



# DOE/UCAR Cooperative Agreement

## Regional and Global Climate Modeling Program



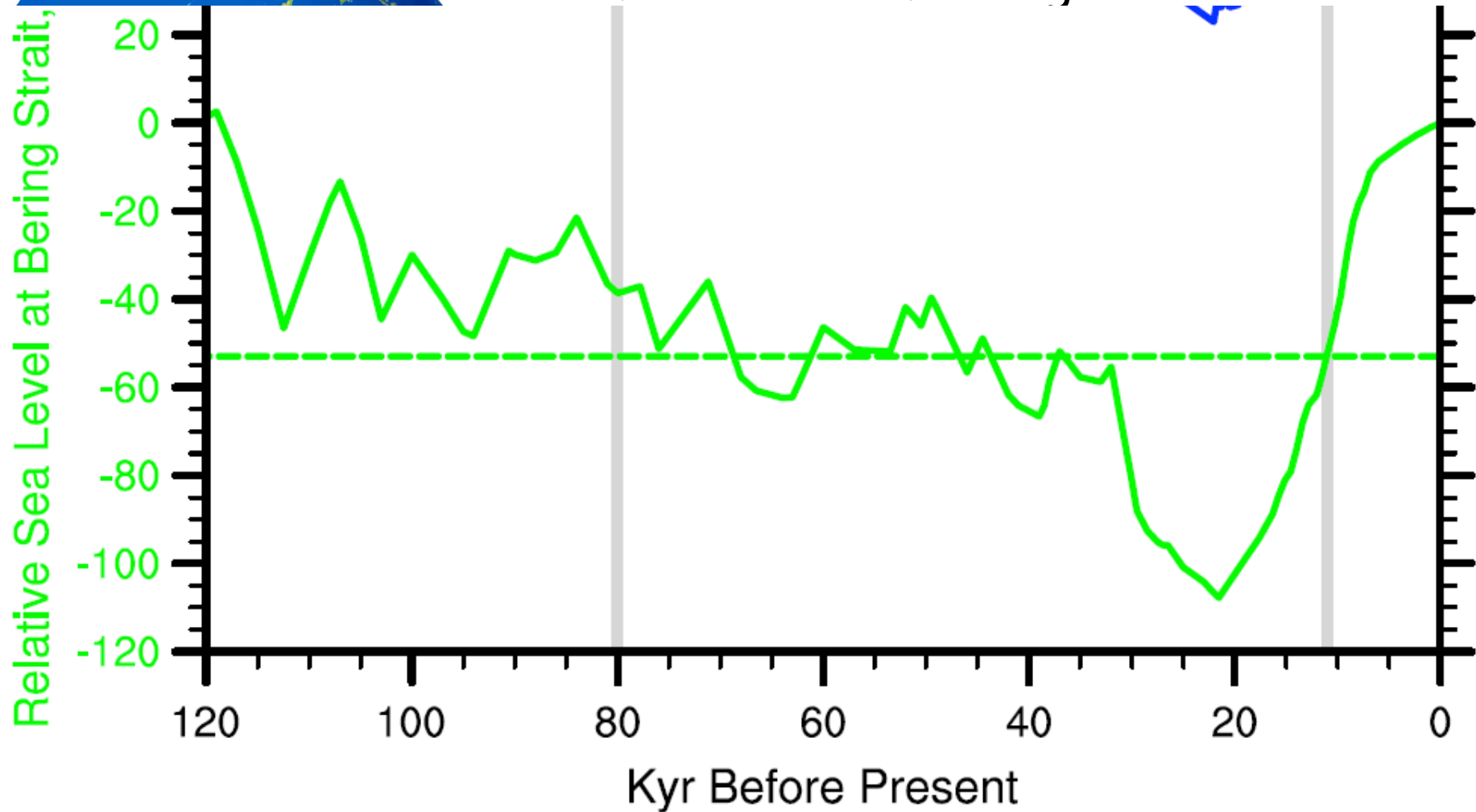
# Effects of the Bering Strait closure on AMOC and global climate under different background climates

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Accepted by Progress in Oceanography

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# 1. The response of the AMOC to freshwater forcing in the North

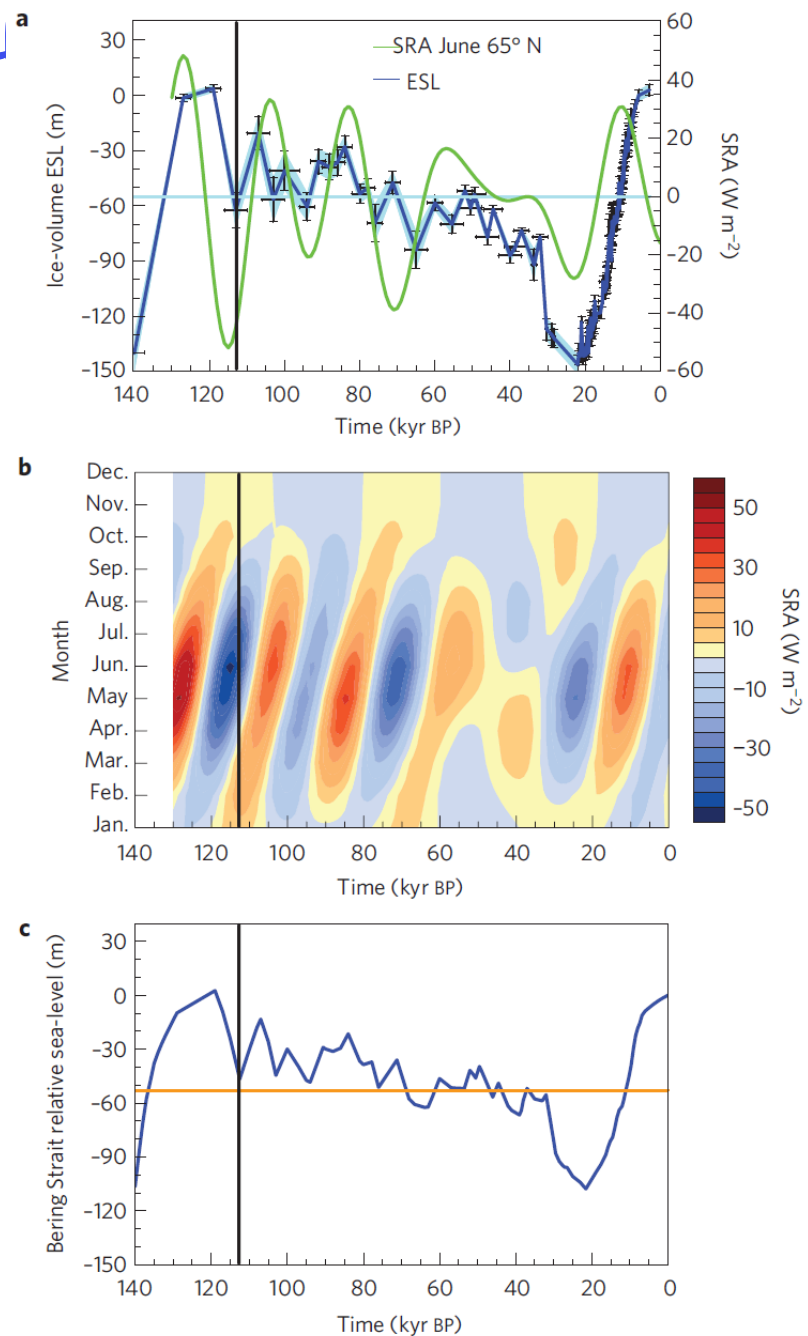


the Arctic, subsequently into the North Atlantic.

2. The formation of Quaternary cycle of climate (Sarnthein et al., 2009).

Sverdrup (Sv)  $\equiv 10^6 \text{ m}^3 \text{ s}^{-1}$  or 1 million cubic meters per second

Here we extend the work of Hu et al., Nature Geosciences, 2010 to study the opening/closure of the Bering Strait on the AMOC and the mean climate with a focus on the North Atlantic, North Pacific and Arctic regions under different climate background states. In Hu et al., 2010 we pointed out that the closure of the Bering Strait may have influenced the ice sheet stability and sea level change during last glacial period.



# Model and Experiments

## Community Climate System Model version 2 and 3:

- CAM2 with T42 horizontally and 26 levels vertically
- POP with 1 degree horizontally and 40 levels vertically
- CSIM4
- CLM2
- Present day (PD)
- CAM3 with T42 horizontally and 26 levels vertically
- POP with 1 degree horizontally and 40 levels vertically
- CSIM5
- CLM3
- PD, 112 kyr BP, 15 kyr BP

**Experiments:** 5 sets experiments - CCSM2 PD, CCSM3 PD, CCSM3 112 kyr BP with or without North American Ice Sheets and CCSM3 15 kyr BP with North American Ice Sheets. In each set, there are two experiments with everything identical except one with an open Bering Strait and the other with a closed Bering Strait. Each simulation runs for 350 years and the last 300 years are presented here.

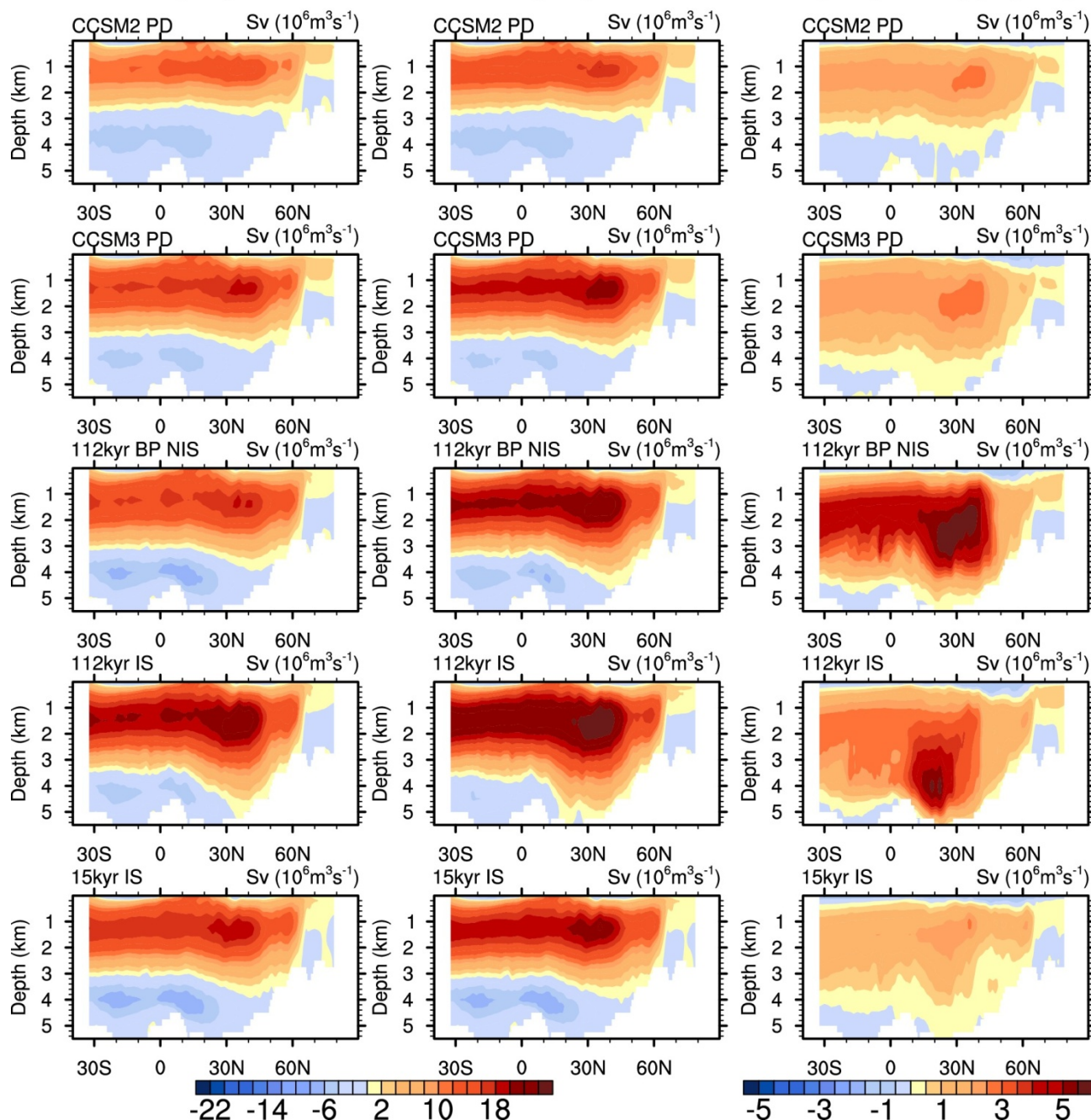


# Atlantic Meridional Streamfunction

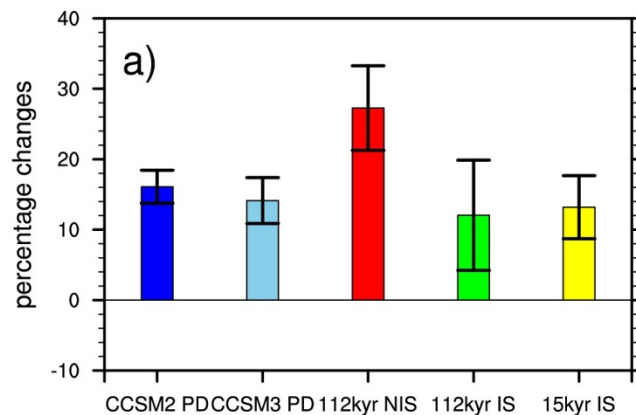
OBS

CBS

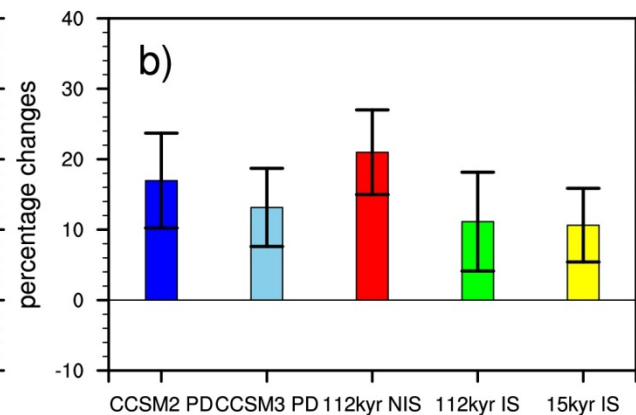
CBS minus OBS



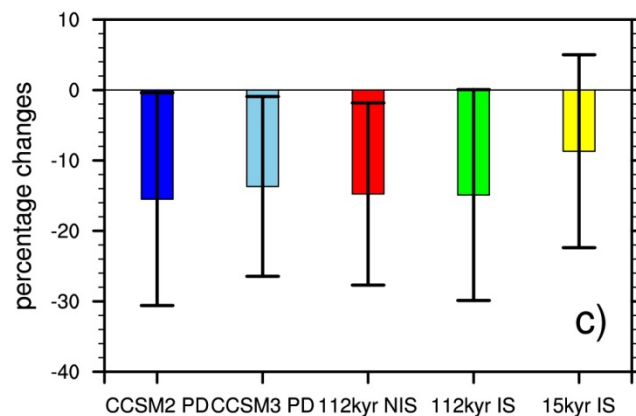
AMOC



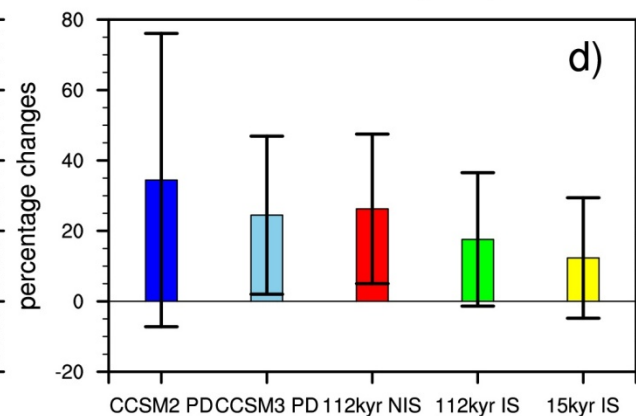
Atlantic MHT (24°N)



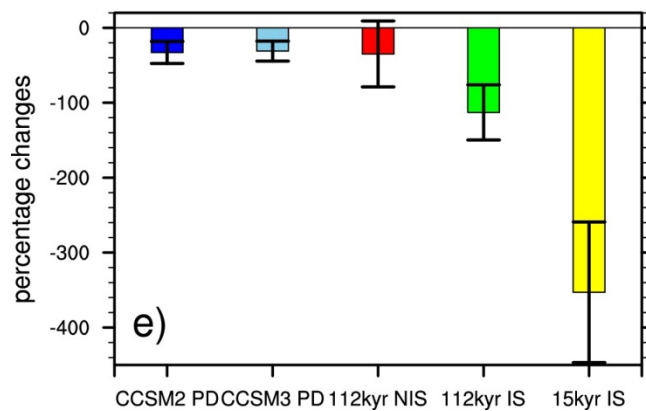
Pacific MHT (24°N)



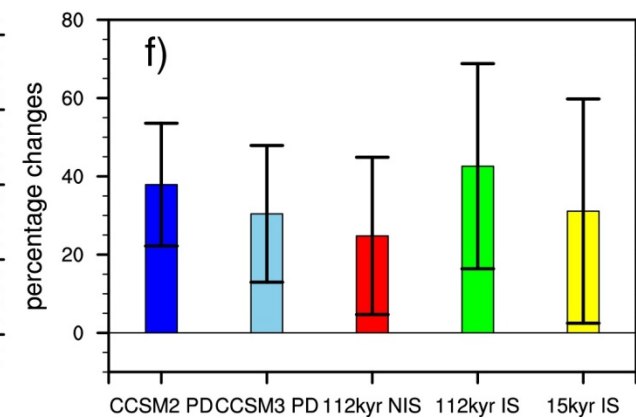
Pacific MHT (30°S)



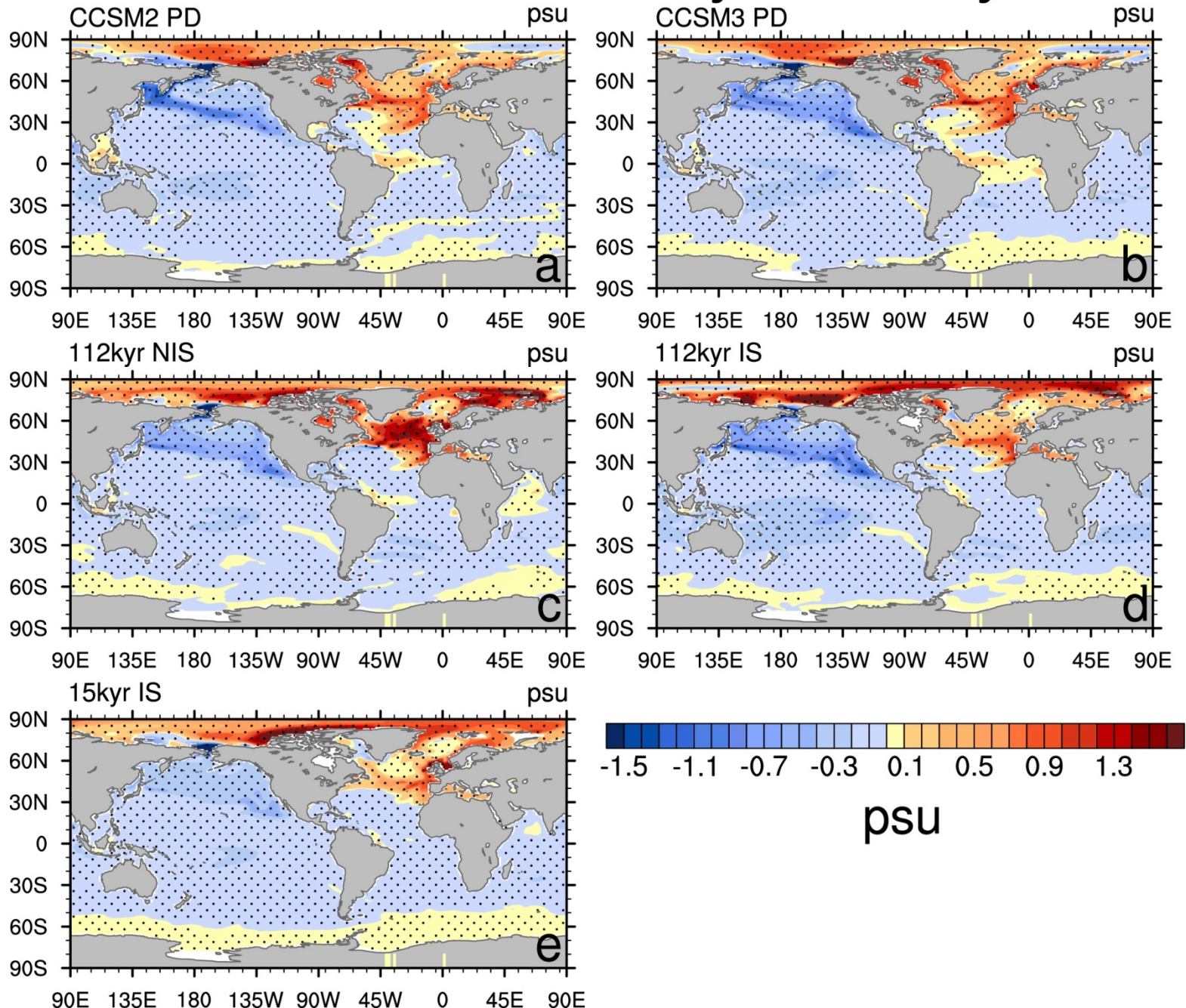
Arctic to Atlantic FWT



Pacific FWT (40°N)

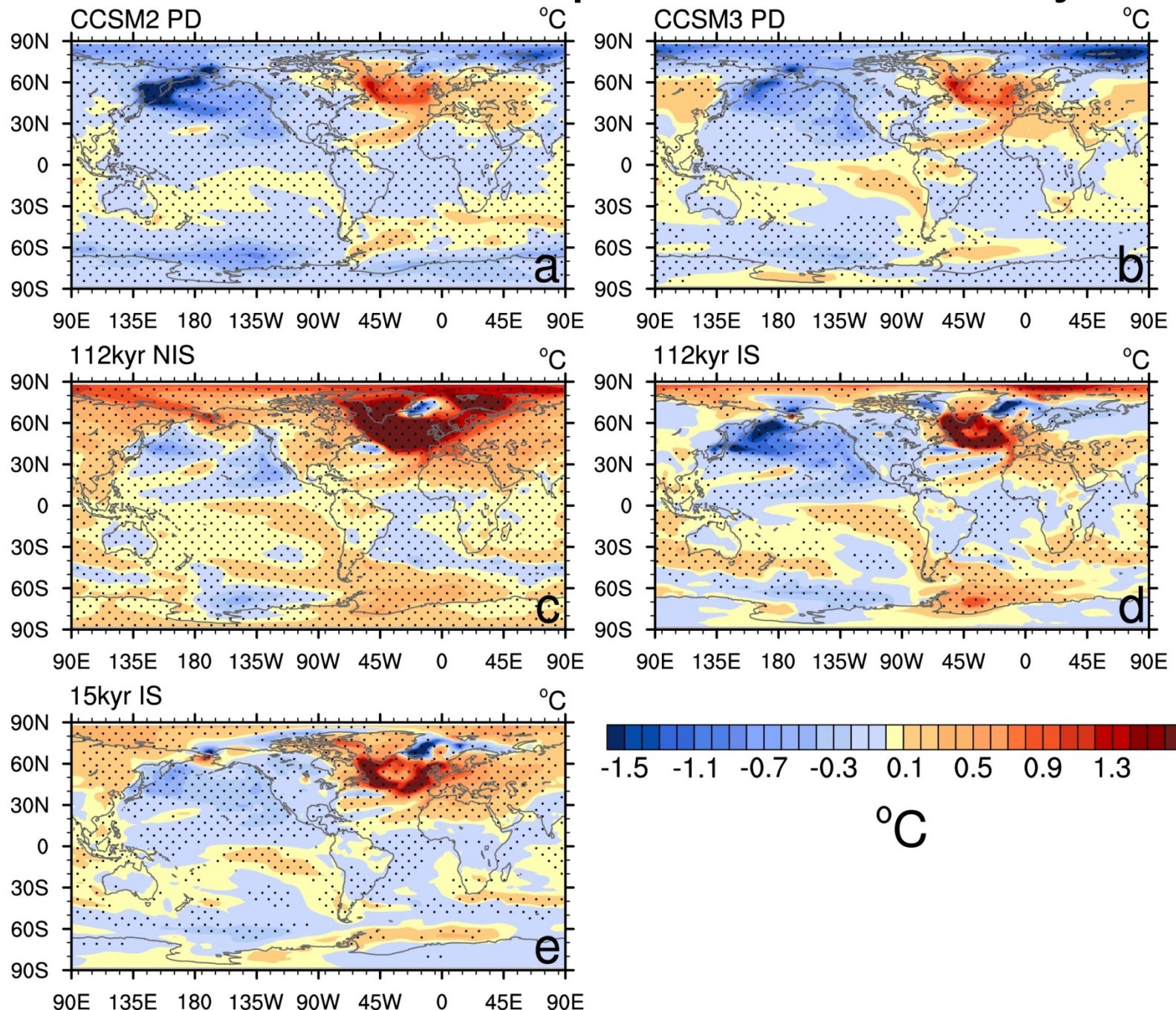


# Sea surface salinity anomaly

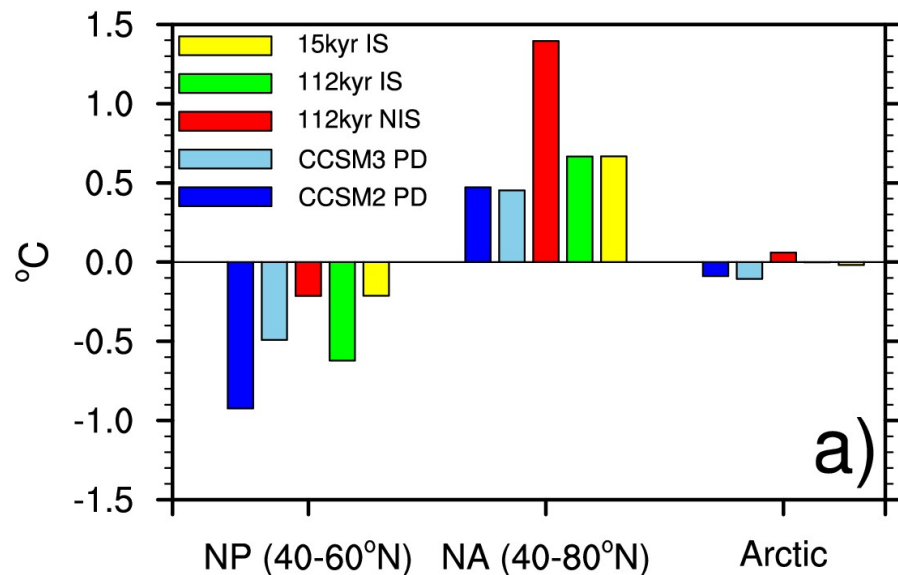




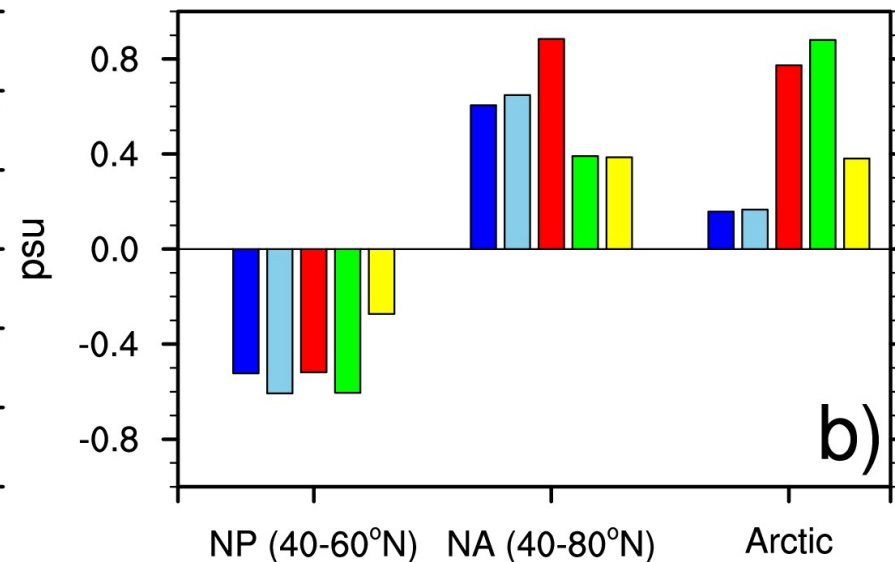
# Sea surface temperature anomaly



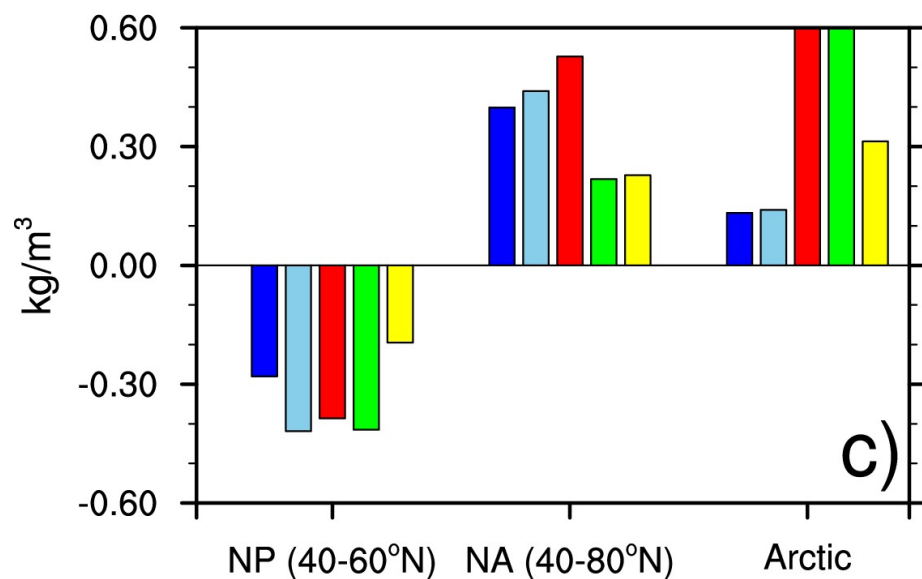
## SST



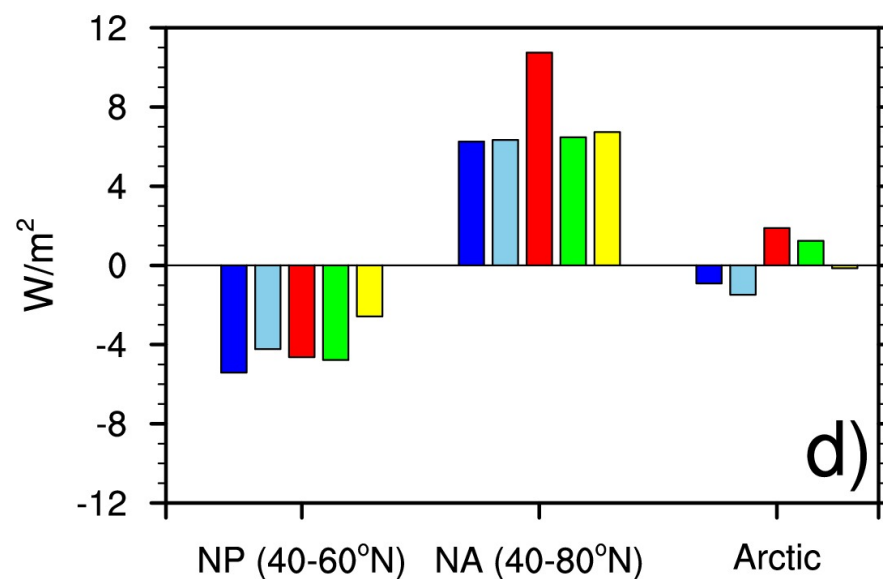
## SSS



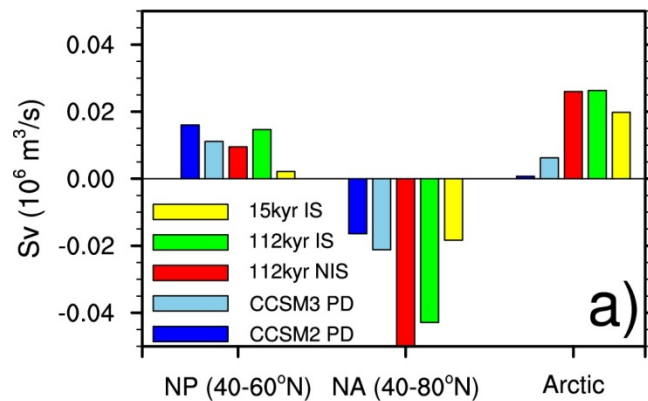
## SPD



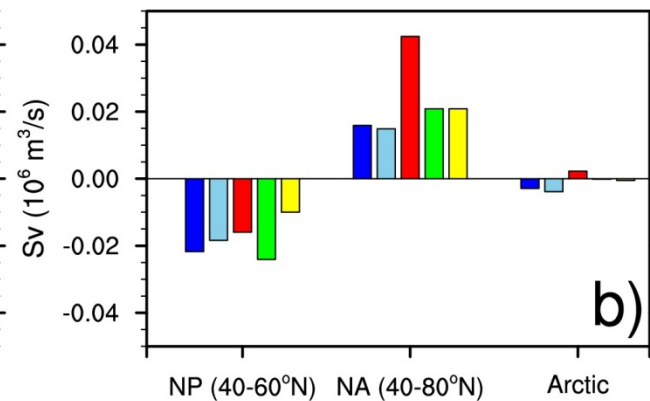
## Surface Heat Flux



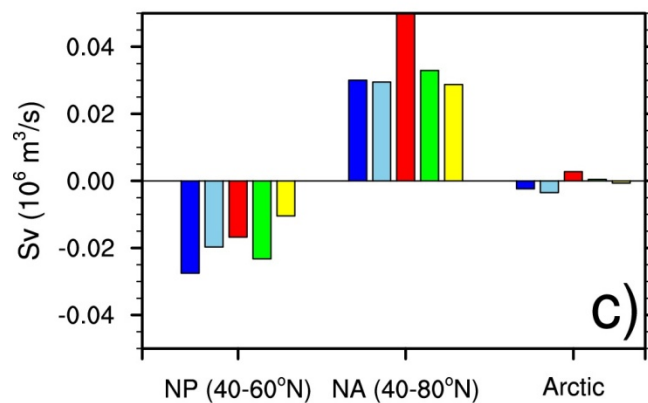
Surface freshwater flux



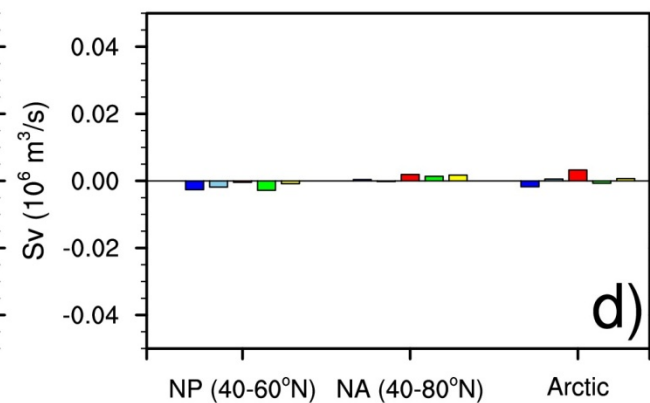
Precipitation



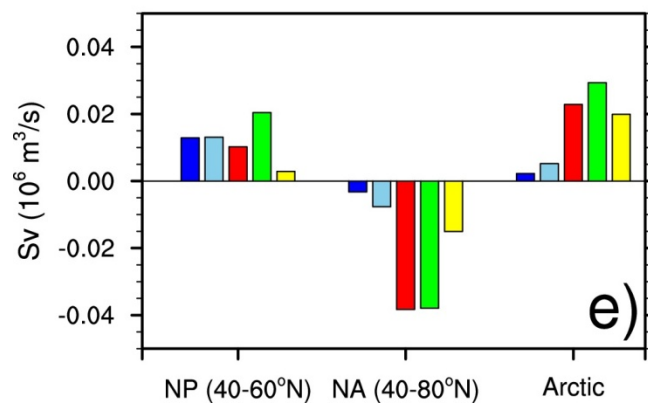
Evaporation



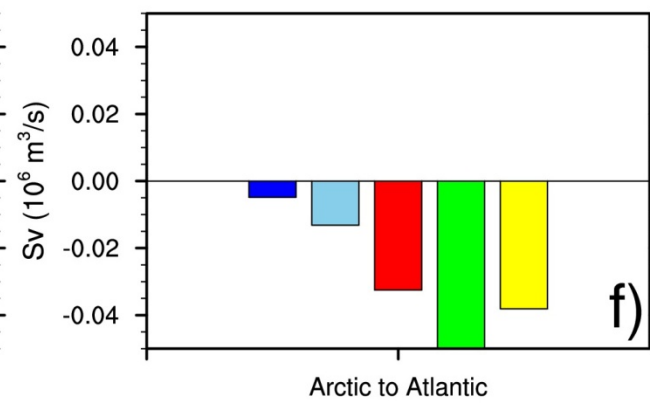
River runoff



Sea ice melt



Sea ice export



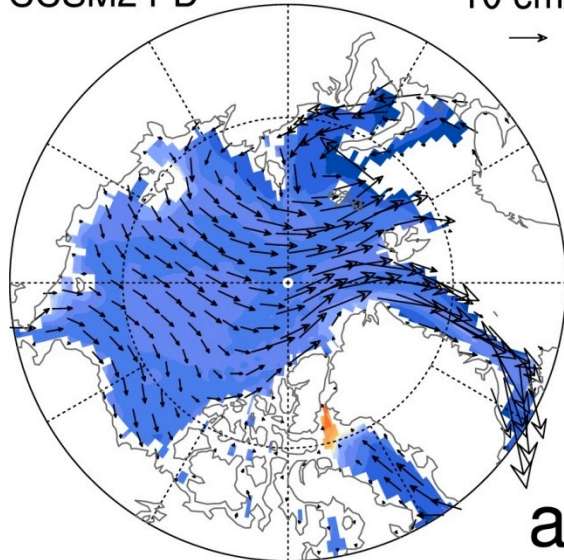


# March Mean Sea Ice Thickness/Velocity

## Open Bering Strait

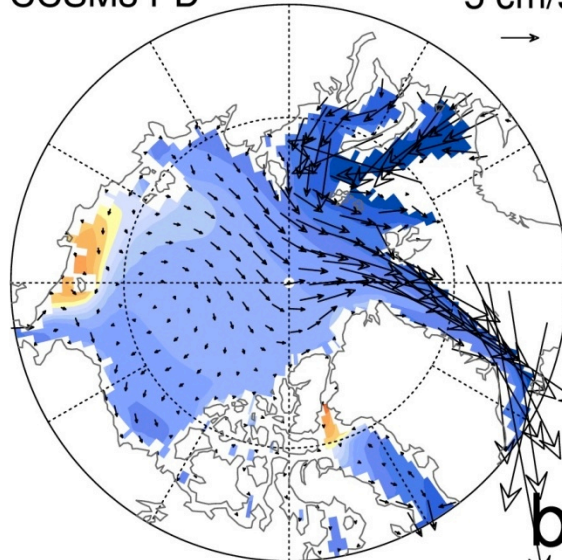
CCSM2 PD

10 cm/s



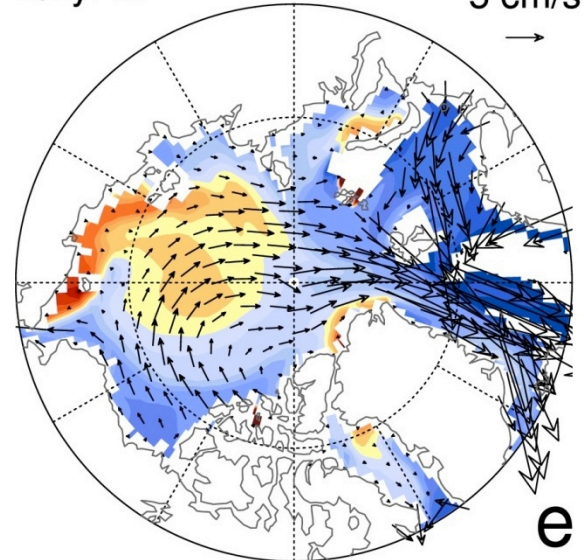
CCSM3 PD

5 cm/s



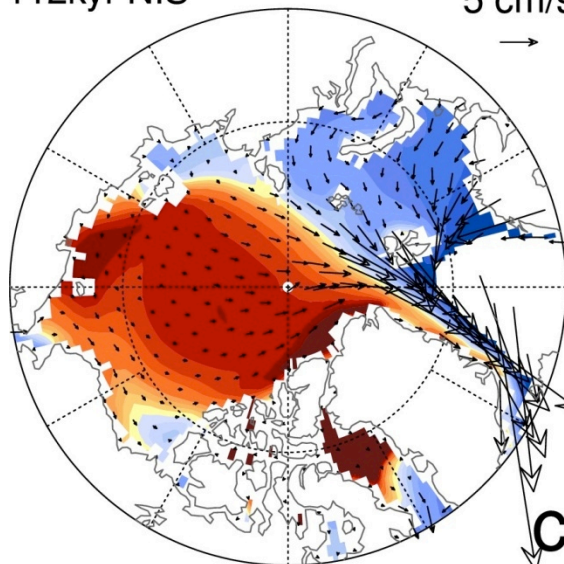
15kyr IS

5 cm/s



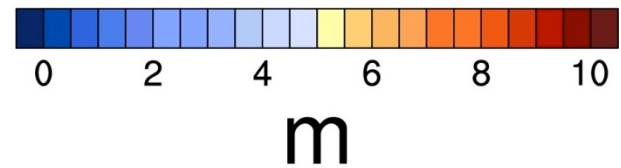
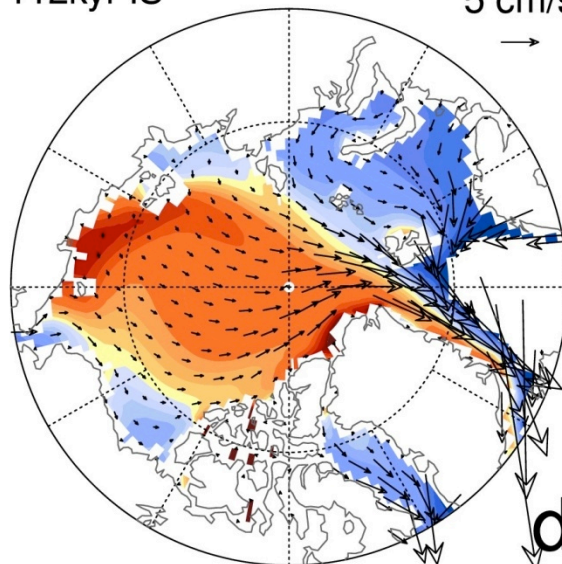
112kyr NIS

5 cm/s



112kyr IS

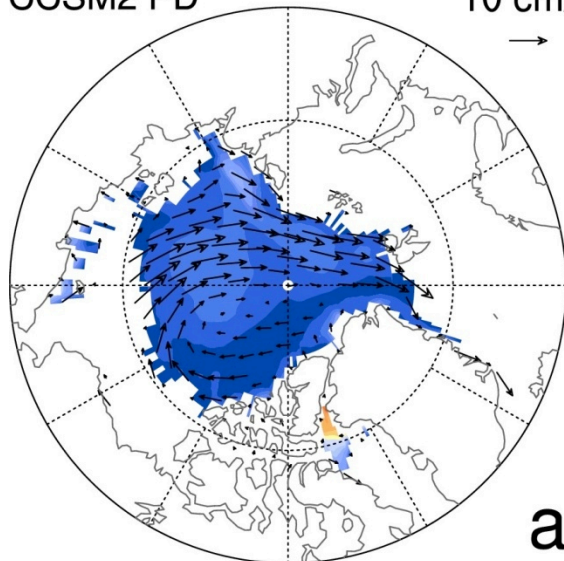
5 cm/s



# September Mean Sea Ice Thickness/Velocity **Open Bering Strait**

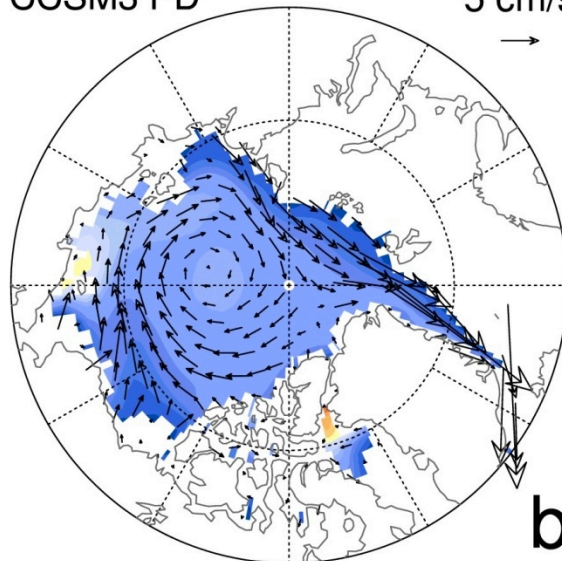
CCSM2 PD

10 cm/s



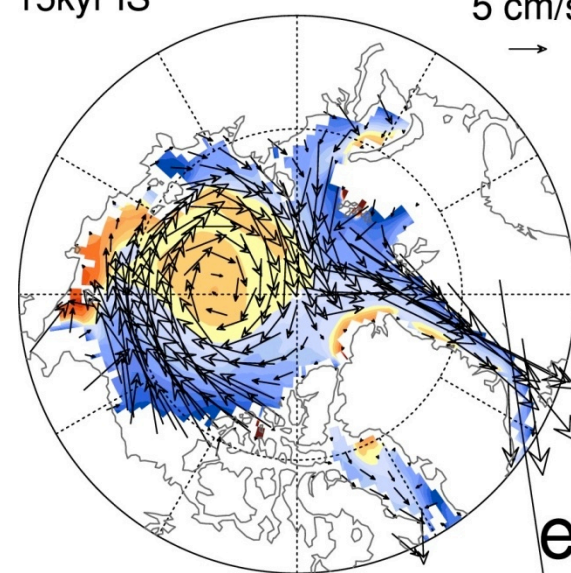
CCSM3 PD

5 cm/s



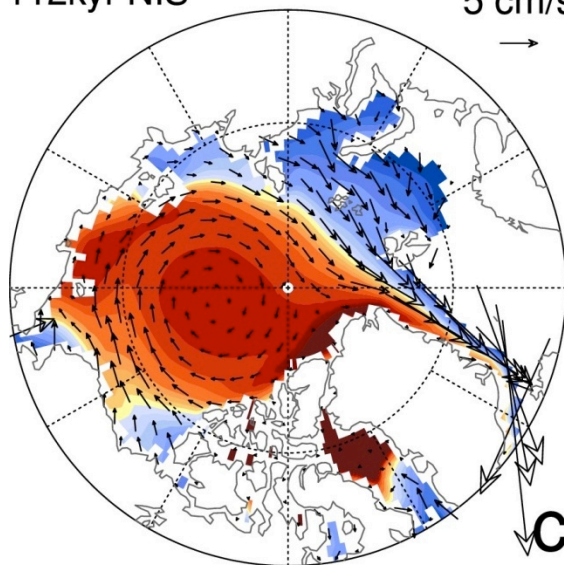
15kyr IS

5 cm/s



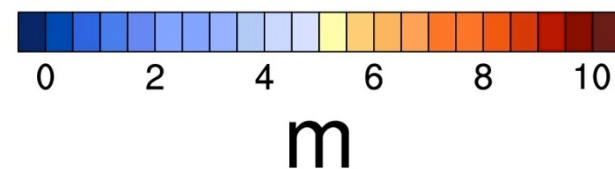
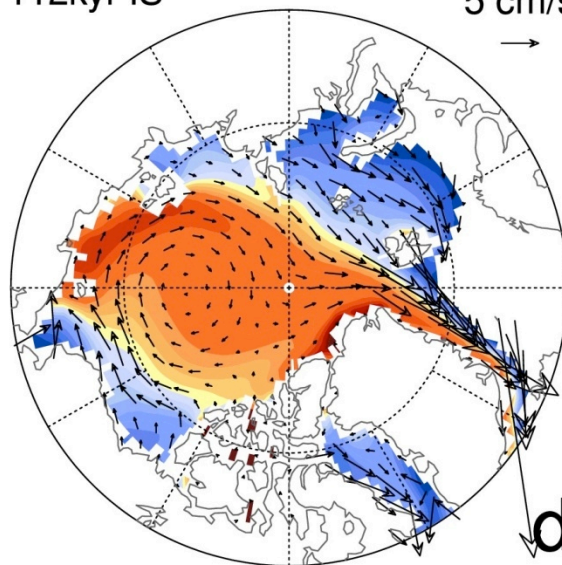
112kyr NIS

5 cm/s



112kyr IS

5 cm/s





# March Sea Ice Thickness/Velocity Difference

## CBS - OBS

CCSM2 PD

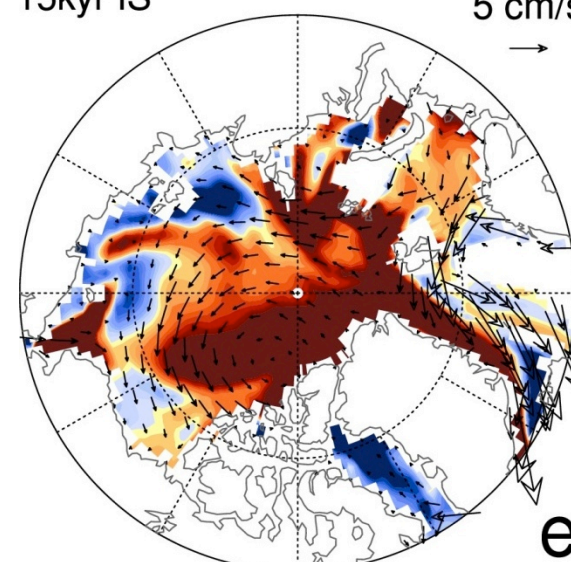
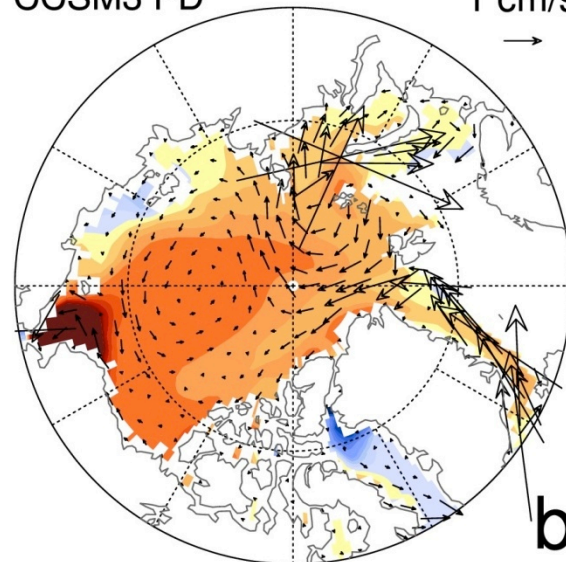
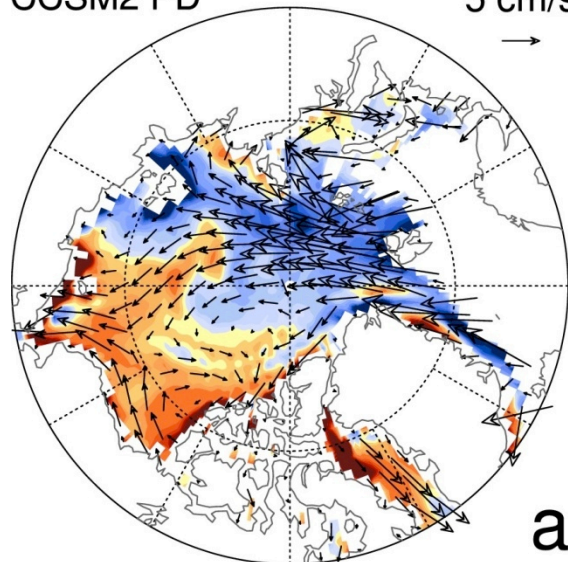
5 cm/s

CCSM3 PD

1 cm/s

15kyr IS

5 cm/s

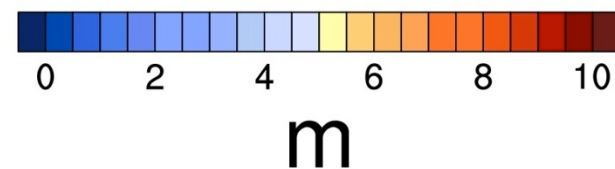
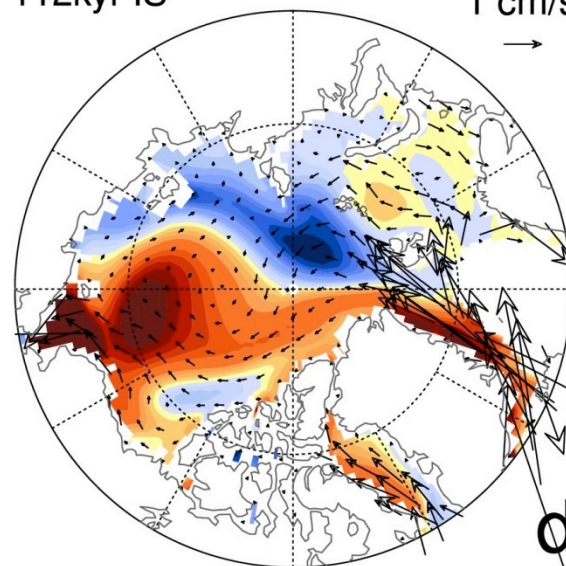
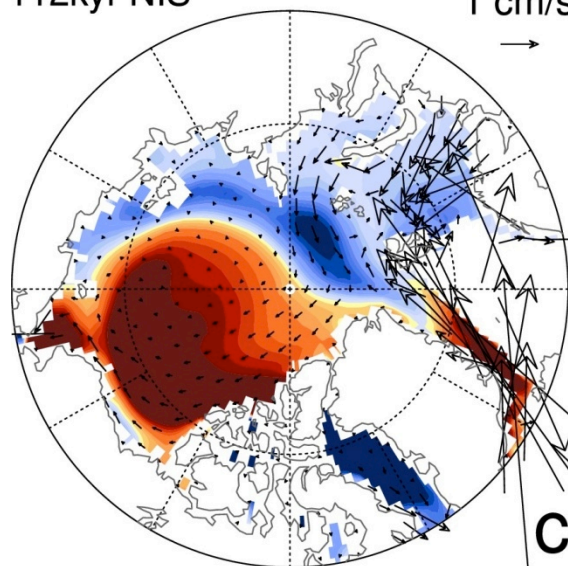


112kyr NIS

1 cm/s

112kyr IS

1 cm/s



# September Sea Ice Thickness/Velocity Difference CBS - OBS

CCSM2 PD

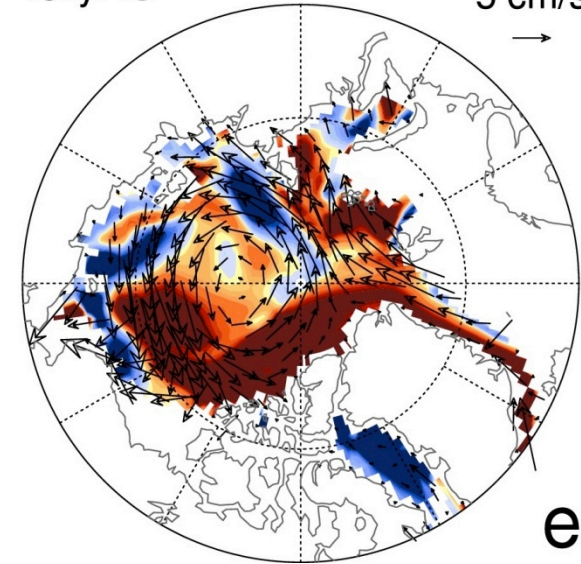
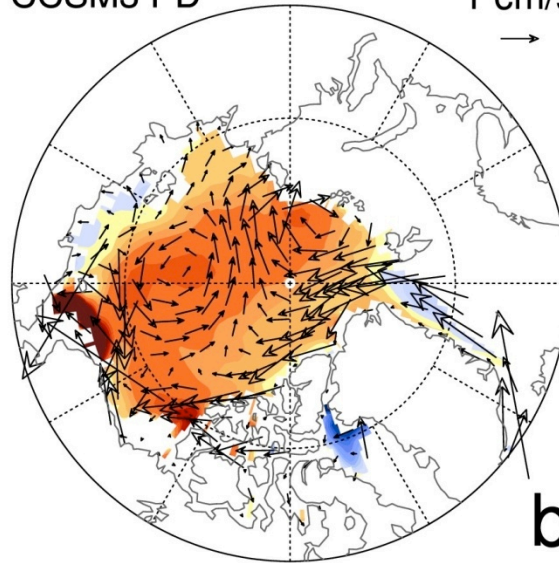
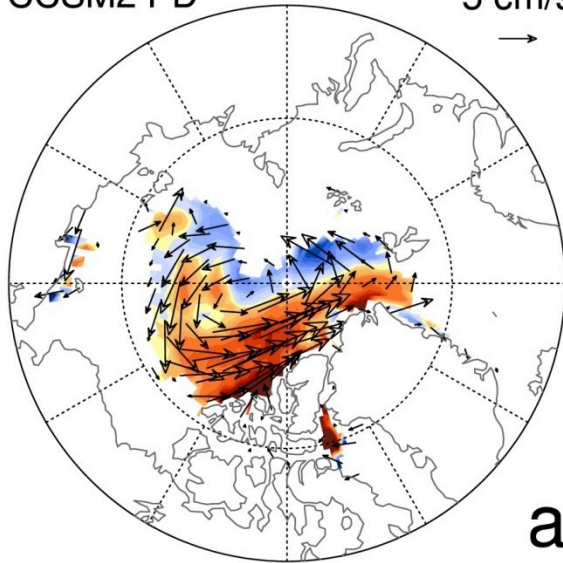
5 cm/s

CCSM3 PD

1 cm/s

15kyr IS

5 cm/s

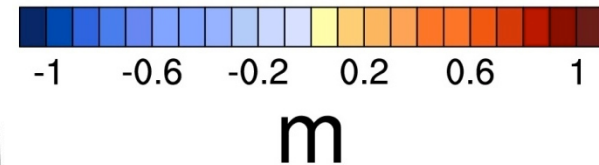
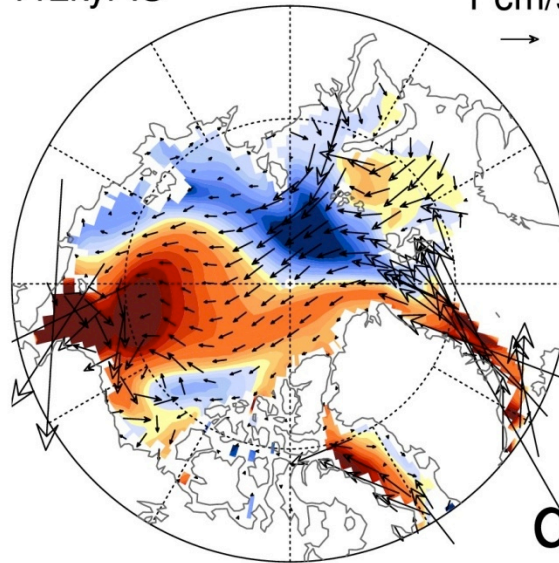
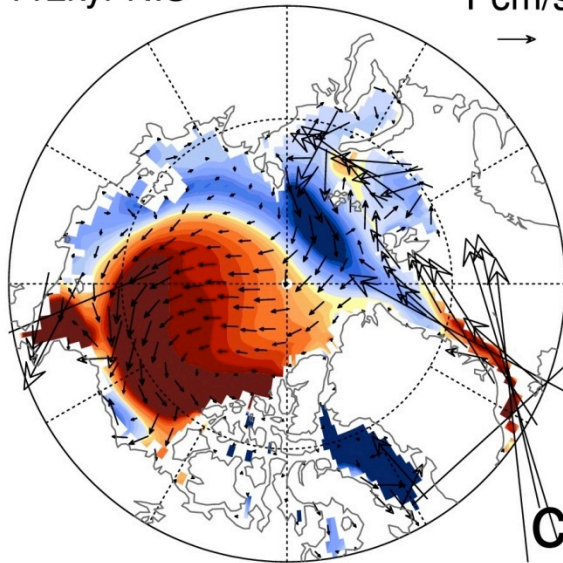


112kyr NIS

1 cm/s

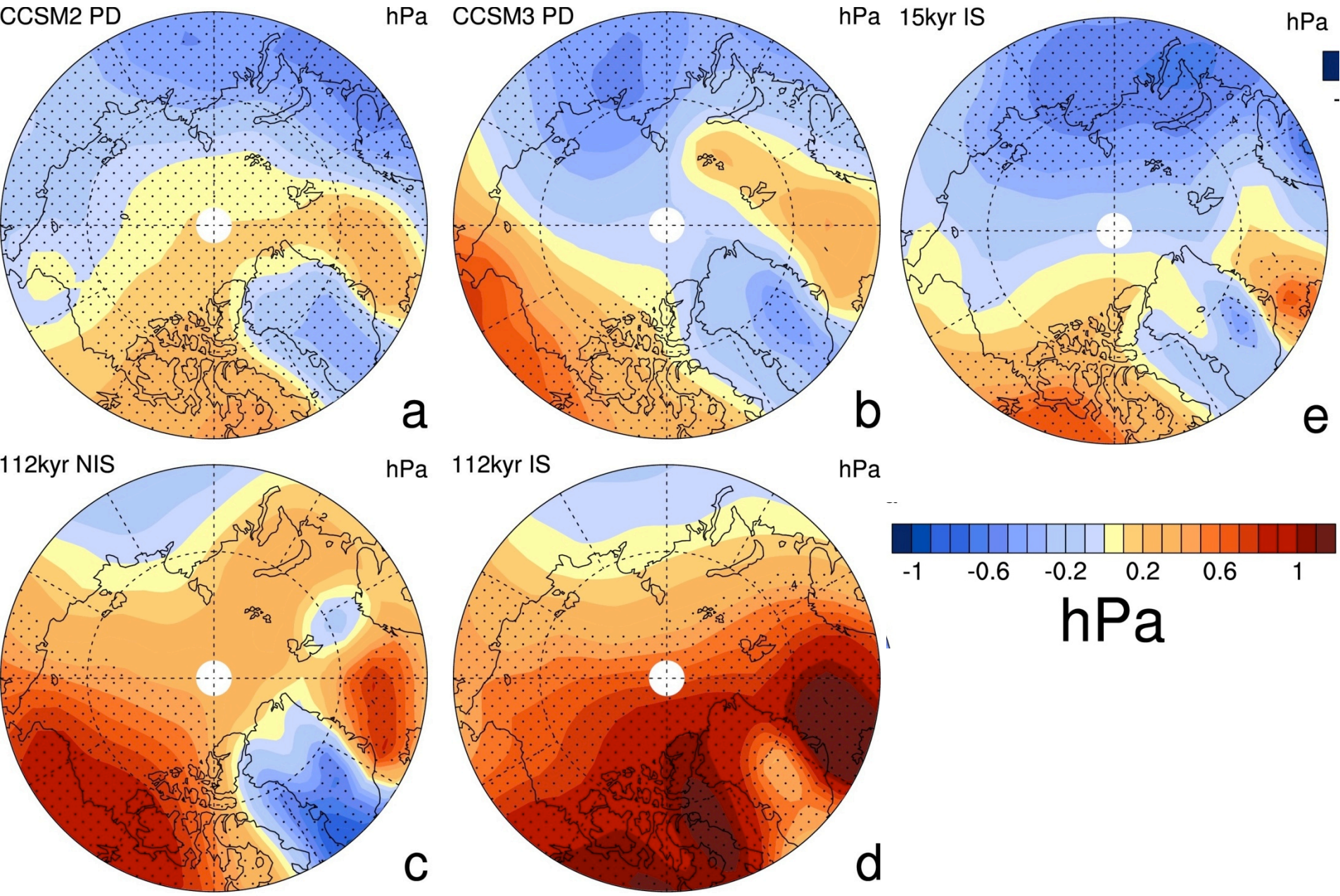
112kyr IS

1 cm/s





# Sea level pressure anomaly (CBS - OBS)



# Sea surface velocity in OBS simulations

CCSM2 PD

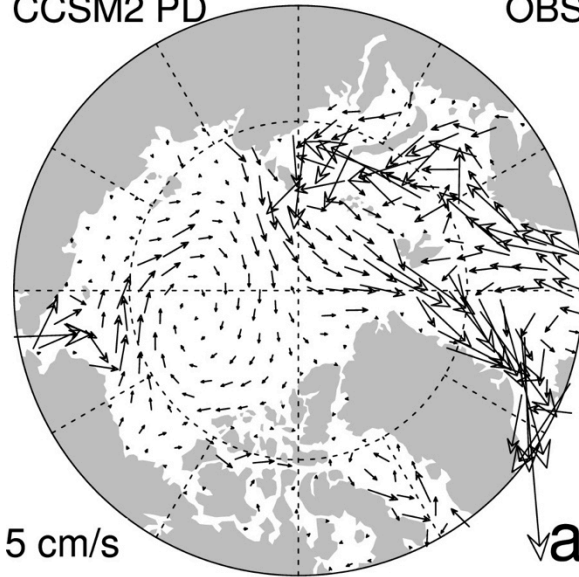
OBS

CCSM3 PD

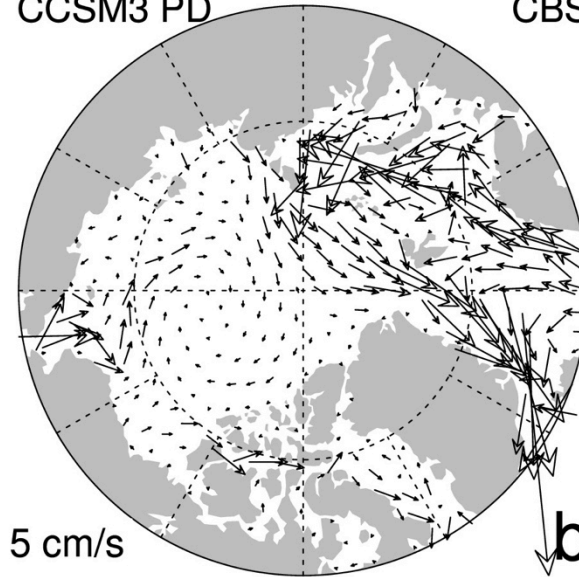
CBS

15kyr IS

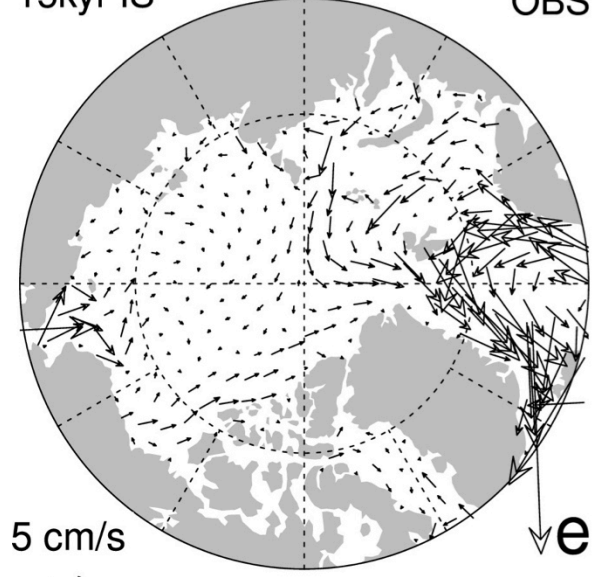
OBS



**a**



**b**



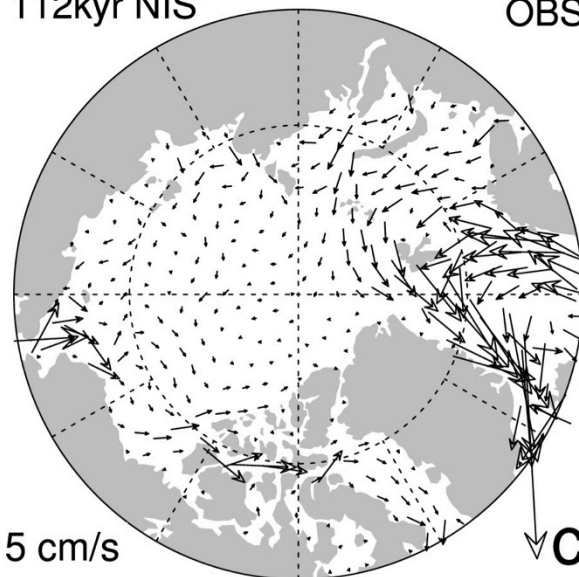
**e**

112kyr NIS

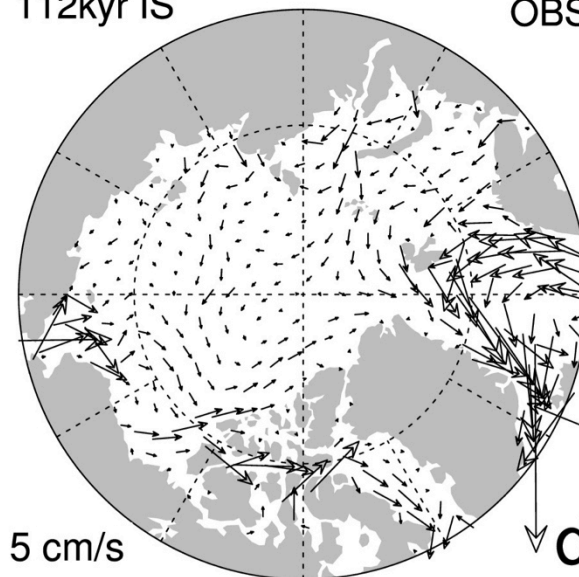
OBS

112kyr IS

OBS



**c**



**d**



# Sea surface velocity anomaly (CBS - OBS)

CCSM2 PD

CBS-OBS

CCSM3 PD

CBS-OBS

15kyr IS

CBS-OBS

2 cm/s

**a**

2 cm/s

**b**

2 cm/s

**e**

112kyr NIS

CBS-OBS

112kyr IS

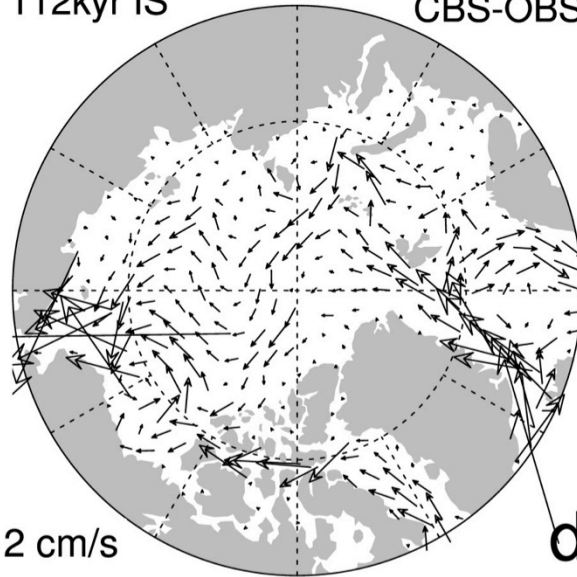
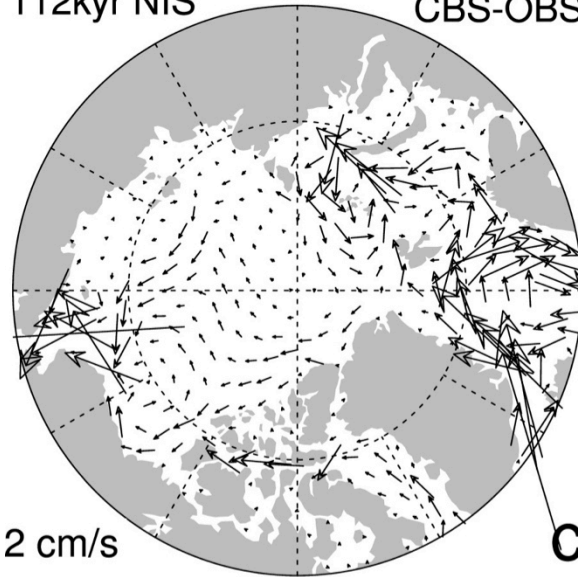
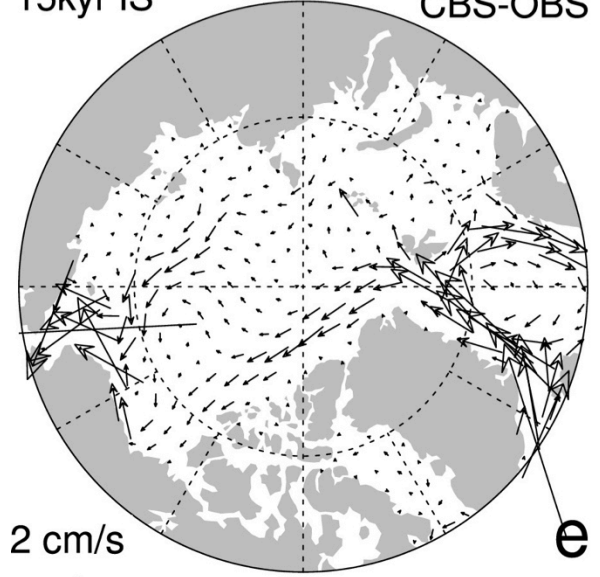
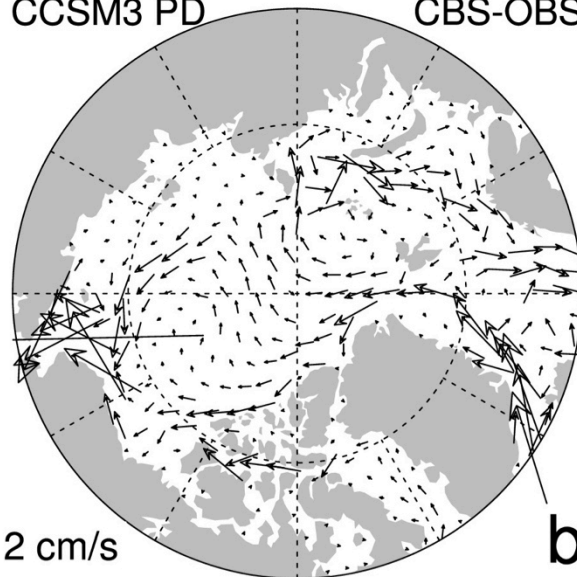
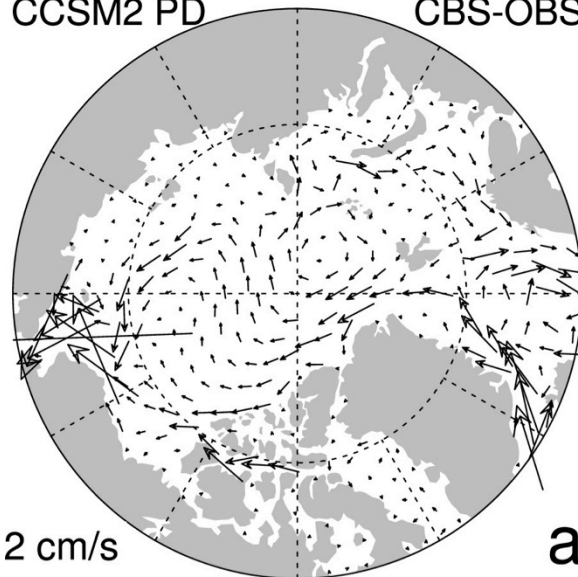
CBS-OBS

2 cm/s

**c**

2 cm/s

**d**



# Summary

- The effect of the Bering Strait closure is, in general, the same across the model versions and under different climate boundary conditions.
- The closure of the Bering Strait induces seesaw-like climate change between the North Atlantic and North Pacific - SST, SSS, surface freshwater input, surface heat flux, precipitation, evaporation, etc.
- In the Arctic, the sea ice motion becomes slower, and ice becomes thicker, and the sea ice export from the Arctic into the Atlantic also reduces.



# DOE/UCAR Cooperative Agreement Regional and Global Climate Modeling Program



## Thank You!

This work is funded by the Office of Science (BER), US Department of Energy,  
Cooperative Agreement No. DE-FC02-97ER62402.



**The NESL Mission is:**

**To advance understanding of weather, climate, atmospheric composition and processes;  
To provide facility support to the wider community; and,  
To apply the results to benefit society.**

NCAR is sponsored by the National Science Foundation