

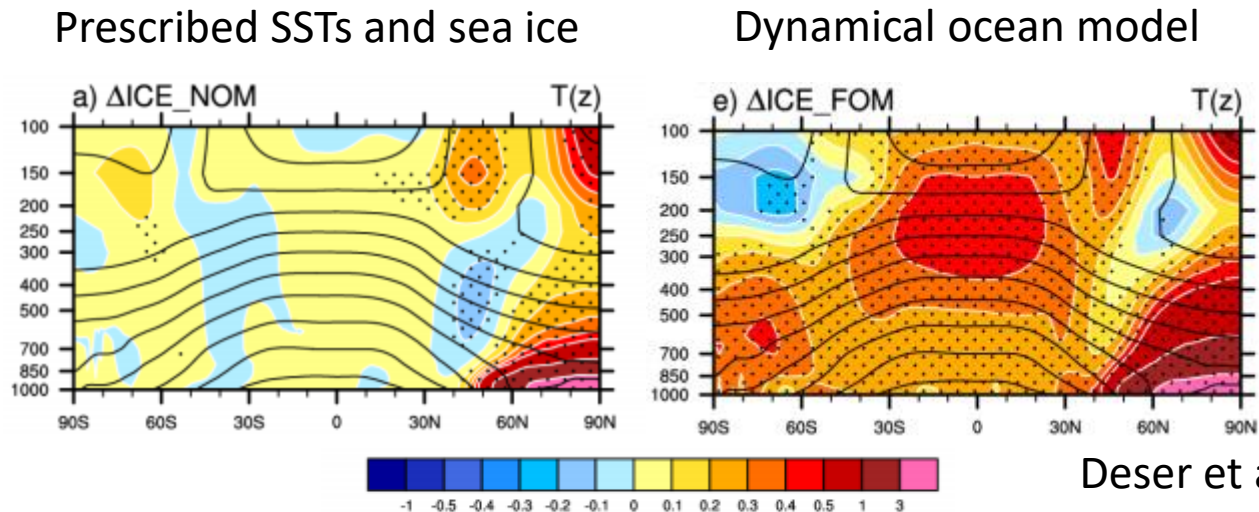
The role of extratropical ocean warming in the coupled climate response to Arctic sea ice loss

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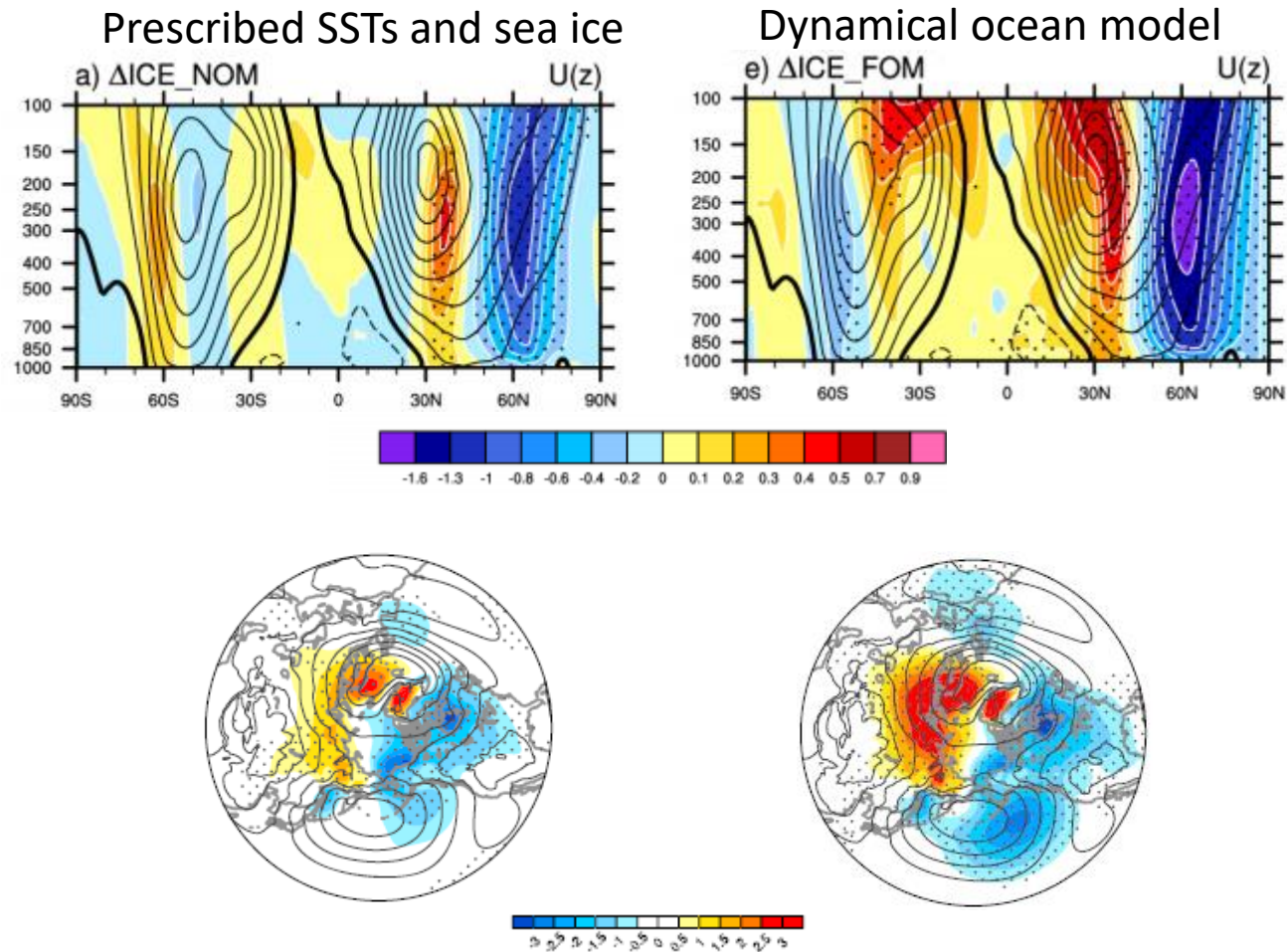
AGCI workshop on Polar Amplification, June 11-16 2017

Motivation



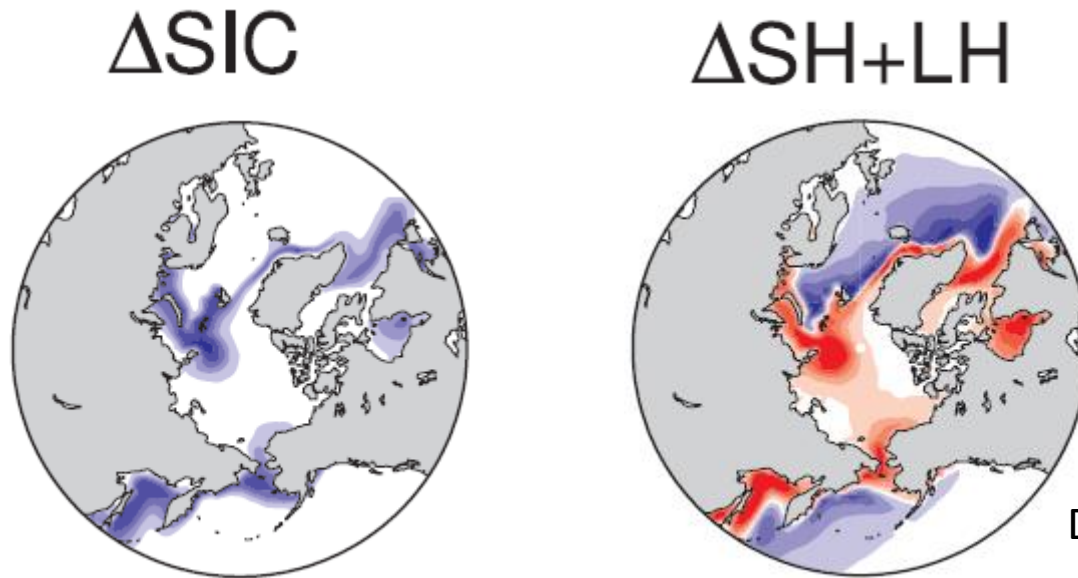
- Coupling causes ‘mini global warming’ response and enhances warming in Arctic mid-troposphere
- Arctic mid-troposphere warming could be due to transport from tropics

Motivation



- Enhanced Arctic mid-troposphere warming amplifies atmospheric circulation response in coupled model

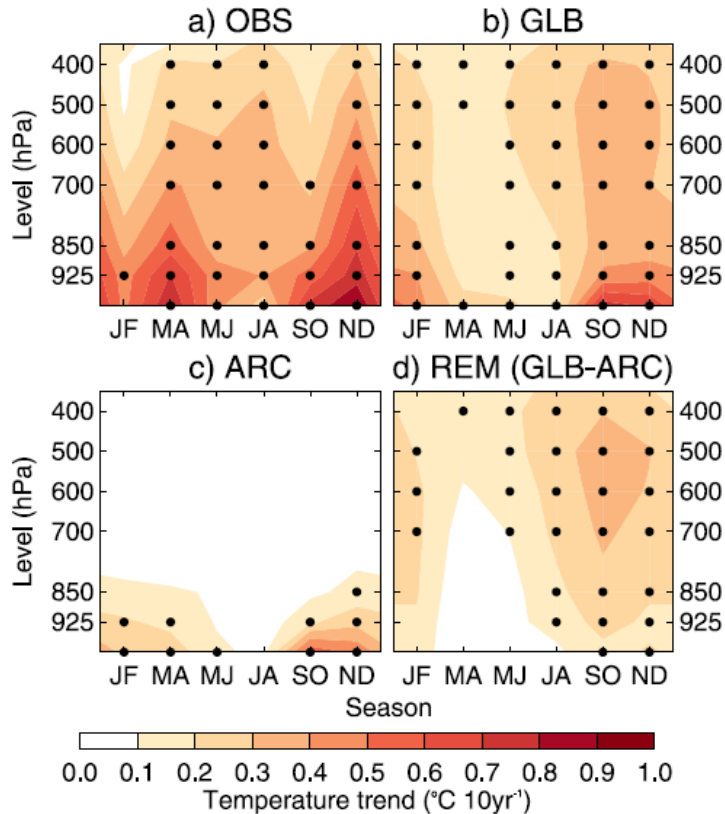
Motivation



Deser et al. 2010

- Warming from sea ice loss spreads out and enters ocean beyond where sea ice is lost
- AGCM experiments do not account for this additional ocean warming

Motivation



- Remote SST warming can warm the Arctic mid-troposphere

Screen et al. 2012

- Can extratropical ocean warming induced by sea ice loss contribute to enhanced Arctic mid-troposphere warming?

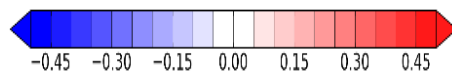
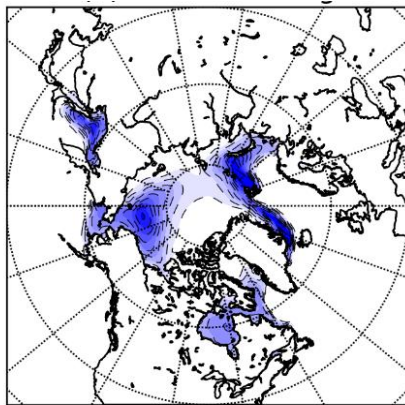
Approach

- Use coupled model experiments to determine extratropical SST response caused by sea ice loss
 - CESM1 Year 2000 control simulation, Sea ice albedo forcing
 - CESM Large ensemble (RCP8.5)
- Force an AGCM with sea ice loss both with and without this SST warming
 - CAM5, 100 year timeslice simulations

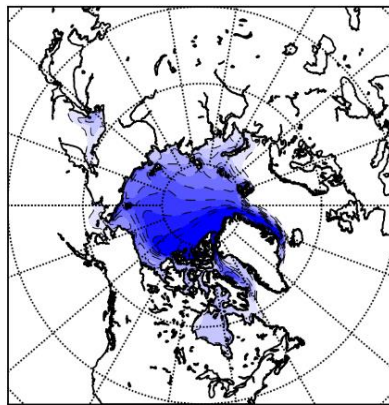
AGCM Experiments

Experiment	Prescribed Sea ice	Prescribed SST
CTL_{ALB}	Year 2000 control	Year 2000 control
I_{ALB}	Sea ice albedo forcing	Year 2000 control
$I_{ALB}T_{ALB40}$	Sea ice albedo forcing	Year 2000 control (<40°N) Sea ice albedo forcing (>40°N)

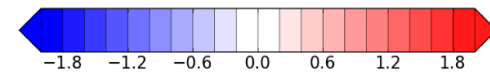
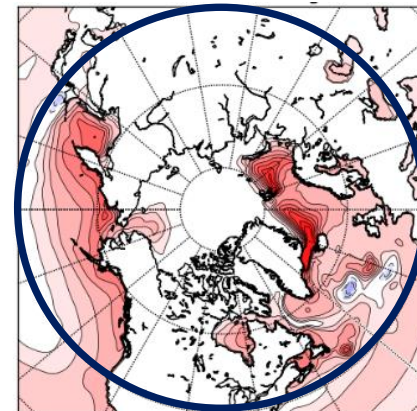
ΔSIC



ΔSIT



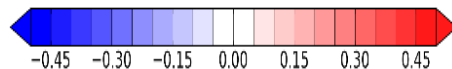
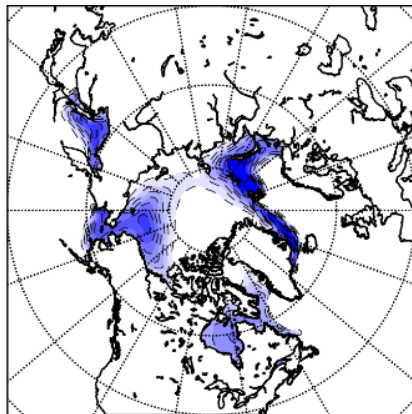
ΔSST



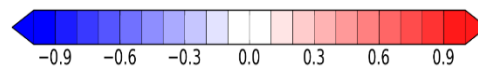
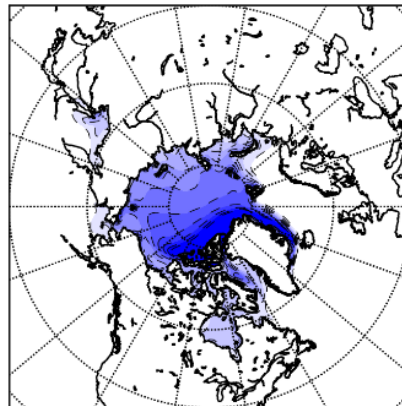
AGCM Experiments

Experiment	Prescribed Sea ice	Prescribed SST
CTL _{RCP}	RCP8.5 2027-2036	RCP8.5 2027-2036
I _{RCP}	RCP8.5 2057-2066	RCP8.5 2027-2036
I _{RCP} T _{SIL}	RCP8.5 2057-2066	RCP8.5 2027-2036 + “Sea Ice Loss” part of response from pattern scaling

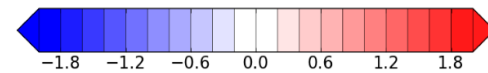
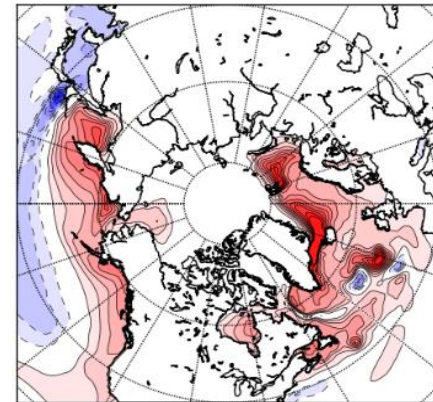
Δ SIC



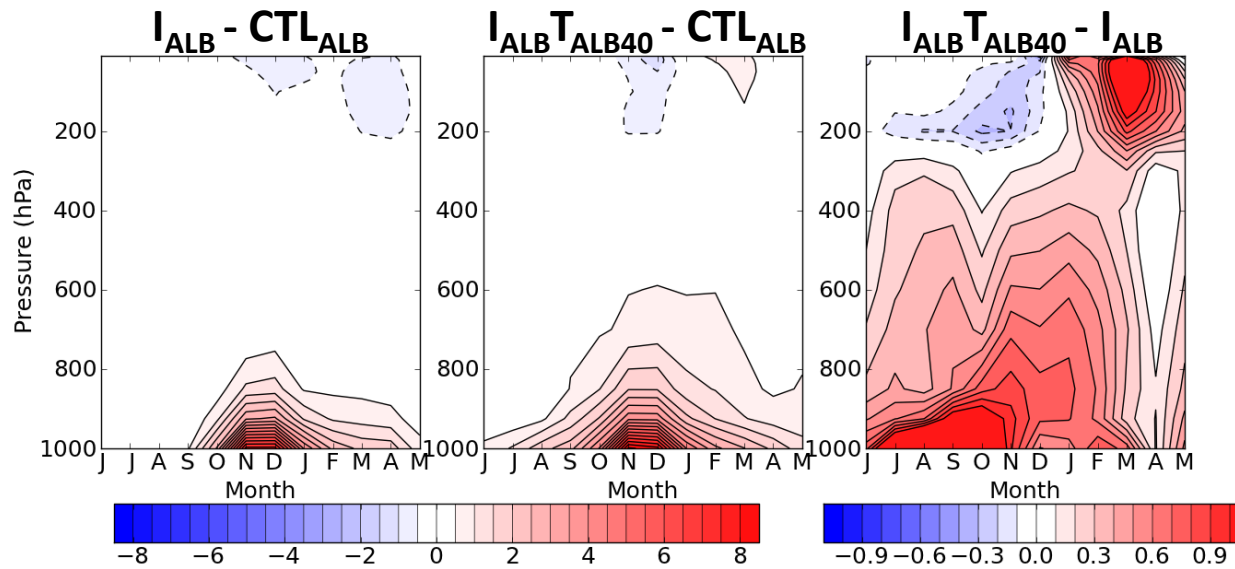
Δ SIT



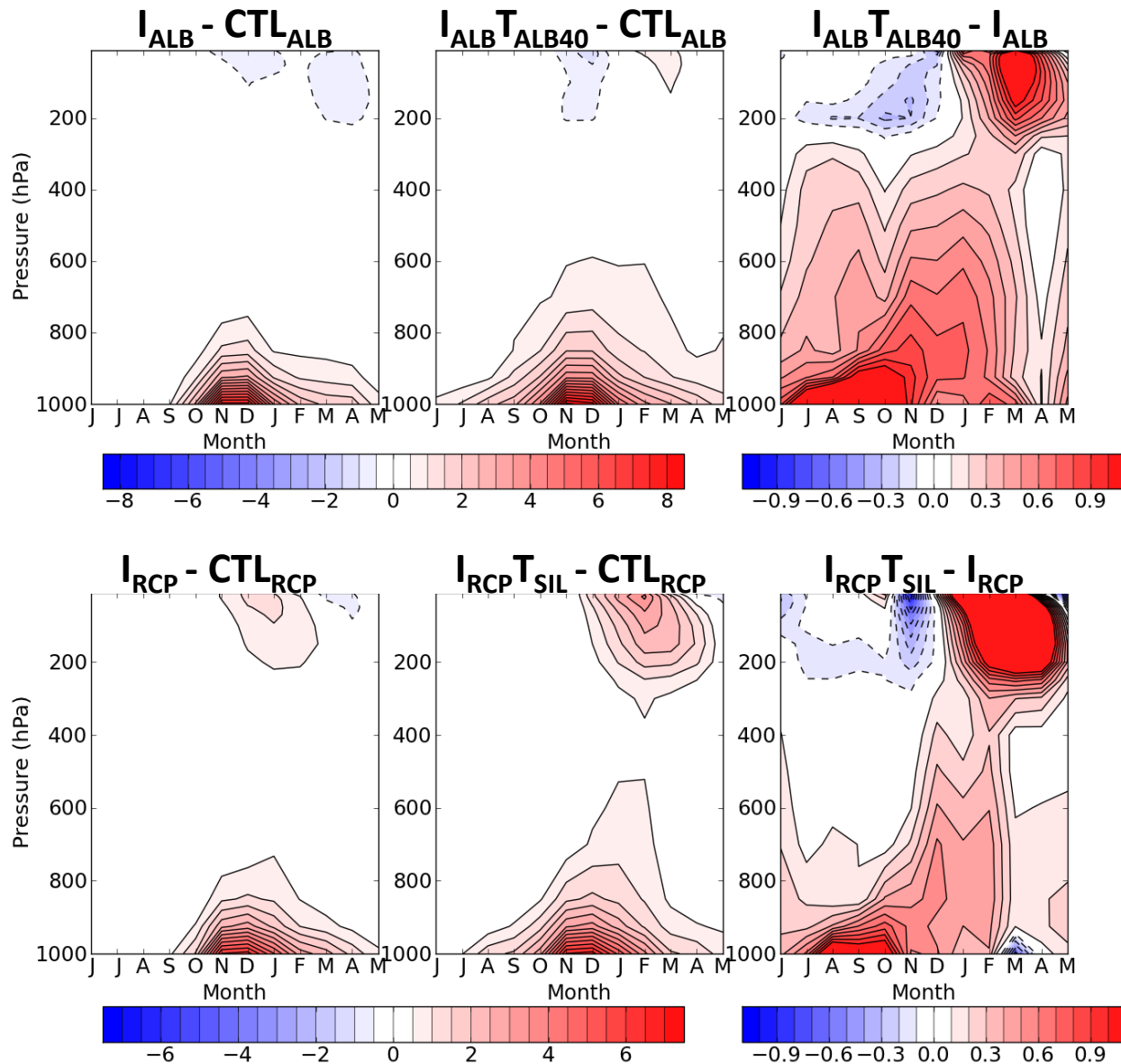
Δ SST



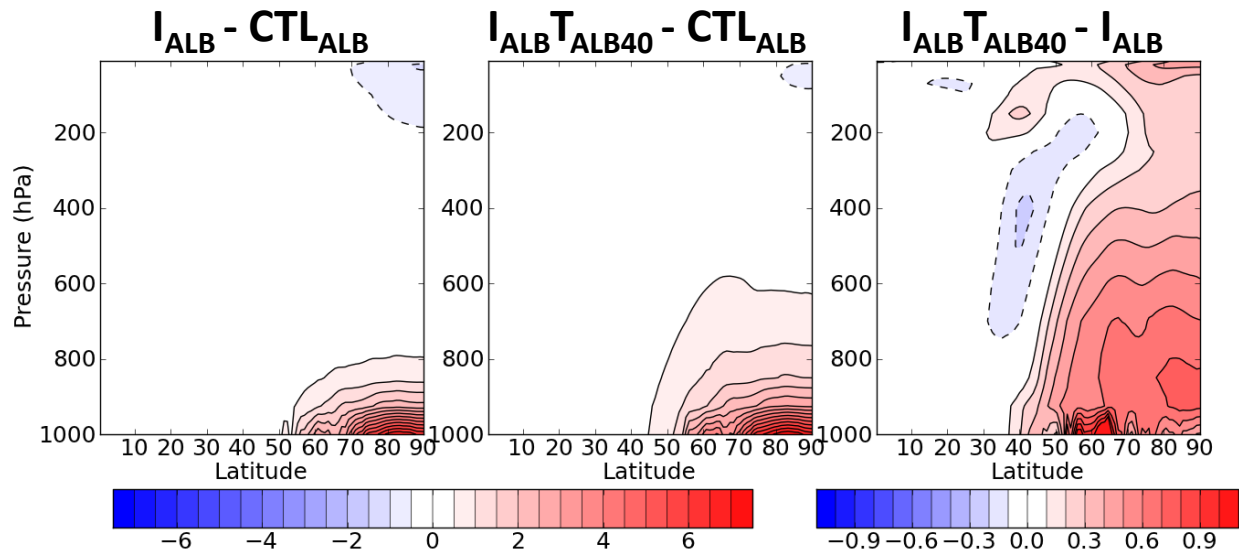
Polar Cap Temperature Response



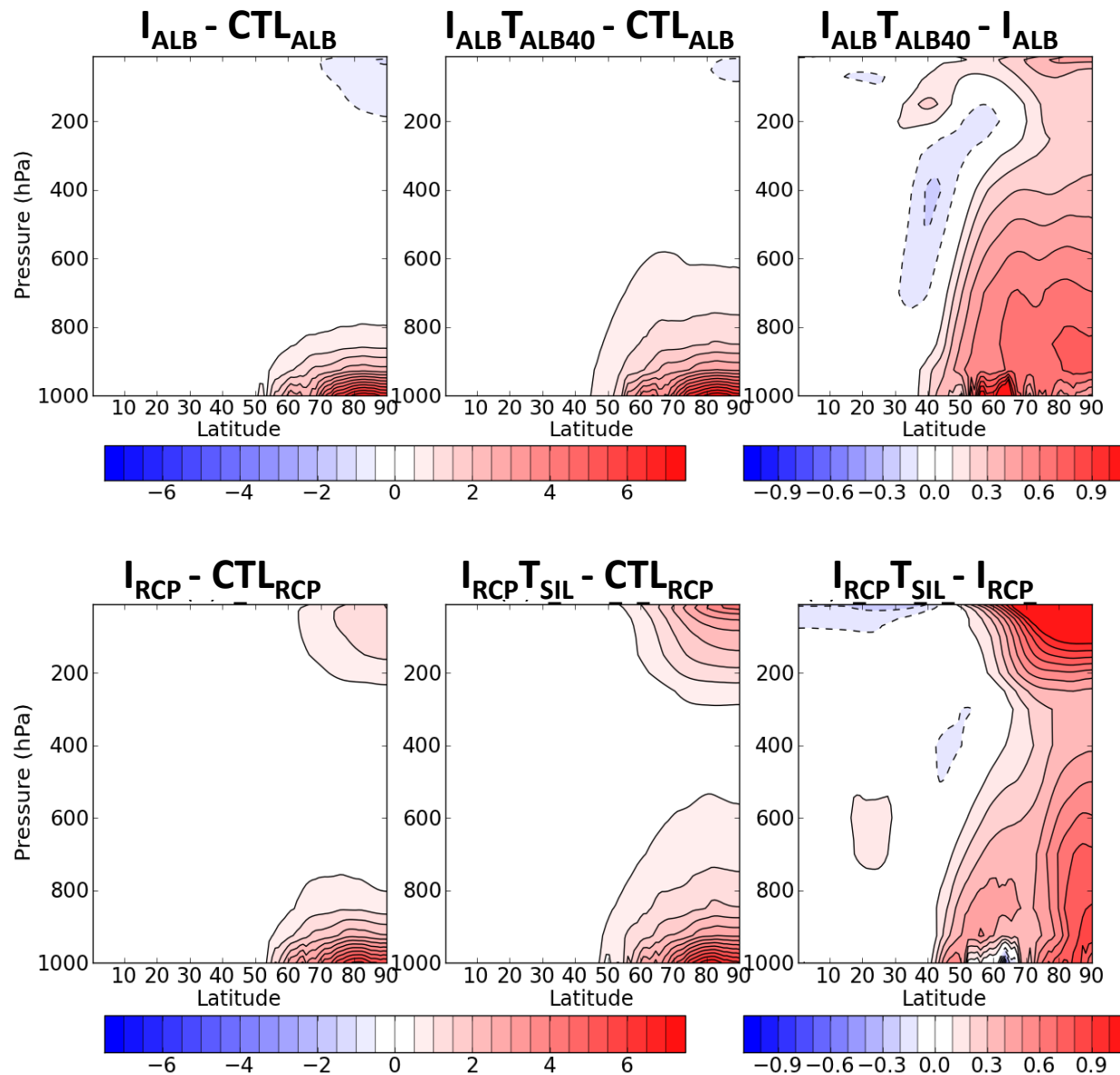
Polar Cap Temperature Response



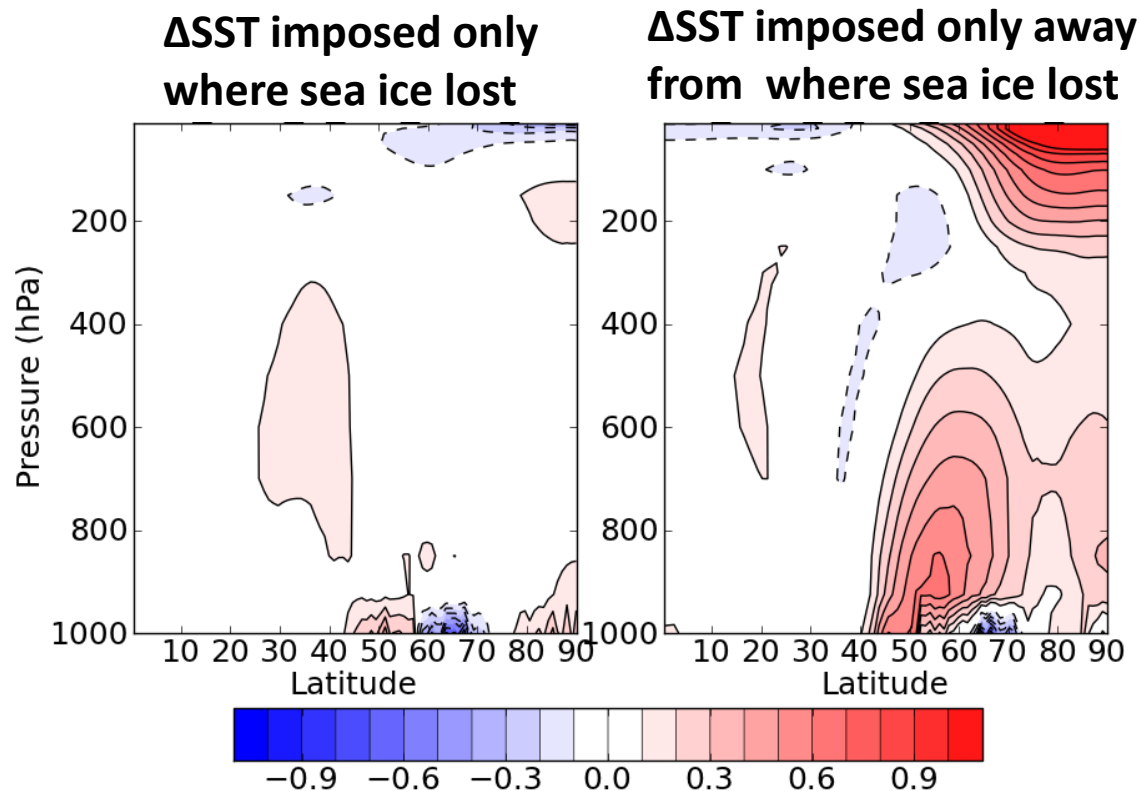
DJF Zonal Mean Temperature Response



DJF Zonal Mean Temperature Response

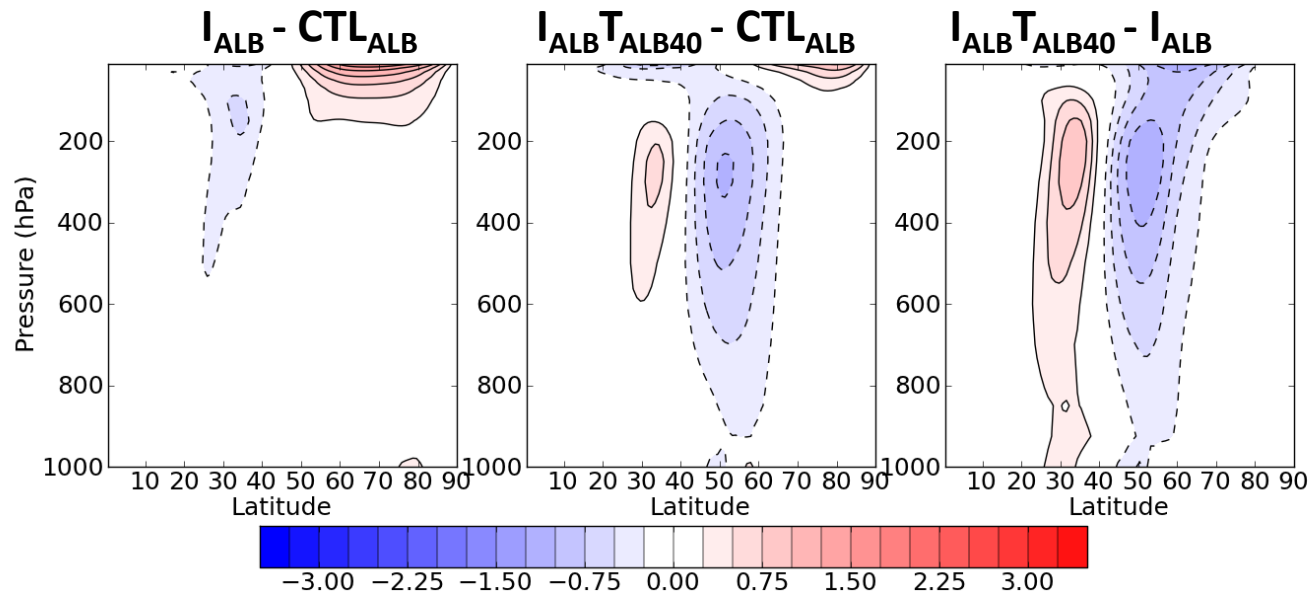


Local vs Remote SST

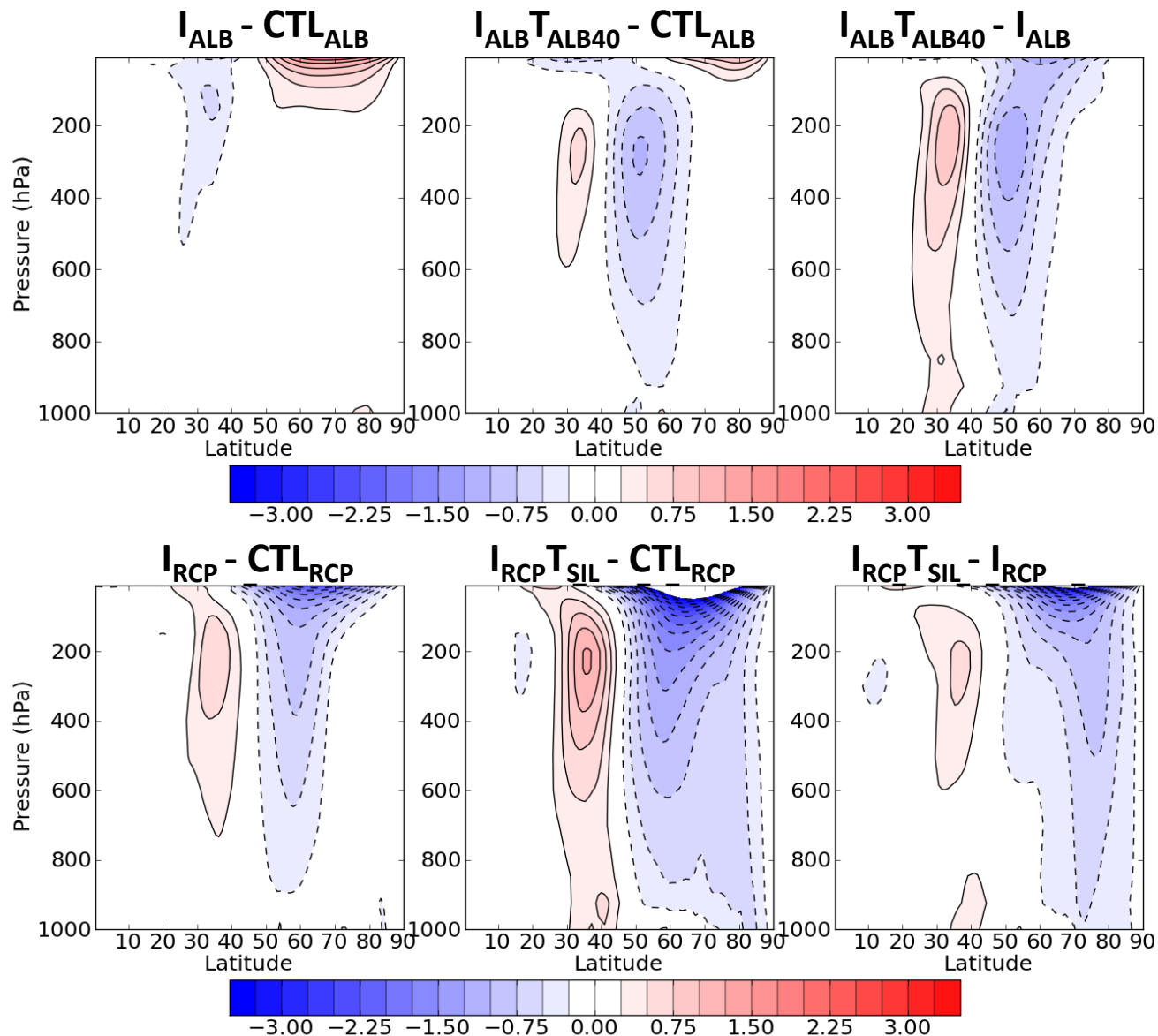


- SST imposed away from regions where sea ice is lost has biggest impact

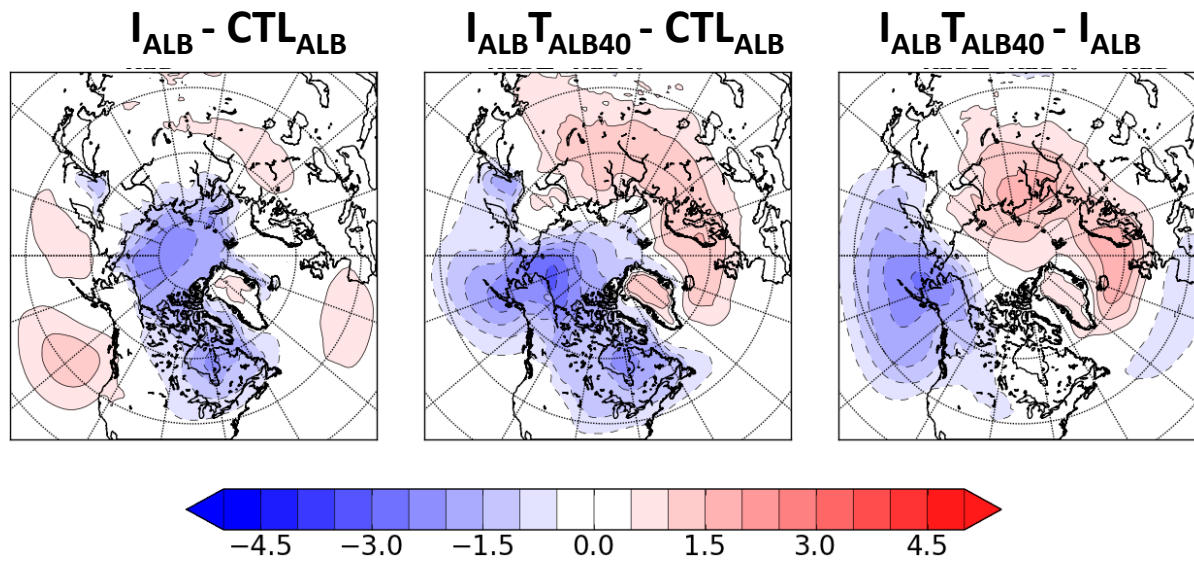
DJF Zonal Mean Wind Response



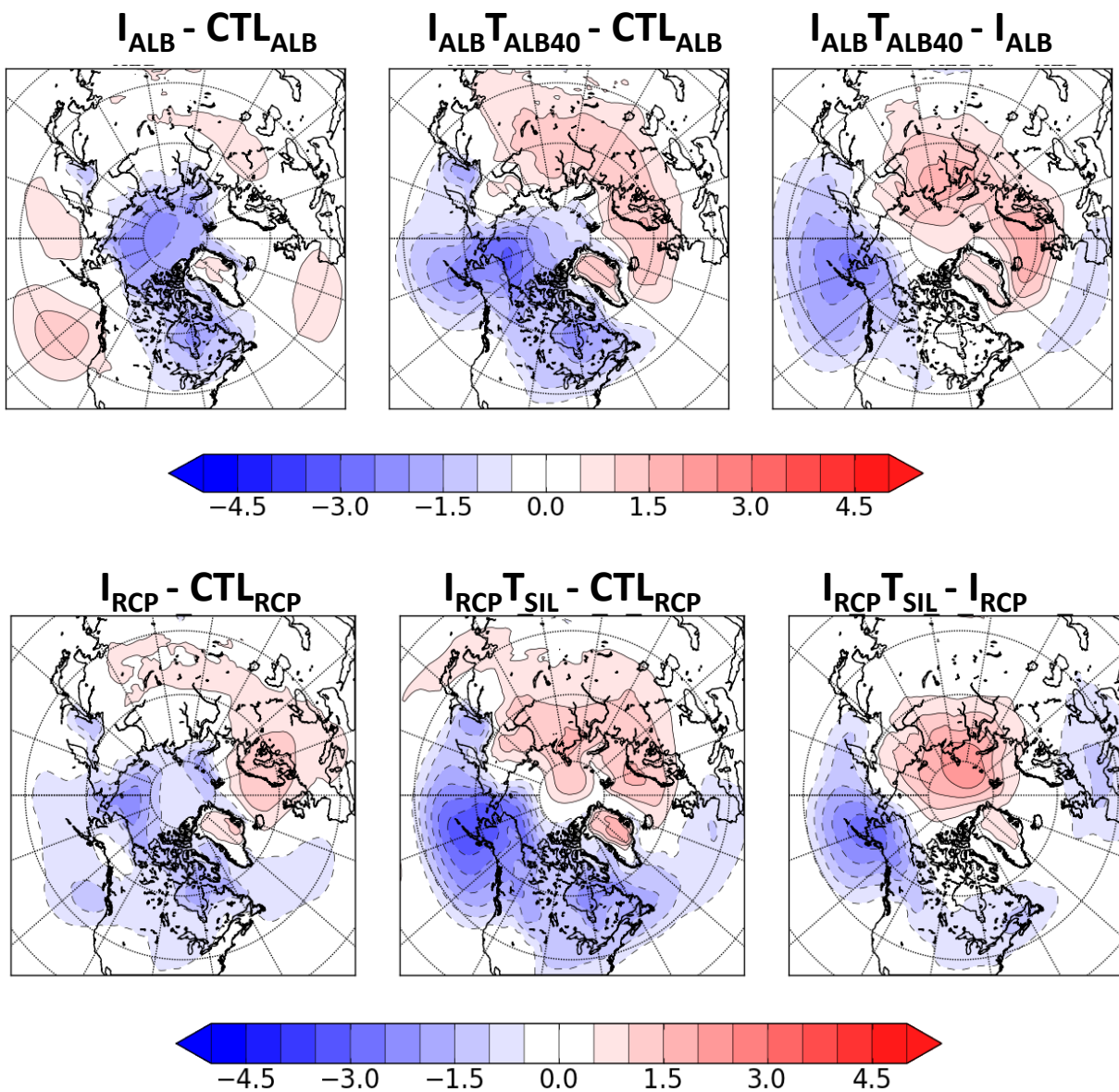
DJF Zonal Mean Wind Response



DJF SLP Response

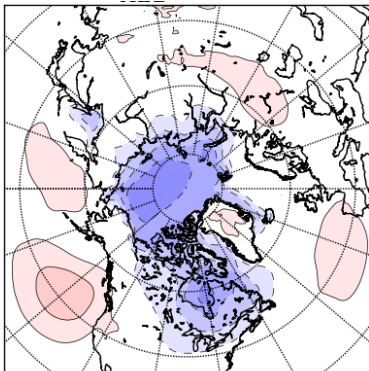


DJF SLP Response

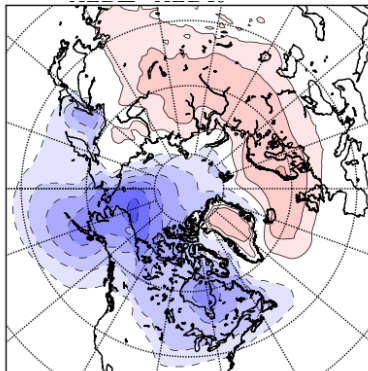


DJF SLP Response

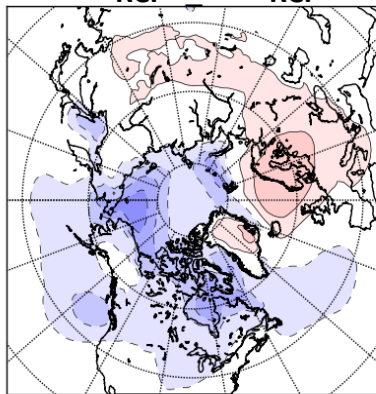
$I_{ALB} - CTL_{ALB}$



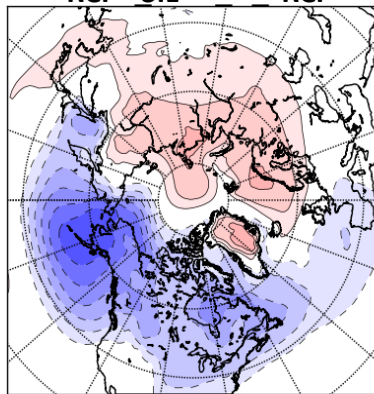
$I_{ALB} T_{ALB40} - CTL_{ALB}$



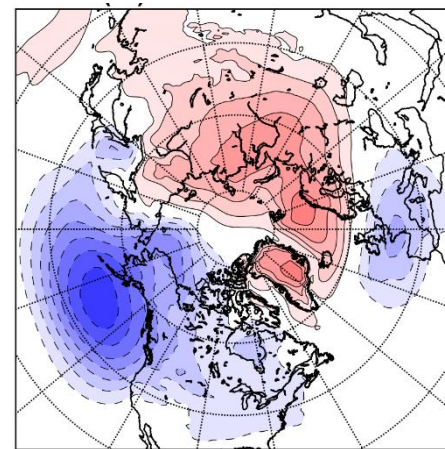
$I_{RCP} - CTL_{RCP}$



$I_{RCP} T_{SIL} - CTL_{RCP}$



Coupled model response



Conclusions

- Extratropical ocean warming from sea ice loss allows warming to spread into mid-latitudes and Arctic mid-troposphere
- This leads to stronger circulation response compared to response to only sea ice loss
- We need to use coupled models to examine atmospheric response to sea ice loss as AGCM experiments will underestimate response