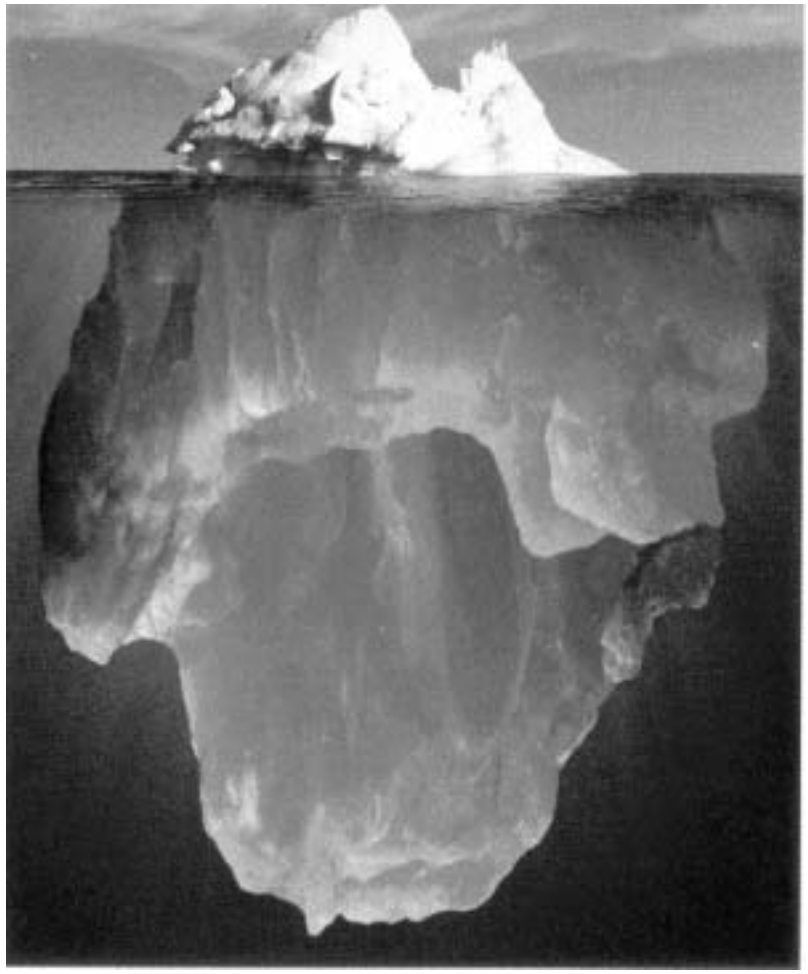
Discussion 3: Sea Ice and Land Ice

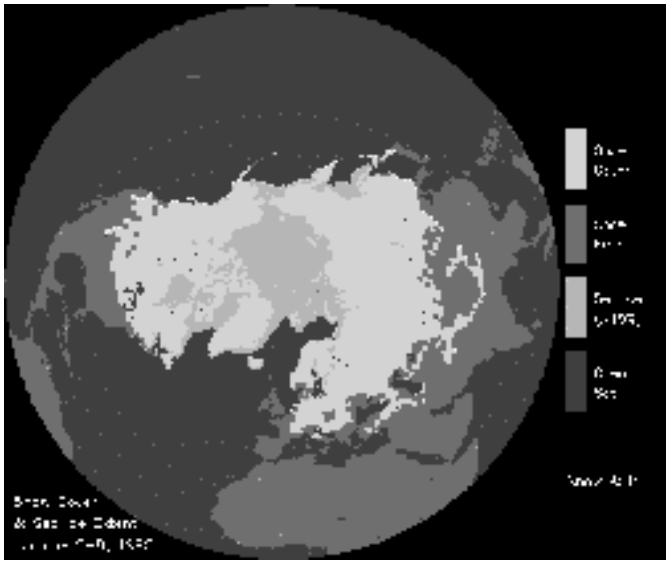
Cryosphere

Sea Ice



(from *The Blue Planet*)

Land Ice



❑ The cryosphere is referred to all the ice near the surface of Earth: including sea ice and land ice.

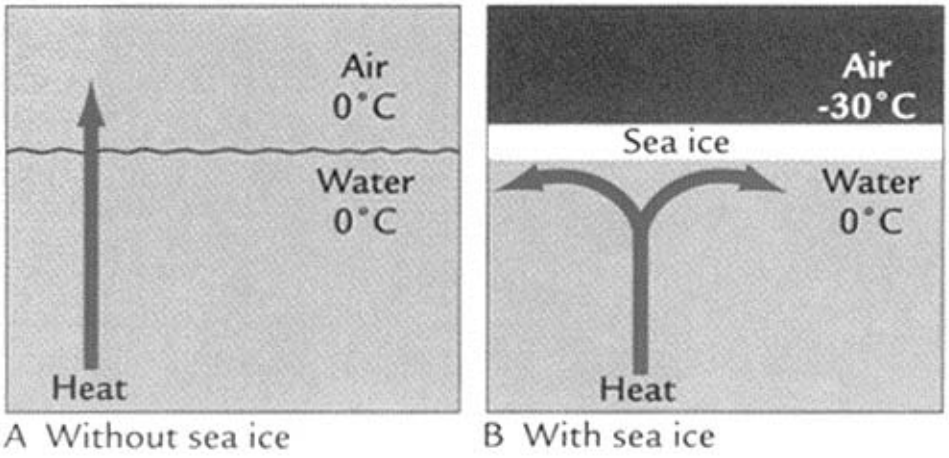
How Much Ice Does the Earth Has?

At present, year-round ice covers 11% of the land area and 7% of the world ocean.

How Cryosphere Affect Climate?

- Affect surface heating to the atmosphere.
- Affect the fresh water forcing to oceans.

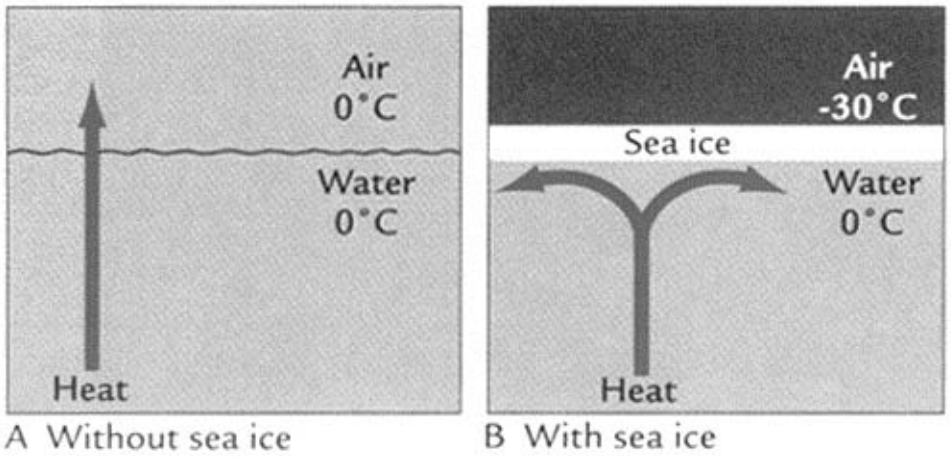
Why is Ice Important to Climate?



(from *Earth's Climate: Past and Future*)

- Surface ice of any depth is a much more effective reflector of solar radiation than the underlying surface.
- Sea ice is a good insulator and allows air temperature to be very different from that of the seawater under the ice.

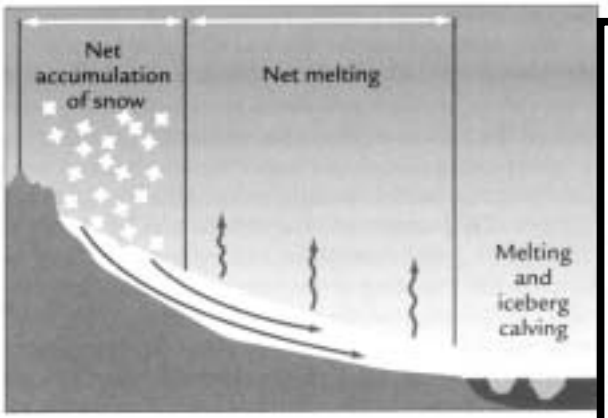
Sea Ice

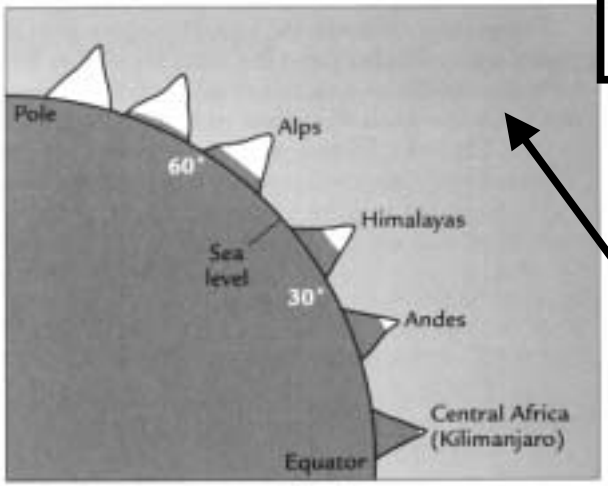


(from *Earth's Climate: Past and Future*)

- One major climate effect of sea ice is to seal off the underlying ocean from interaction with the atmosphere.
- Without an sea ice cover, high-latitude oceans transfers large amount of heat to the atmosphere, especially in winter.
- With an sea ice cover, the heat flux into the atmosphere is stopped. In addition, the ice surface absorbs little incoming solar radiation. Winter air temperature can cool 30°C or more near a sea-ice cover.

Land Ice





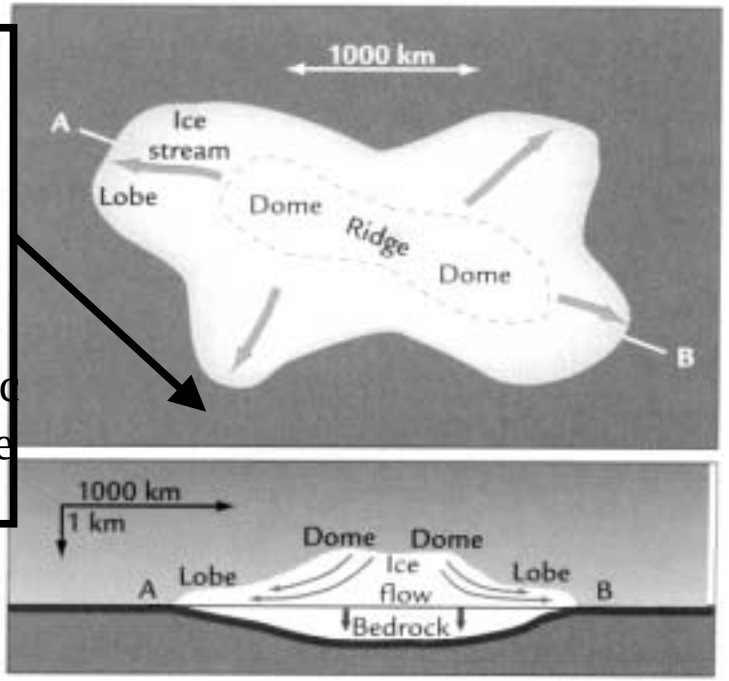
(from *Earth's Climate: Past and Future*)

❑ **Continental Ice Sheets:**

100-1000 km in horizontal extend.

1-4 km in thickness.

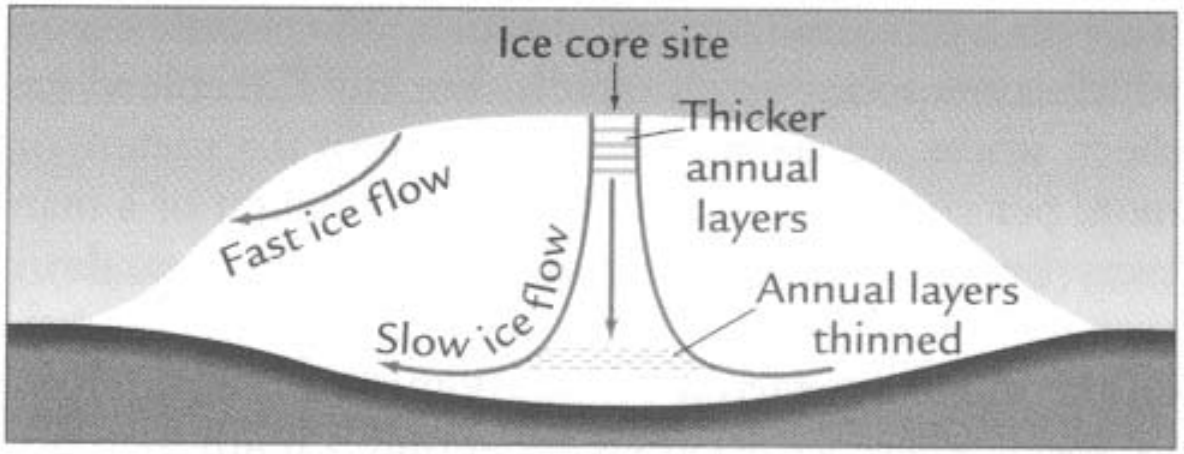
Two larges sheets: Antarctic Ice Sheet and Greenland Ice Sheet.



❑ **Mountain Glaciers:** a few kilometers in length and 10-100 meters in width and thickness.

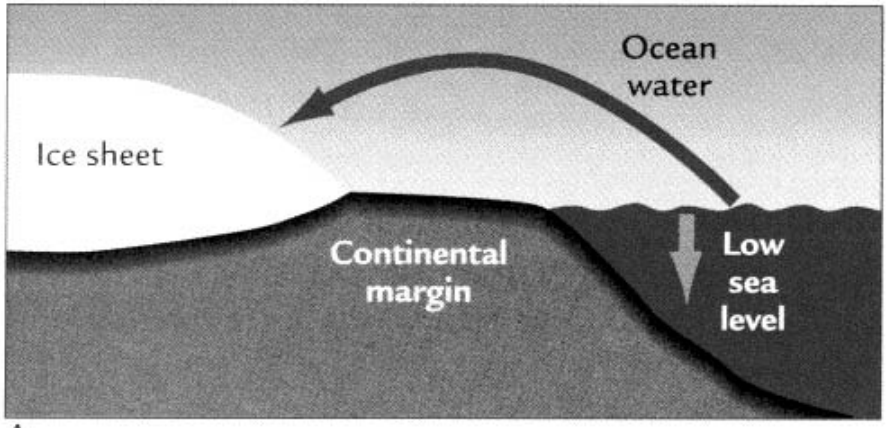
Glacial Ice

(from *Earth's Climate: Past and Future*)

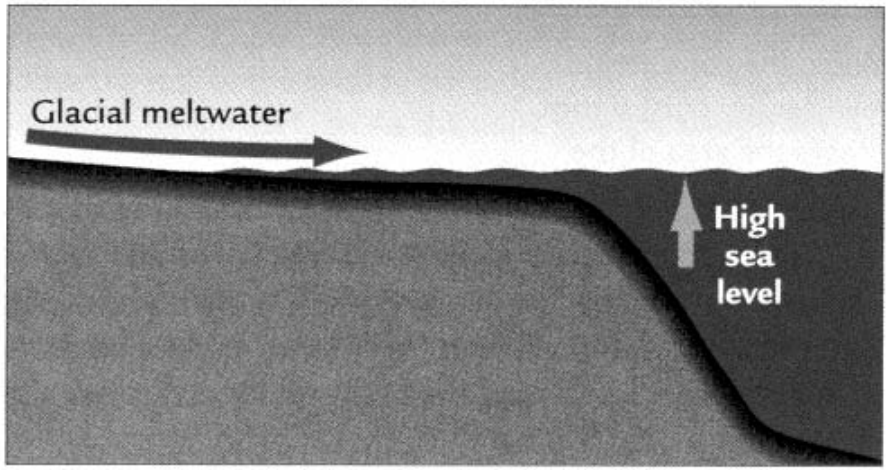


- Ice cores retrieve climate records extending back thousands of years in small mountain glaciers to as much as hundreds of thousands of years in continental sized ice sheets.
- The antarctic ice sheet has layers that extend back over 400,000 years.
- The Greenland ice sheet has layers that extended back 100,000 years.

Ice and Sea Level



A

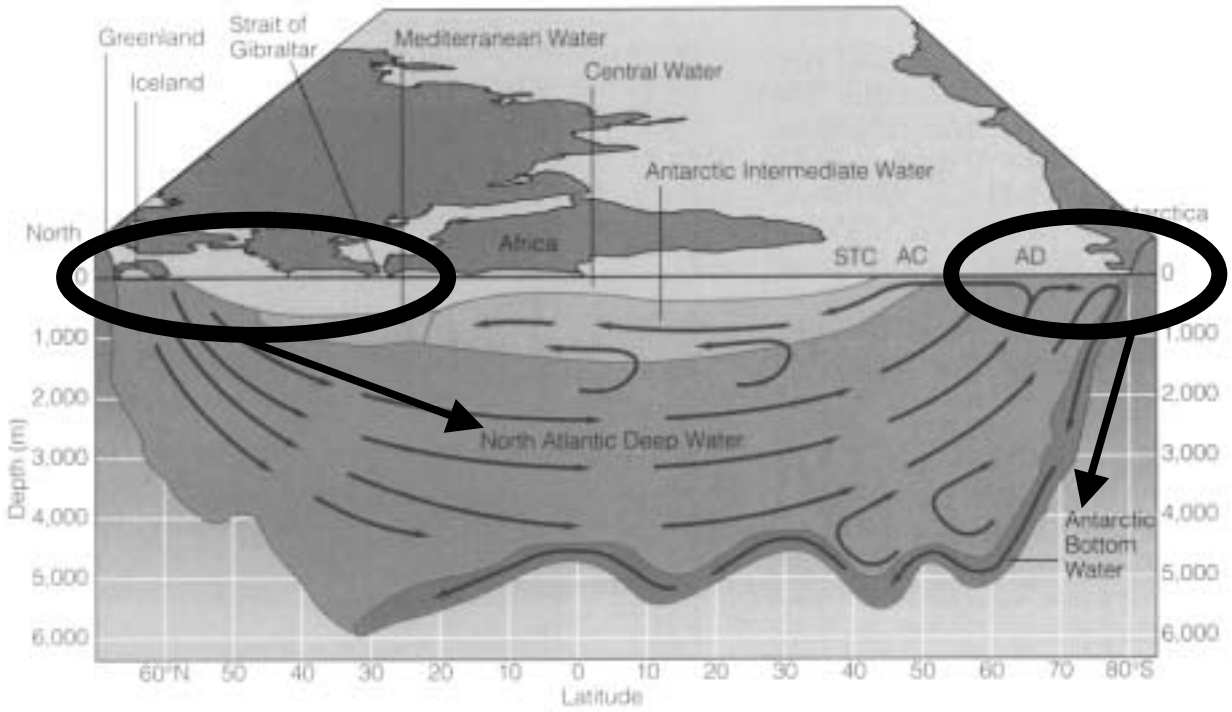


B

(from *Earth's Climate: Past and Future*)

- The Antarctic Ice Sheet holds the equivalent in seawater of 66 meters of global sea level.
- The Greenland Ice Sheet holds the equivalent of 6 meters of global seawater.

Two Regions of Deep Water Formation



(Figure from *Oceanography* by Tom Garrison)

- Antarctic Bottom Water

  Salinity = 34.65‰

  Temperature = -0.5°C

  Density = 1.0279 g/cm^3

  Formed at Weddell Sea

  Related to ice formation

  During Winter

- North Atlantic Deep Water

  Due to winter cooling and evaporation.

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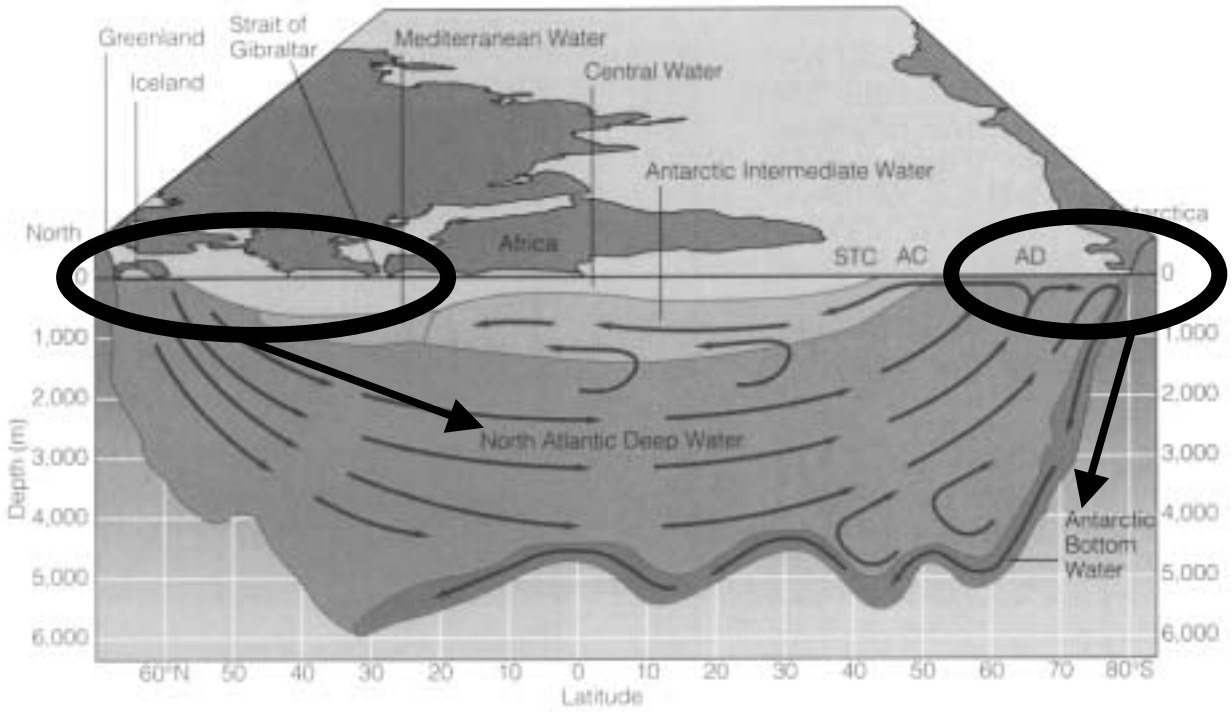

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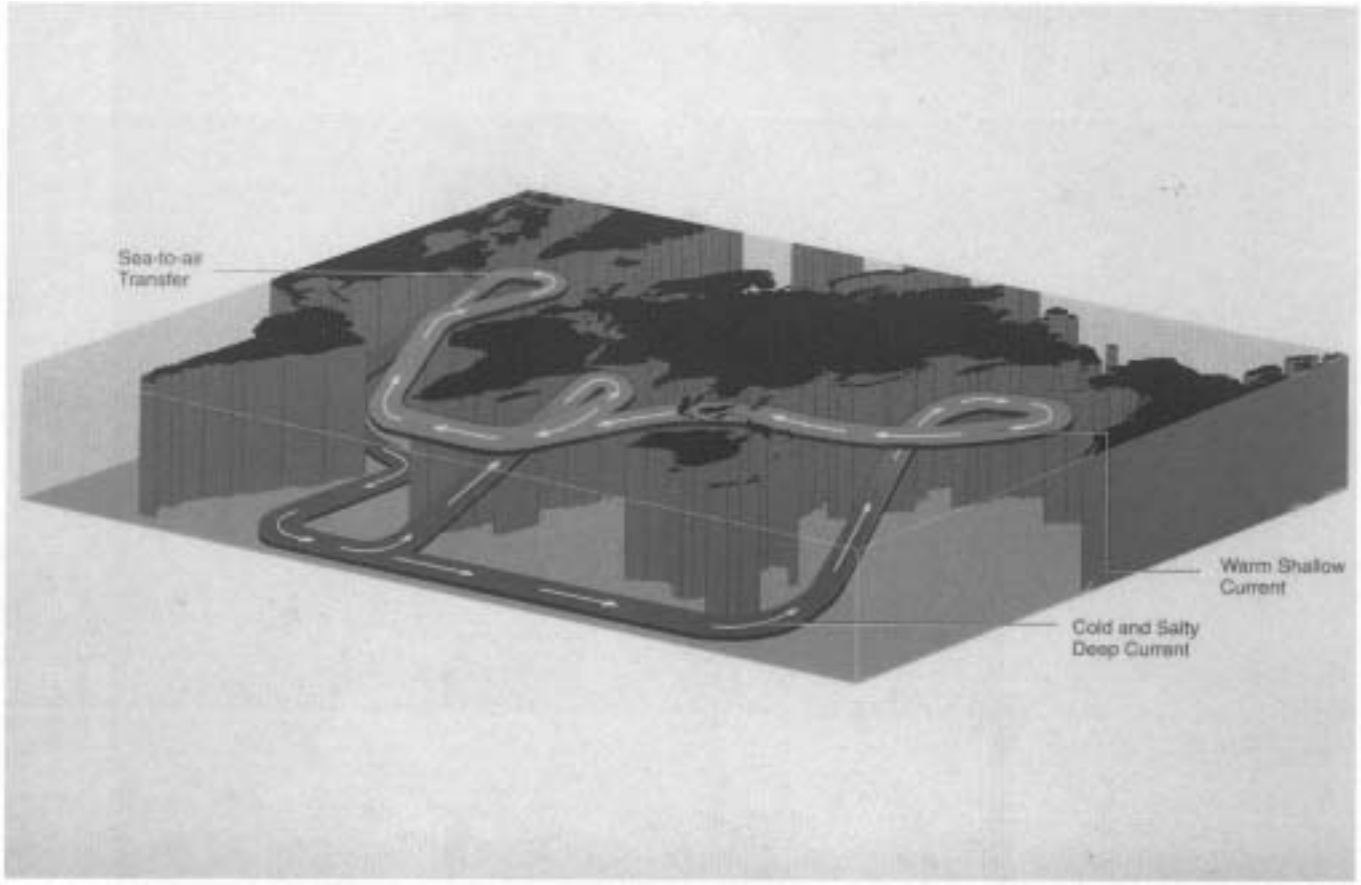
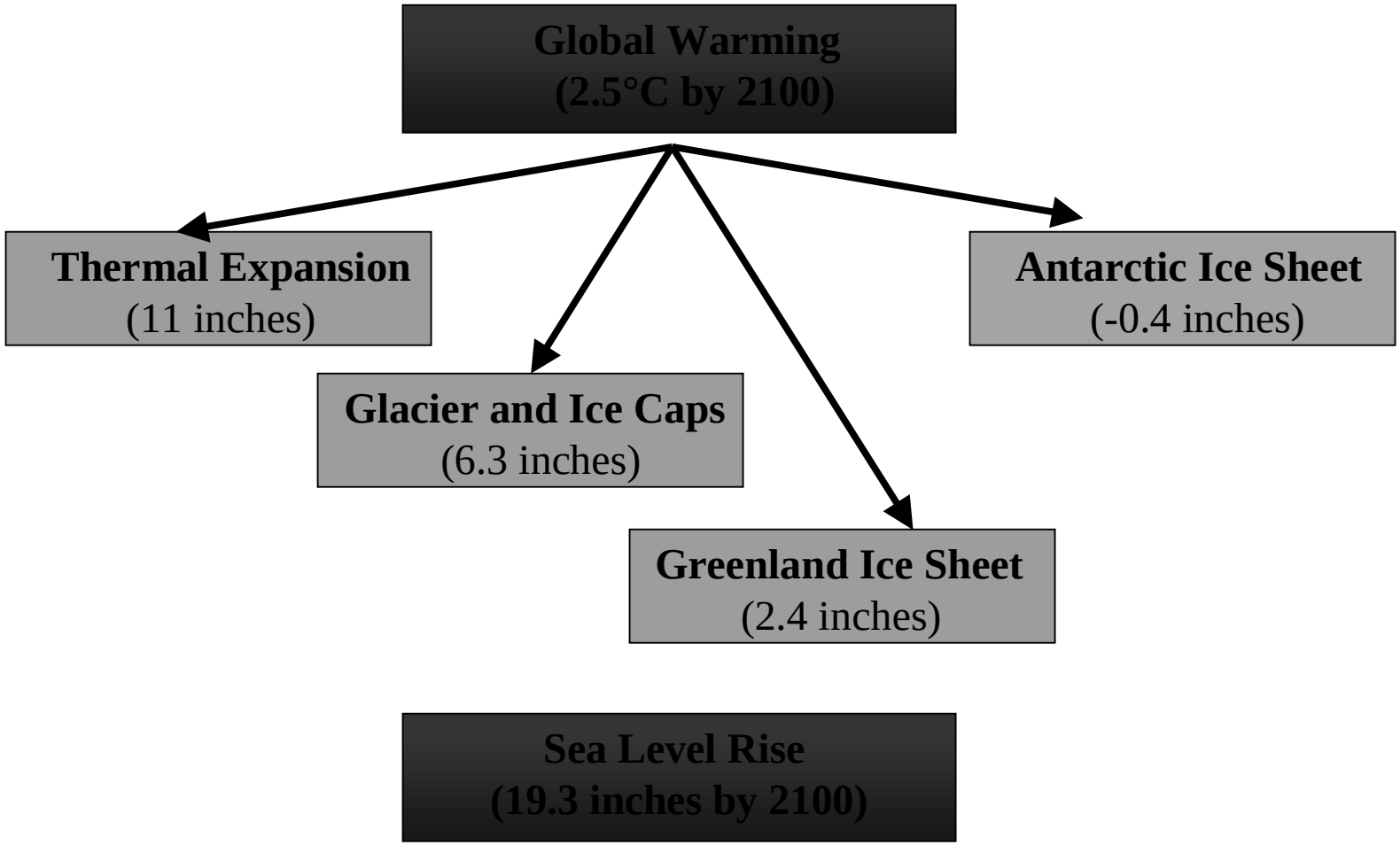
Thermohaline Conveyor Belt

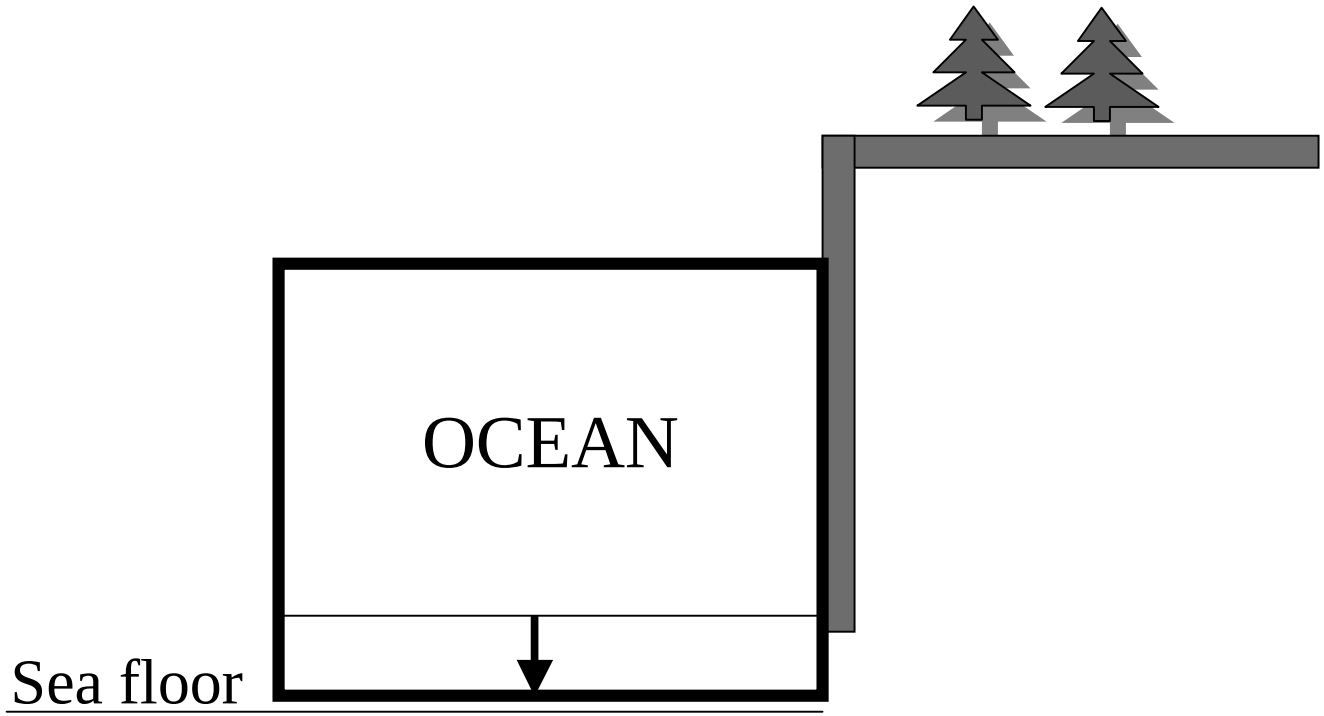


(Figure from *Climate System Modeling*)

Global Warming and Sea-Level Change



Sea Level Rise .vs. Sea Floor Sink



After a certain amount of land-supported ice melts, in stead of saying the sea level will rise “so much”, we should say the oceans will get “so much” deeper. -- (Kivioja 2003; *EOS*)