



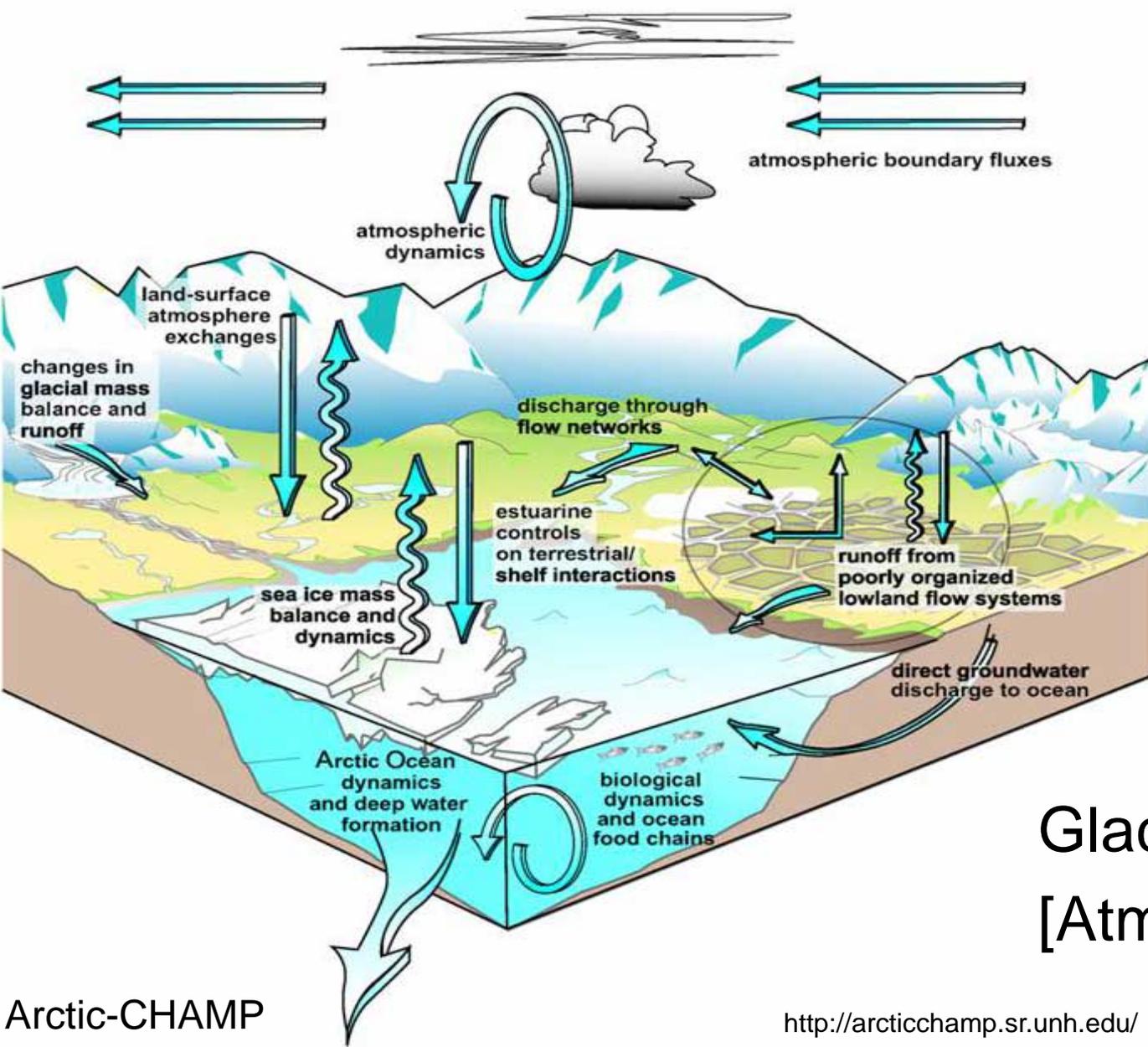
Freshwater systems in the Arctic and how they are endangered

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Arctic Hydrological Cycle



Components

- Permafrost
- Soil moisture
- Lakes/wetlands
- Rivers
- Snow cover
- Glaciers/ice sheets
- [Atmosphere]

Quantifying freshwater



Permafrost

- **perennially frozen** ground with an annual ground temperature at or below 0°C for at least two consecutive years
- covers **about 25 %** of the land masses of the Northern Hemisphere



Soil moisture

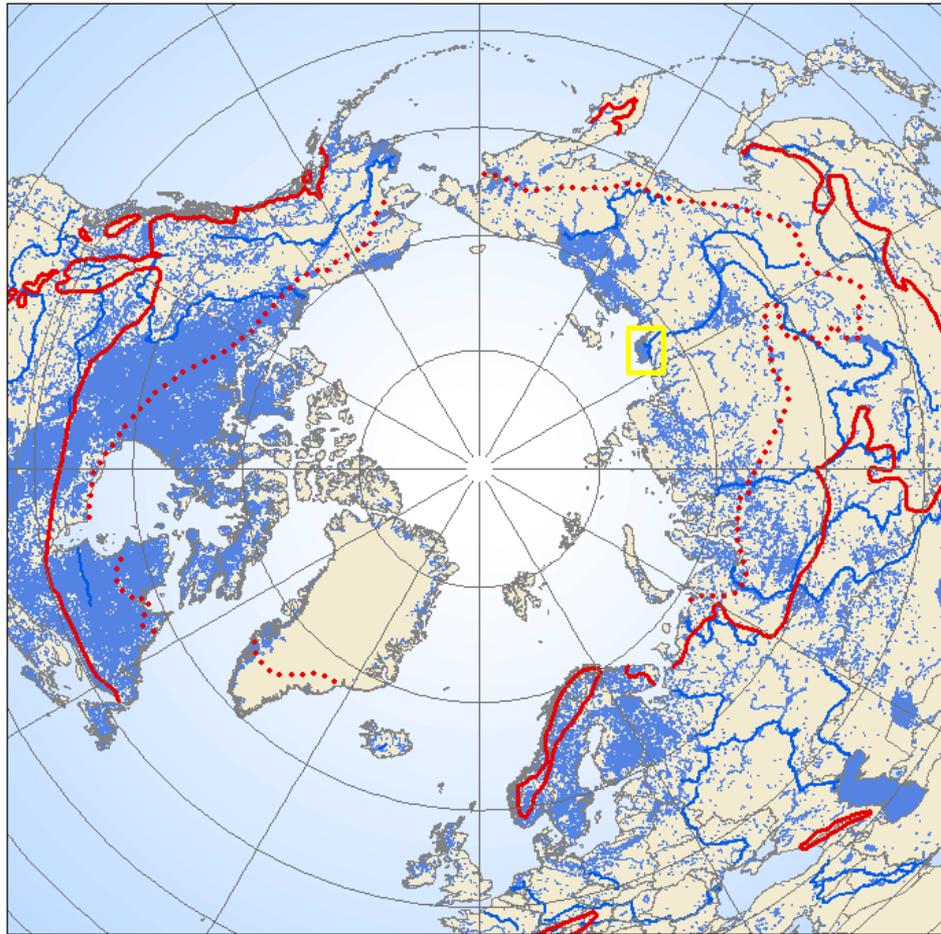
Water content of the soil

- Affects land-atmosphere moisture and energy fluxes and soil heat transfer
- Important variable for crop land („green water“)



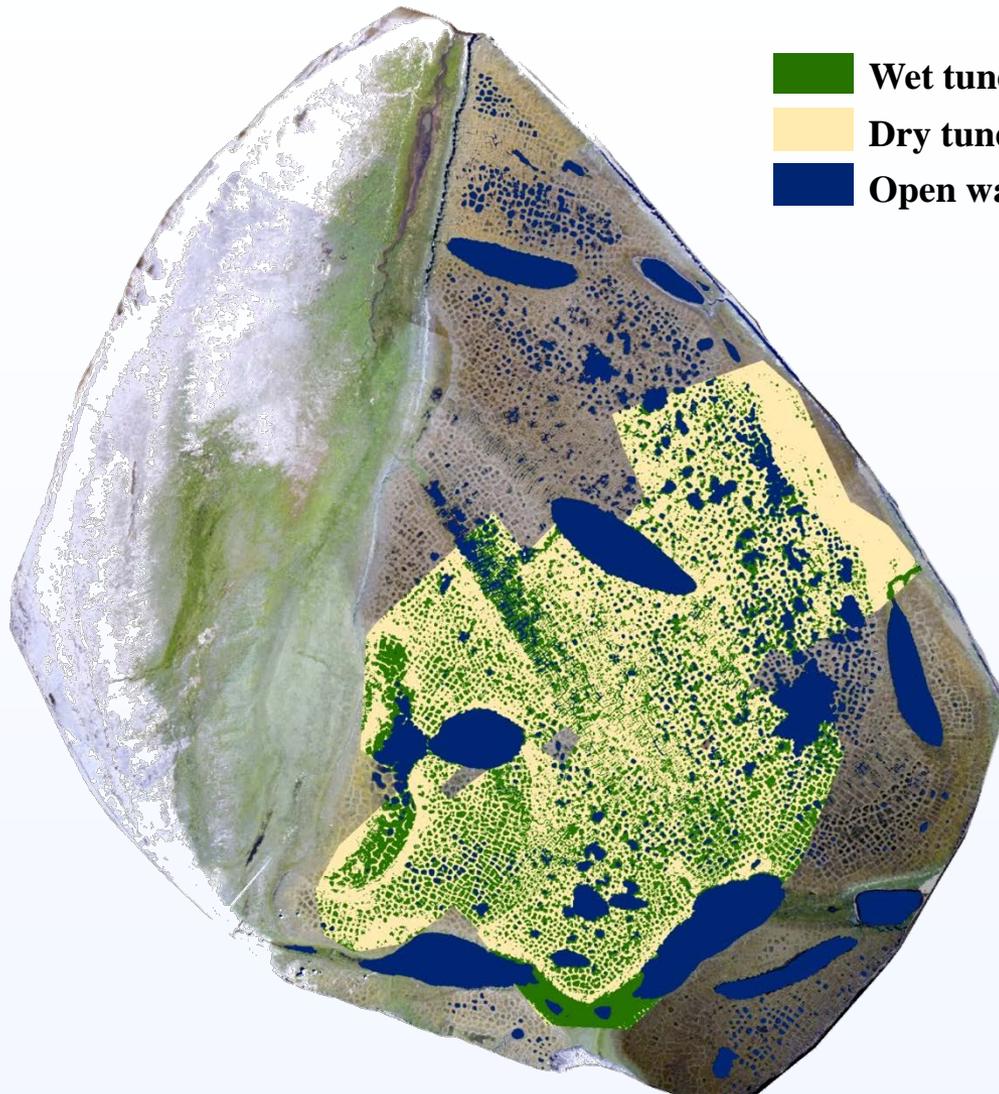
Langbein Lecture: The Soil Underfoot: Green Water and Global Food Security, AGU, 2012 (video on demand)
by Garrison Sposito (University of California, Berkeley, USA)

Lakes and ponds



- Arctic is dry desert (very little precipitation)
- Water stored in large lakes is mostly “fossil”
- Smaller water bodies (smaller than 10 000m²) are not accounted for!

Zooming in on polygonal tundra



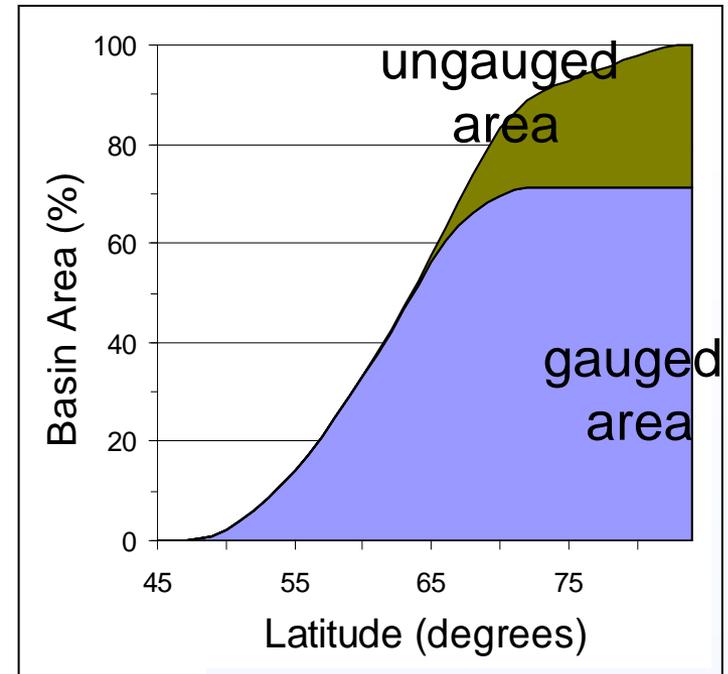
Wet tundra
Dry tundra
Open water

Few large lakes

Ponds (smaller than 1 000m²)
dominate in number

Ponds need precipitation ($P \sim ET$)
to sustain their water level

River runoff



- nearly all of the ungauged portion lies north of 67 degrees latitude
- total runoff not known
- many freshwater observing networks have diminished

CAFF map number 21: <http://library.arcticportal.org/1347/>

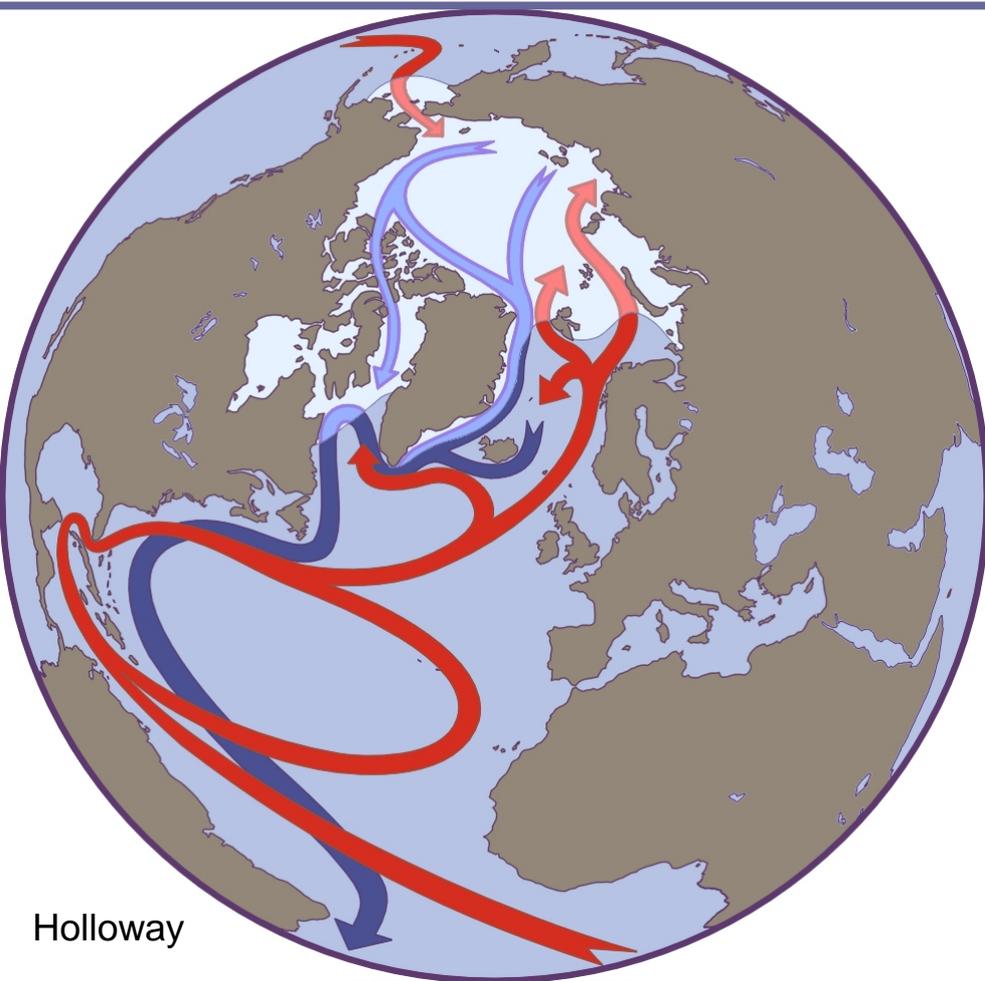
→ Major riverine transport of freshwater in km³
— Arctic watershed area

Freshwater inflow Arctic ocean

Thermohaline Circulation

(heat)

(salt)



- NADW formation is driving factor for conveyor belt
 - less influx through rivers could slow this down or shut off
- temperature drop in continental Europe (2-5° C)

Snow cover

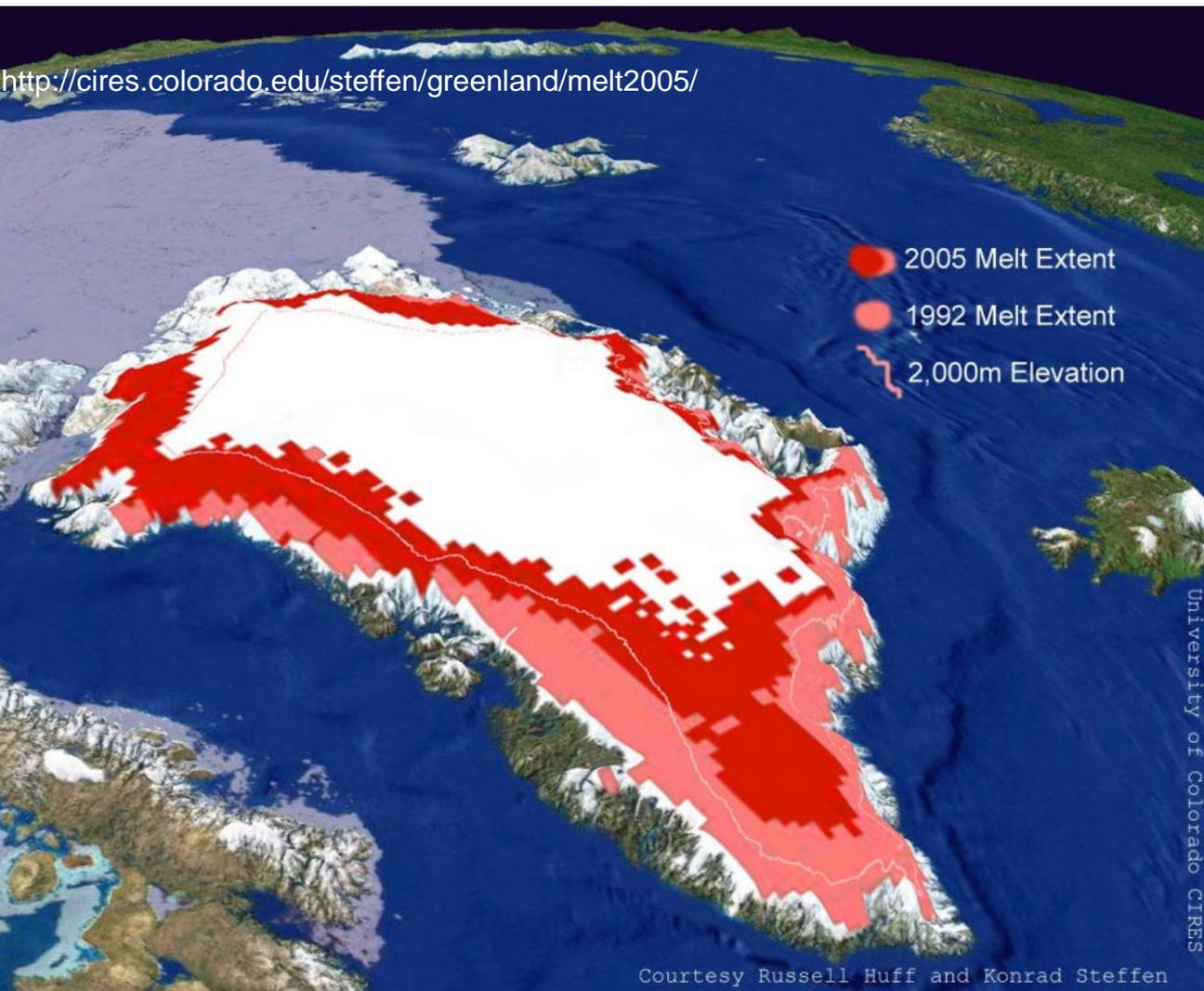
Largest component of the cryosphere: mean maximum extent in the Northern Hemisphere of approximately 47 mio km² or nearly 50%.

Its effects

- albedo
- energy and water exchange
- water balance (ponds, lakes, rivers)



Ice sheets and glaciers



Ice sheets contain enormous quantities of frozen fresh water!

Influence on Arctic

- Freshwater budget
- Weather
- Climate

If the Greenland Ice Sheet melted, the estimated sea level rise ~ 6 meters

Regional impacts



Freshwater systems in the Arctic

Global importance:

- (1) Albedo feedback
- (2) Greenhouse gas emissions/uptake (currently the Arctic is a sink)
- (3) Ocean circulation feedbacks (freshwater flow and energy flux into Arctic ocean as drivers of global climate change)

Regional importance:

- (1) Water and energy exchange
- (2) Resources for people (freshwater supply, industry, fisheries, agriculture, transport, leisure)
- (3)

Challenges and priorities

We are observing changes! There is a need for....

- ..models that are useful at scale of interest
- ..weather and climate data collection (with adequate spatial and temporal scales for development and validation of models)
- ..coordination of long term monitoring sites
- ..improving communication among scientists, residents, managers,...



Freshshwater systems are
also simply beautiful.....

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