Glacial Inception in CCSM4

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with

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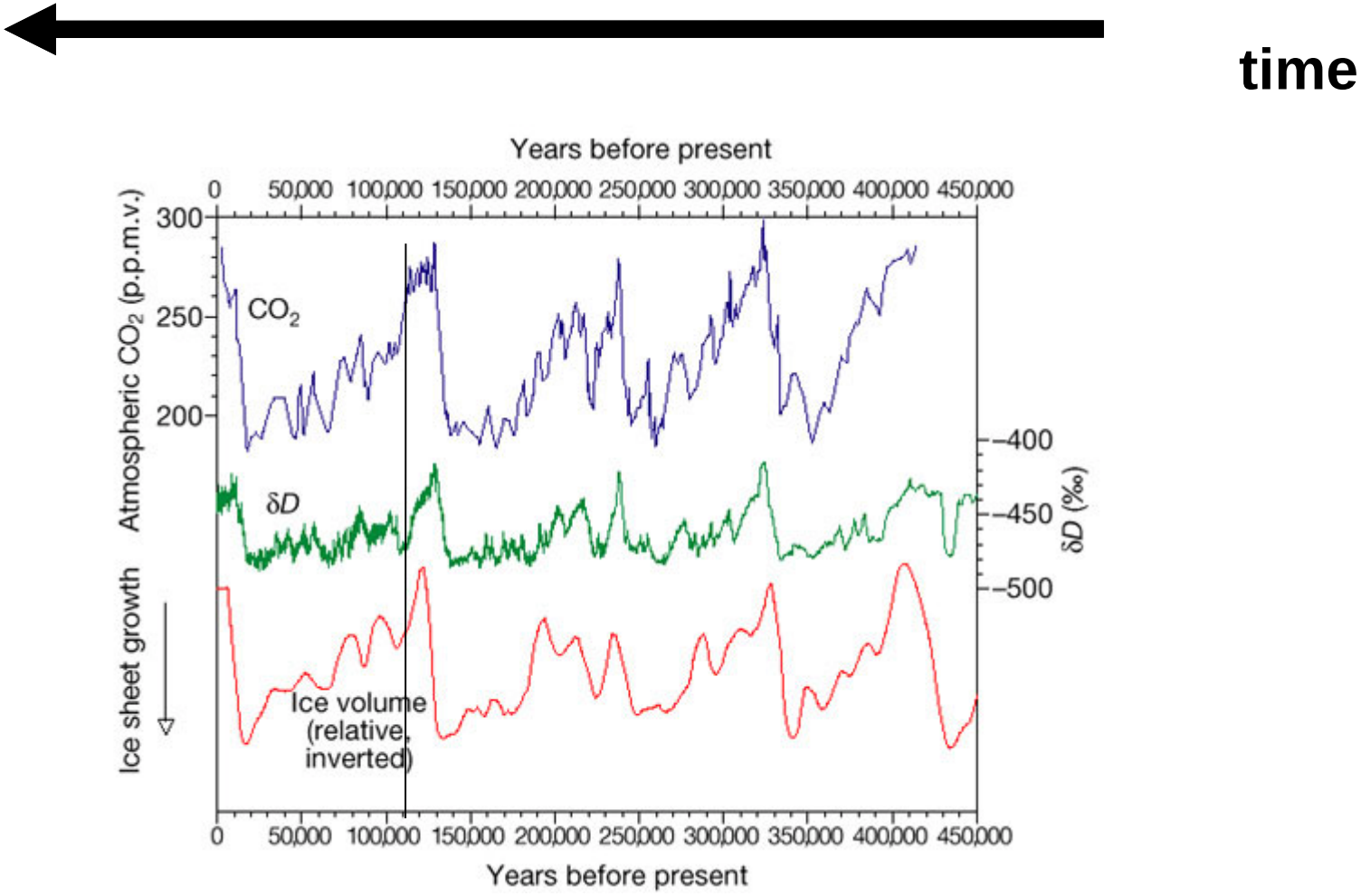
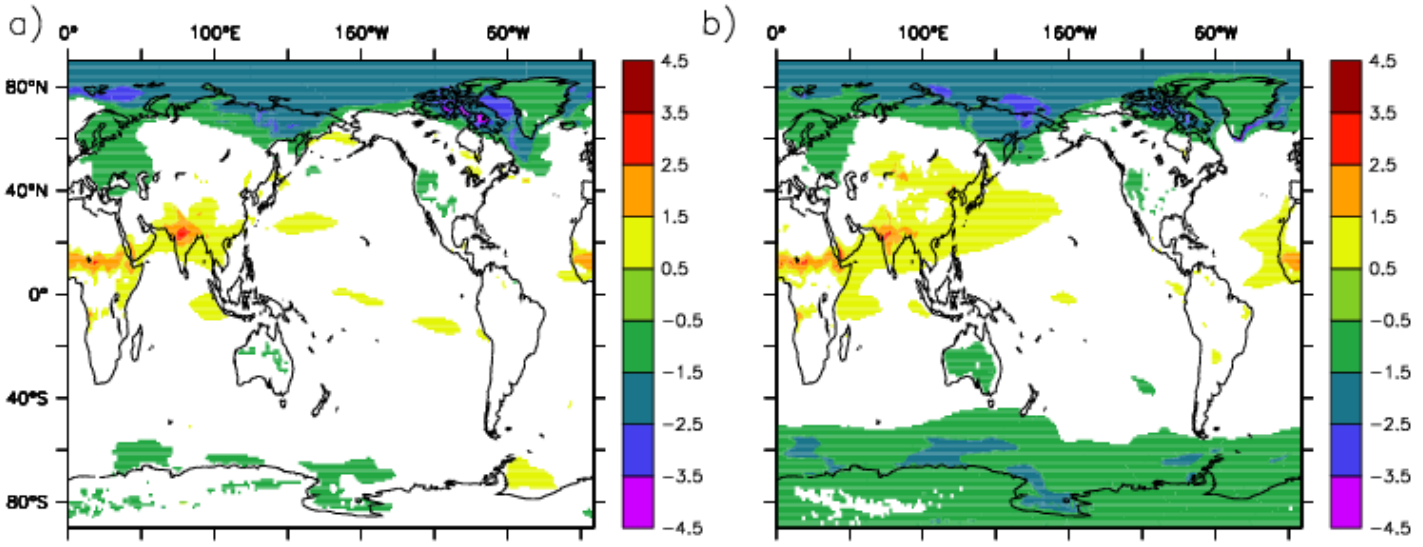
NCAR



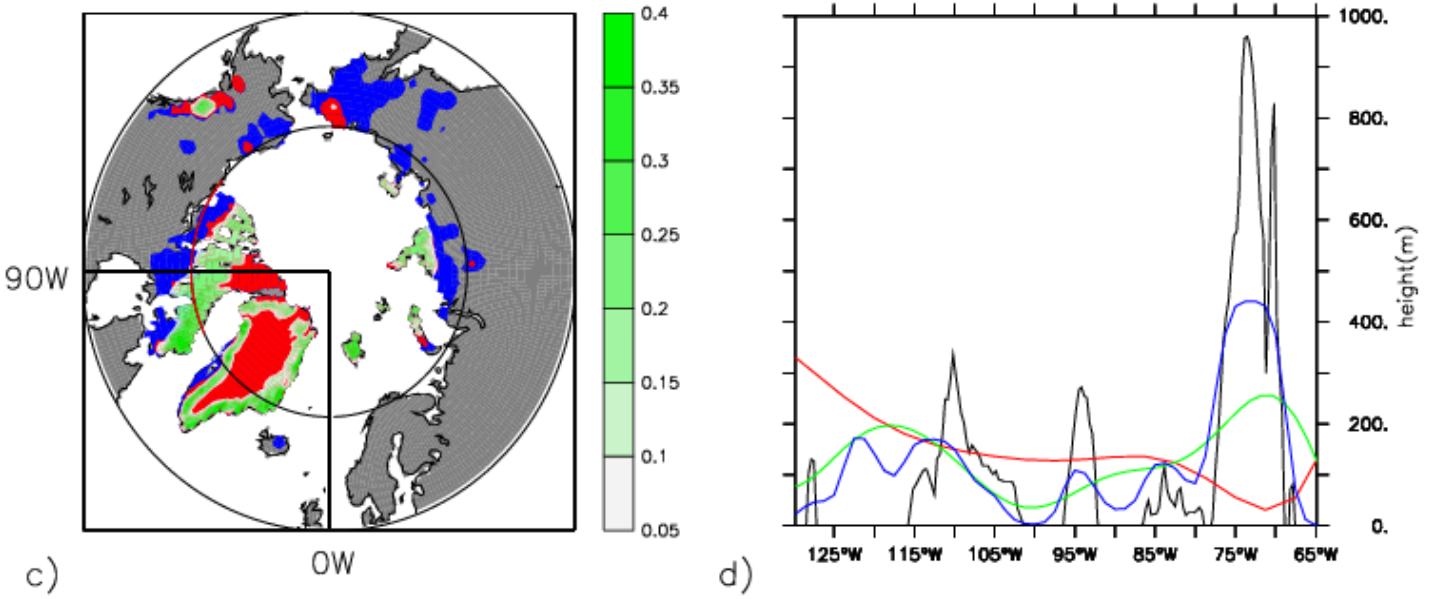
Carbon dioxide, and deuterium/hydrogen ratio from the Vostok Ice core; and global ice volume from sediment cores (inverted). (Sigman & Boyle, 2000)

difference in surface temperature (OP115-CONT)

full ocean



slab ocean



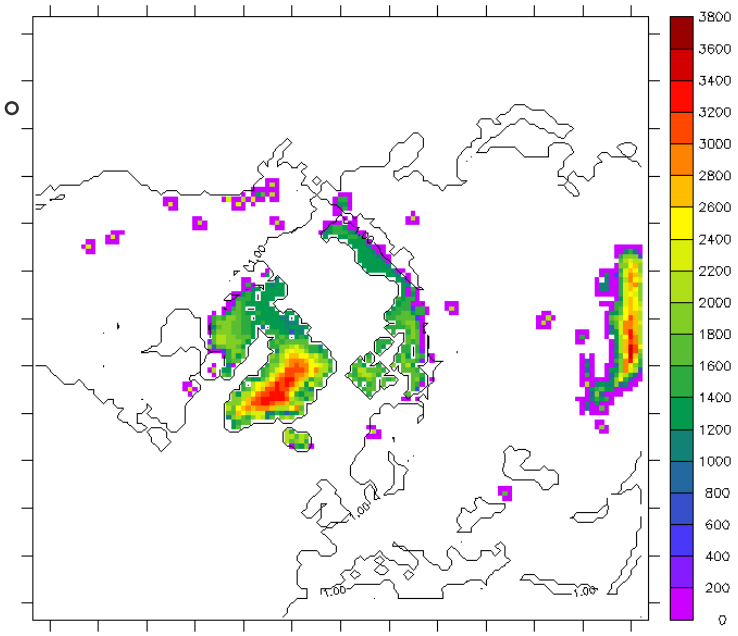
snow cover and accumulation

orography along 70N in Canada

Difference in snow accumulation is equiv. to 20 m sea-level drop in 10 kyrs

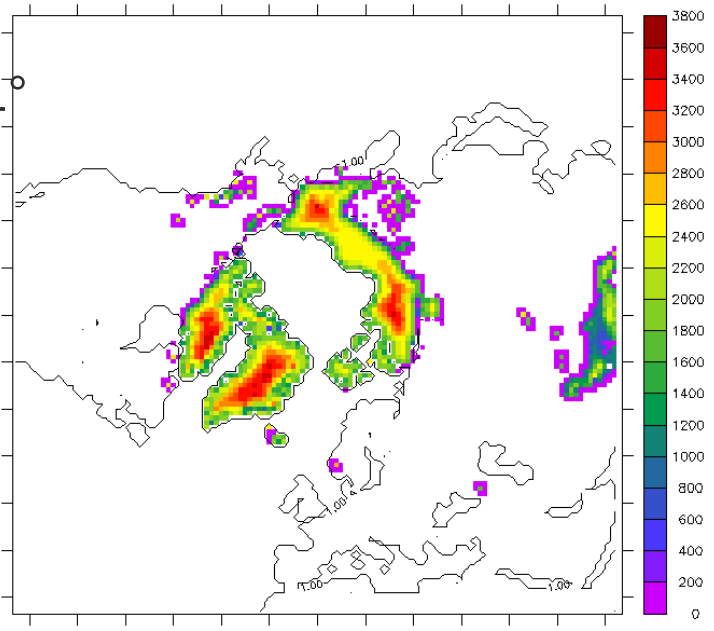
Climate:
CESM 3°x3°

Ice grid:
100km



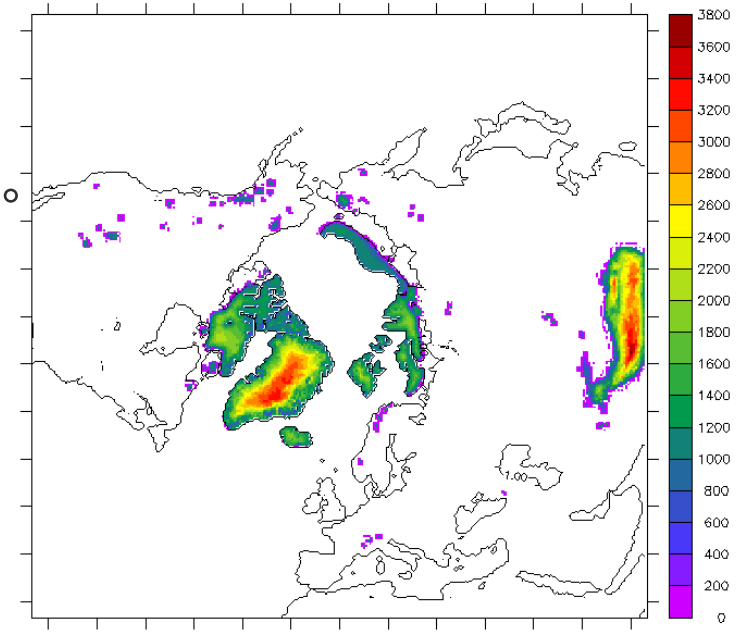
Climate:
CCSM4 1°x1°

Ice grid:
100km



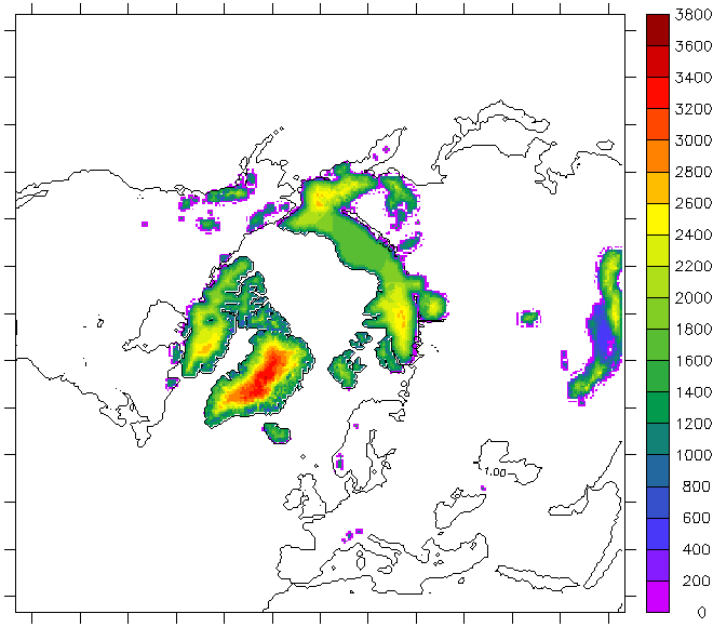
Climate:
CESM 3°x3°

Ice grid:
40km

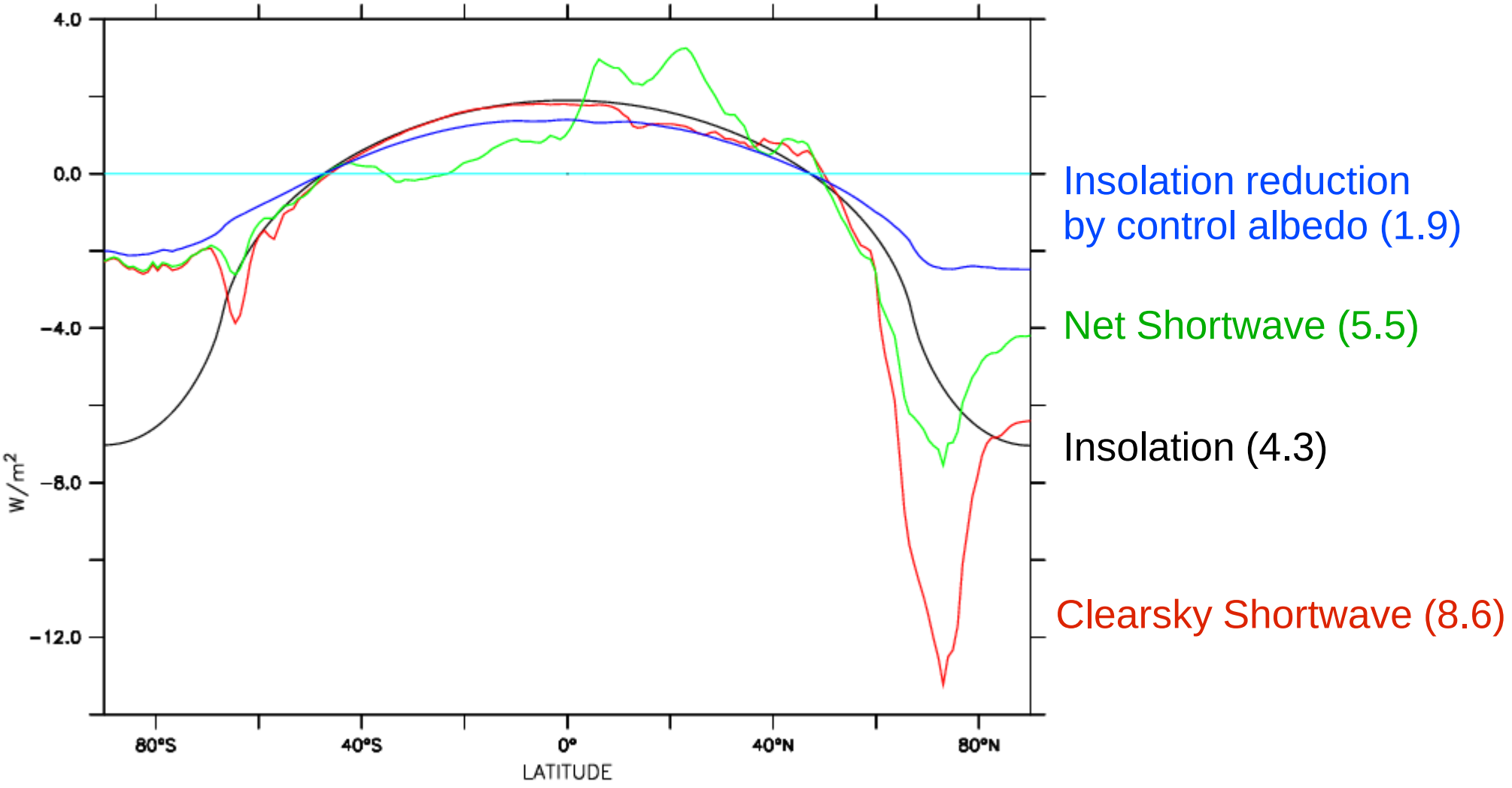


Climate:
CCSM4 1°x1°

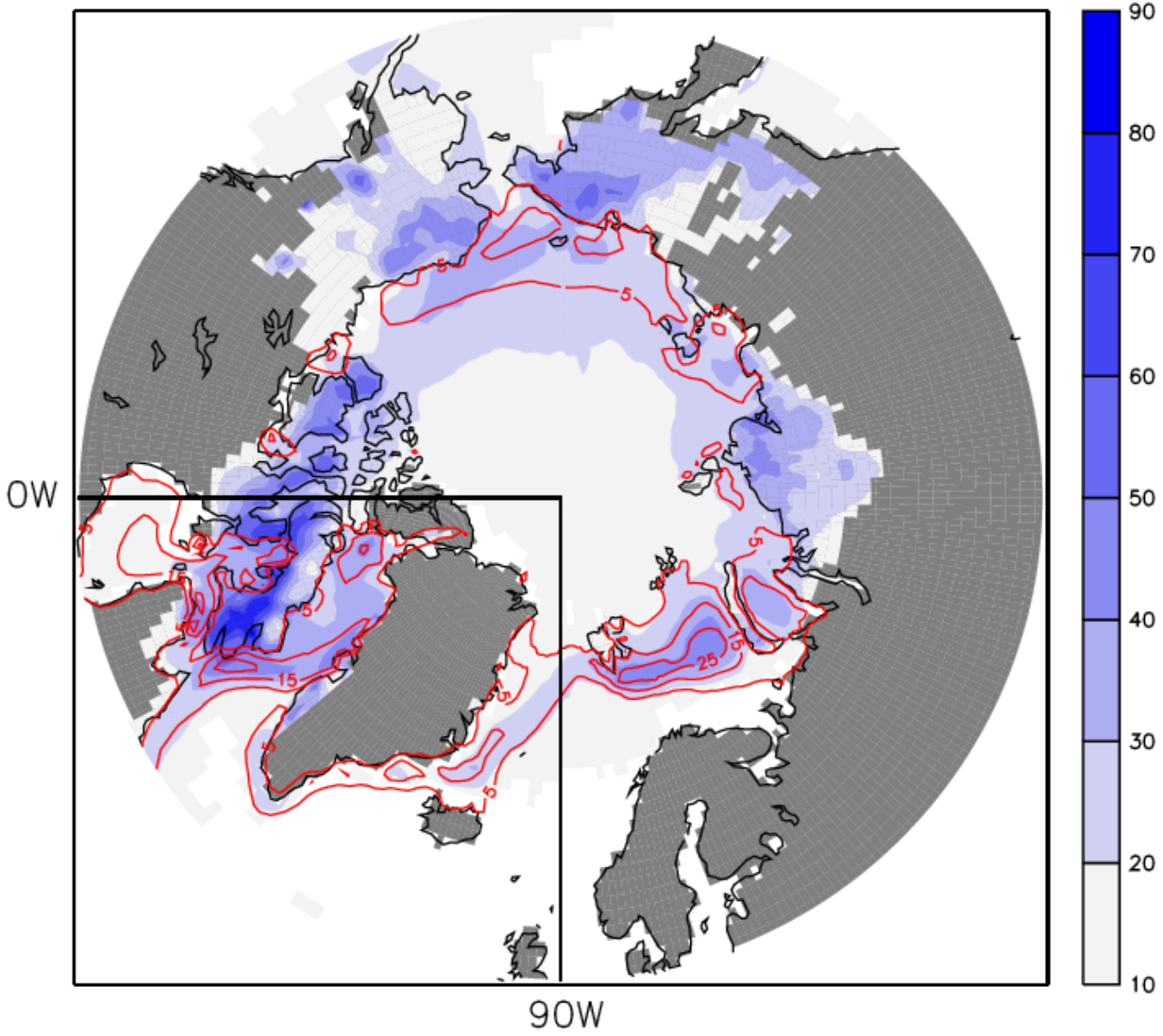
Ice grid:
40km



Feedbacks: positive snow/ice albedo feedback: 6.7 W/m2
negative ice/low-cloud feedback: 3.1 W/m2
negative merid. Temp. gradient feedback (not shown): 3.1 W/m2
positive total feedback: 0.5 W/m2

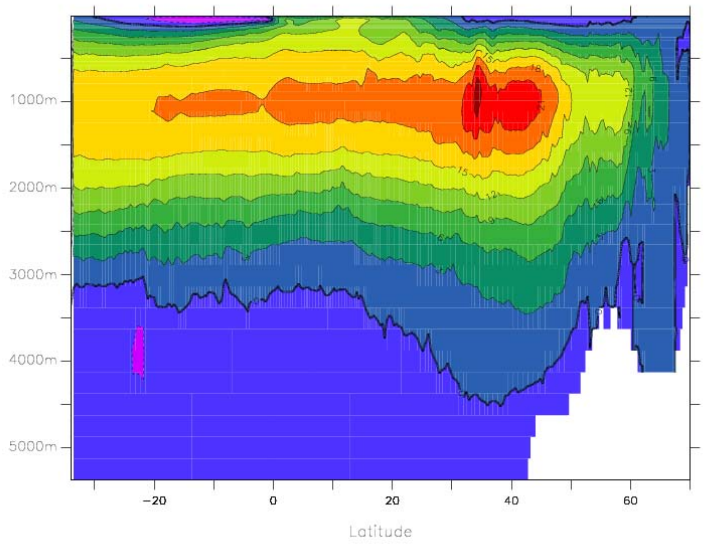


difference of zonally averaged TOA fluxes

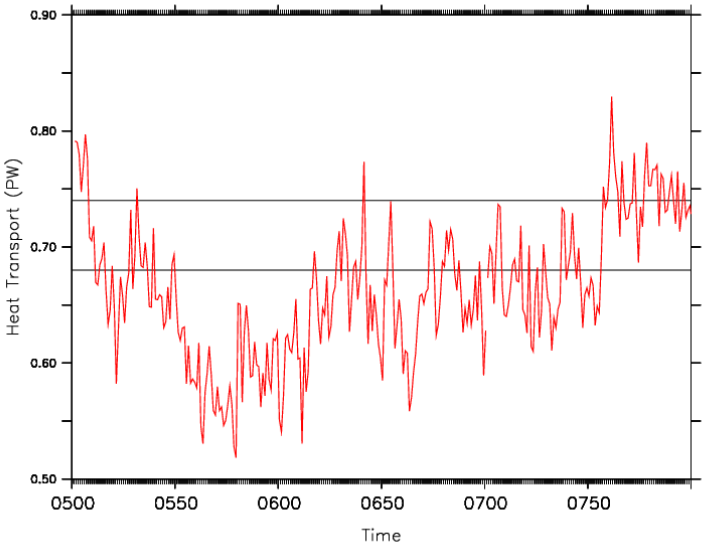


Difference in summer shortwave cloud forcing (blue shades, W/m2), and difference in summer sea-ice cover (red lines, %, OP115-CONT).

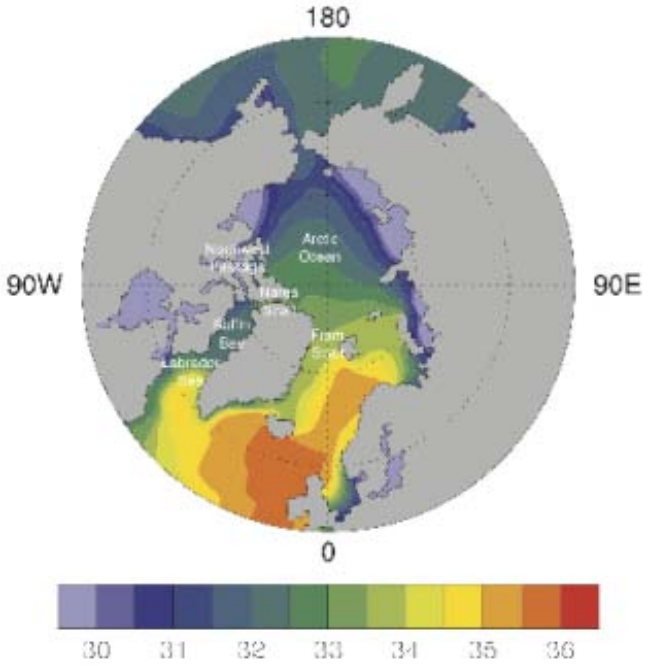
The Atlantic Meridional Overturning Circulation



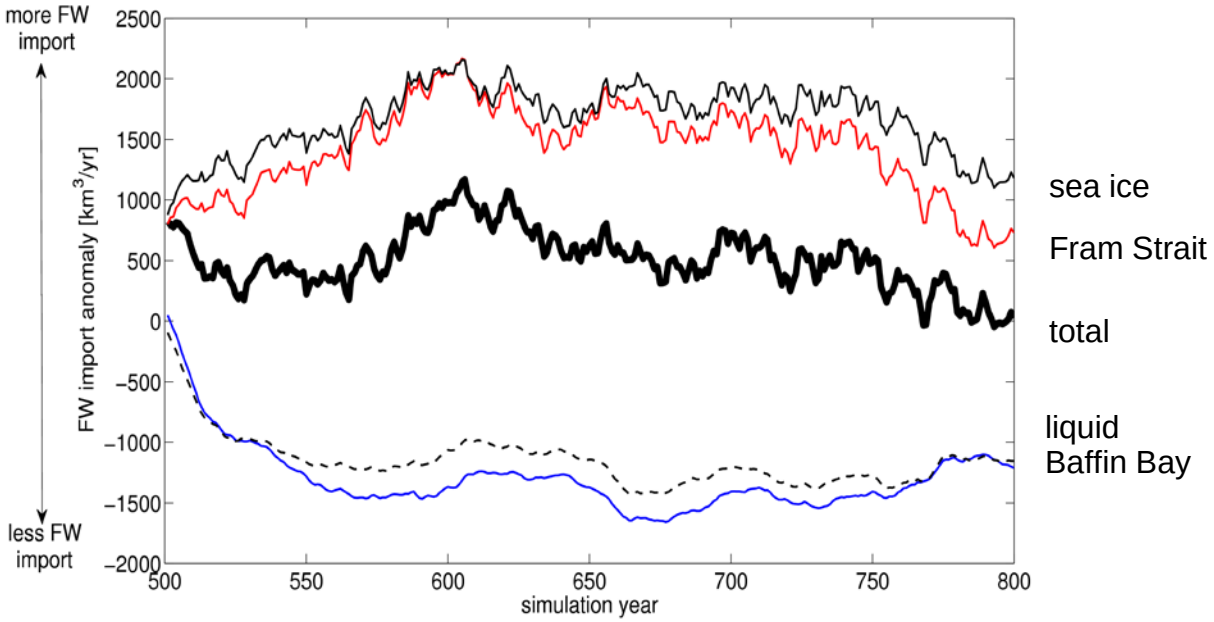
Zonally averaged volume transport in the Atlantic for CONT.



Time series of the associated heat transport for OP115.



Surface salinity in CONT.



Time series of freshwater anomalies entering the North Atlantic in OP115

Conclusions

- changes in Earth's orbit are sufficient to explain glacial inception
- the AMOC does not appear to play a role
- the sea-ice/cloud feedback emerges as a key process that needs verification
- the fact that CCSM4 can reproduce a very different climate provides confidence in its future projections
- now that we trust the CCSM4 physics we can tackle the carbon cycle