Atmospheric Circulation Response to Projected Arctic Sea Ice Loss

CAM4
Low-top model

WACCM
High-top model

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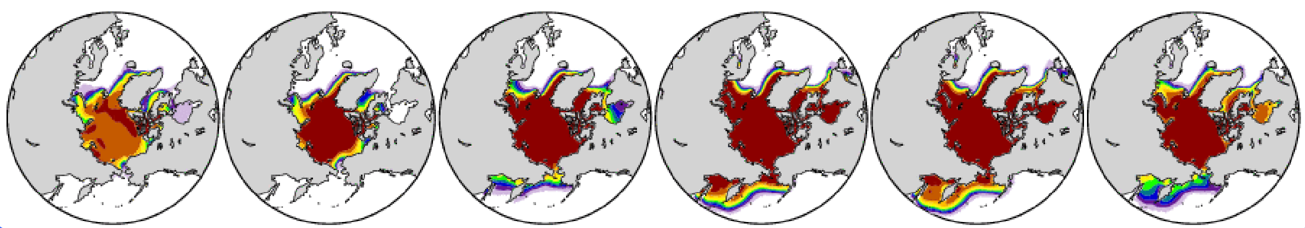
WACCM Experiment Design

WACCM fully-coupled historical run: 1980-1999 Ice Cov (%)

JA SO ND JF MA MJ

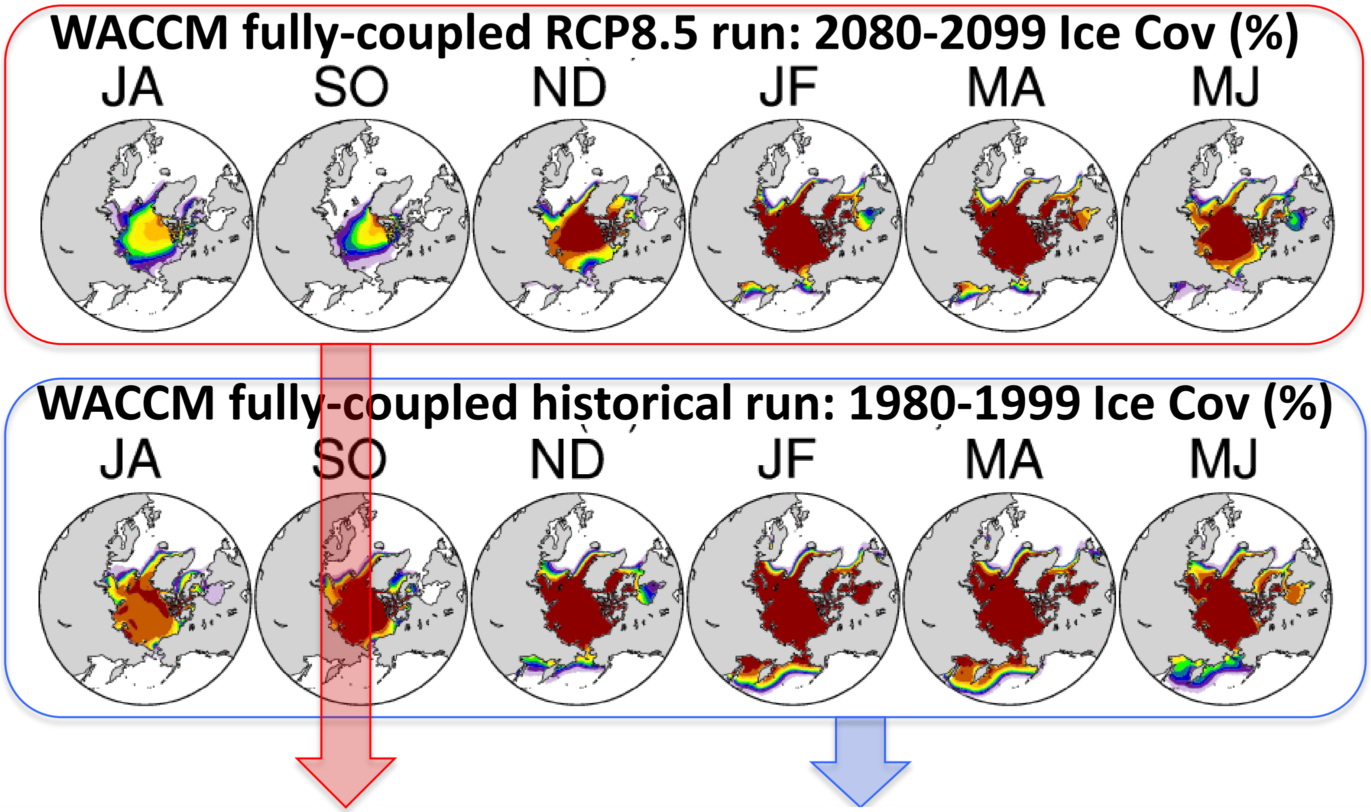


Control Run

WACCM

Repeating seasonal cycle of sea ice concentrations for 160 years, radiative forcing and ODS fixed at year 2000.

WACCM Experiment Design



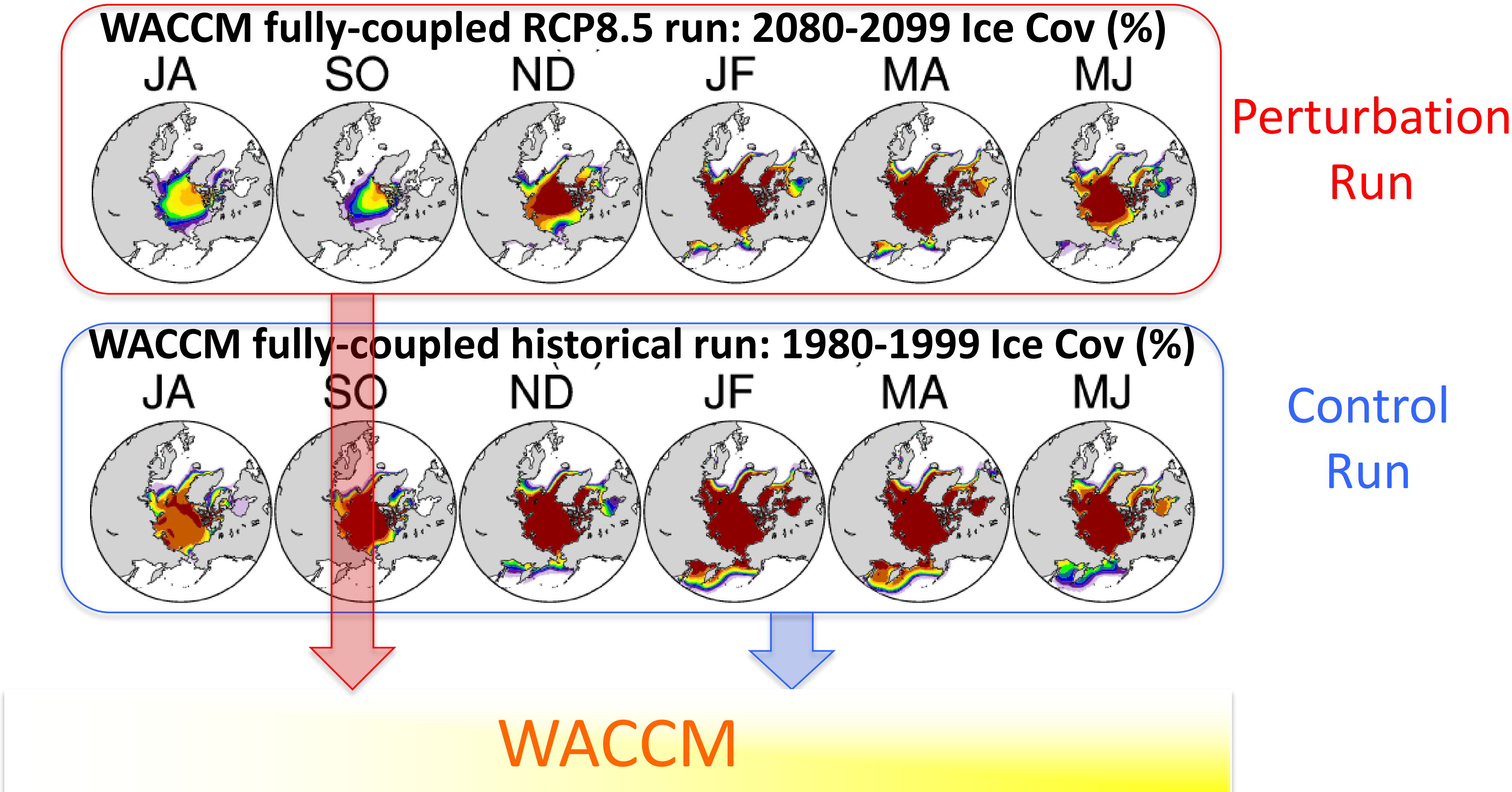
Perturbation Run

Control Run

WACCM

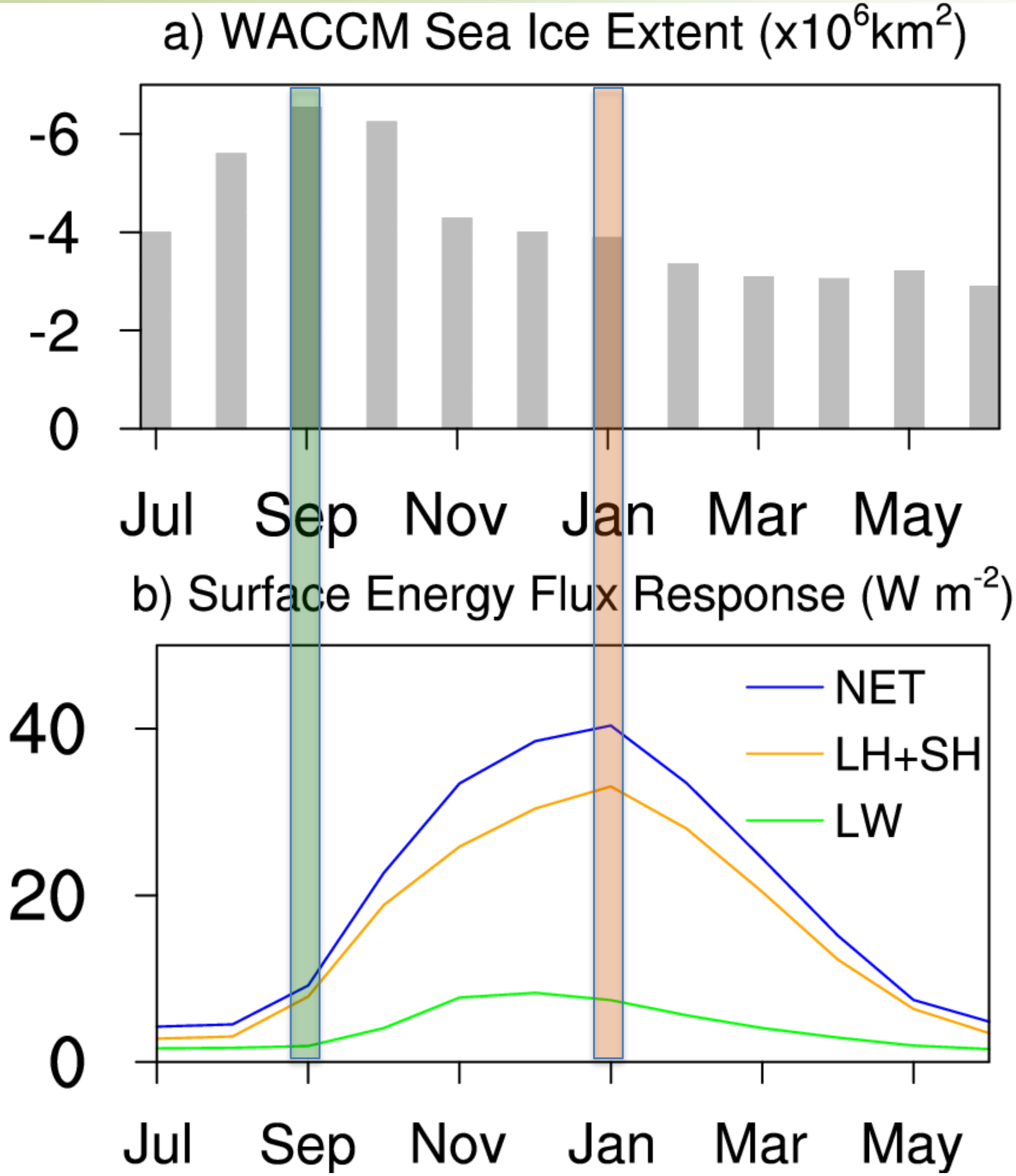
Repeating seasonal cycle of sea ice concentrations for 160 years, radiative forcing and ODS fixed at year 2000.

WACCM Experiment Design



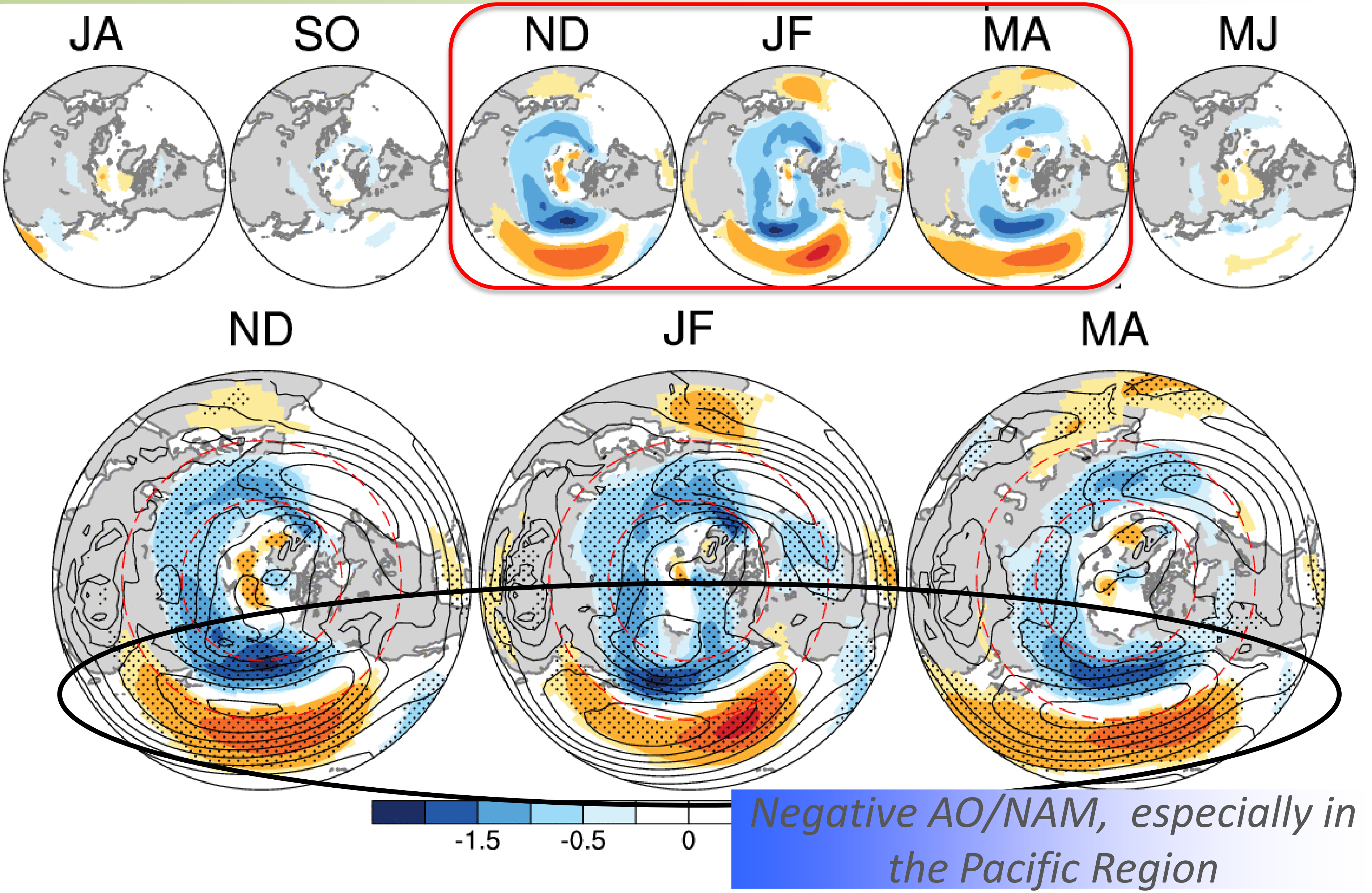
Perturbation – Control => Response to Arctic sea ice loss

Arctic Sea Ice Loss and Surface Energy flux Response



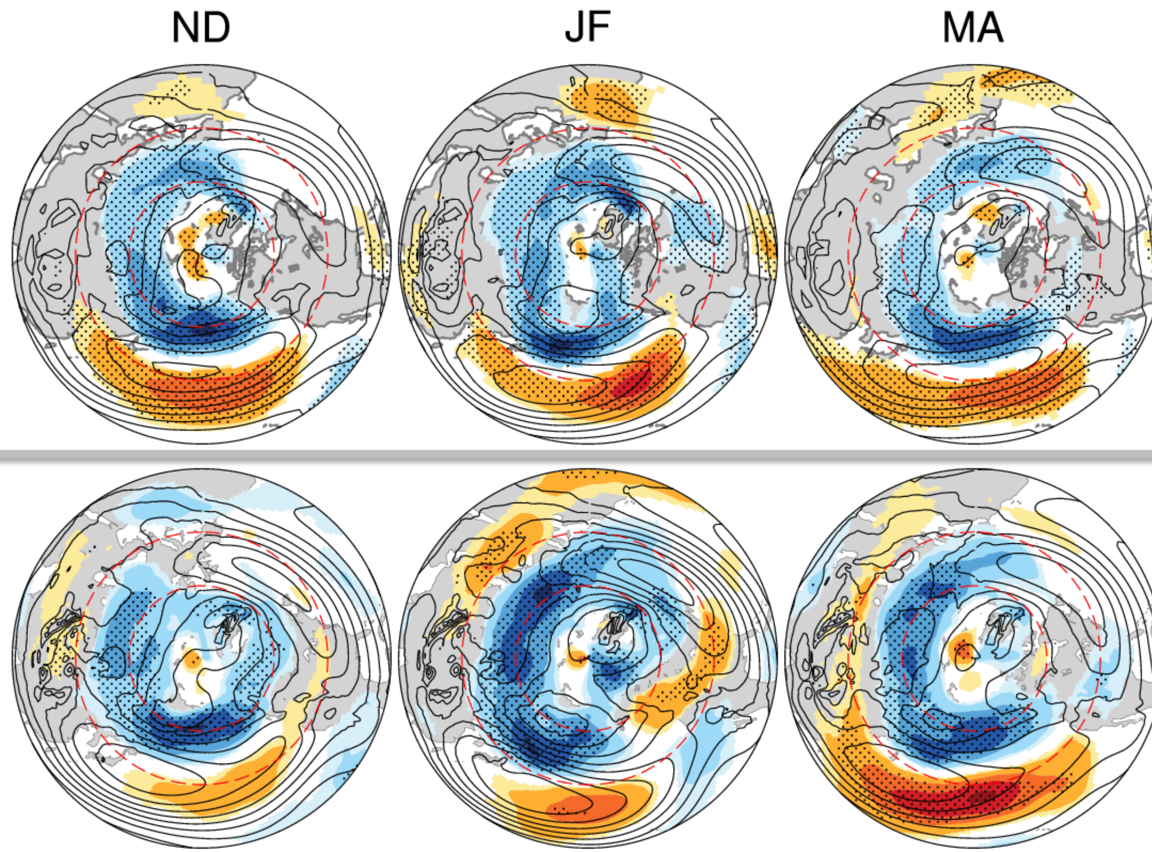
Delay in the surface energy flux response relative to the maximum sea ice loss (Deser et al., 2010)

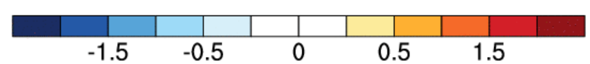
WACCM zonal wind response at 700 hPa

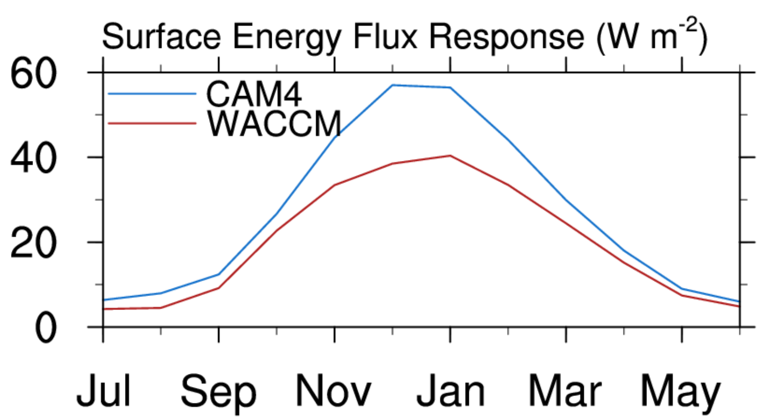


WACCM
(WACCM ICE)

CAM4
(CCSM4 ICE)

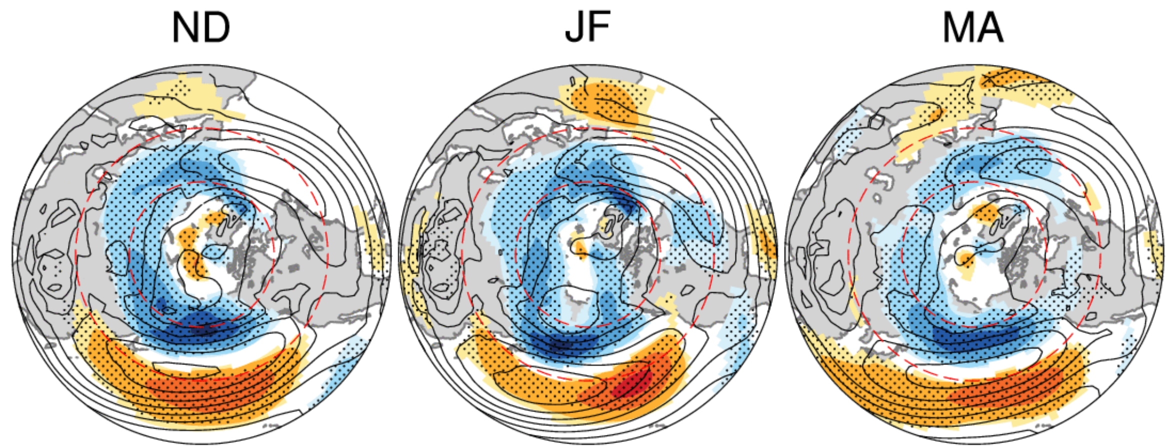


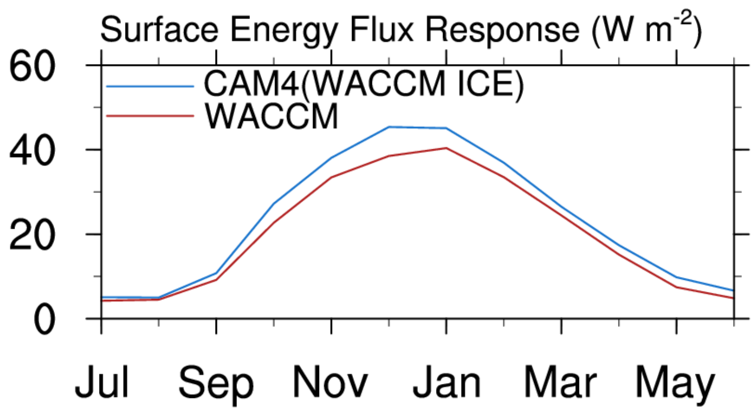




More Arctic sea ice loss in CCSM4, therefore, more heat flux in CAM4

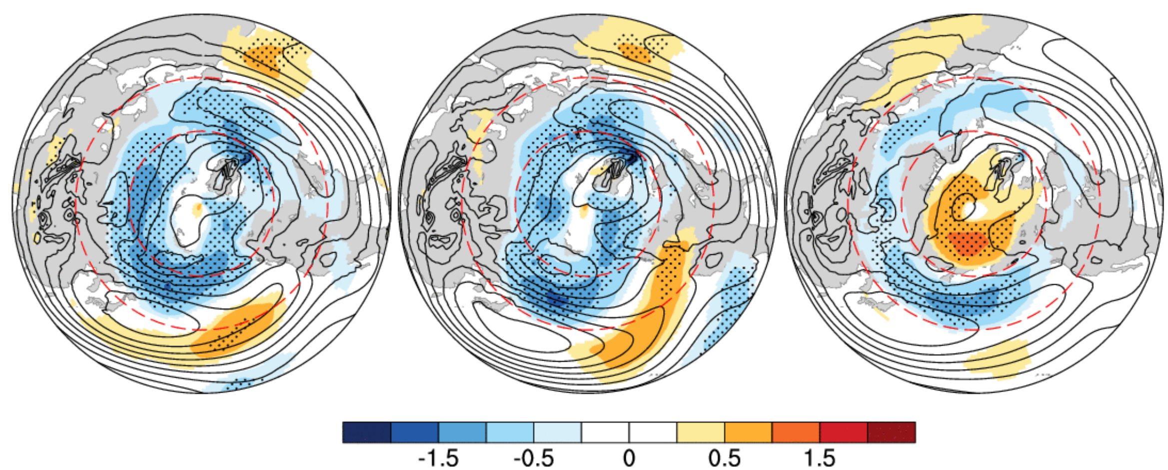
WACCM
(WACCM ICE)



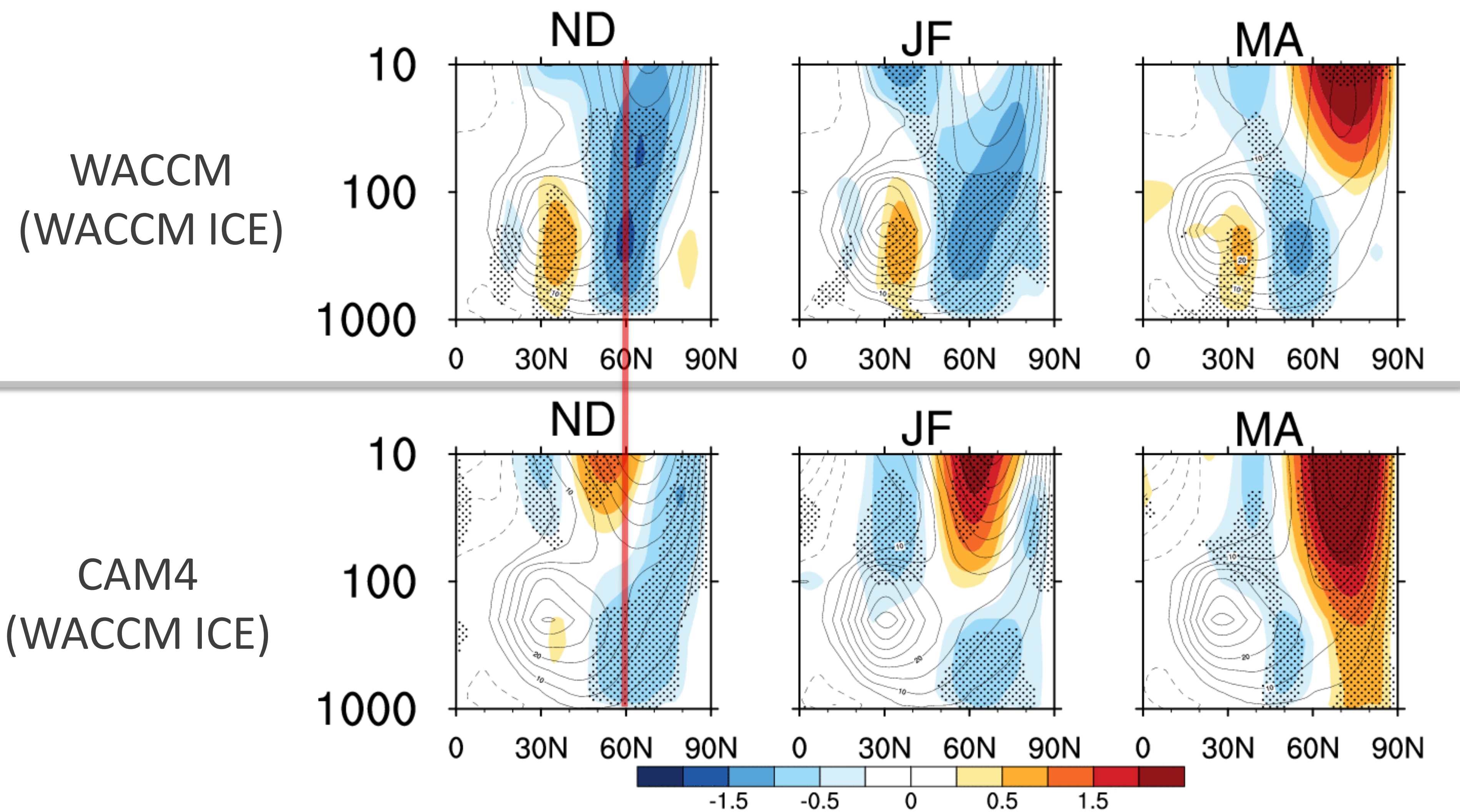


Same sea ice forcing, very similar heat flux response, yet, weaker response in CAM4

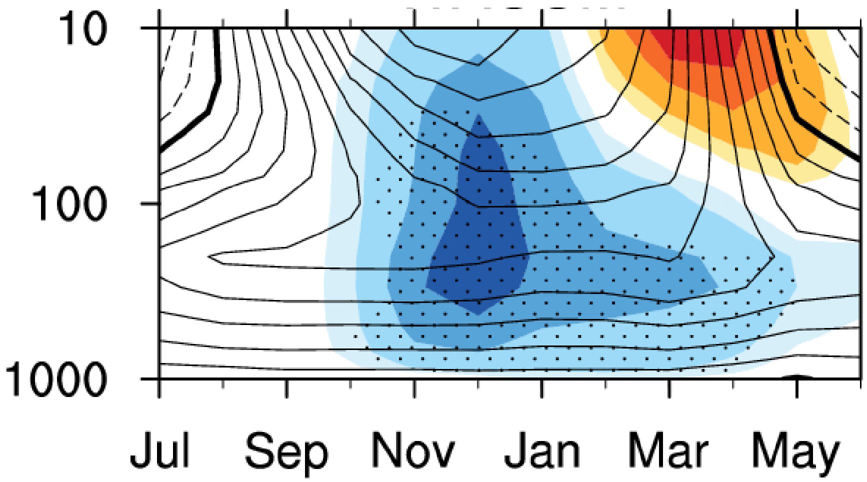
CAM4
(WACCM ICE)



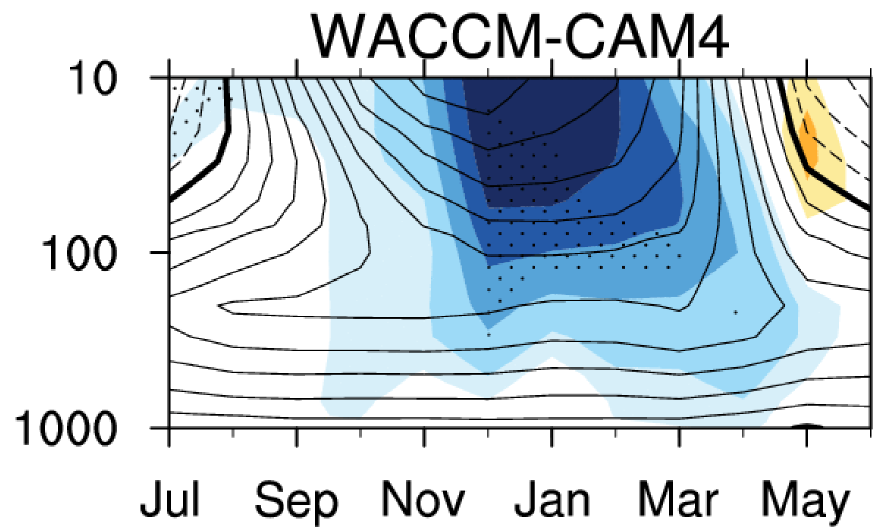
Vertical Structure: Zonal-mean zonal wind response

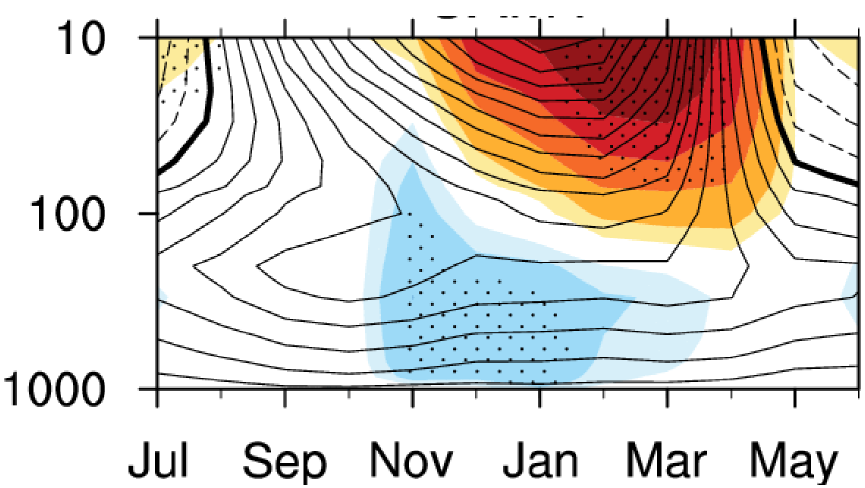


Evolution of zonal wind response at 60°N



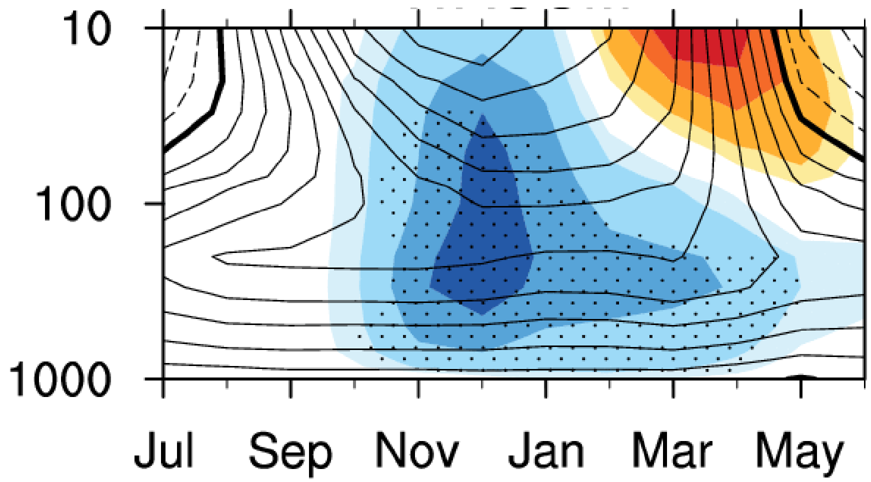
WACCM
(WACCM ICE)





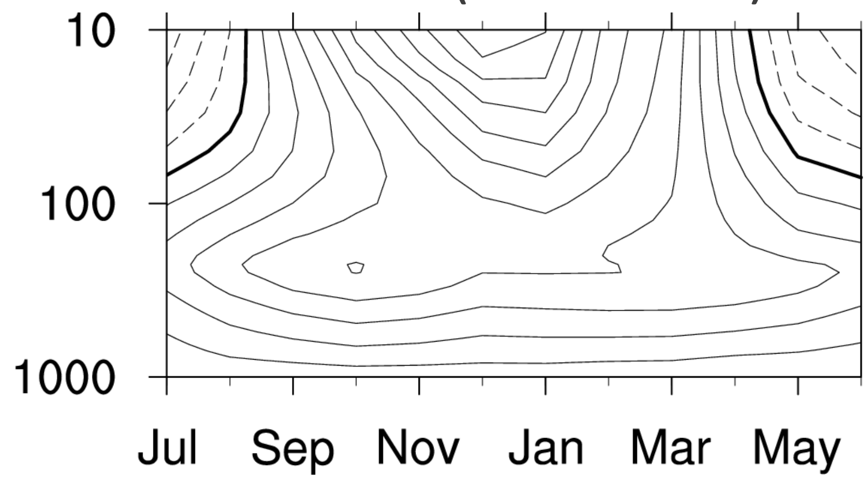
CAM4
(WACCM ICE)

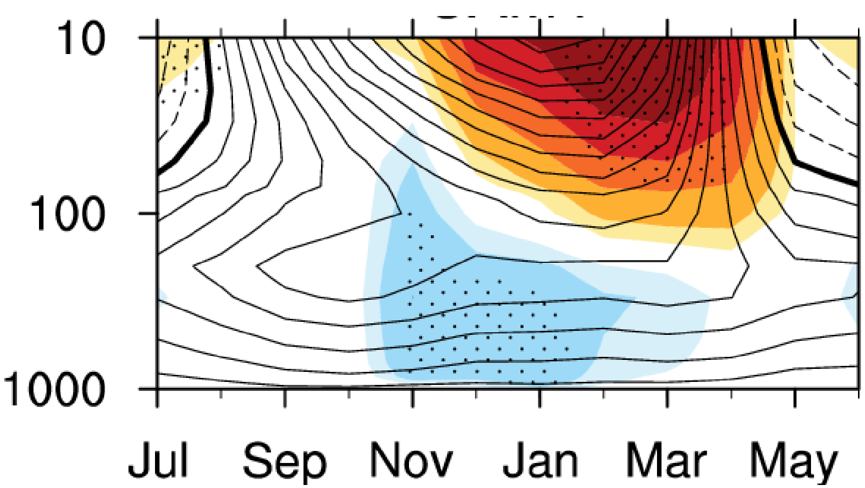
Evolution of zonal wind response at 60ºN



WACCM
(WACCM ICE)

ERA-I (1990-2010)





CAM4
(WACCM ICE)

Conclusions

- Despite the fact that sea ice loss reaches its maximum in the early fall, surface energy flux response peaks in the winter, and so does the atmospheric circulation response.
- Robustness in atmospheric circulation response: Negative AO/NAM pattern, especially in the Pacific region (CAM4 vs WACCM).
- Given the same sea ice forcing, the atmospheric circulation response is still model-dependent. Stratosphere likely plays a role in this process.