

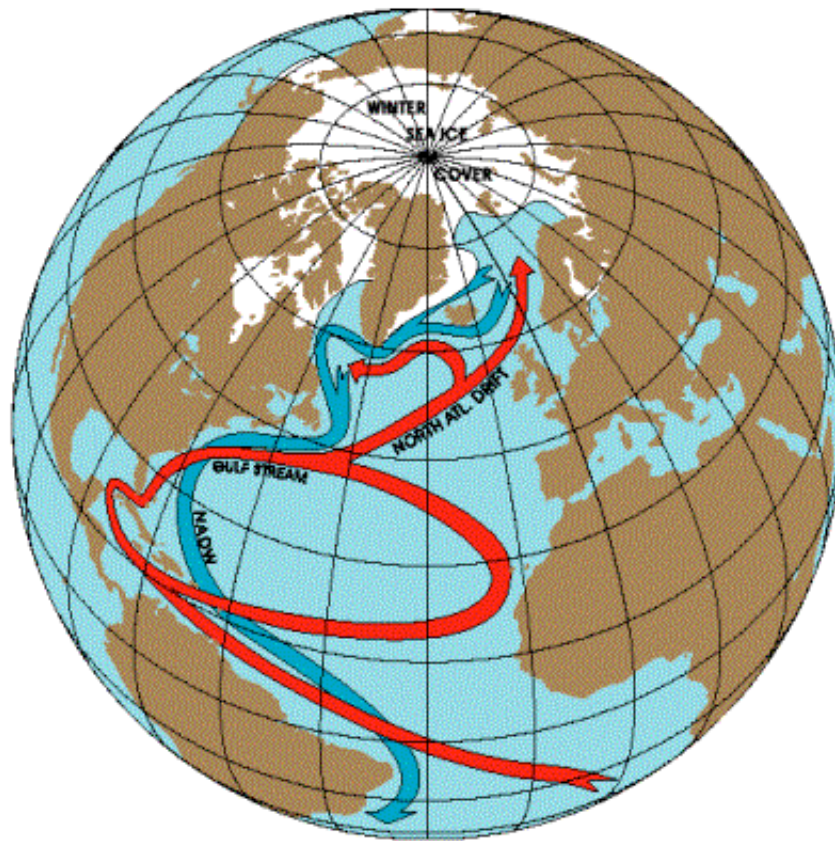
Abrupt and Variable Climate Change

Overview

- I. Thermohaline circulation (THC) influences on climate in the North Atlantic Region
 - Present/Past/Future
- II. Ecosystem Structure and Function
 - Flood and drought control
 - Climate feedbacks
 - Albedo (reflectivity)
 - Carbon Storage
 - Hydrological cycle

Thermohaline Circulation

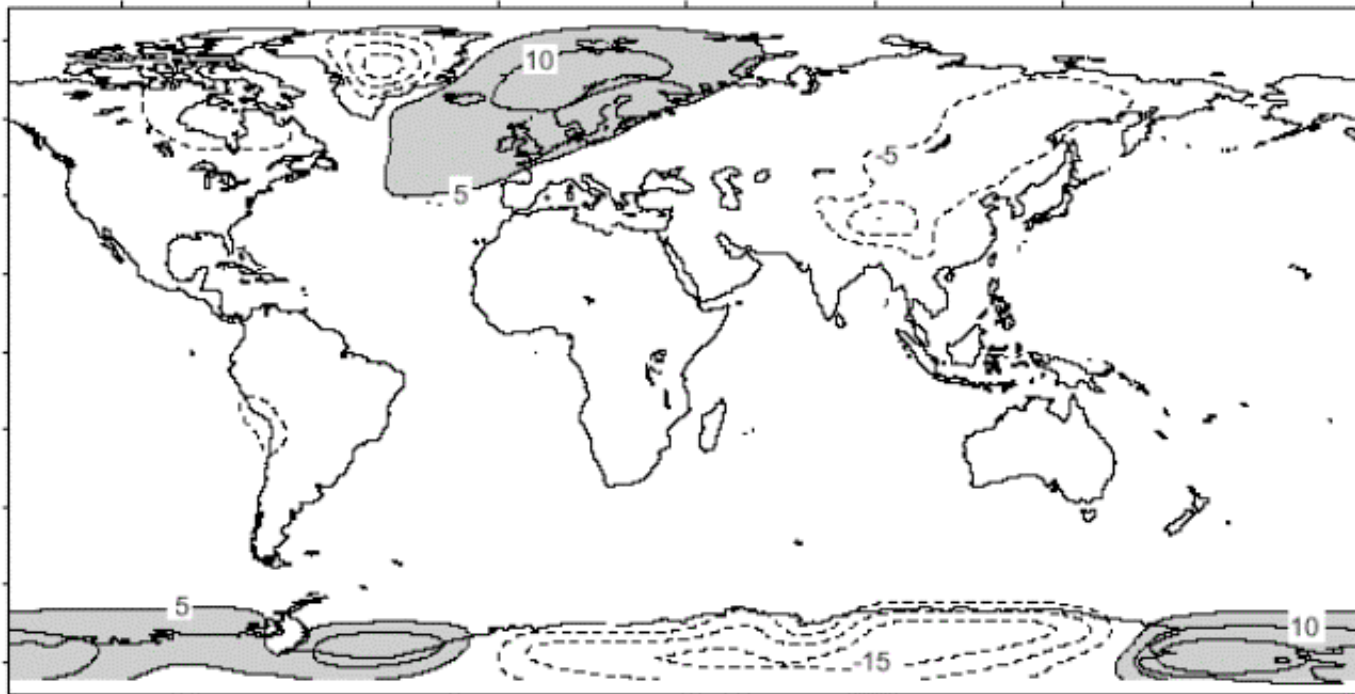
Temperature and salinity
variability causes density
differences that then drive
ocean circulation



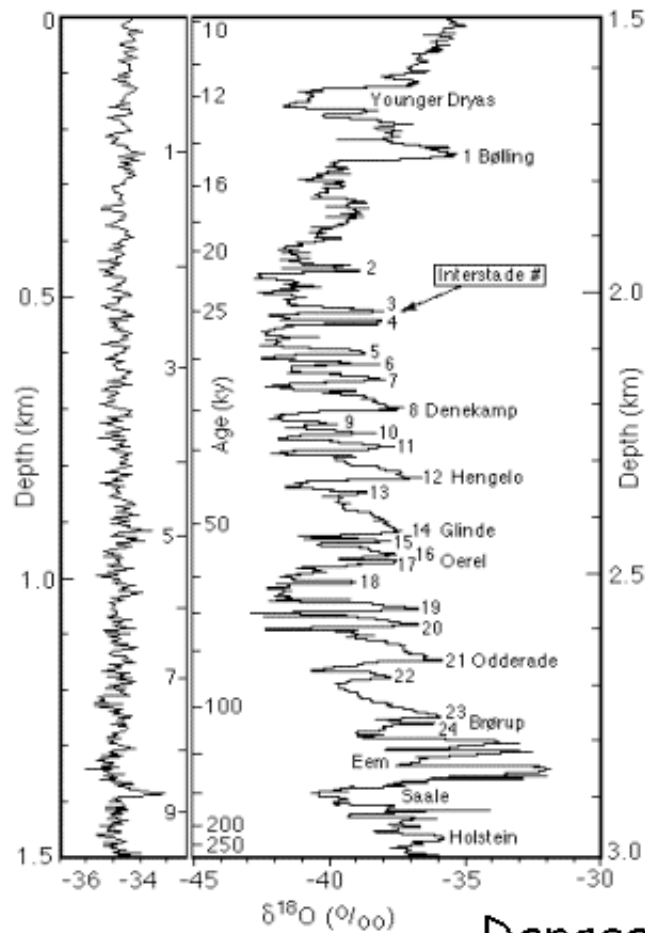
Simplified picture of THC in the Atlantic. The red ribbon shows surface water, the light blue shows North Atlantic Deep Water. Note the sea ice margin.

-Rahmstorf (Climatic Change, 2000)

Deviation of observed annual mean surface air temperature from the zonal mean.



-Rahmstorf and Ganopolski (Climatic Change, 1999)

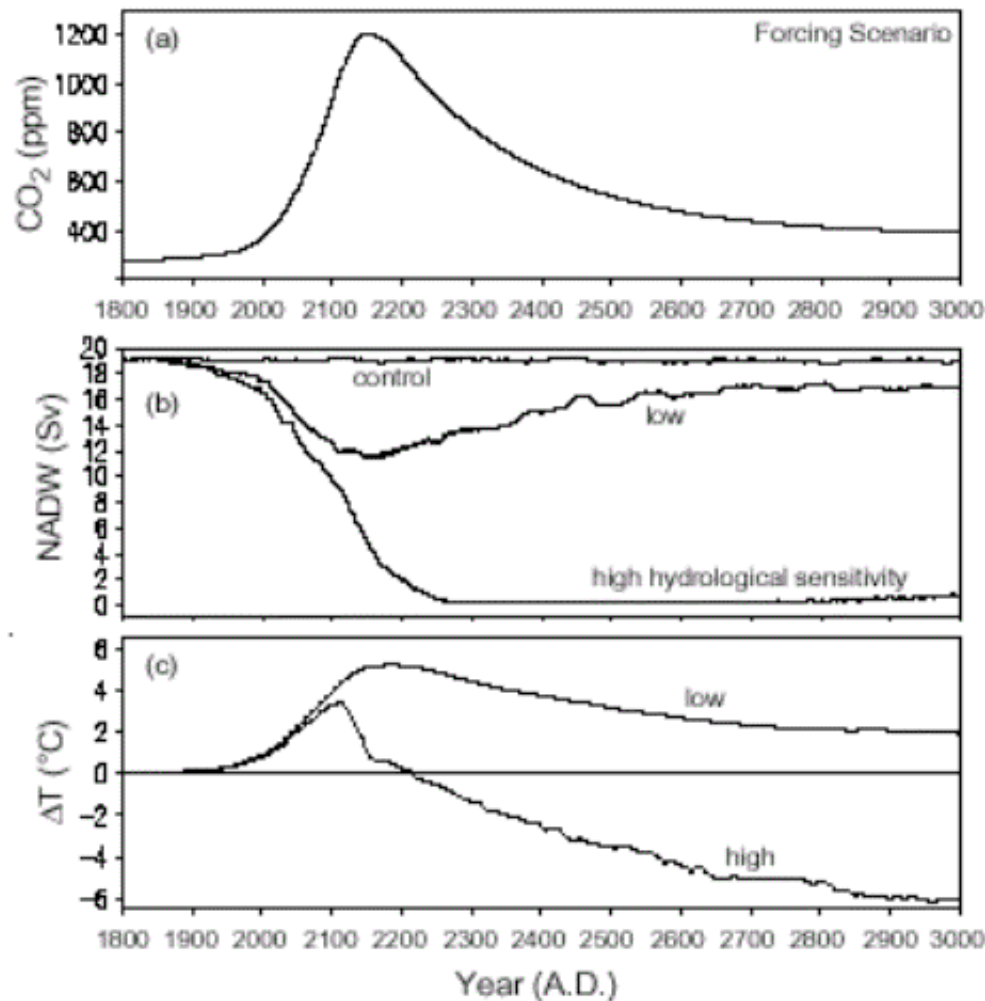


-Dansgaard et al. (Science, 1993)

Greenland ice core
18-O record. The
Holocene is pictured
on the left, the
previous glacial period
on the right.
Dansgaard/Oeschger
events are numbered
1-24

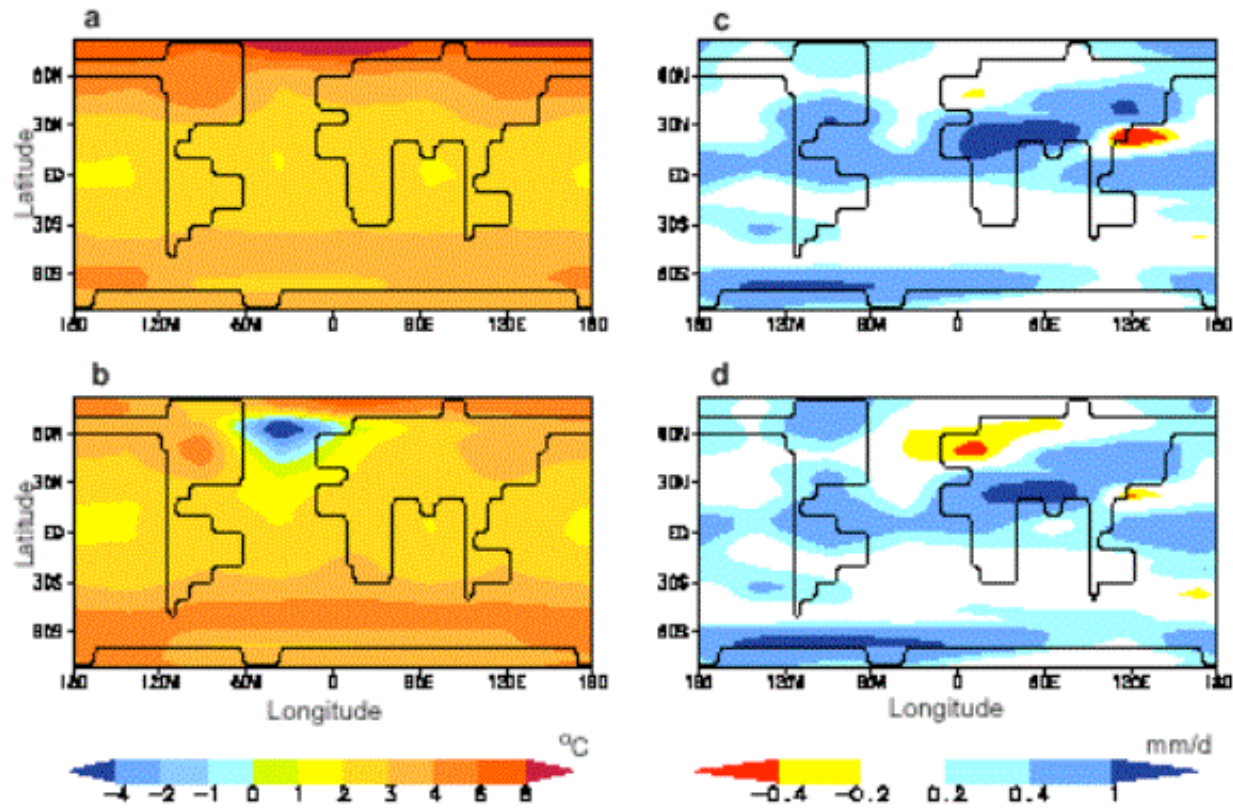
Future Changes

- Why might climate change alter thermohaline circulation?
- What climate might result from the combination of THC collapse and increasing greenhouse gas concentration?



Climate change scenarios with high and low hydrological sensitivity. (a) CO₂ forcing. (b) NADW formation. (c) Temperature response between 50°N and 60° N.

-Rahmstorf and Ganopolski (Climatic Change, 1999)



-Rahmstorf and Ganopolski (Climatic Change, 1999)

Changes in winter air temp (left) and summer precipitation (right) for the maintained (top) and collapsed (bottom) THC.

Ecosystem Consequences

- **Climate feedbacks**
 - Albedo
 - Carbon storage
 - Hydrological cycle
- **Ecosystem services**
 - Forests (direct use, recreational value, flood and drought control, provision of habitat for pollinators)
 - Bird distributions (recreational value, pest control, seed dispersal)
 - Fisheries (direct use, sport fishing)

Conclusions

- THC influences climate in the North Atlantic and can change abruptly
- The combination of GHG and THC effects could lead to abrupt and variable climate changes
- The ensuing ecosystem perturbations may alter human quality of life

Acknowledgments

- **Mentors**

- Steve Schneider
- Steve Schwartz
- Chris Field

- **GCEP**

- Jeff Gaffney
- Milton Constantin
- Mary Kinney
- Pat Shoulder