Lecture 22: Survey of the Last Glacial Maximum

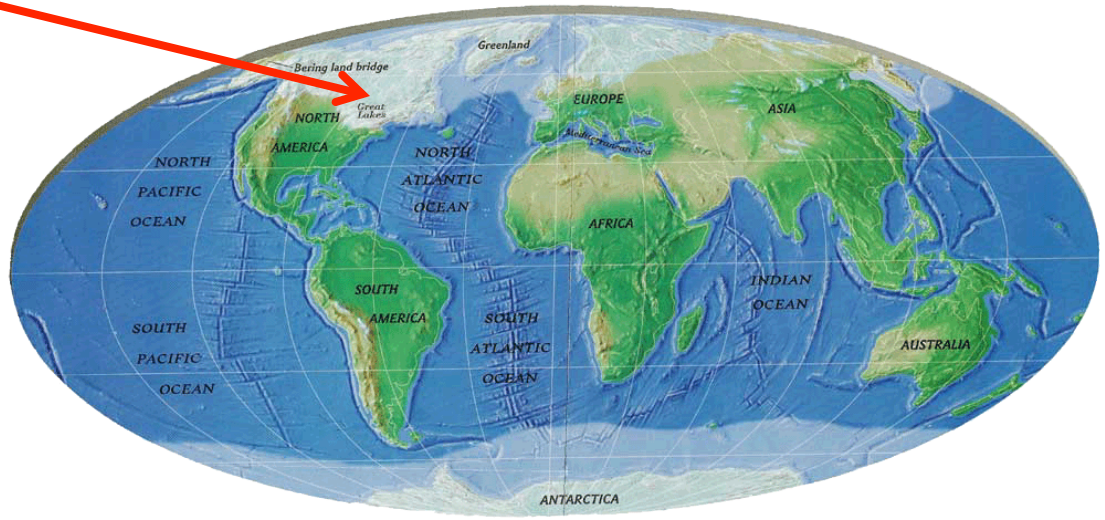
Part IV, p. 206-207; Chapter 12 (p. 209-224)

Survey of The Last Glacial Maximum

(21 k yrs ago)

Ch. 12, p. 209-224

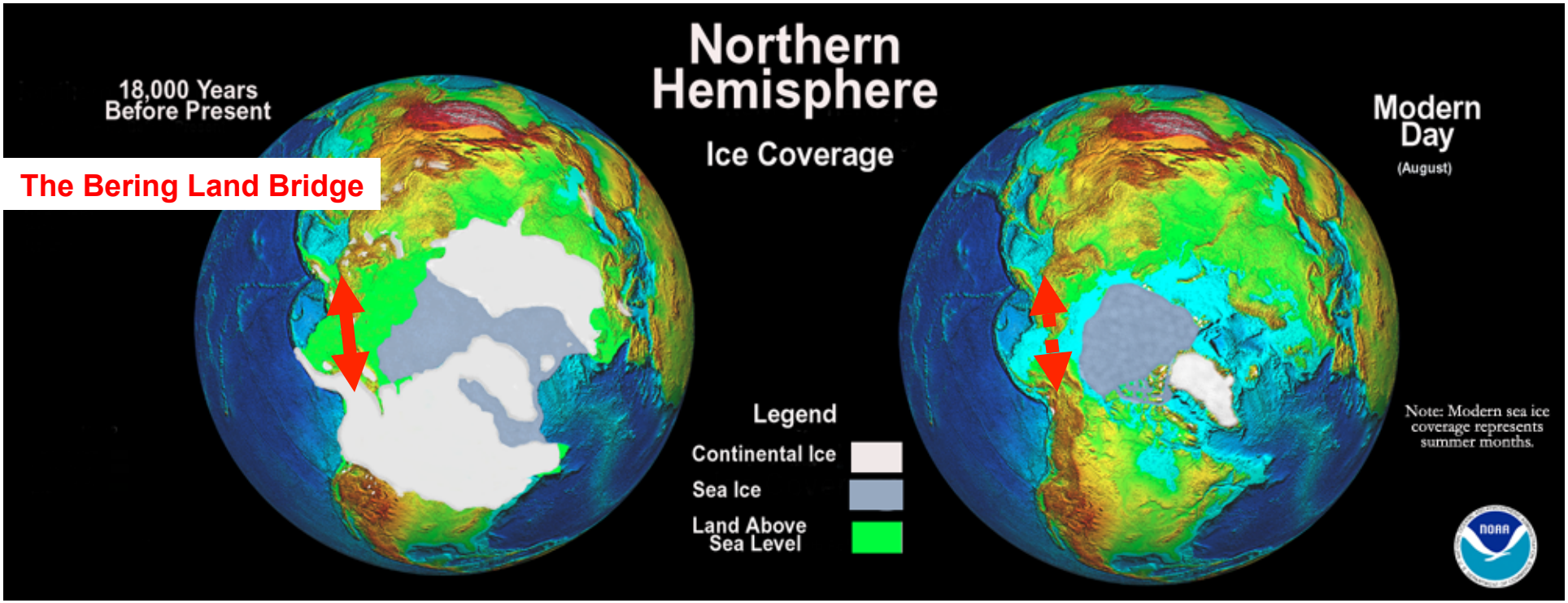
CN Tower, Toronto, Canada



- Continental ice sheets greater than 3 km (1.8 miles) thick covered parts of North America and Eurasia

- Sea ice around Antarctica and in the North Atlantic was considerably more extensive

Differences between LGM and Today

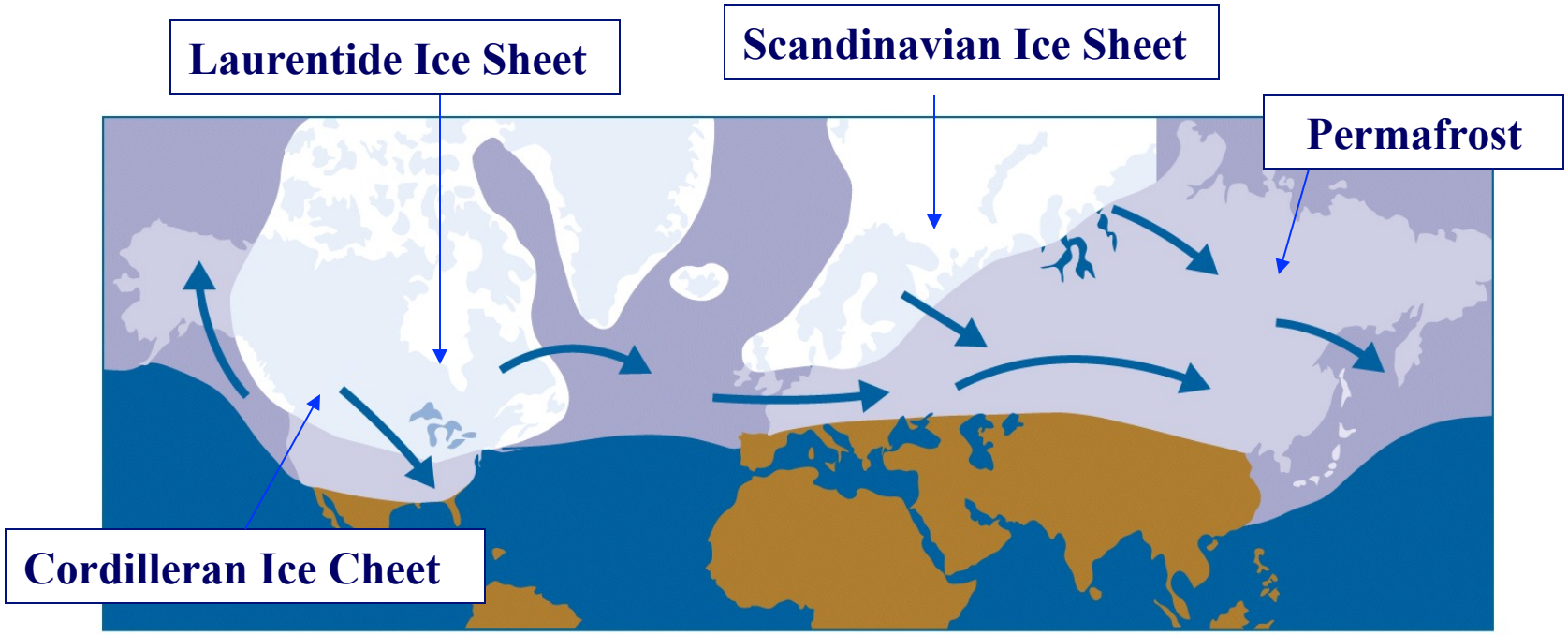


- Ice covered ~25% of modern land area (about half of North America)
- Temperature ~ 4-8°C lower than today
- Sea level 120 m (or 400 ft) lower than today
- Windier; dustier; Strong overturning; restricted fauna/flora
- CO_2 = 180 ppmv now 381 ppmv (in 2006)
- CH_4 = 350 ppbv now 1751 ppbv (in 2006)
- N_2O = 185 ppbv now 310 ppbv

1. Land-sea configuration
   glacial ice → high albedo
   smaller oceans for transferring heat

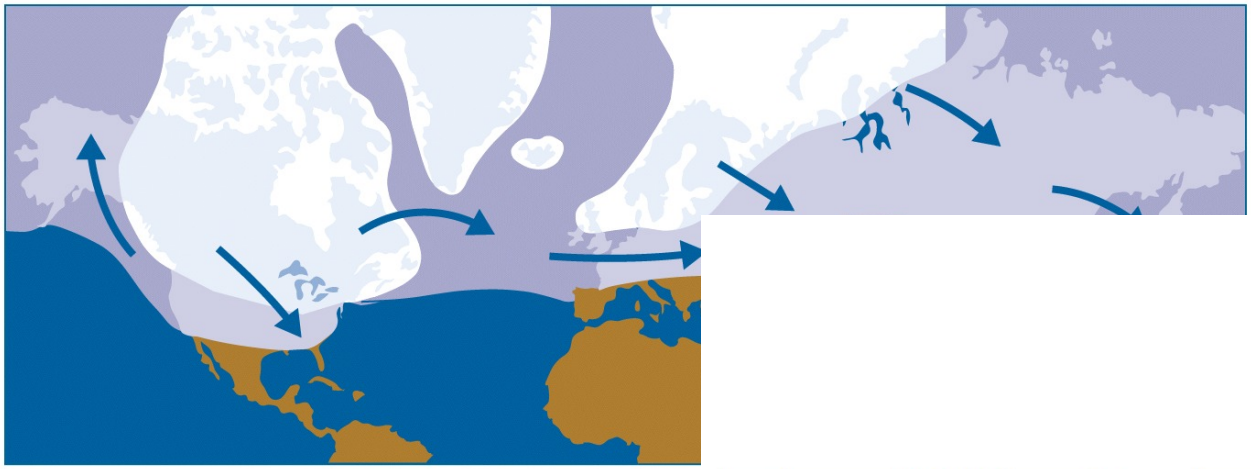
2. Insolation is similar to today

Regions of Northern Hemisphere Ice Sheets



The North American ice sheet was the largest of the N.H. ice sheets.

How Large Were the Ice Sheets?



The lateral extent of the ice sheets?

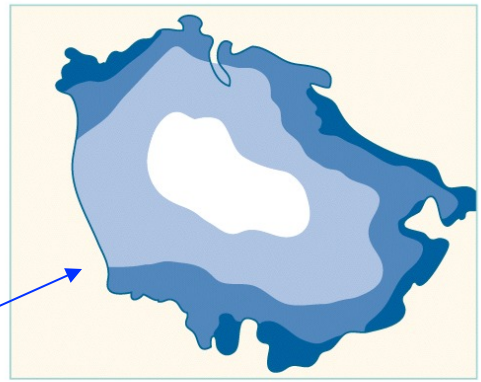
The northern limits?

The thickness of the ice sheets?

Thick?

Thin?

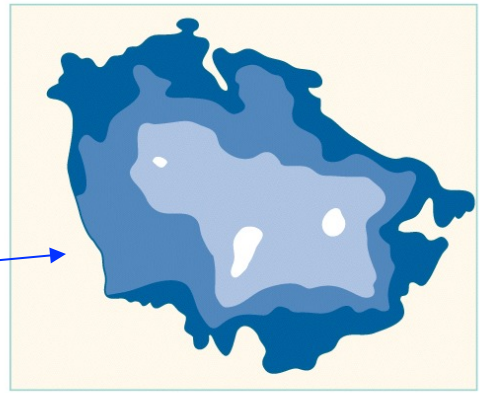
A Ice sheet extent



B Thick ice (CLIMAP)

Ice elevation (km)

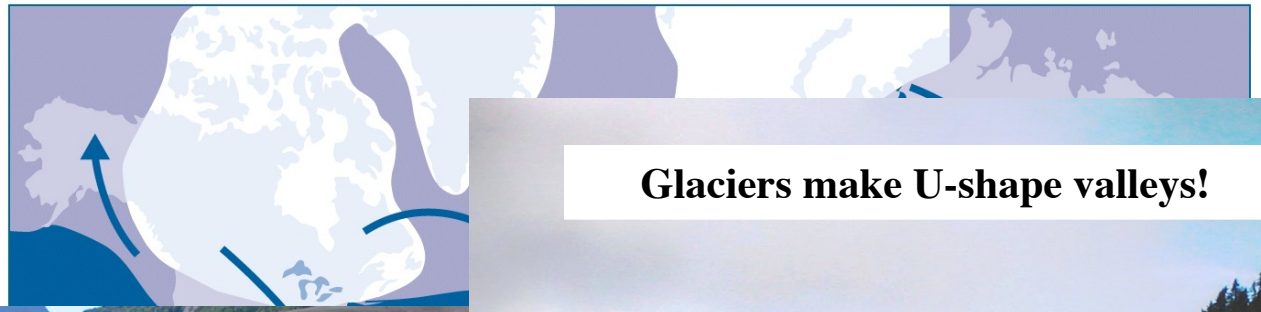
< 1 | 1 – 2 | 2 – 3 | > 3



C Thin ice

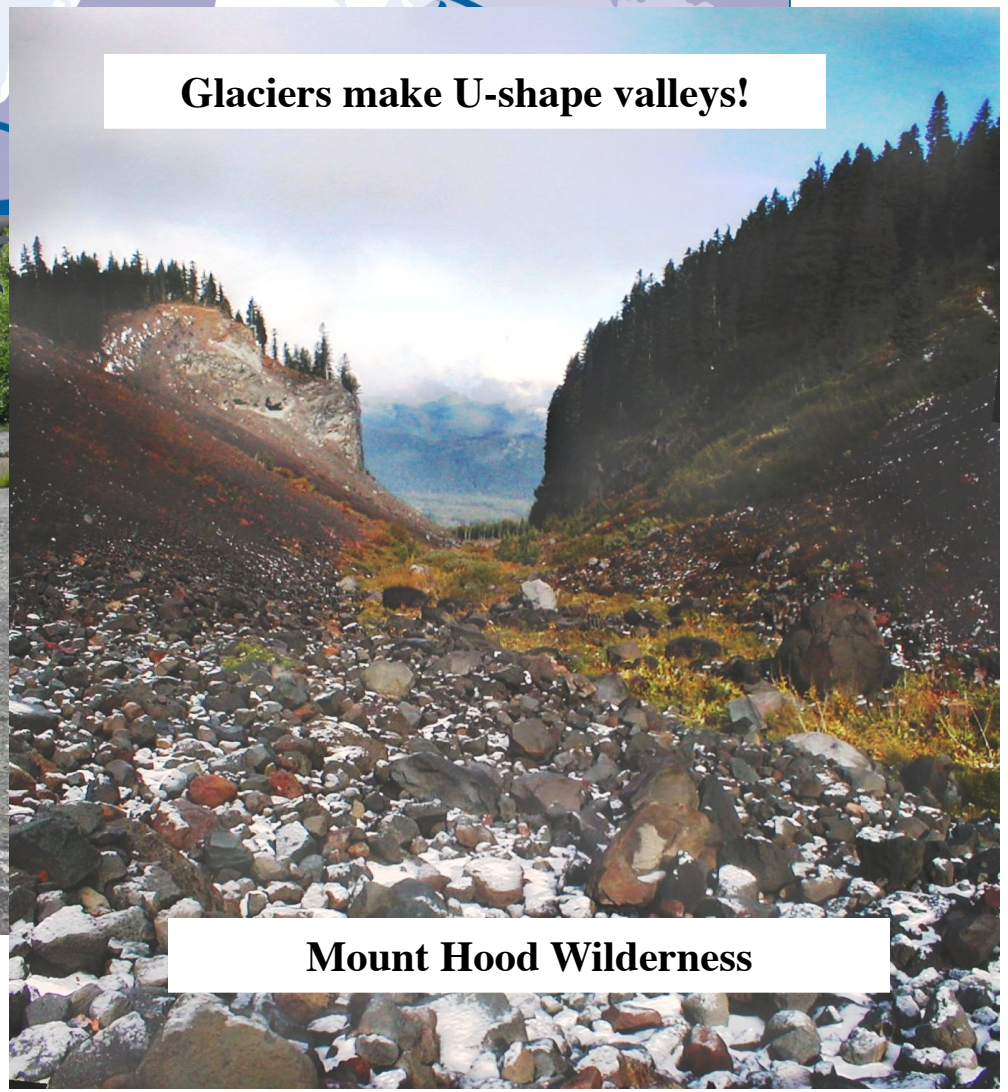
How do we know the extensiveness of the glaciers during the LGM?

Glaciers Transform Landscape



Norway (near Jostedalsbreen glacier)

Glaciers abrade rocks!

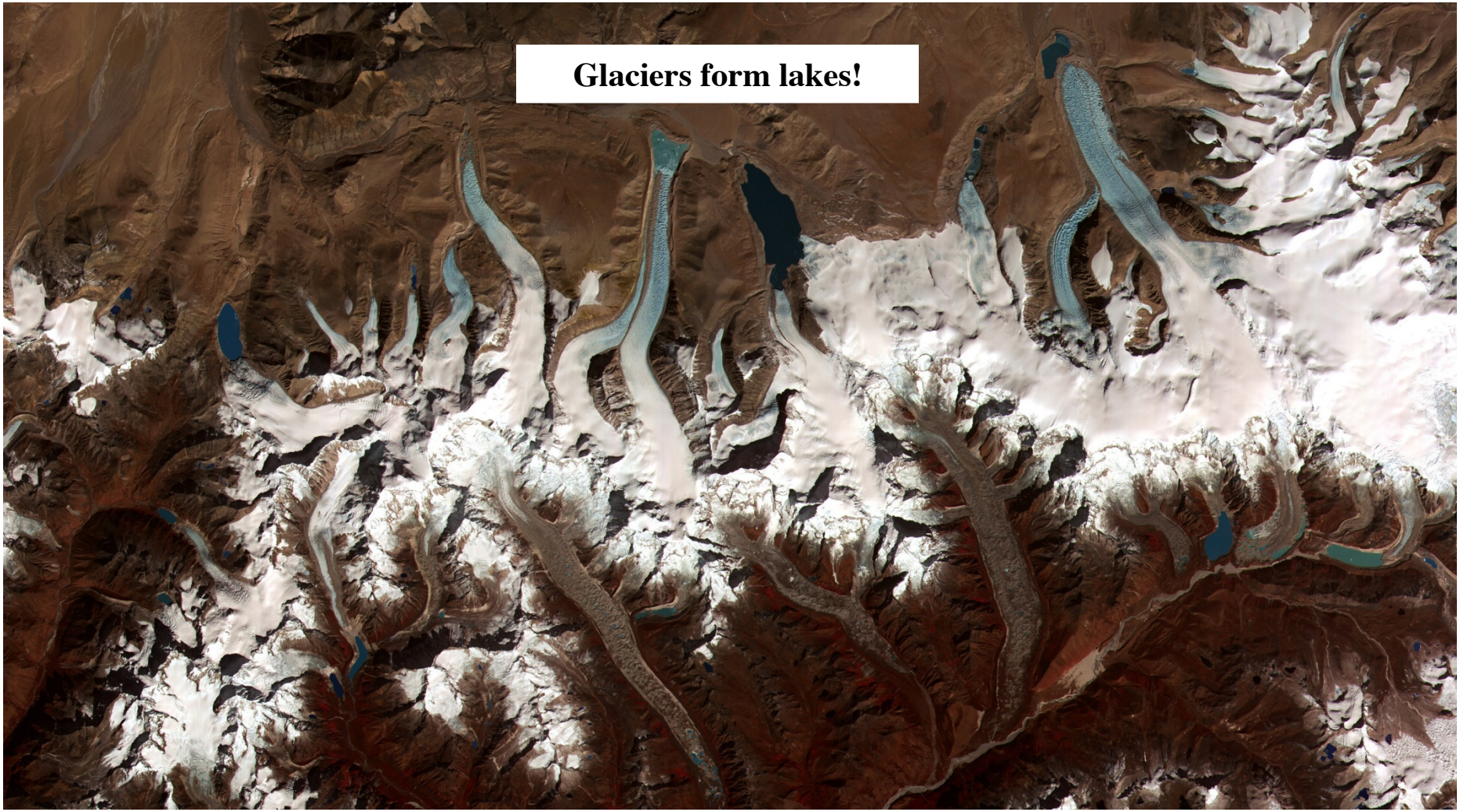


Glaciers make U-shape valleys!

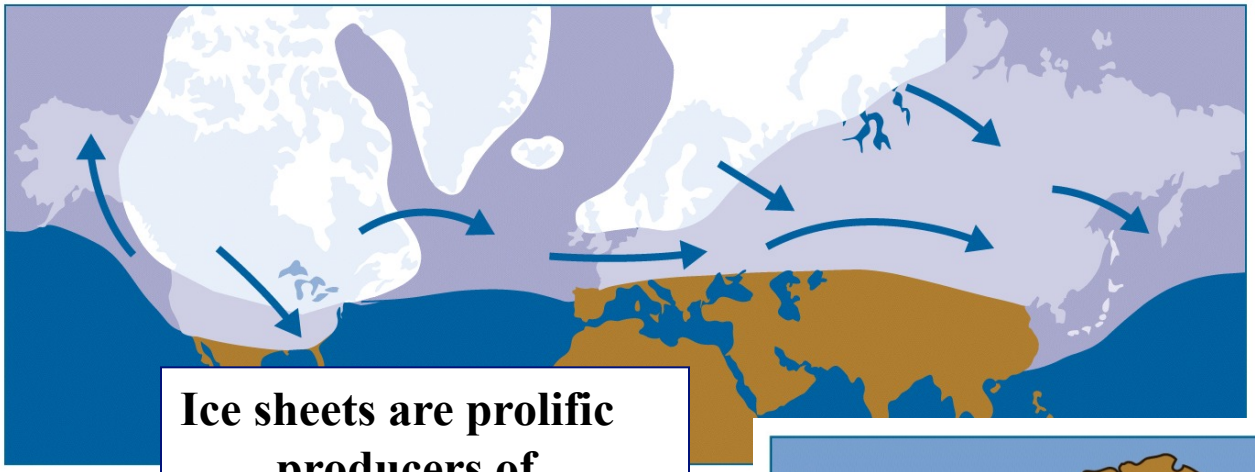
Mount Hood Wilderness

Glaciers Transform Landscape

Bhutan Himalaya



Glaciers Transform Landscape



Ice sheets erode land!

Grind / scrape / dislodge

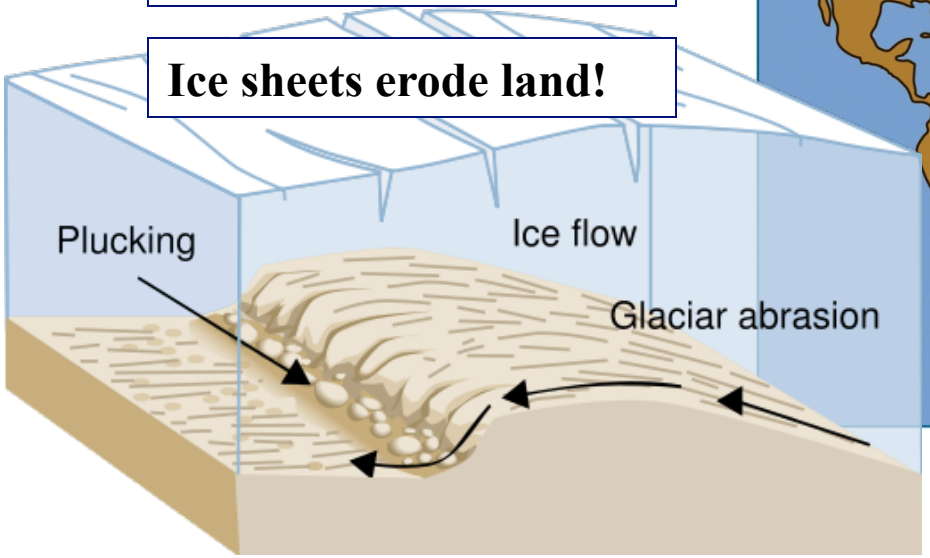
Freeze-thaw process

Carry toward margins

Ice sheets are prolific producers of debris in all sizes.

Winds carry deposits downwind.

Ice sheets erode land!



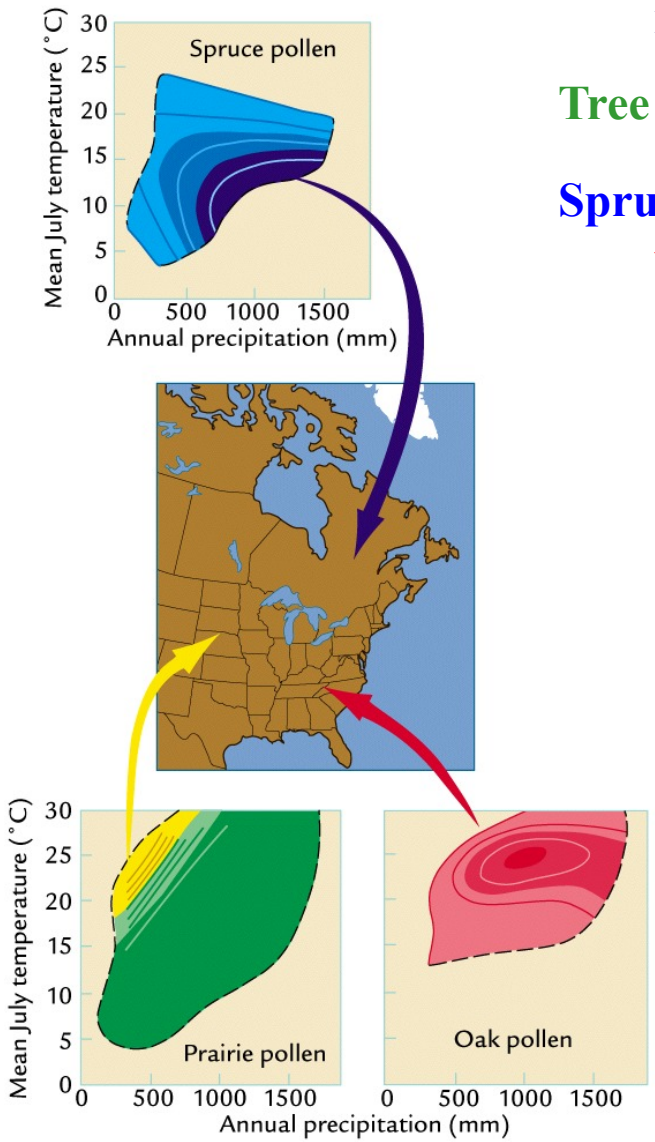
How do we know climate during the LGM?

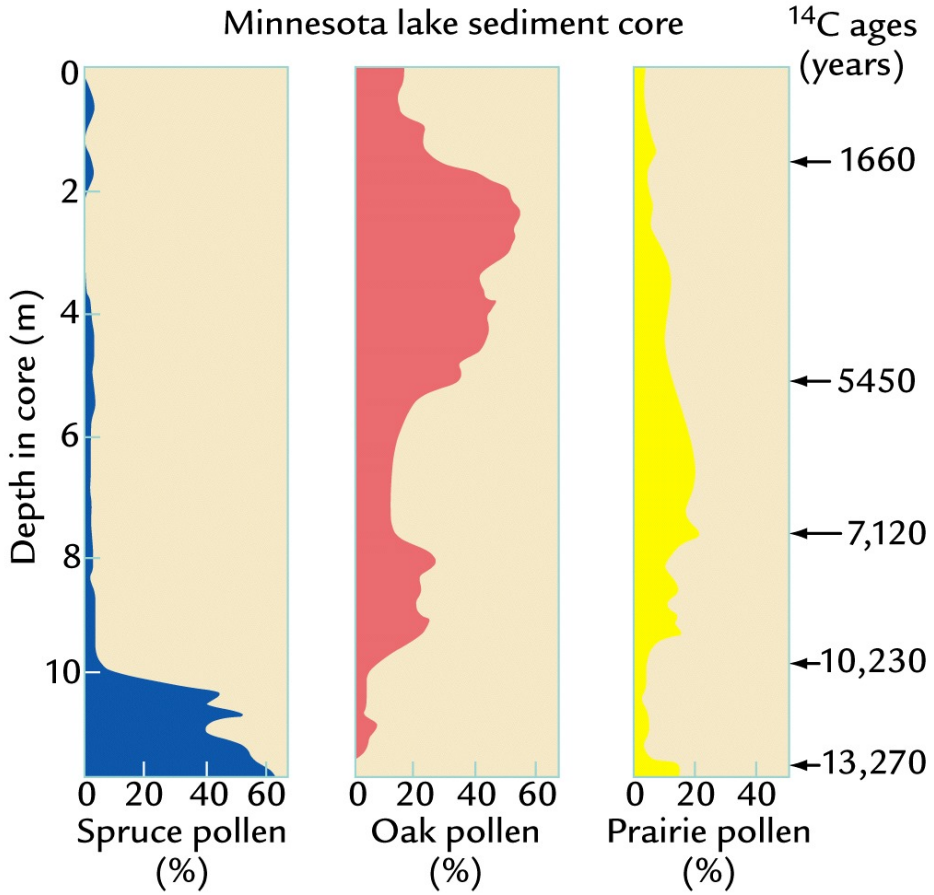
Pollen Percentages and Climate on the Continents

Prairie grasses and herbs are most abundant where rainfall is low.

Tree pollen is more common in wetter eastern regions.

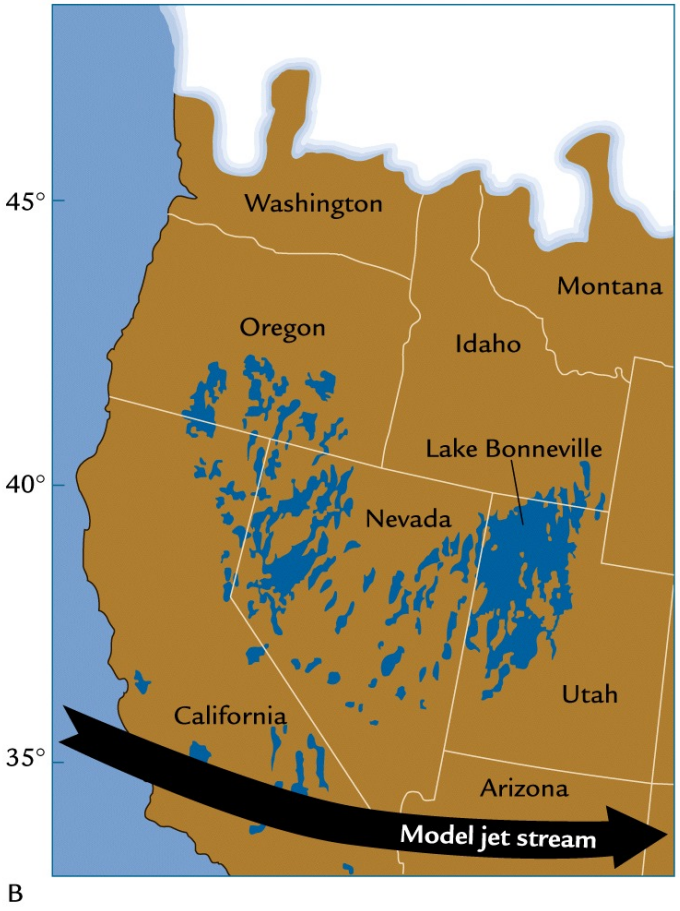
Spruce trees are common in the colder north, oak in the warmer south.





Glacial and Present-day Climate in SW USA

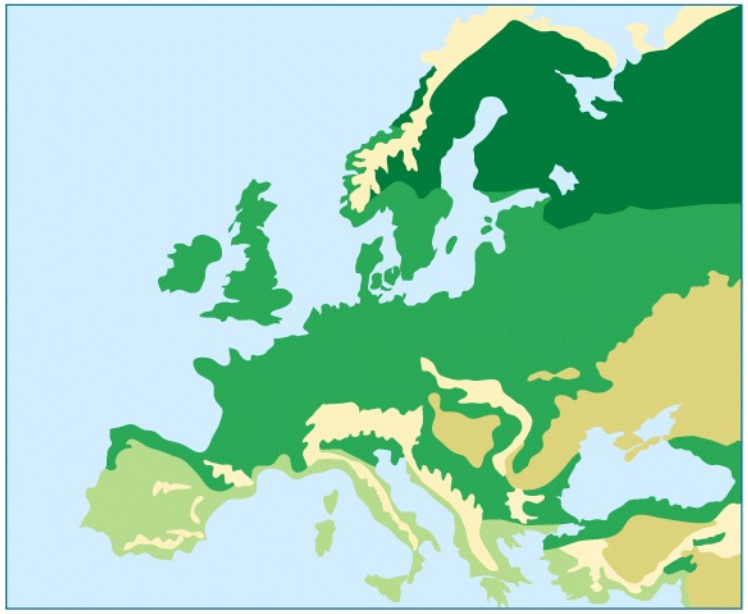
Today the southwester US is dry!

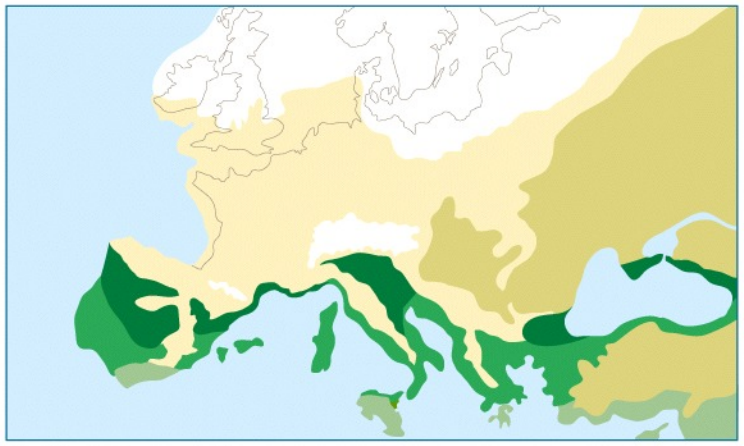


At the LGM, the southwest was wetter.

because of the southward displacement of the jet stream brought increased rain and cloud.

Glacial and Present-day Climate in Europe



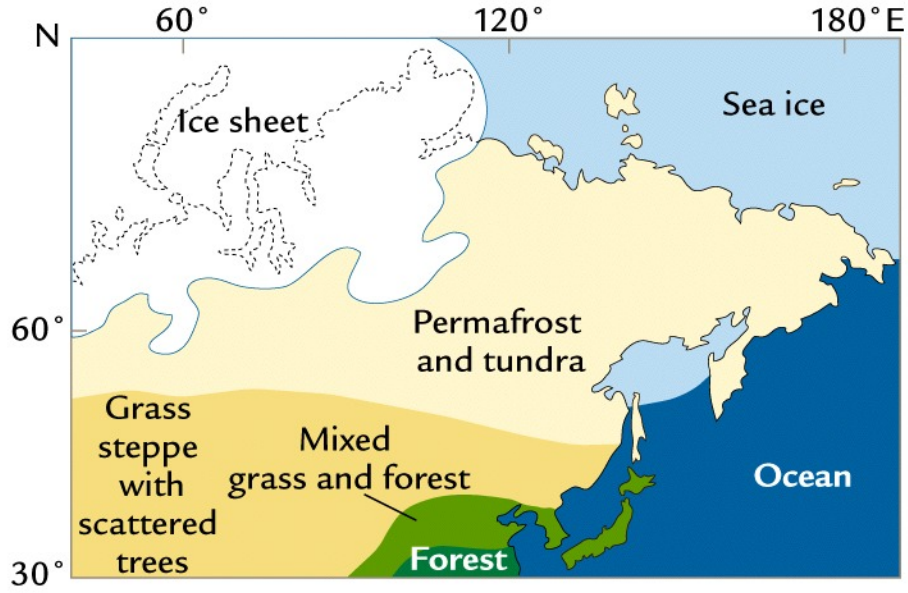


Europe was completely transformed during LGM.

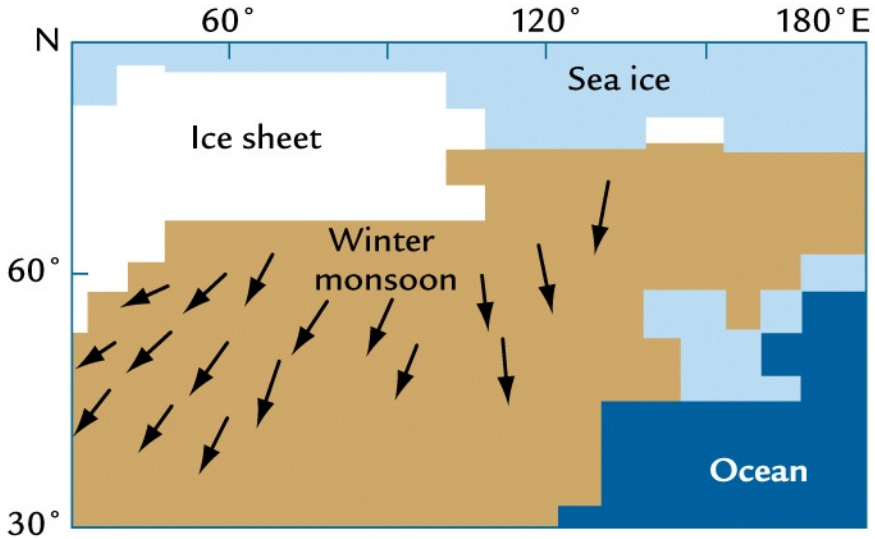
Today: extensive forest covers (conifer and deciduous)

LGM: mostly tundra and grass-covered steppes, with Scandinavian ice sheet in the north and forests scattered in the south

Glacial Climate in Asia

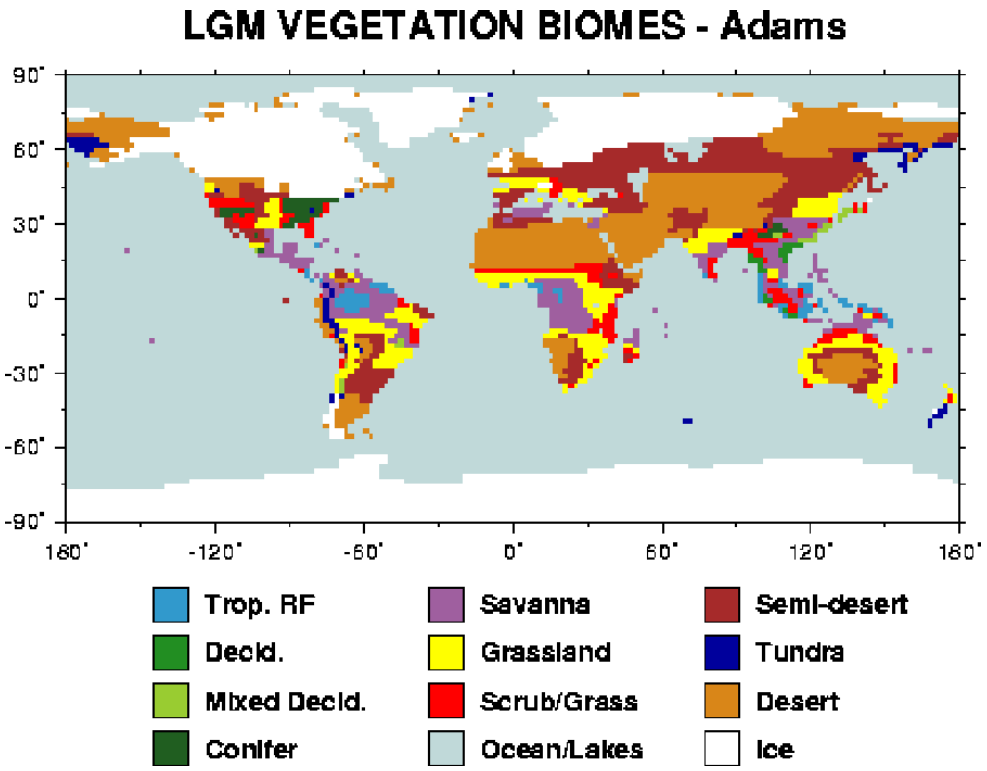


A Glacial maximum (observed)

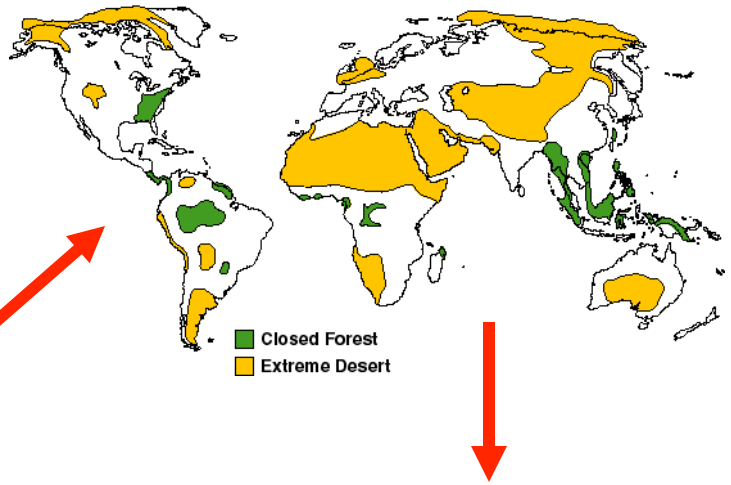


B Glacial maximum (model)

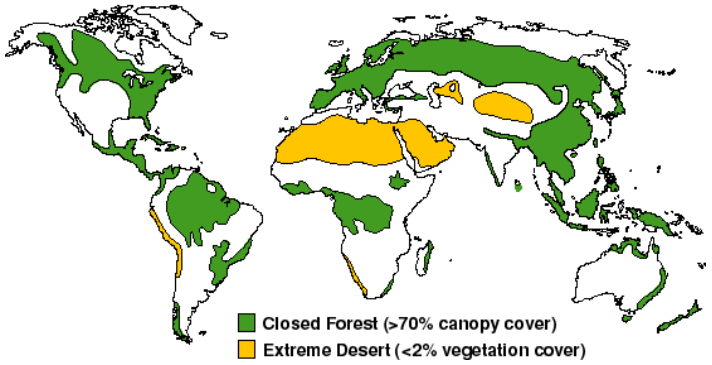
Glacial and Present-day Biomes



LGM Tree Cover



Present Potential Vegetation



Present-day Tree Cover

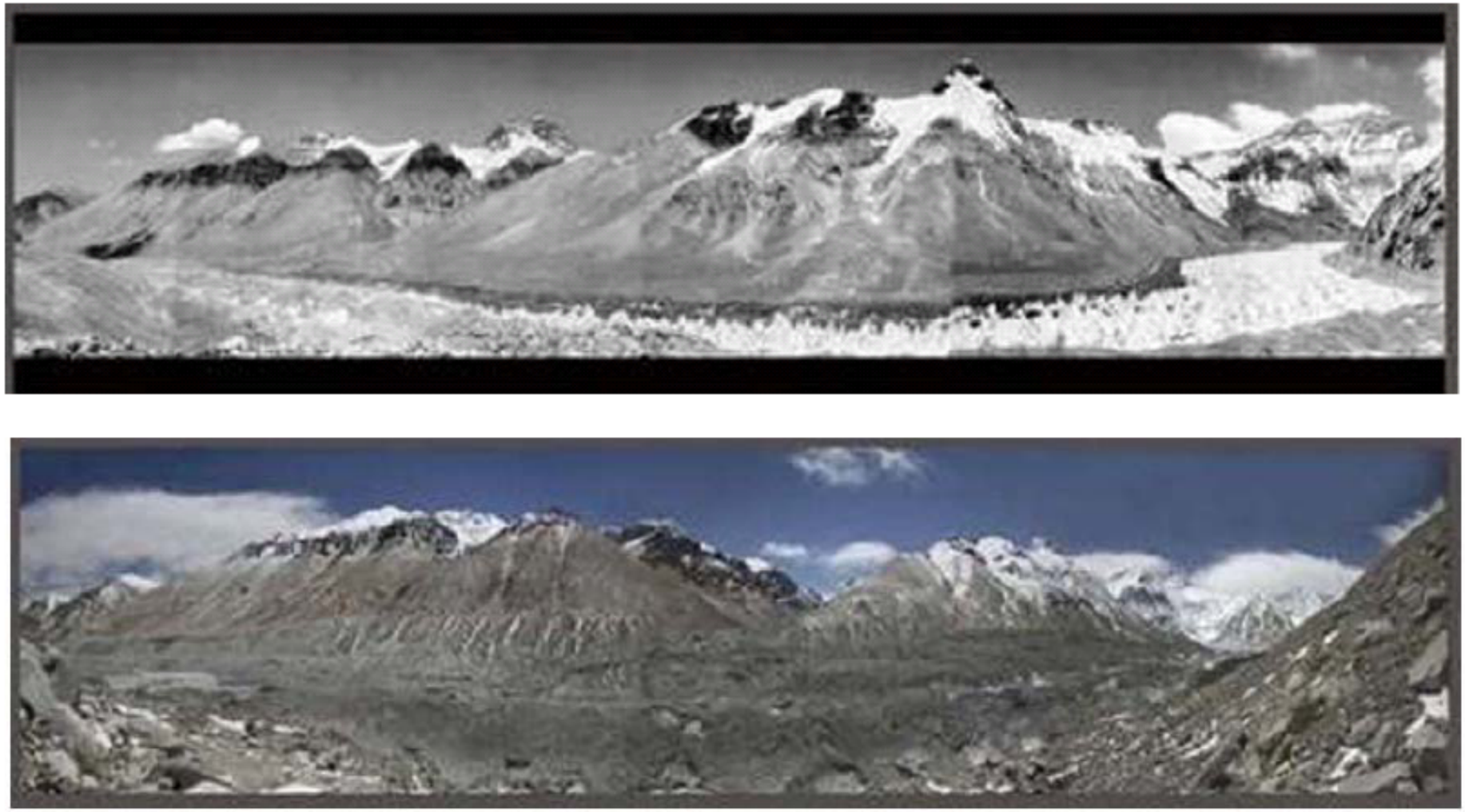
Ice Sheet and Glacier Melt in Today's climate:

Surface Melt on Greenland

Melt descending into a moulin, a vertical shaft carrying water to ice sheet base.

Source: Roger Braithwaite, University of Manchester (UK)

Rongbuk Glacier



Rongbuk glacier in 1968 (top) and 2007. The largest glacier on Mount Everest's northern slopes feeds Rongbuk River.

Jakobshavn Ice Stream in Greenland

Discharge from major Greenland ice streams is accelerating markedly.

Source: Prof. Konrad Steffen, Univ. of Colorado

Discuss-Summary:

1. When was the Last Glacial maximum (LGM)?
1. Where and how much were the earth land surface covered by ice sheet and glaciers during the last glacier maximum?
2. How much colder was the global mean surface temperature during the LGM compared to that of today? What was the sea-level change during the LGM?
3. How do we determine the spatial coverage of glaciers, temperature and sea-level during the LGM?