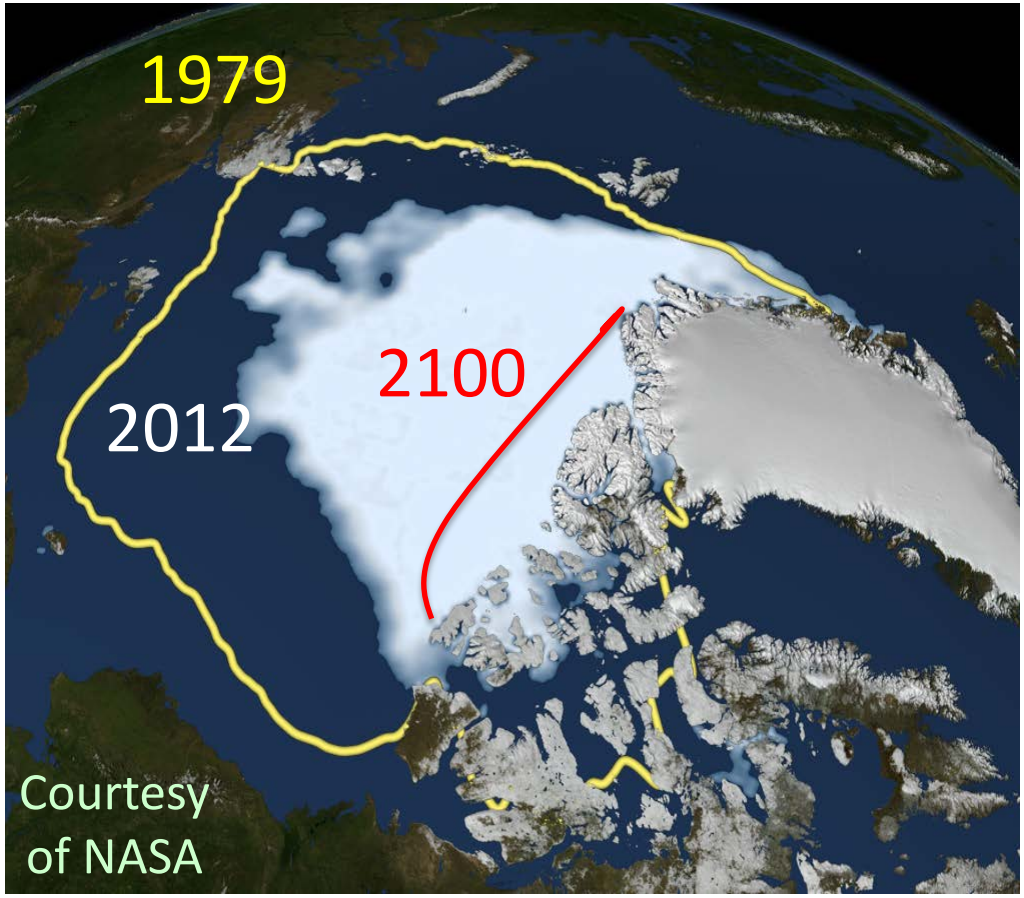
Global Climate Response to Future Arctic Sea Ice



The role of ocean-heat transport

Bob Tomas, Clara Deser & Lantao Sun, NCAR Feb. 2015

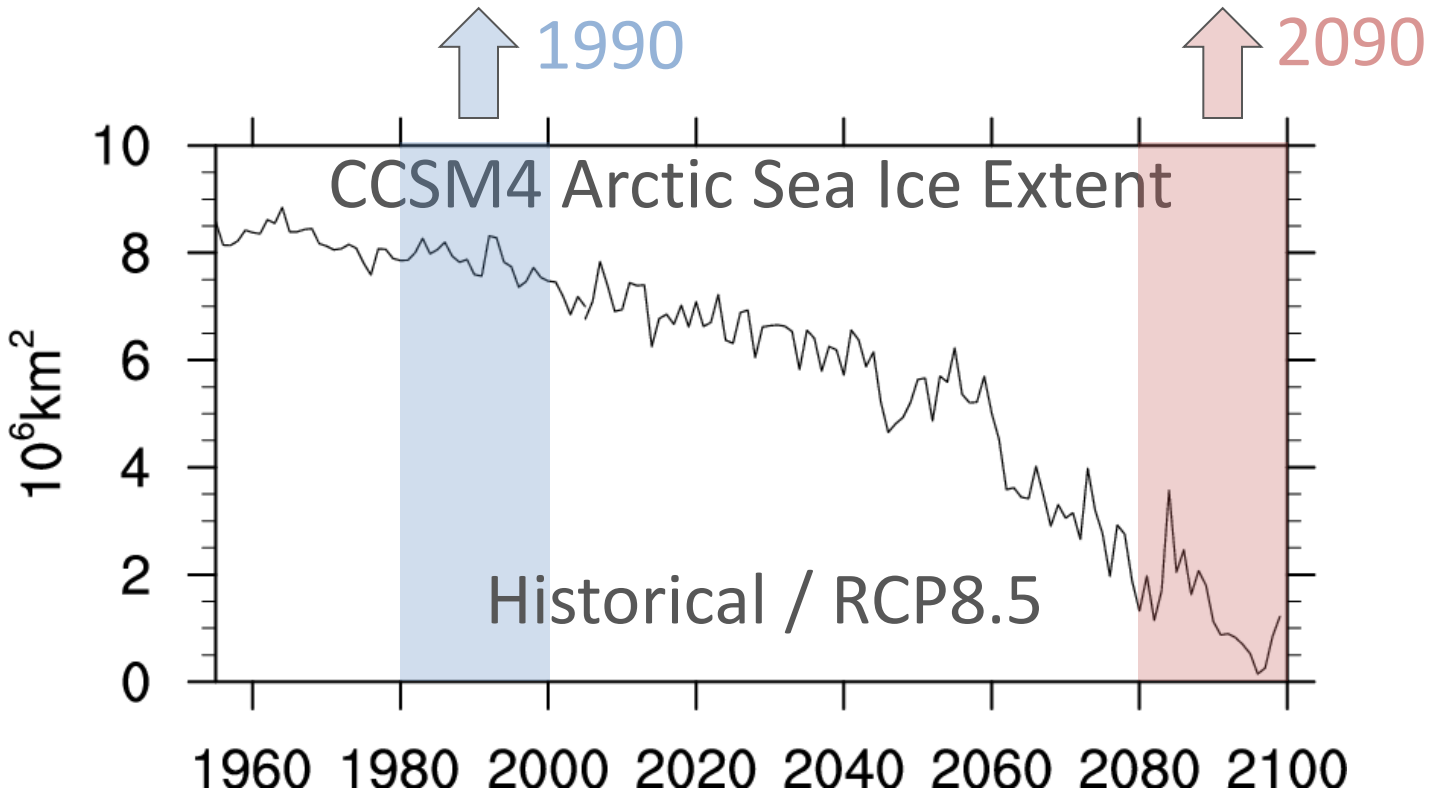
Model Experiments (CESM 1°)

Coupled dynamical ocean (POP)

Coupled slab ocean (SOM)

Atmosphere-Land only (AMIP)

Fix GHG at 1990 levels to isolate impact of Arctic sea ice loss

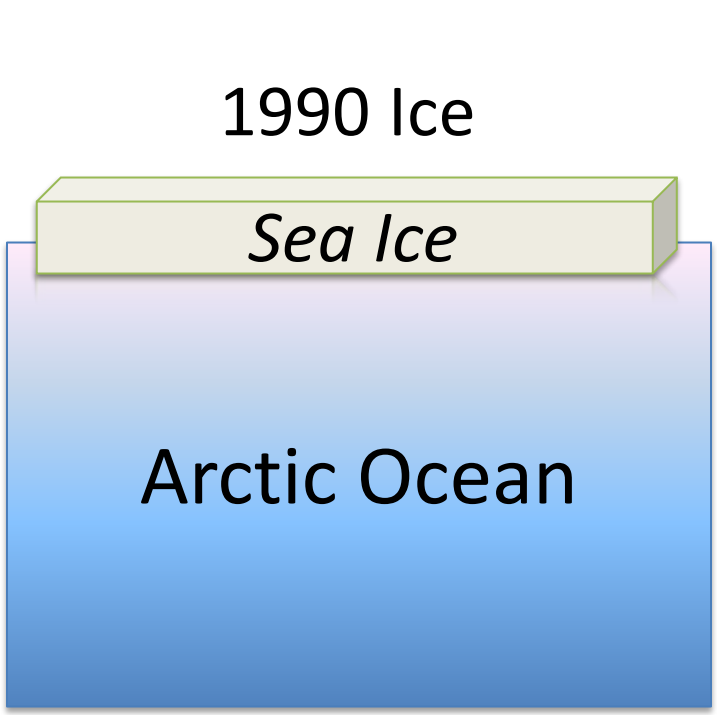


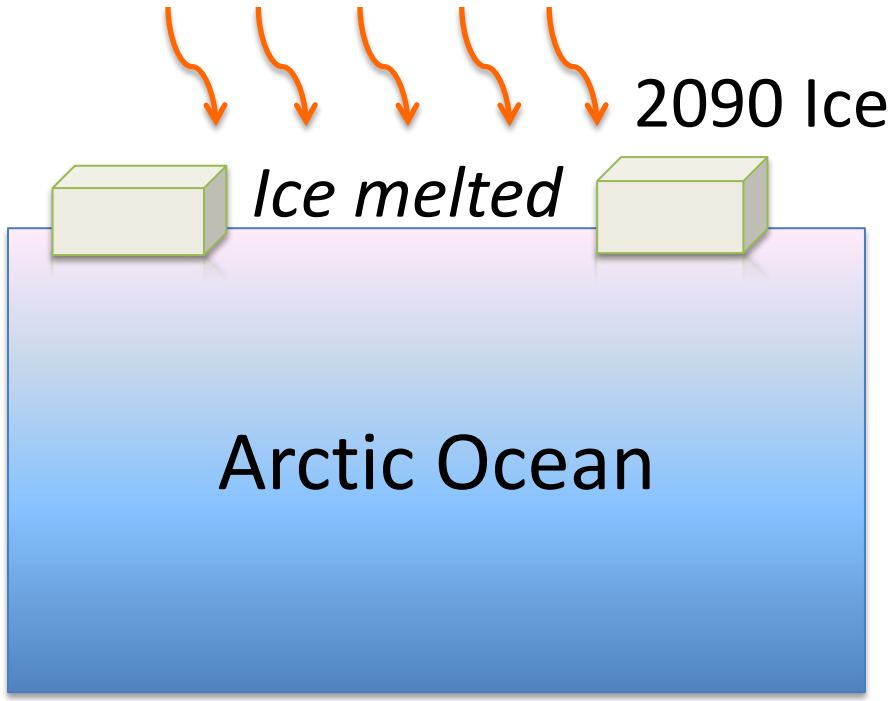
Artificially Control Ice

Only ice “sees” the extra long wave

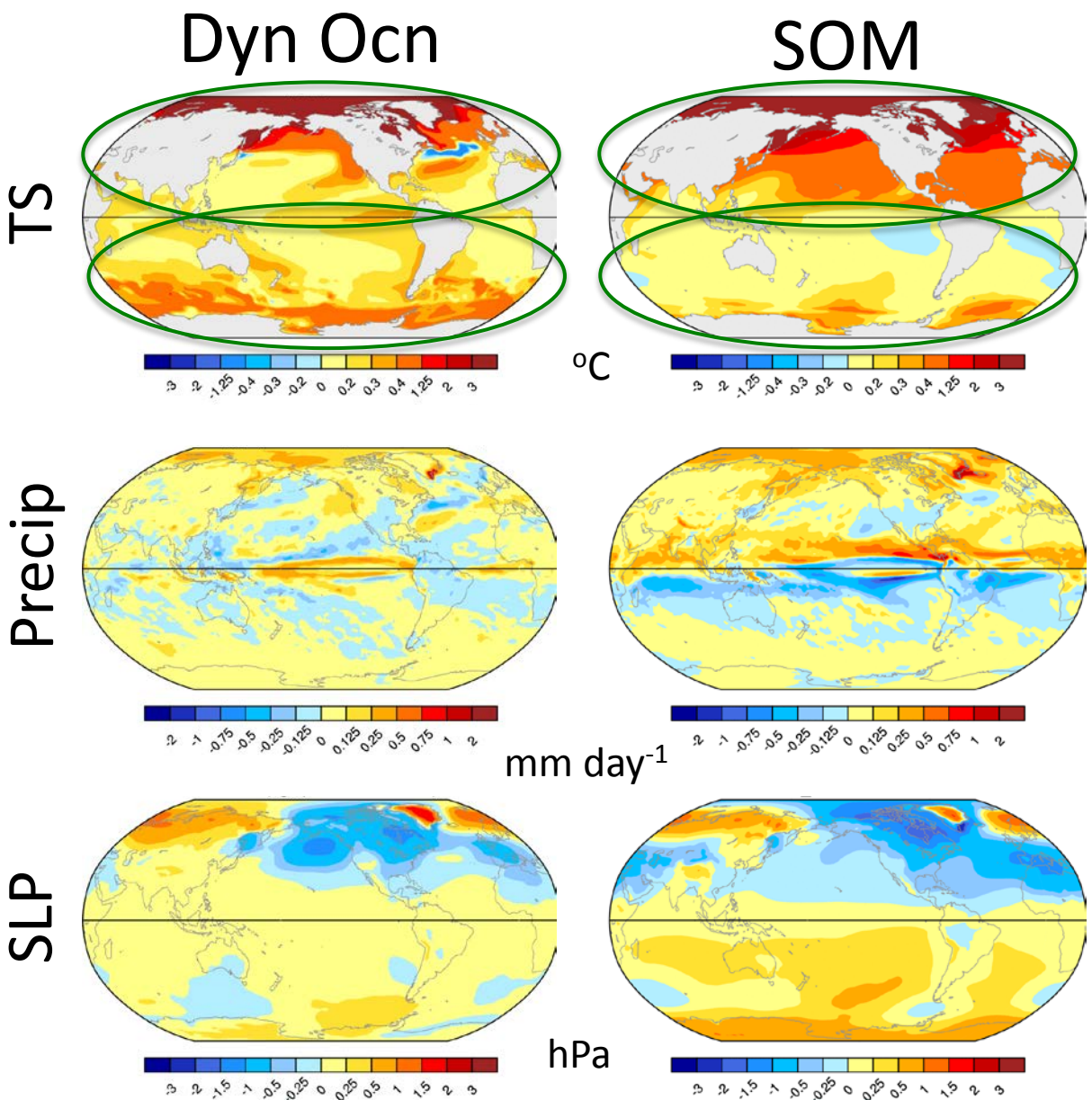
Want to remove some ice cover?

Add long wave radiation into ice model code





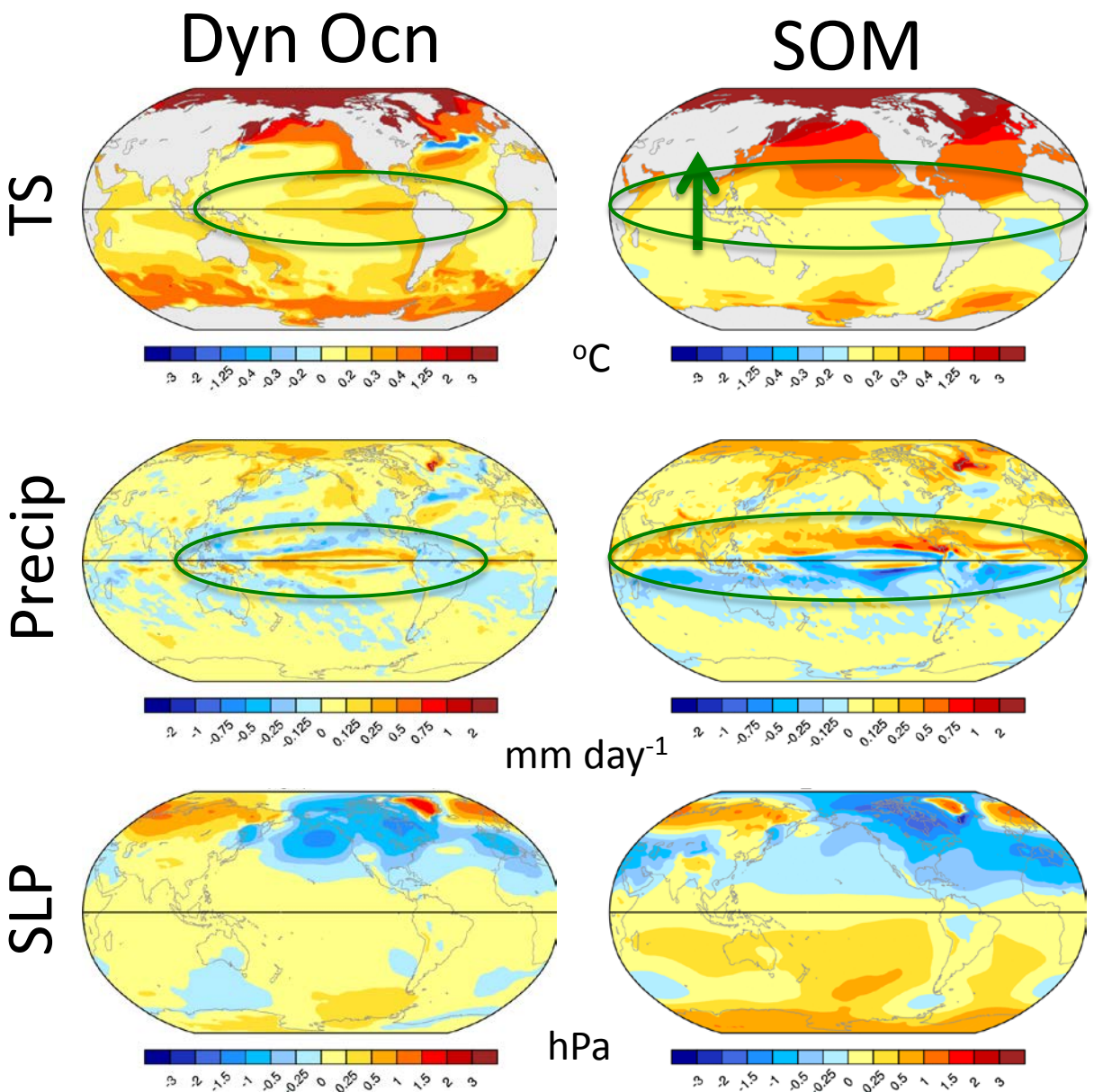
Annual Surface Response to Arctic Sea Ice Loss



Dynamical Ocean -> more symmetric global response

Slab Ocean-> more asymmetric global response

Annual Surface Response to Arctic Sea Ice Loss



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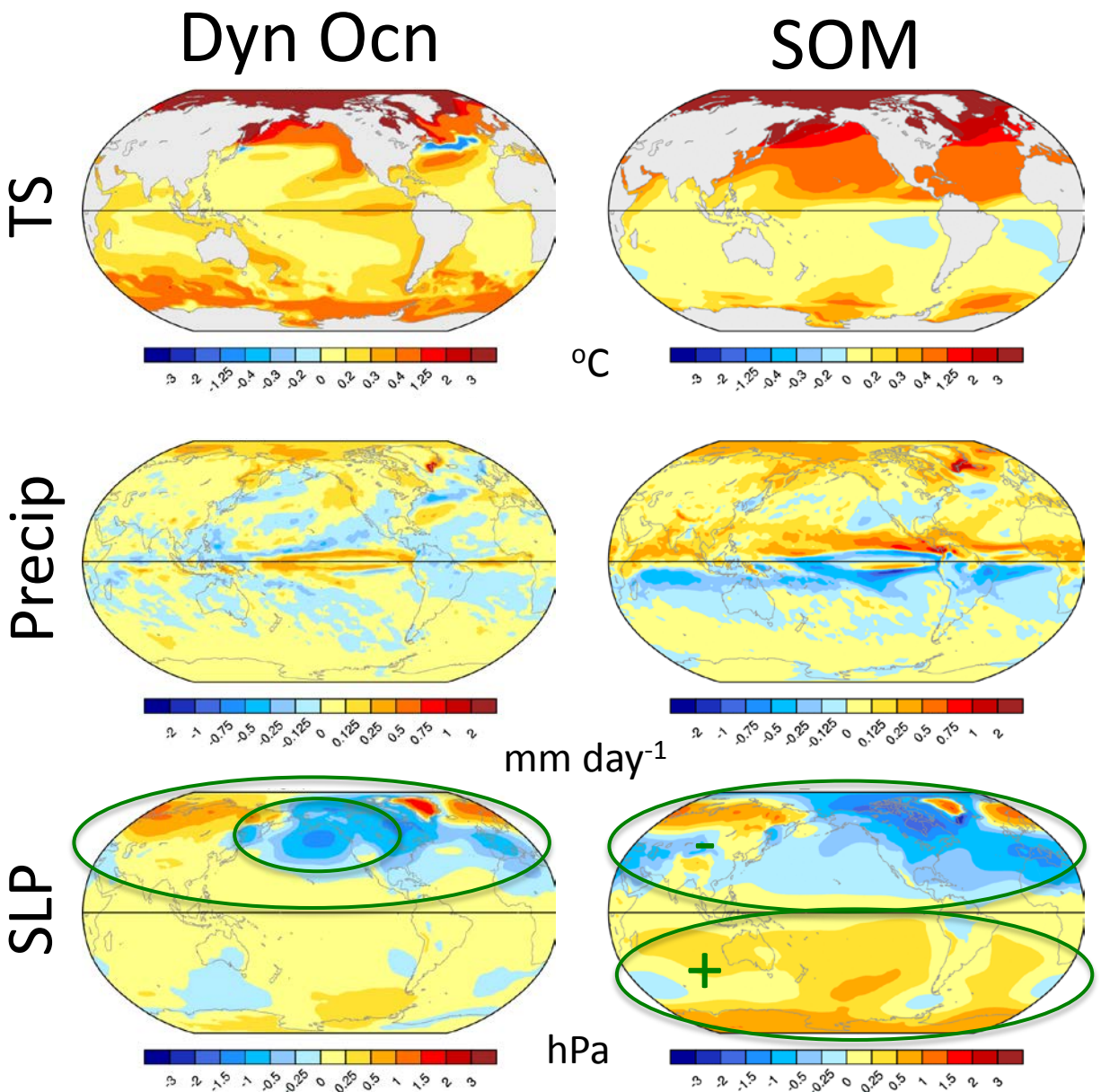

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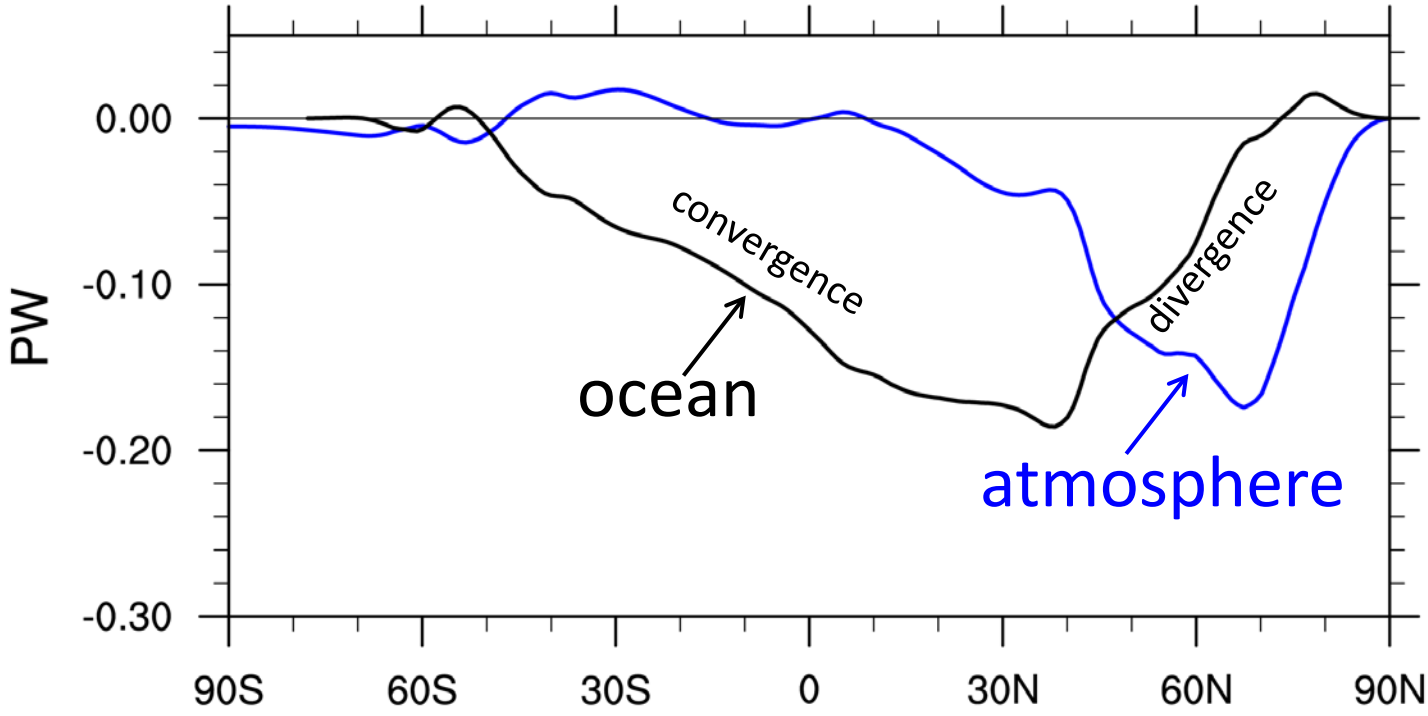
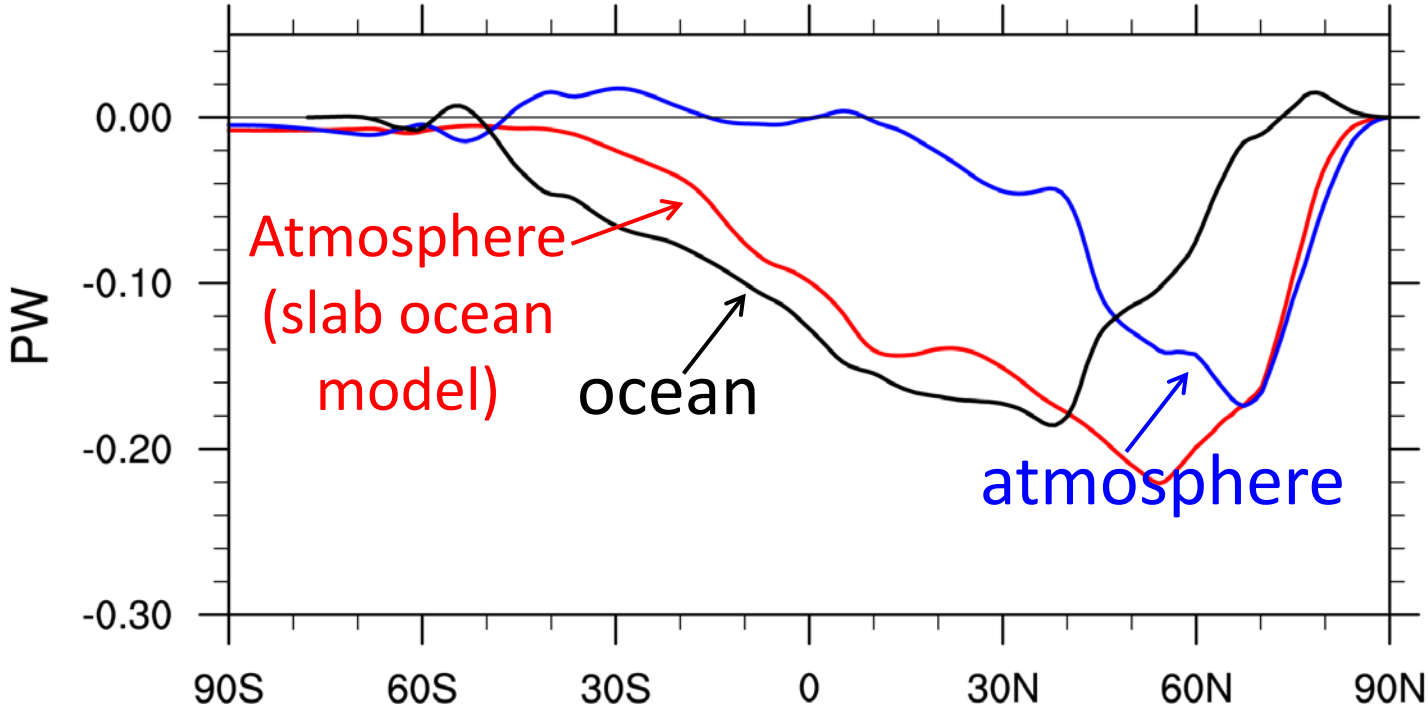
Northward Energy Transport: Response to Arctic Sea Ice Loss



Atmosphere brings heat to mid-latitudes

Ocean brings heat into the tropics and SH

Northward Energy Transport: Response to Arctic Sea Ice Loss



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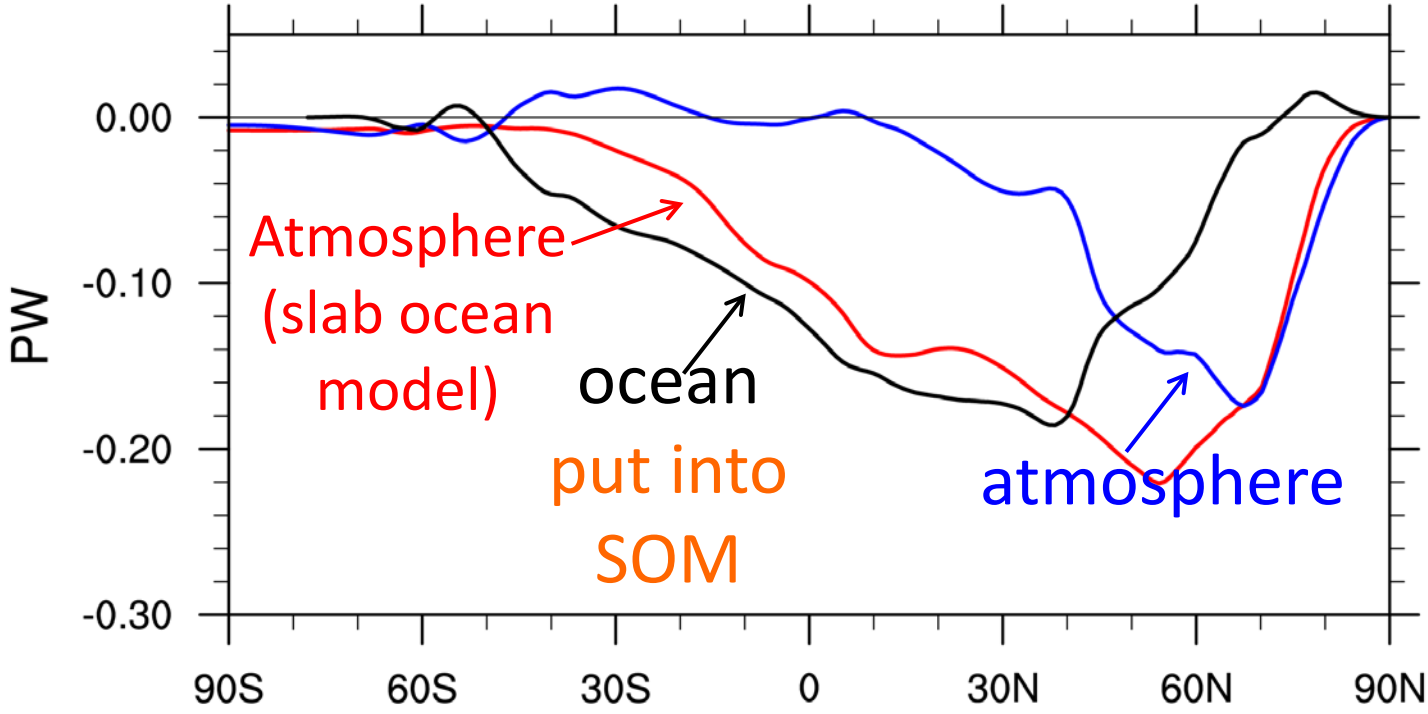
Slab ocean: atmosphere has to do all the work

Northward Energy Transport: Response to Arctic Sea Ice Loss



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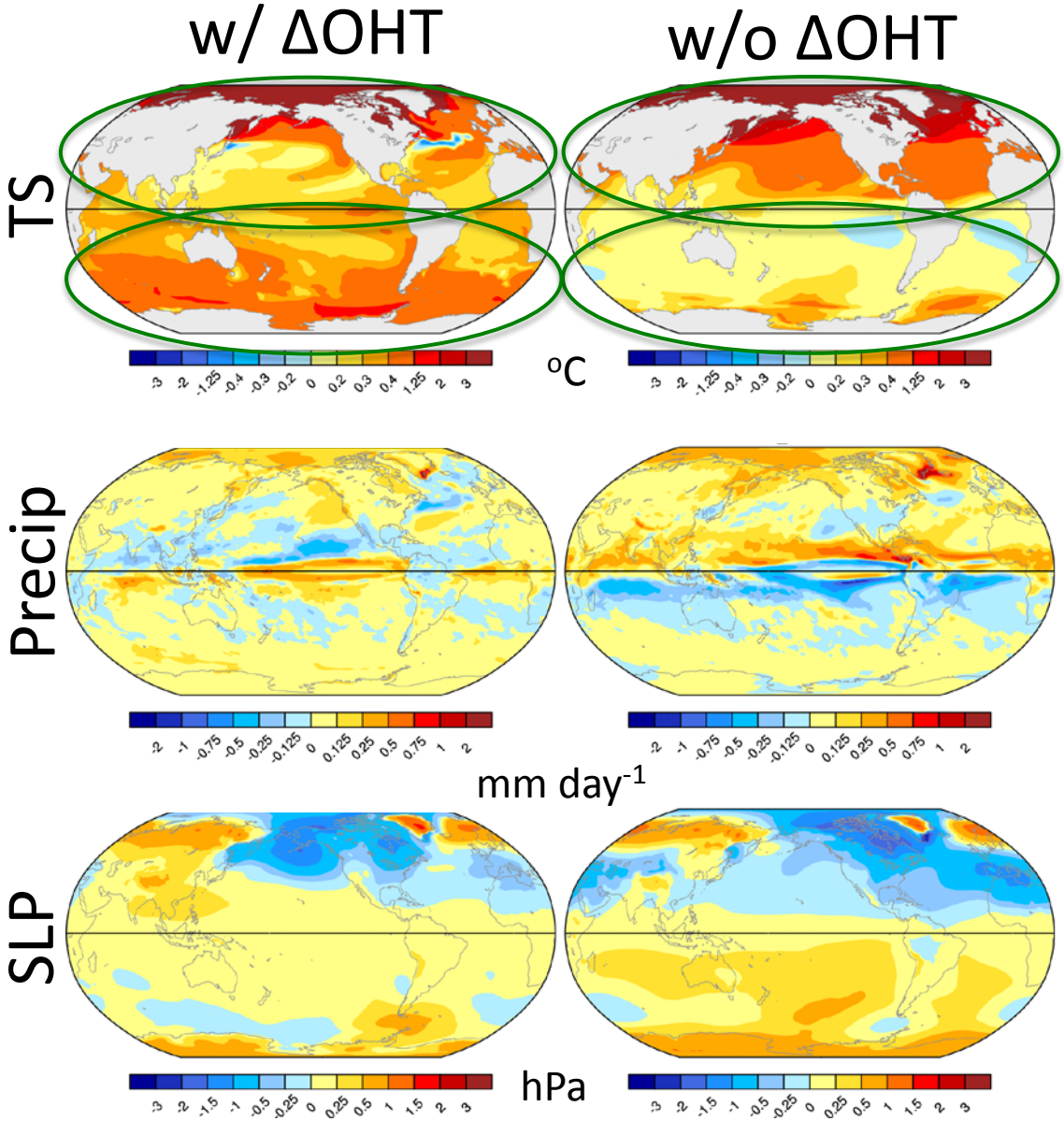
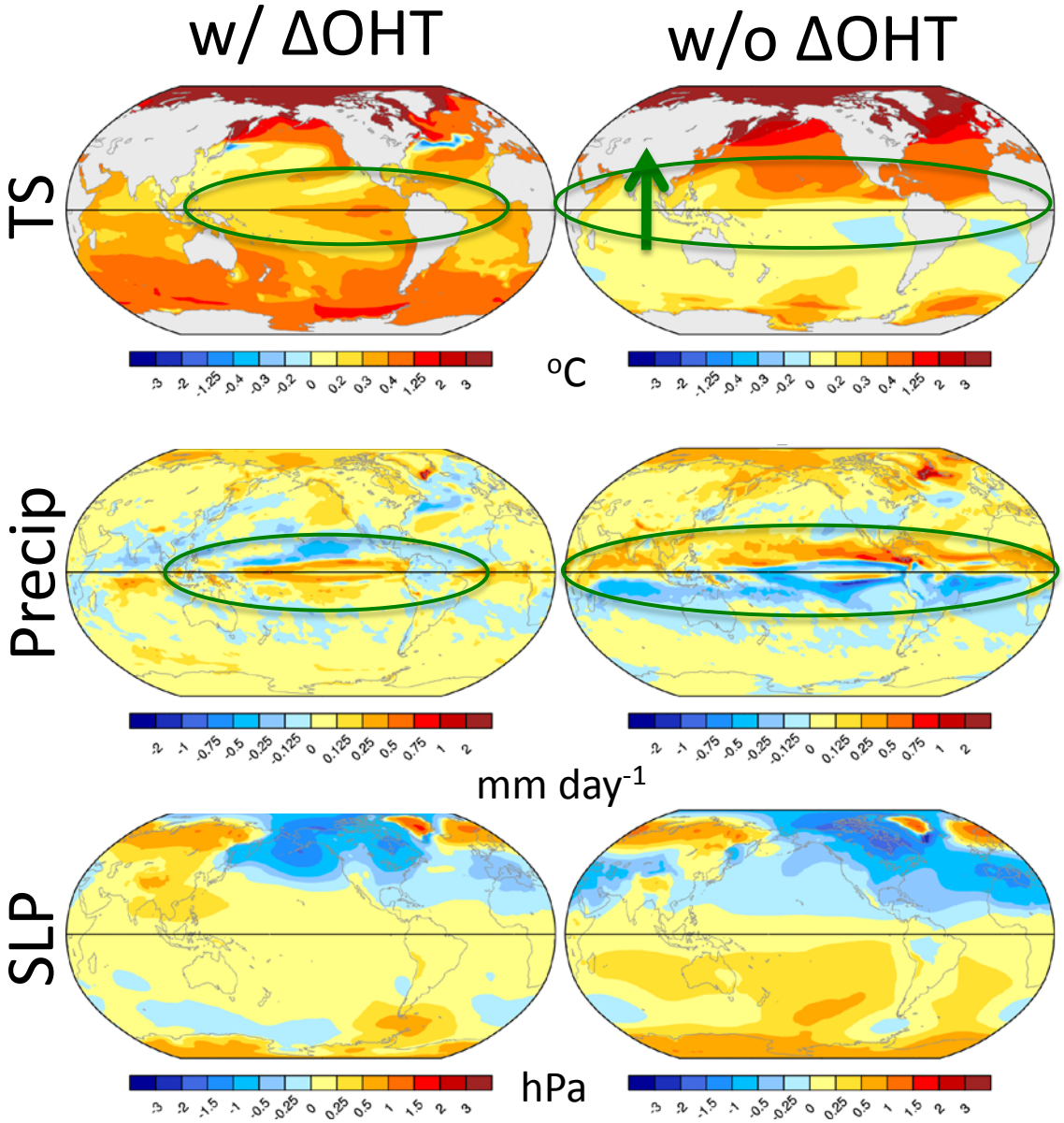
SOM Annual Surface Response to Arctic Sea Ice Loss



ΔOHT in fully coupled simulation explains symmetric global response

SOM Annual Surface Response to Arctic Sea Ice Loss



ΔOHT in fully coupled simulation explains symmetric global response

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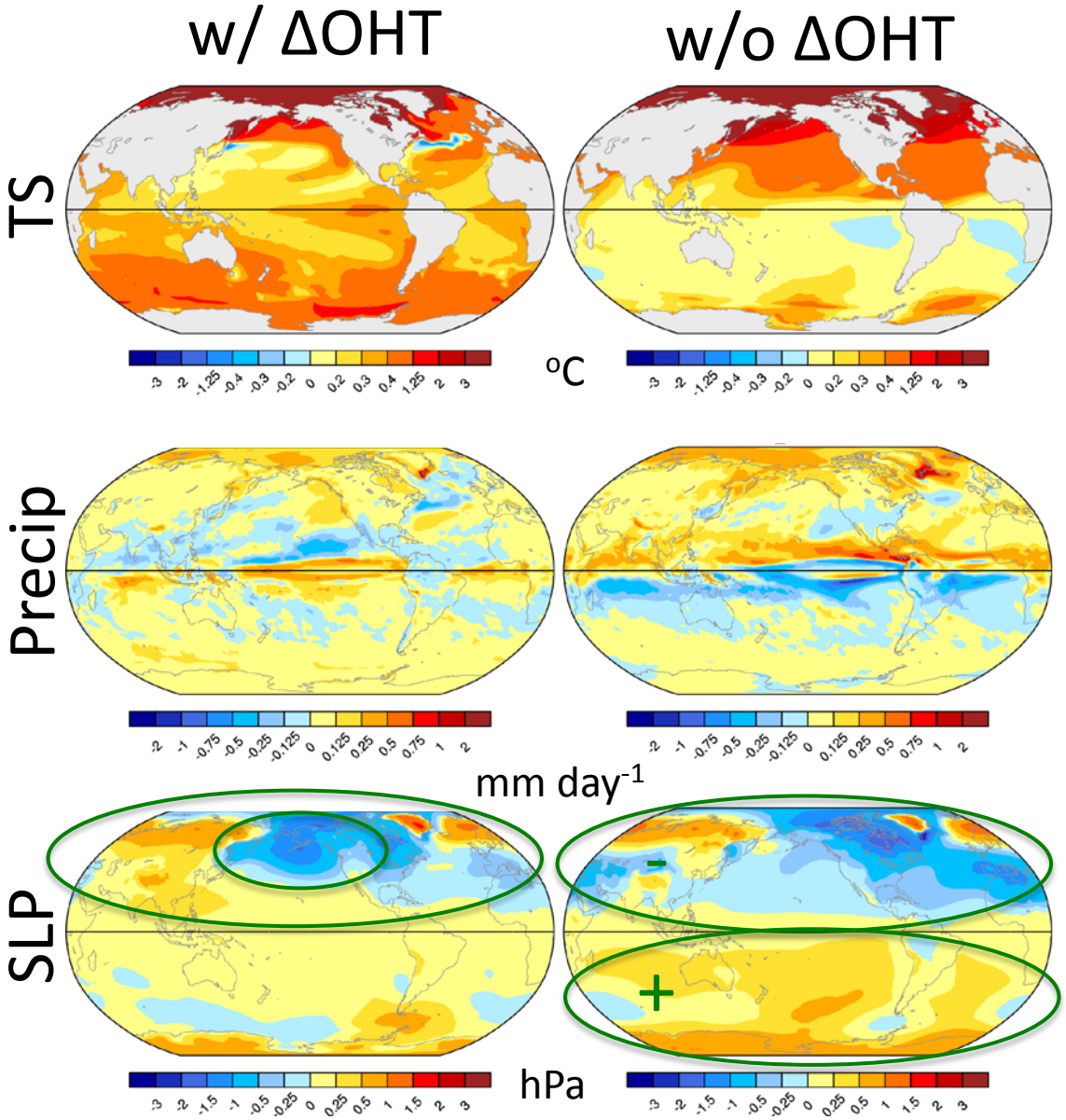

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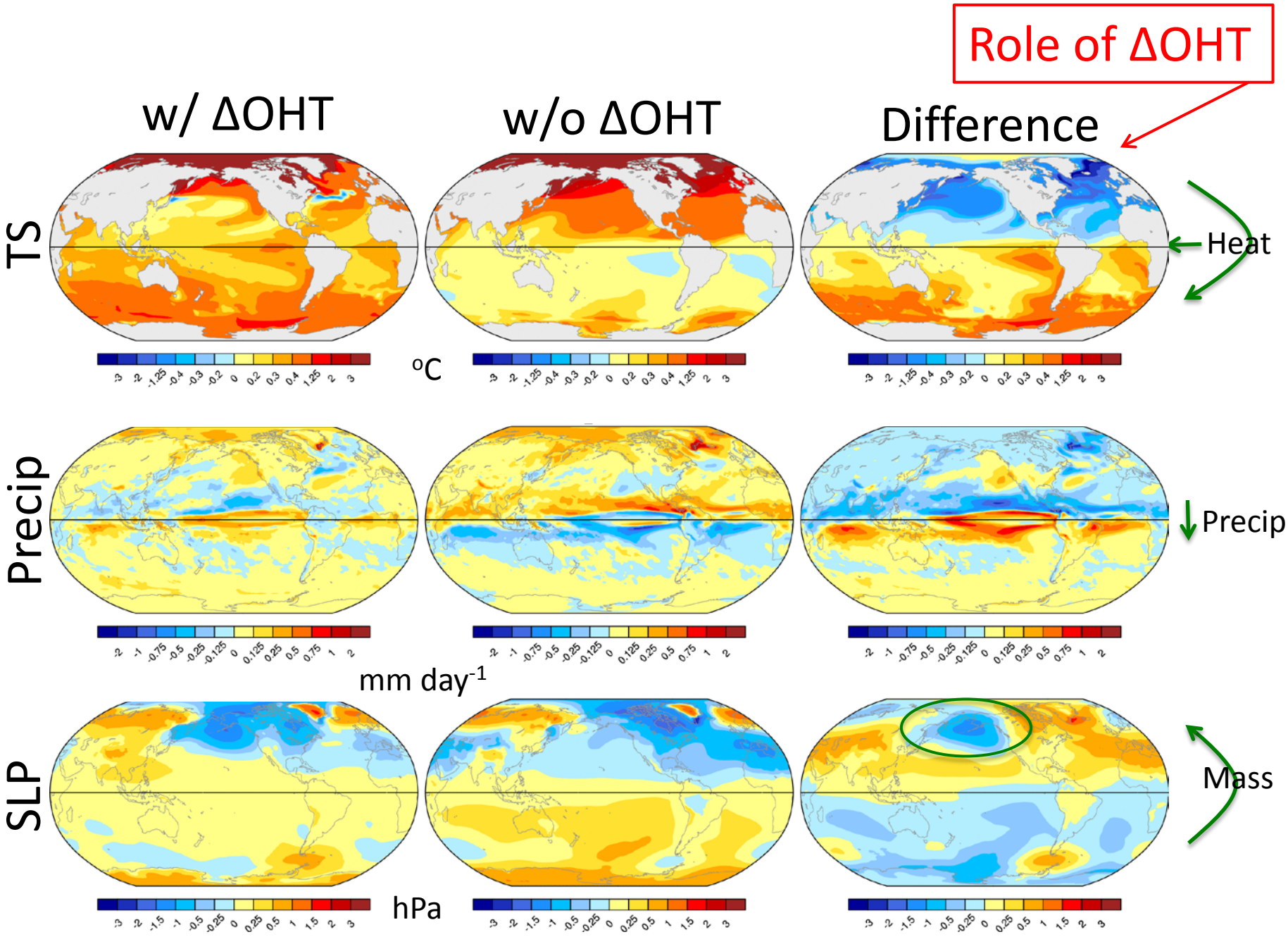
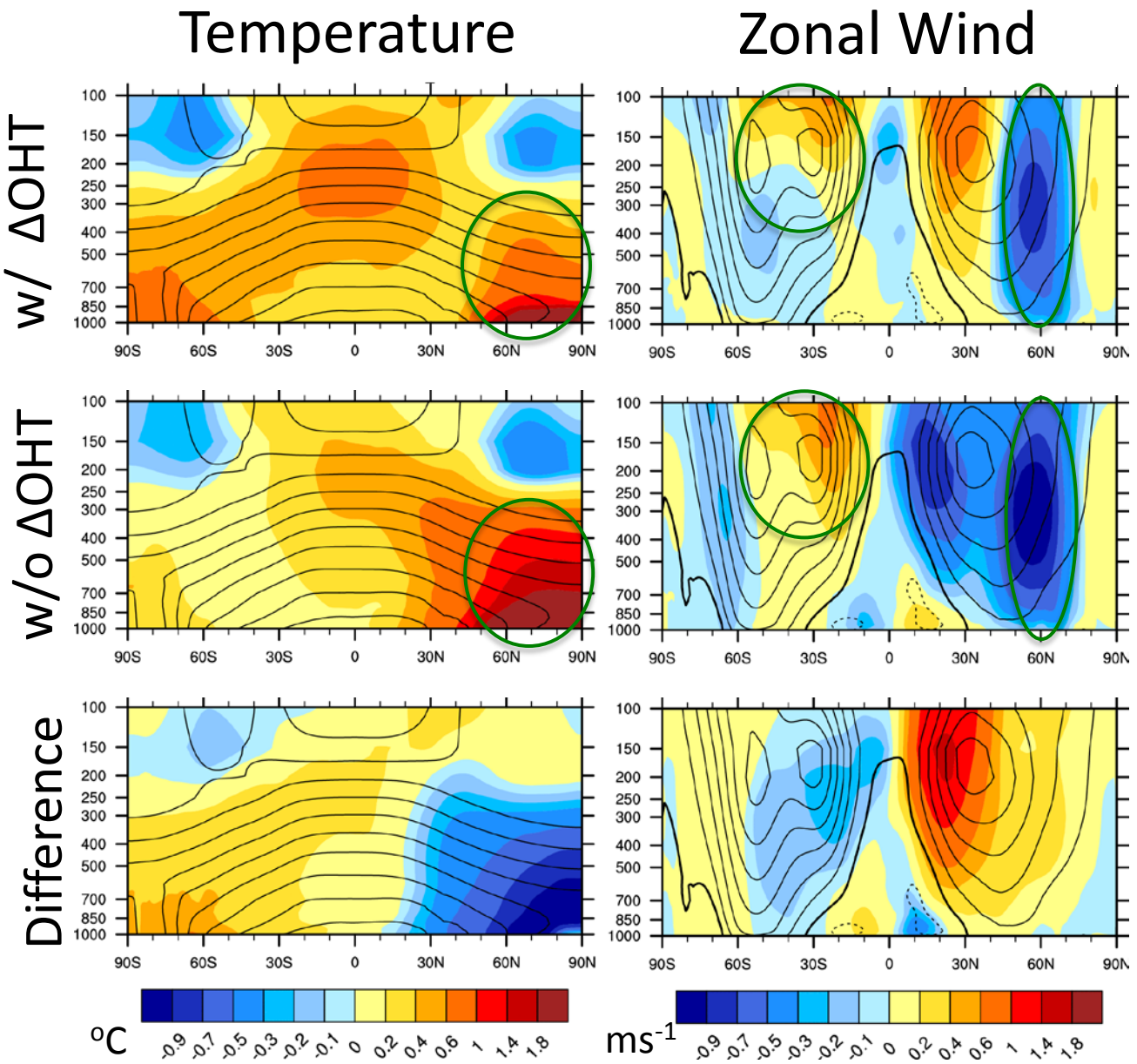


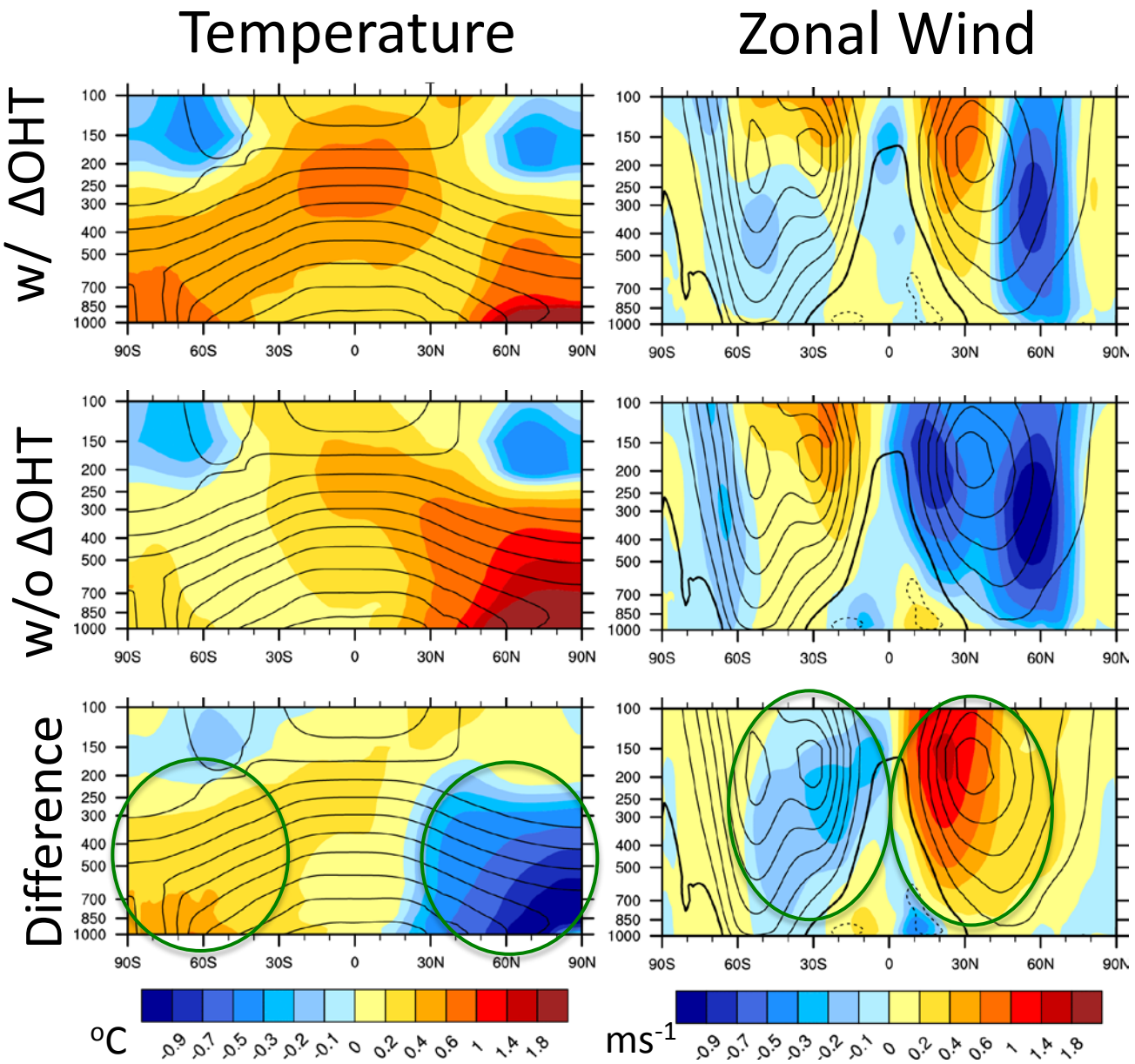
SOM Annual Zonal Mean Response to Arctic Sea Ice Loss



Some common features in troposphere response …

Role of ΔOHT

SOM Annual Zonal Mean Response to Arctic Sea Ice Loss

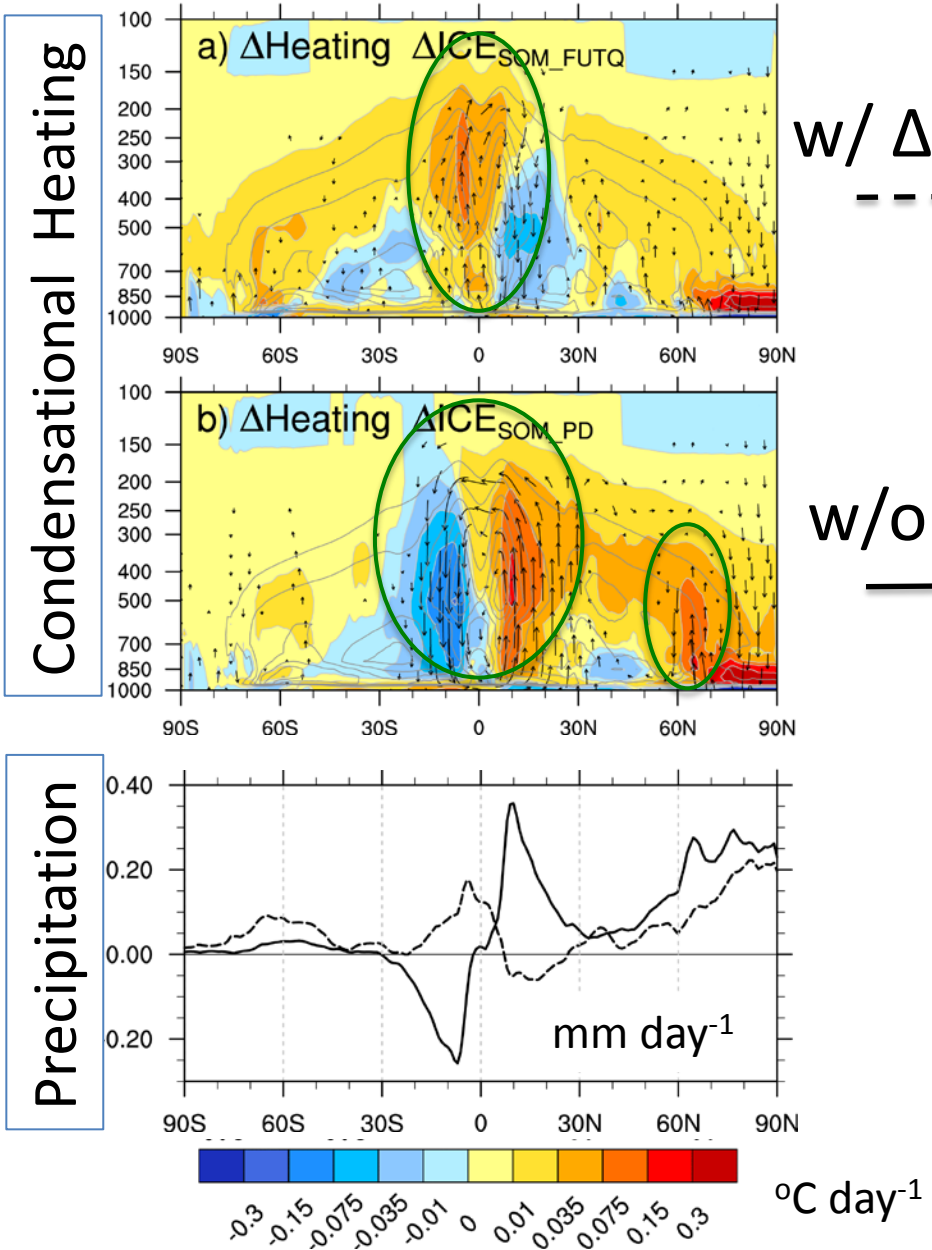


… also differences

ΔOHT impacts climate response throughout troposphere

Role of ΔOHT

SOM Annual Zonal Mean Response to Arctic Sea Ice Loss



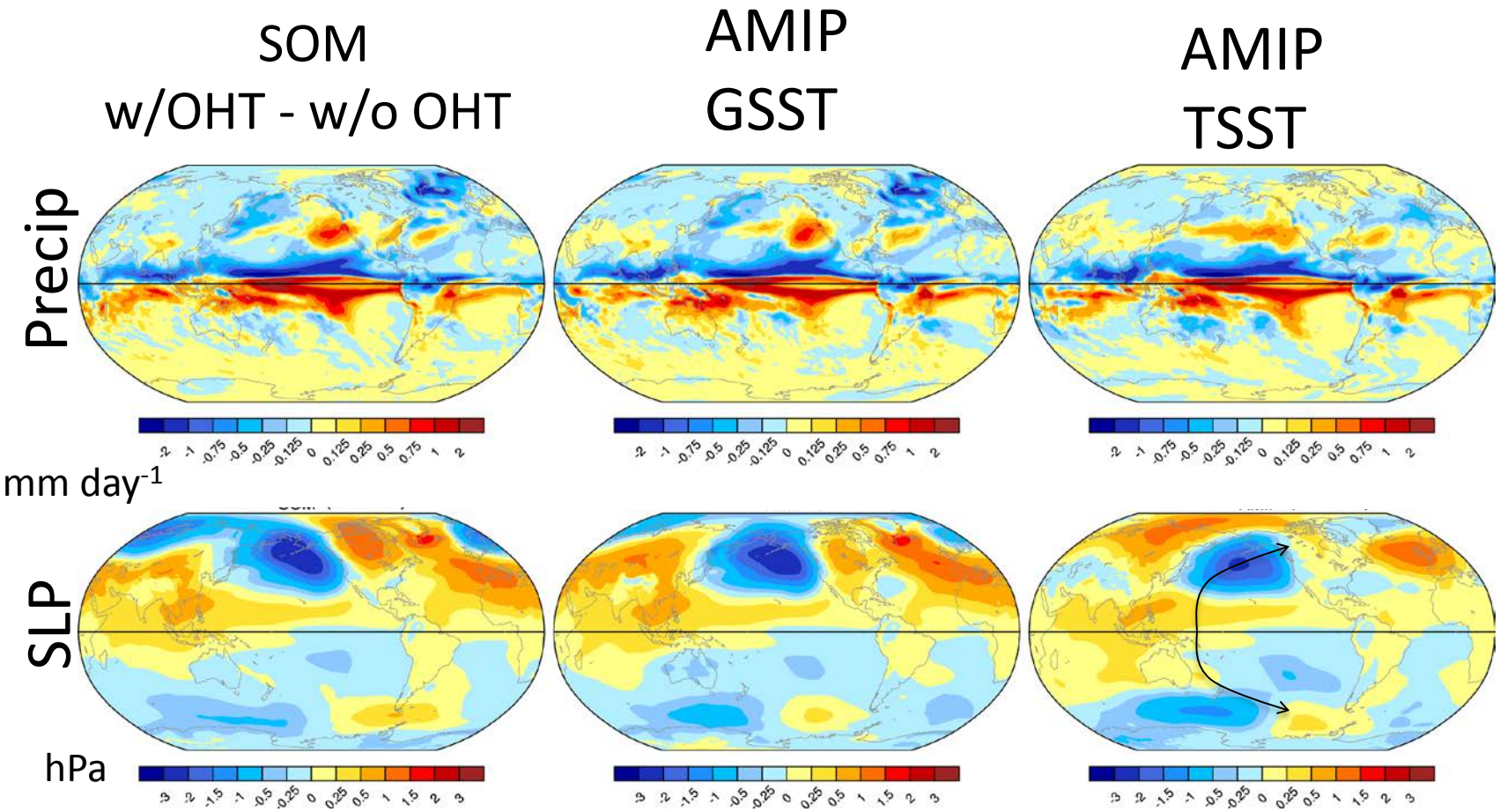
w/ ΔOHT

w/o ΔOHT

w/ ΔOHT: precip. increases slightly equatorward & above clim. maxima

w/o ΔOHT: ITCZ "shifts" into NH - transports energy from NH -> SH

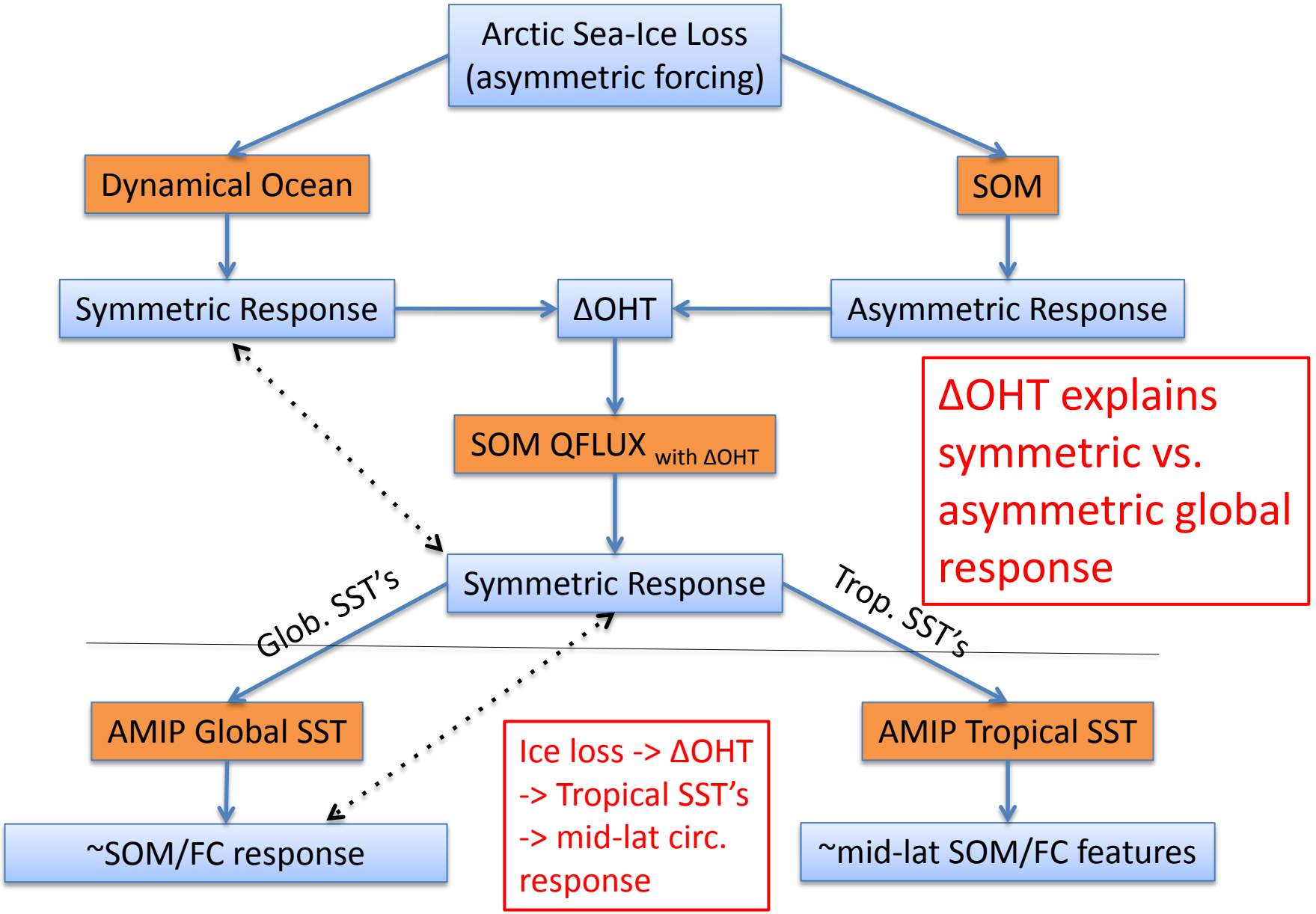
SOM & AMIP DJF Mean Surface Response to SST's



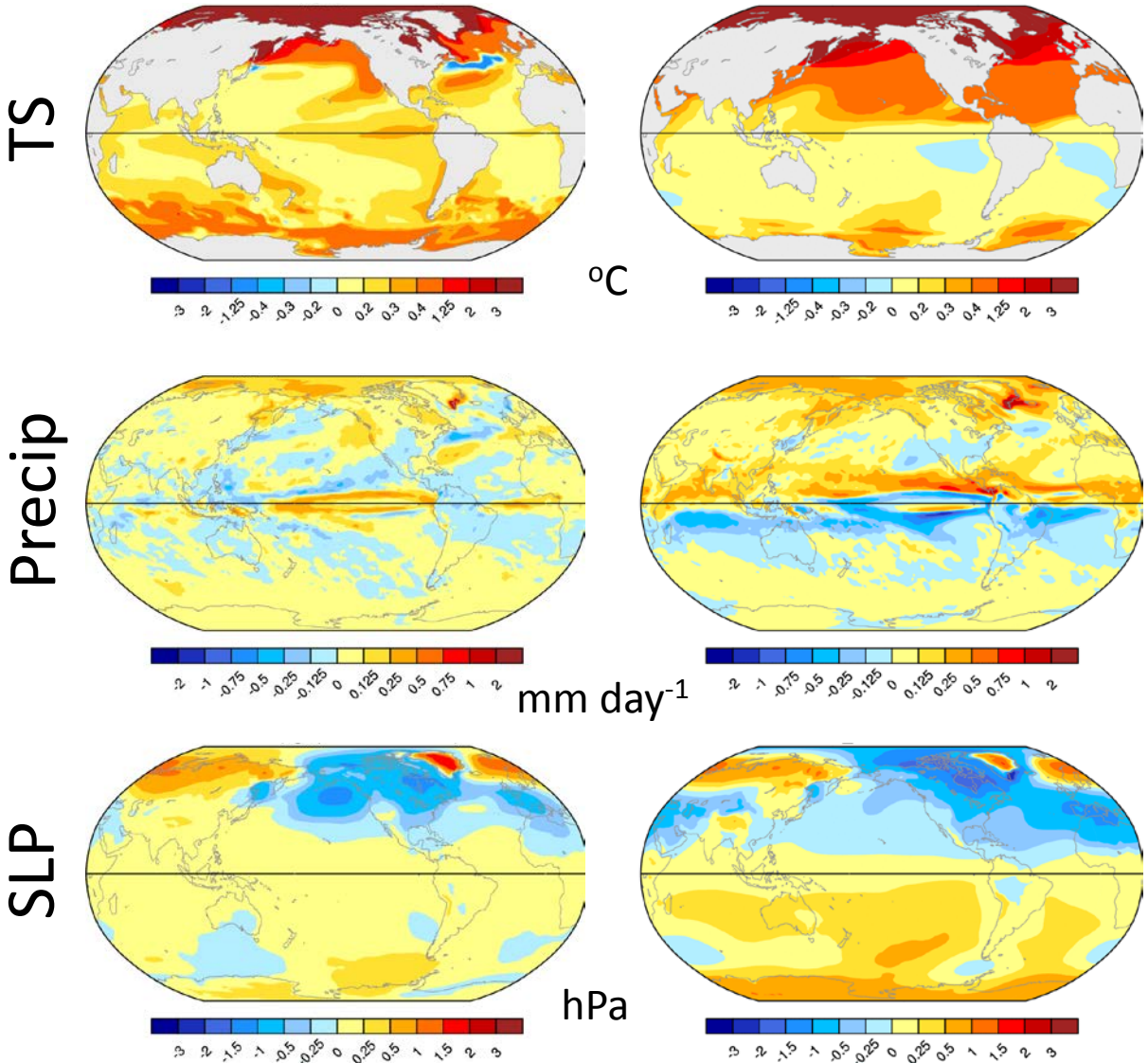
Ice loss -> ΔOHT -> ΔTropical SST's -> mid-lat. circulation response

Role of Tropical SST's

Summary and Conclusions (1)



Summary and Conclusions (2)



Are there *broader implications* for other studies that examine the response to asymmetric forcings and use a slab ocean model?

Extra Slides

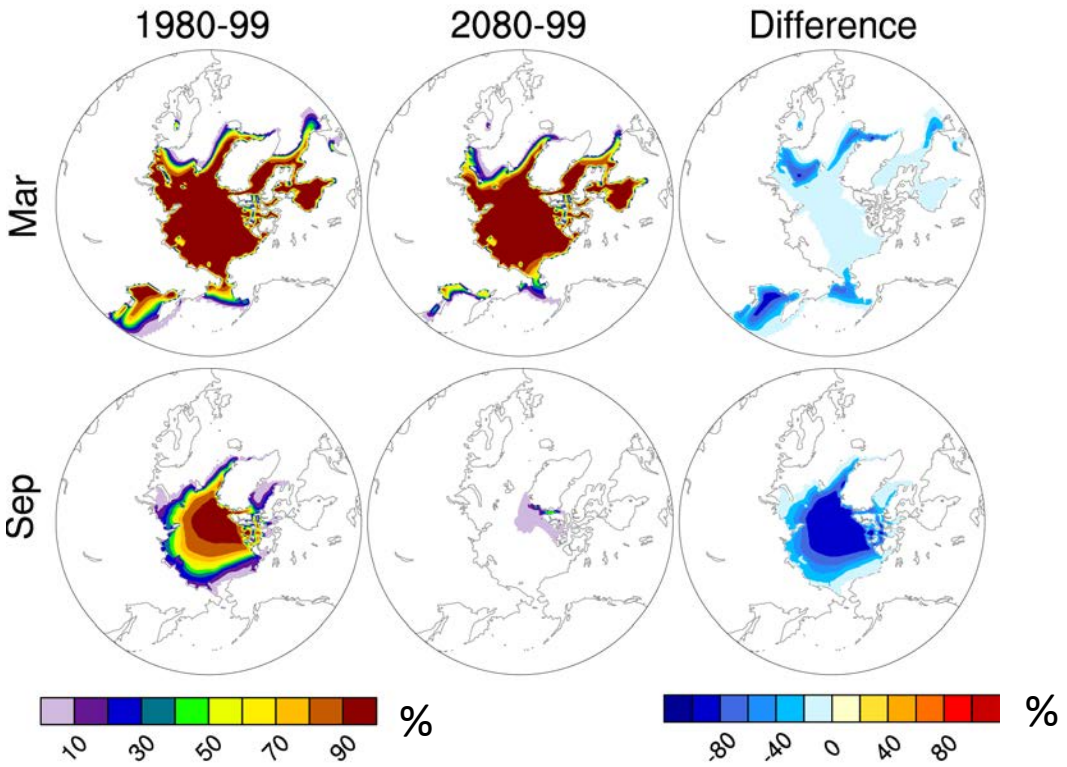
Model Experiments

Coupled atm-dynamical ocean (CCSM4 1°)

Coupled atm- slab ocean (SOM) (CCSM4 1°)

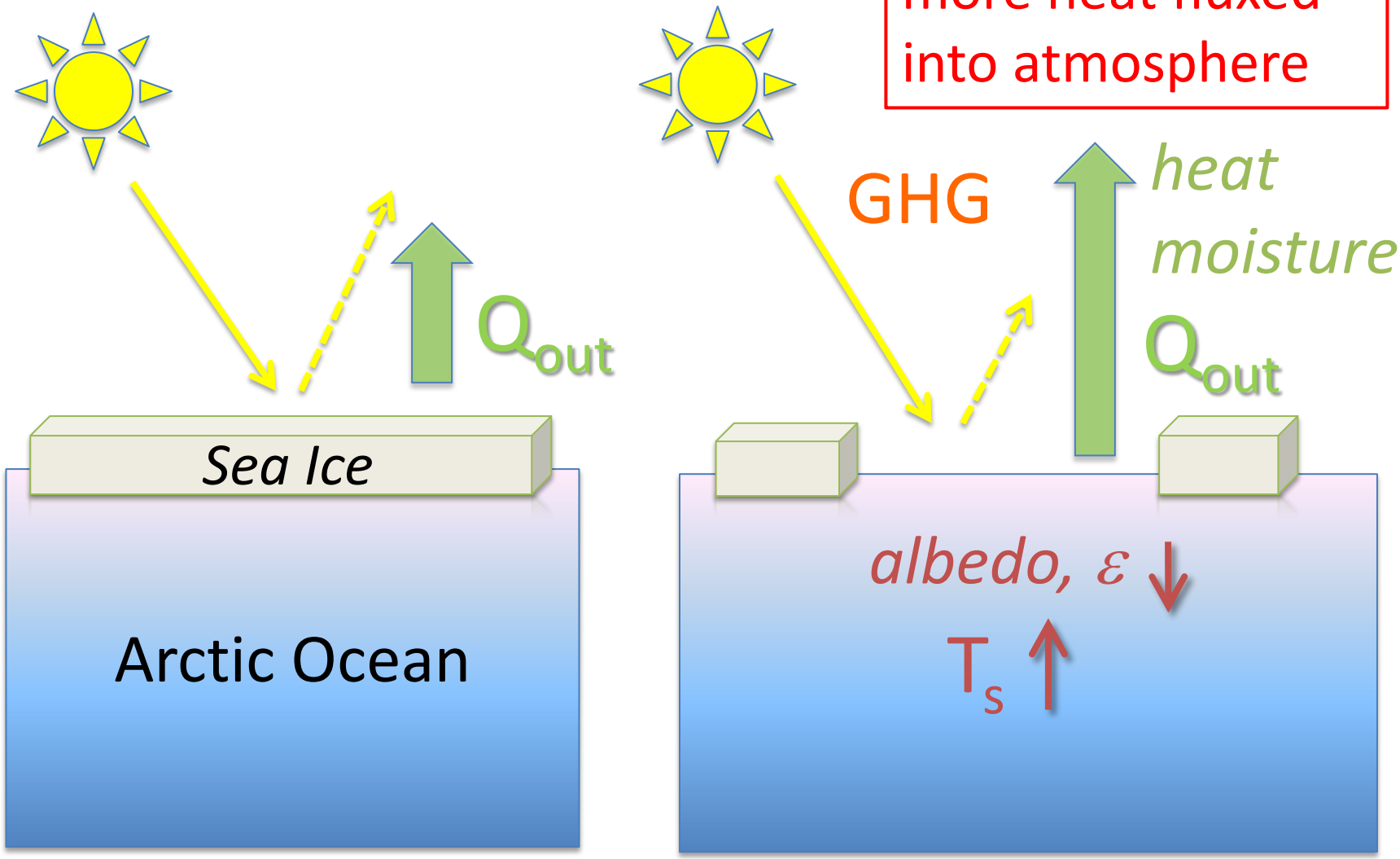
Atmosphere-only (CAM4 1°)

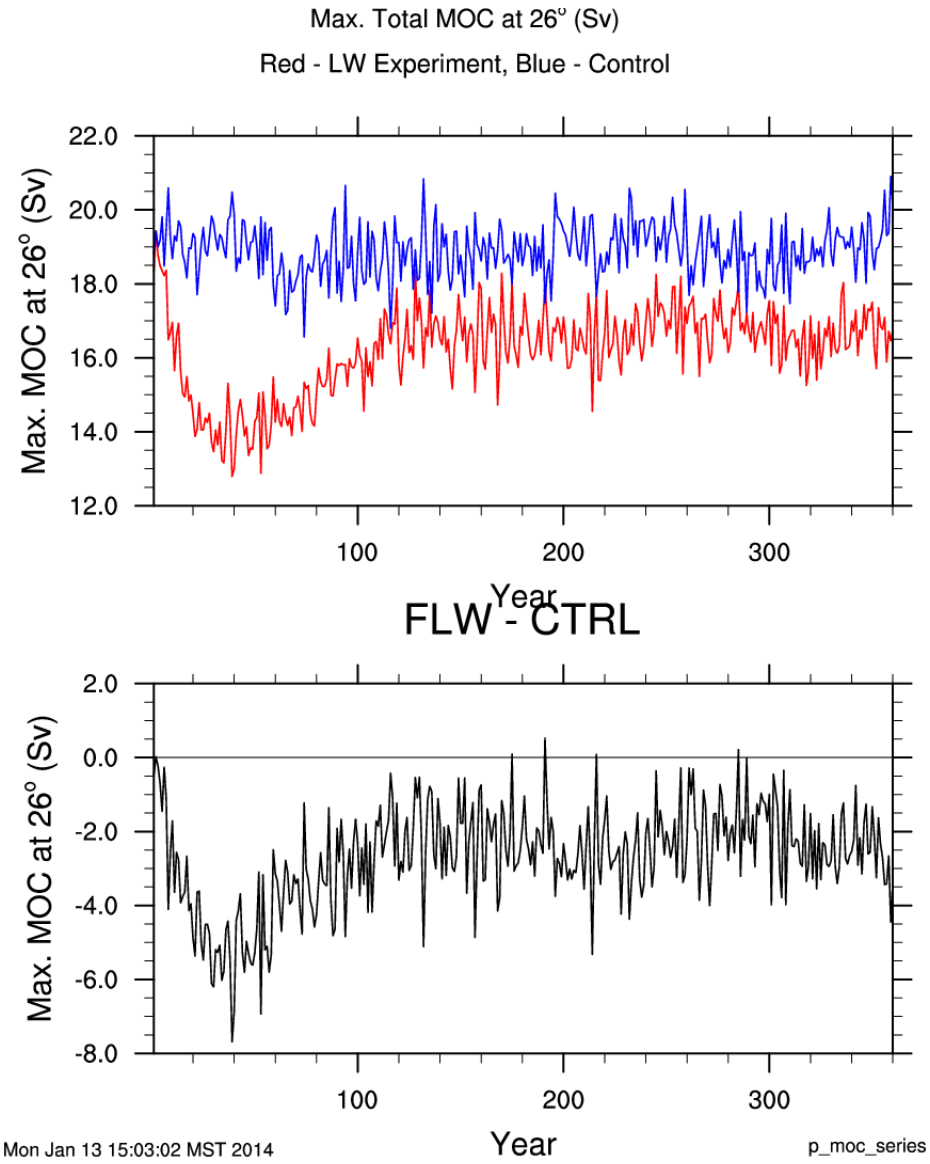
Fix GHG at 1990 levels to isolate impact of Arctic sea ice loss



Response of surface energy exchange to Arctic sea ice loss

Less sea ice -> more heat fluxed into atmosphere

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Red - LW Experiment, Blue - Control
Max. MOC at 26° (Sv)
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20.0
18.0
16.0
14.0
12.0
100
200
300
Year
FLW - CTRL
Max. MOC at 26° (Sv)
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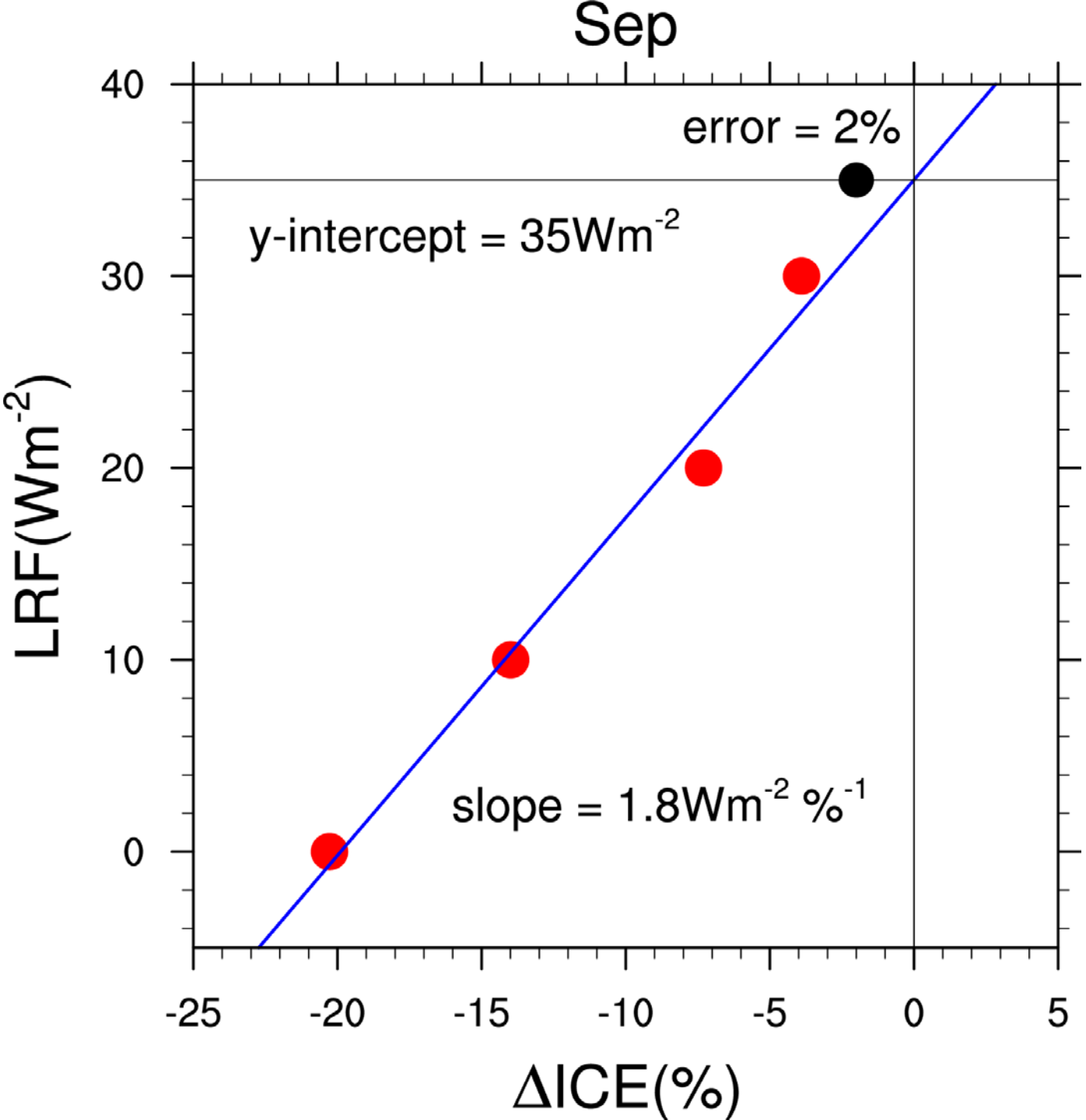
0.0
-2.0
-4.0
-6.0
-8.0
100
200
300
Year
Mon Jan 13 15:03:02 MST 2014
p_moc_series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ΔICE(%)
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-25
-20
-15
-10
-5
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5