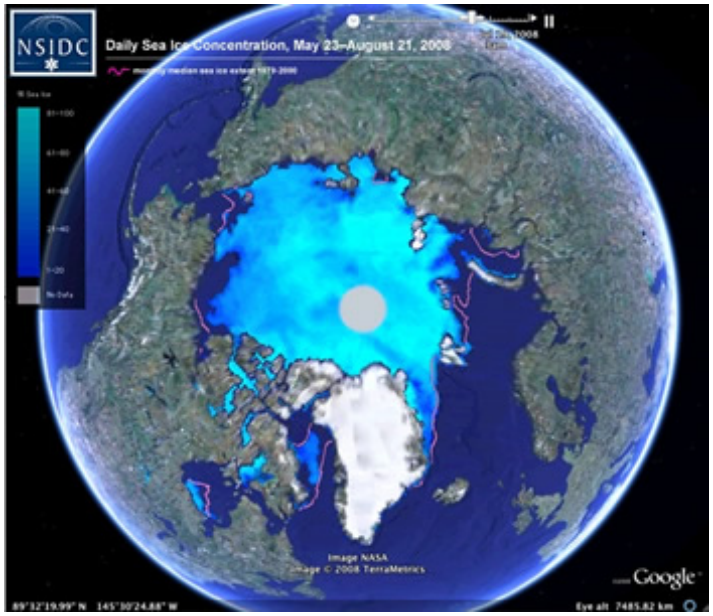
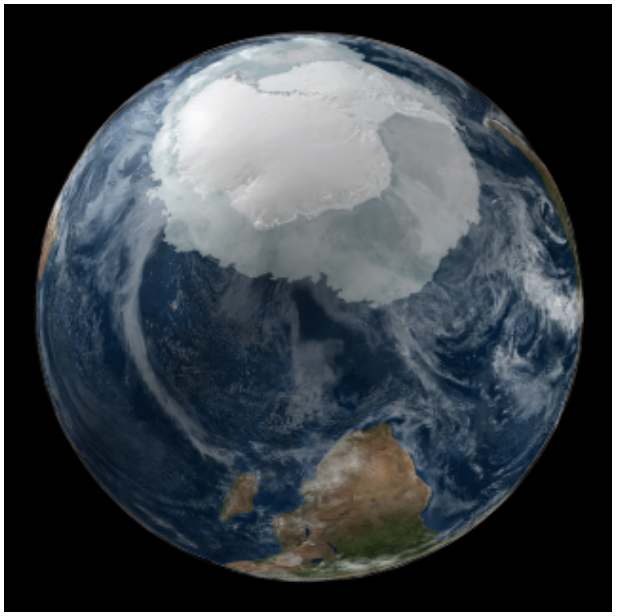
Lecture 10: Ice on Earth

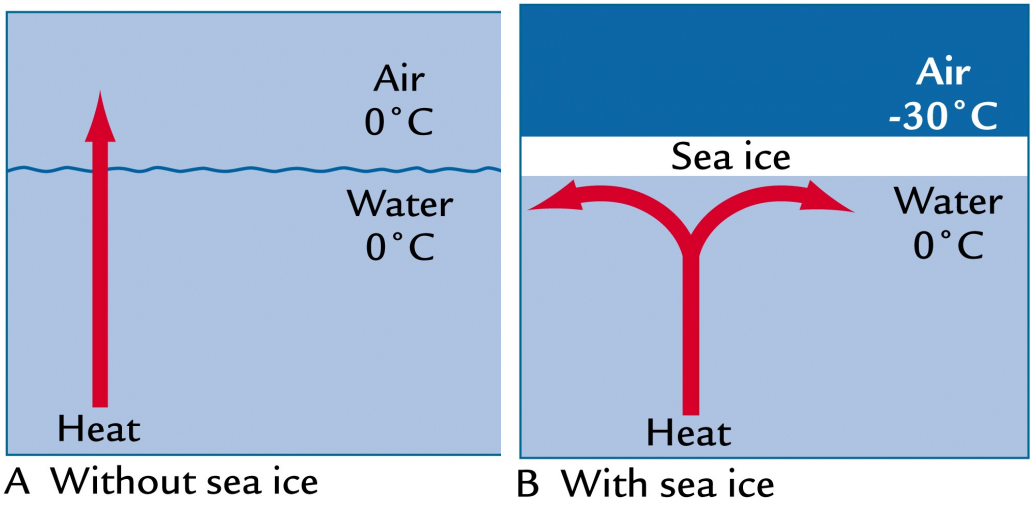
EarthsClimate_Web_Chapter.pdf, p. 8, 27-30; Ch. 2, p. 21; Ch. 10, p. 176-177

I. Sea Ice
II. Glacial Ice





I. Sea Ice



Locations: in the Arctic Ocean surrounded by landmass;

in the Southern Ocean, surrounding Antarctica.

Depth: ~1–4 m in the Arctic; ~1 m in the Southern Ocean.

Lifetime: in the Arctic, 4–5 yrs; in the Southern Ocean, forms and melts yearly.

Albedo: 60-90%, highest on Earth's surface

Density: less than seawater, hence floats on top.

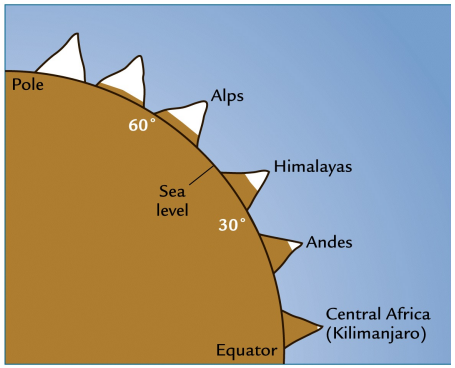
The role in the climate system:

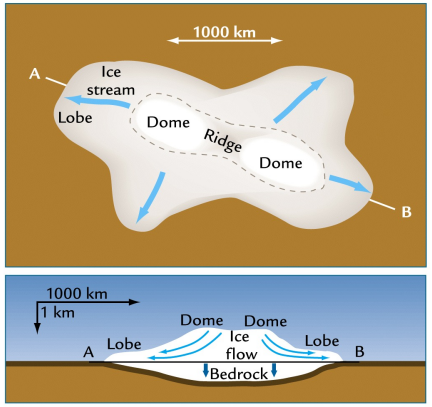
Albedo-temperature feedback

Prevents the underlying (warm) ocean from interaction with the atmosphere, thus cools the air.

Melting of sea ice extracts heat from the atmosphere; Formation of sea ice releases heat to the atmosphere.

II. Glacial Ice





Two forms: Mountain (alpine) glaciers
Continental ice sheets.

Locations: Near sea-level at hi. lat.
> 5 km near equator
Antarctica and Greenland (polar ice caps)

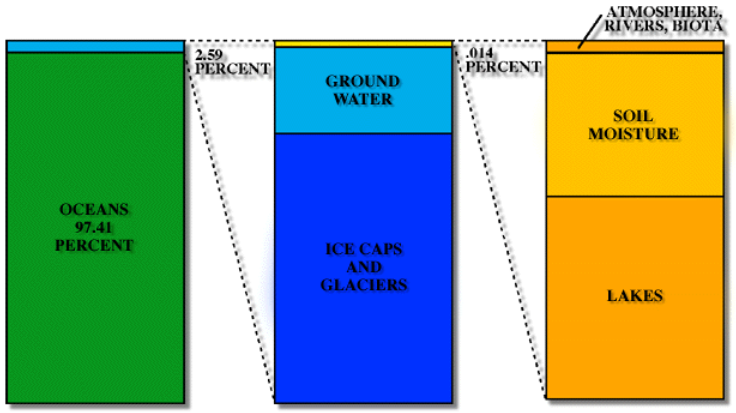
Sizes: A few km in length, tens to hundreds of m in width and thickness.
Hundred to thousands of km in length, 1–4 km in thickness.
Area of the two current ice sheets:
~11% of land surface; 70 m sea level rise when all melted.

Movement: Flows downhill by gravity along mountain valleys
Flows to the lower margins. The weight depresses bedrock.

Albedo: 60-90%, highest on Earth's surface

The role in the climate system:

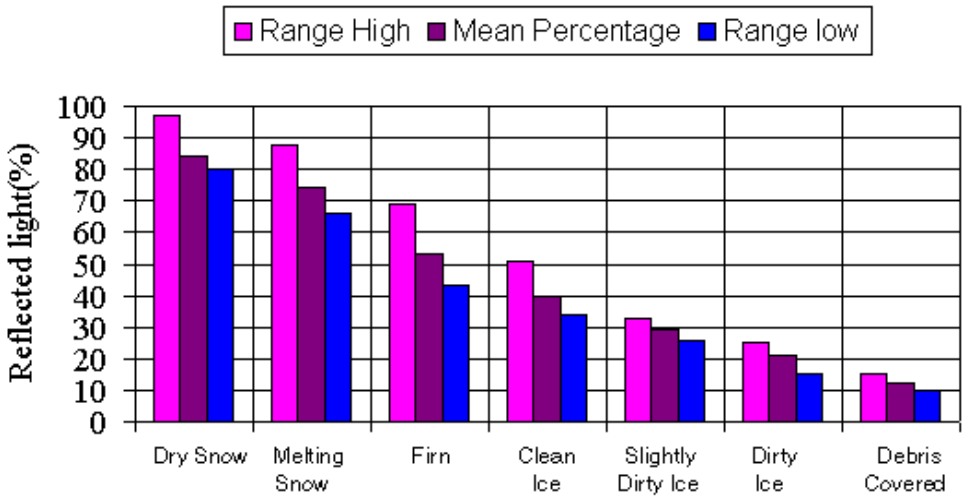
Stores 70% of world's fresh water
Changes salinity, circulation and sea level when melt
Albedo-temperature feedback



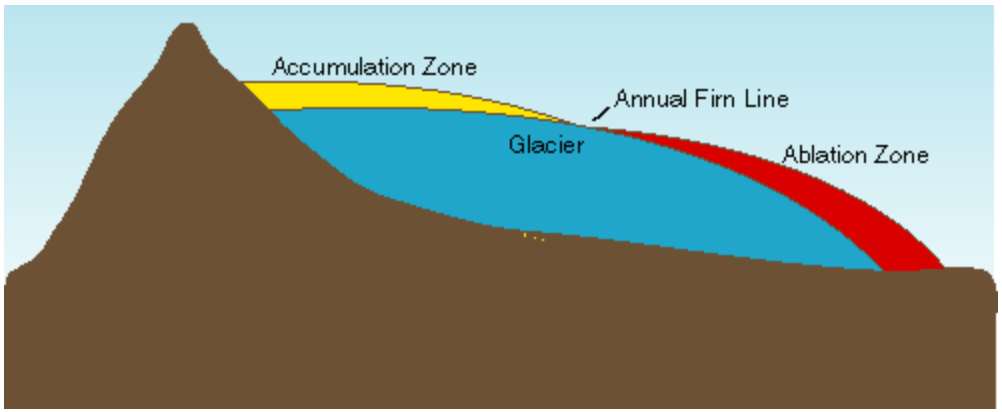
II. Glacial Ice (cont'd)

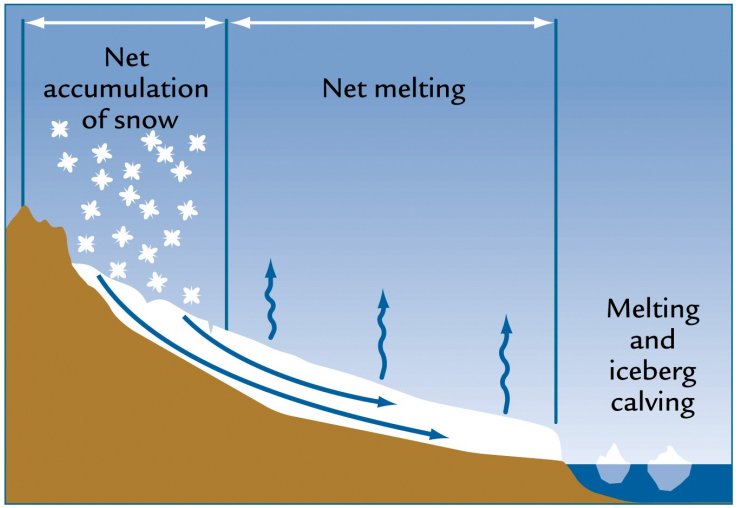
Steps to Form Glaciers

Albedo for different Glacier Surfaces



Mass Balance



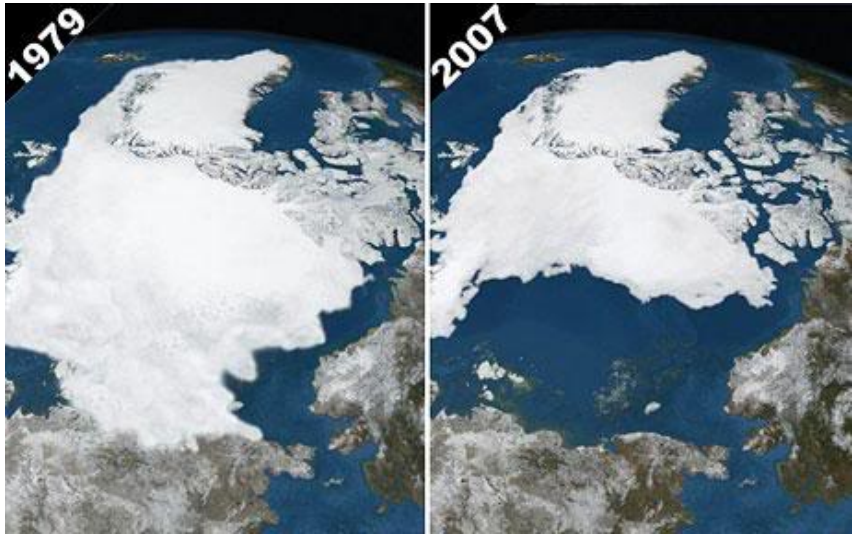


Sea ice has been melting faster than scientists predicted. How do you envision its impact on

a. Polar temperature

b. Winter storm in N. America and Europe

c. Thermohaline circulation



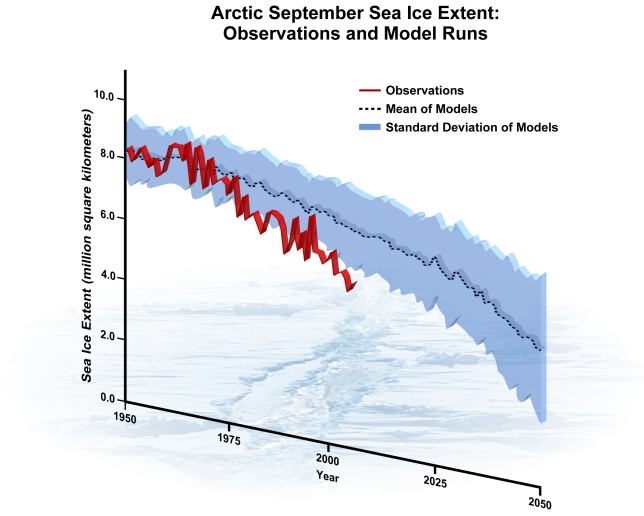
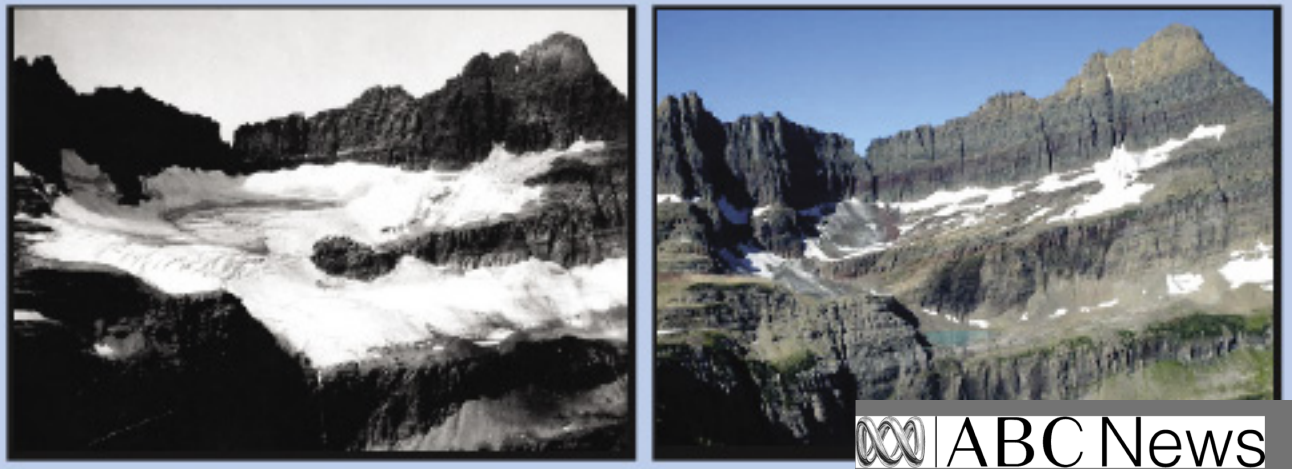


Figure 2. Shepard Glacier, Glacier National Park, MT, 1913 and 2005



SOURCE: U.S. Geological Survey Repeat Photography Project, http://nrmsc.usgs

ABC News

Crisis looms for Bolivia as glaciers melt

By Mark Corcoran for *Foreign Correspondent*

Posted Tue Jul 10, 2007 12:22pm AEST
Updated Tue Jul 10, 2007 12:37pm AEST

The glaciers in the Andes mountains of Bolivia provide about half the drinking water for two million people down the mountain. But the glaciers are now melting at an unprecedented rate and will be completely gone within 20 years.

A ski hut on a barren mountain in Bolivia. (ABC)

The mountain's traditional guardians, the Aymara Indians, say that to ascend this 6,000-metre peak without absolution is to incur the wrath of the gods.

"They're not angry with us, they're telling us something," an Aymara priest says as he gives a blessing to local people.

"We have to live with nature in a balanced way - if we don't pollute more, and if we don't industrialise, if we learn not to pollute we'll be able to live a bit longer."

Example of a positive feedback

More energy retained in system

Warm temperatures

Ice and snow melt

Albedo decreases
Less solar energy reflected

If this were the only mechanism acting, we'd get a runaway temperature increase

Example of a negative feedback

More energy retained in system

Warm temperatures

More evaporation
More clouds

Albedo increases
More solar energy reflected

Another Positive Feedback

More energy retained in system

Warm temperatures

More evaporation
More clouds

More longwave energy absorbed

Summary:

- How much global fresh water is stored as ice/glacier?
- How would sea ice/glacier affect climate?
- How has sea ice and glacier changed during the last century and how would such a change affect humanity?