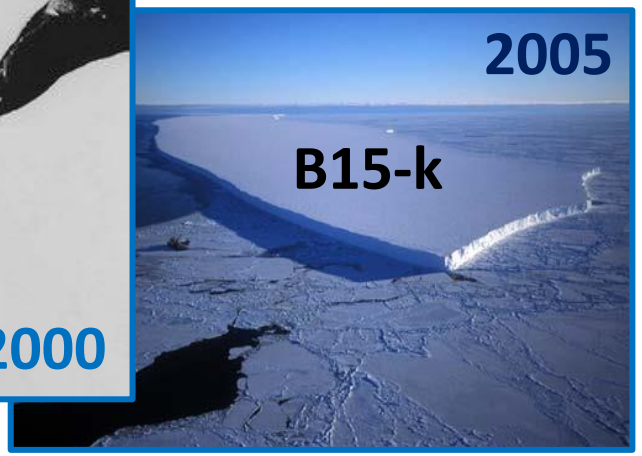
**Typically, only one-tenth of the volume of an iceberg is above water.**

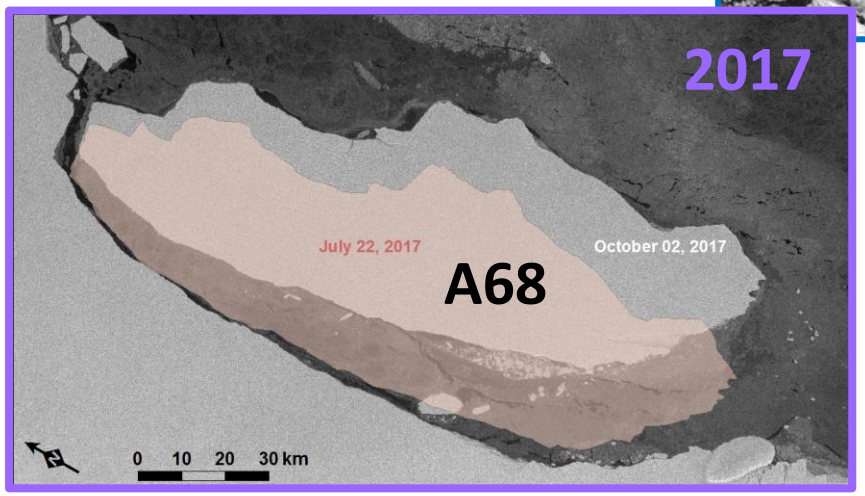
# How large can an iceberg be?

**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 the state 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 the state of Delaware) and weighing over one trillion tons. It calved from the Larsen C Ice Shelf in July 2017, and has since completely disintegrated.**