

Fast response of the Tropics to an Abrupt Loss of Arctic Sea Ice via Ocean Dynamics

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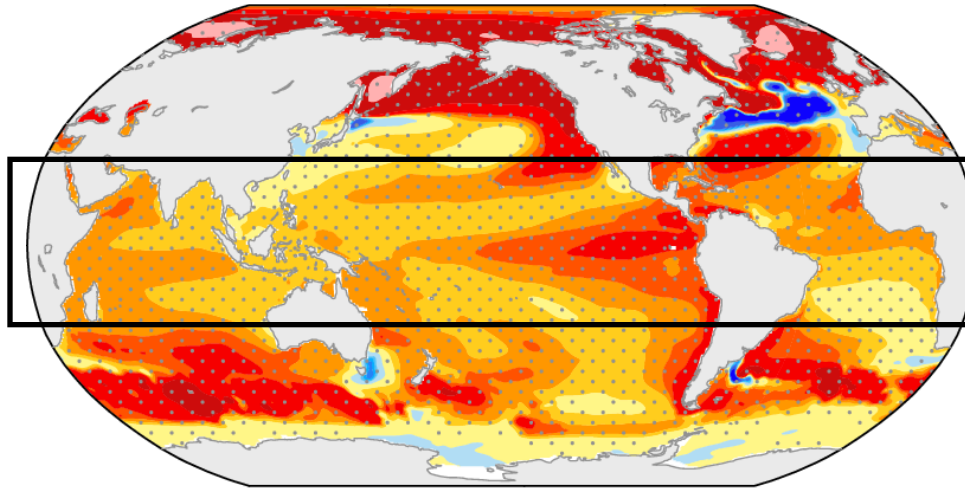
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Follow-up to Deser et al. (2015) and Tomas et al. (2016) who examined the **equilibrium** coupled ocean-atmosphere response to Arctic sea ice loss.

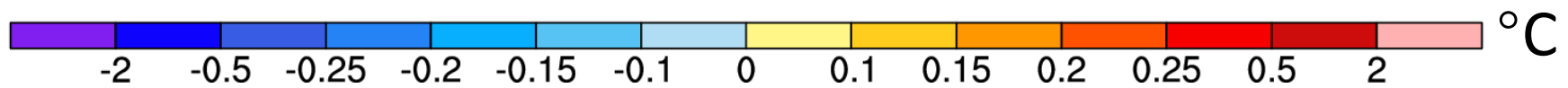
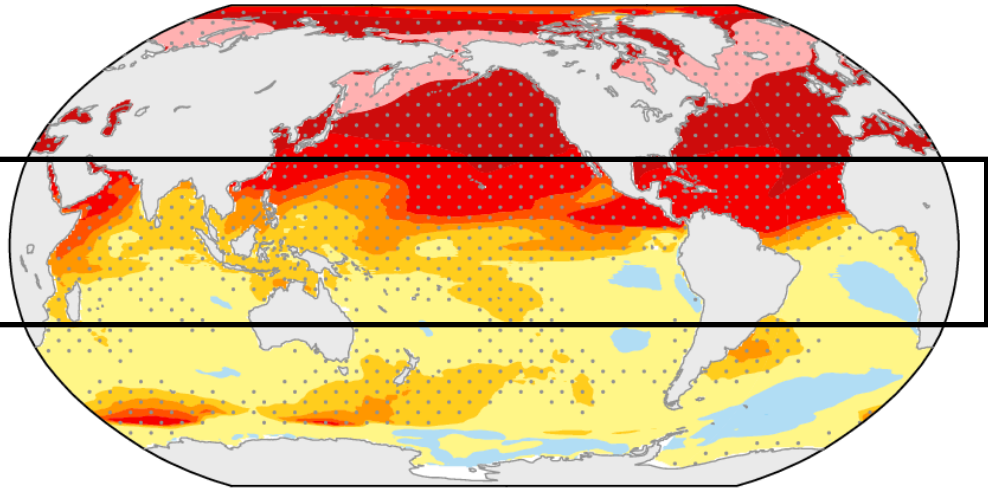
Here we examine the **transient** response using the same experimental design.

Equilibrium SST Responses

Full ocean model

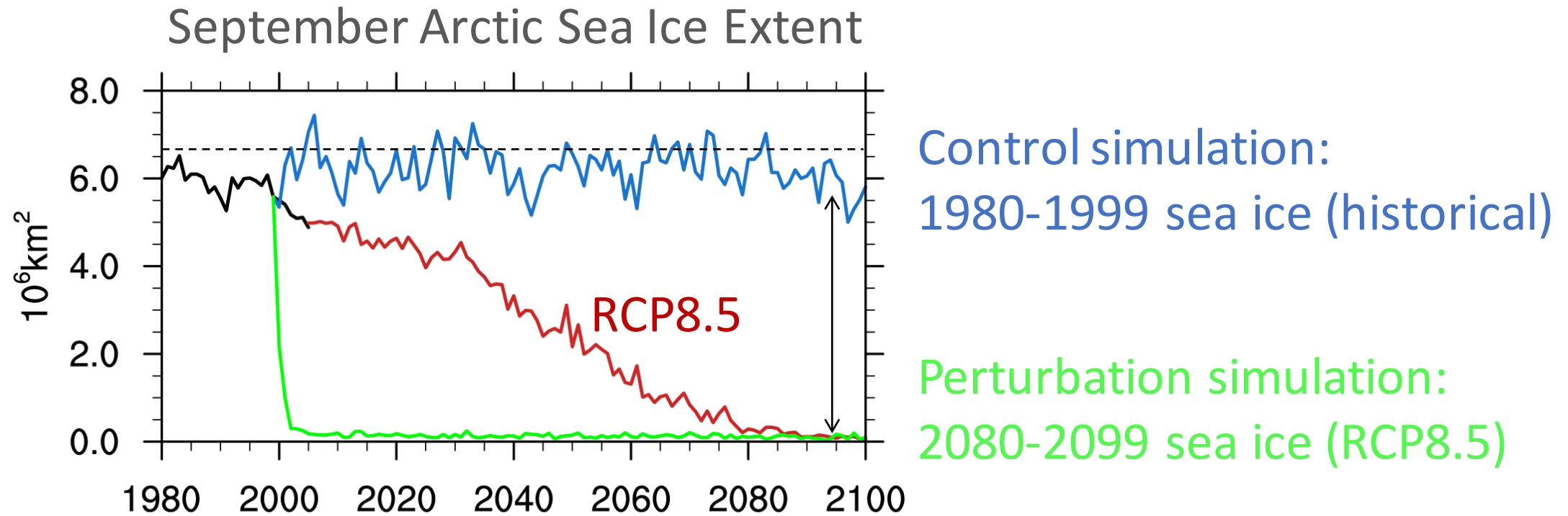


Slab ocean model



After Tomas et al. (2016)

Sea Ice Nudging in CCSM4-1° via LW flux to sea ice model (GHG fixed at year 2000)

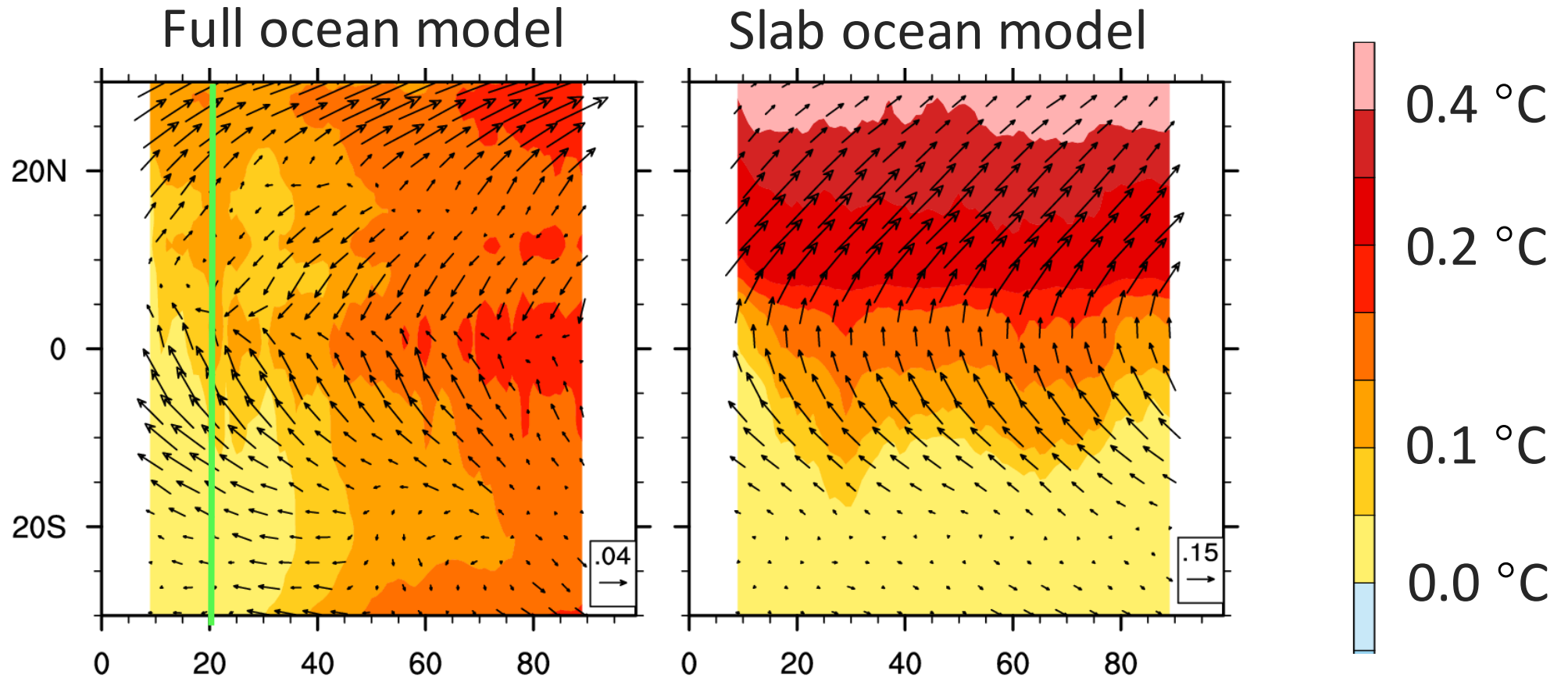


- 20 pairs of simulations with fully-coupled version
- 10 pairs of simulations with slab-ocean version
- Each simulation is 100 years long

- 1) How long does it take for ocean dynamics to influence the Tropical response to Arctic sea ice loss?
- 2) What processes are involved?

Zonal-mean Tropical SST and Surface Wind Responses

~ 20 years

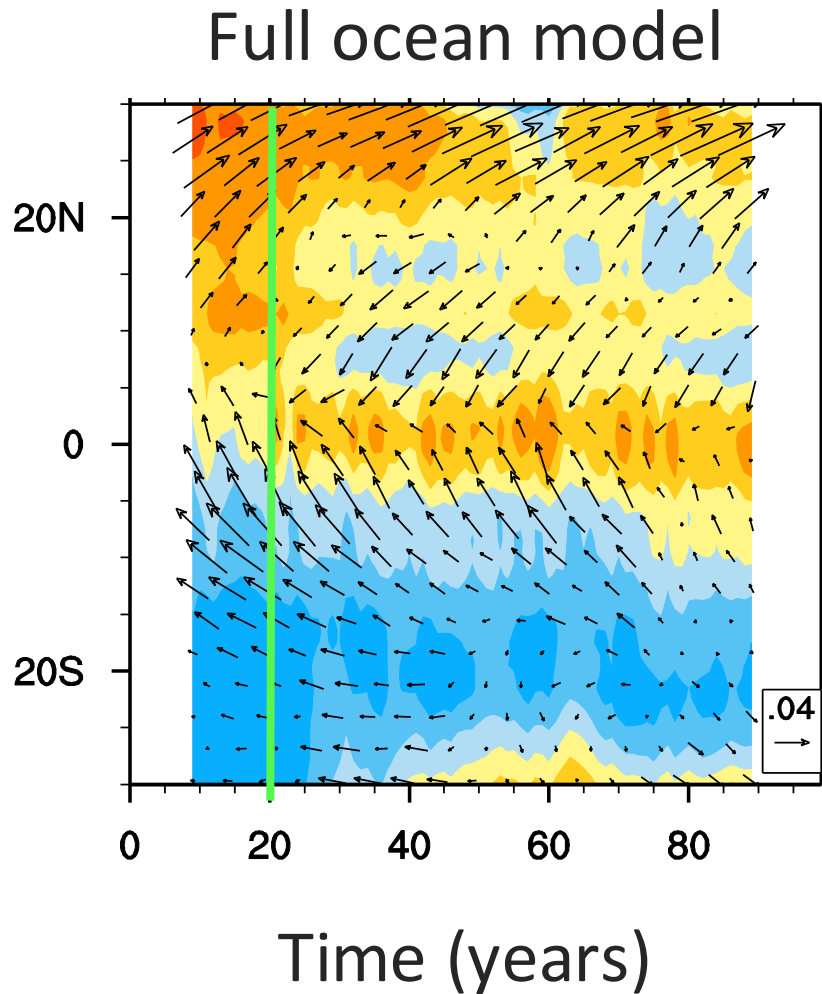


Equatorial maximum

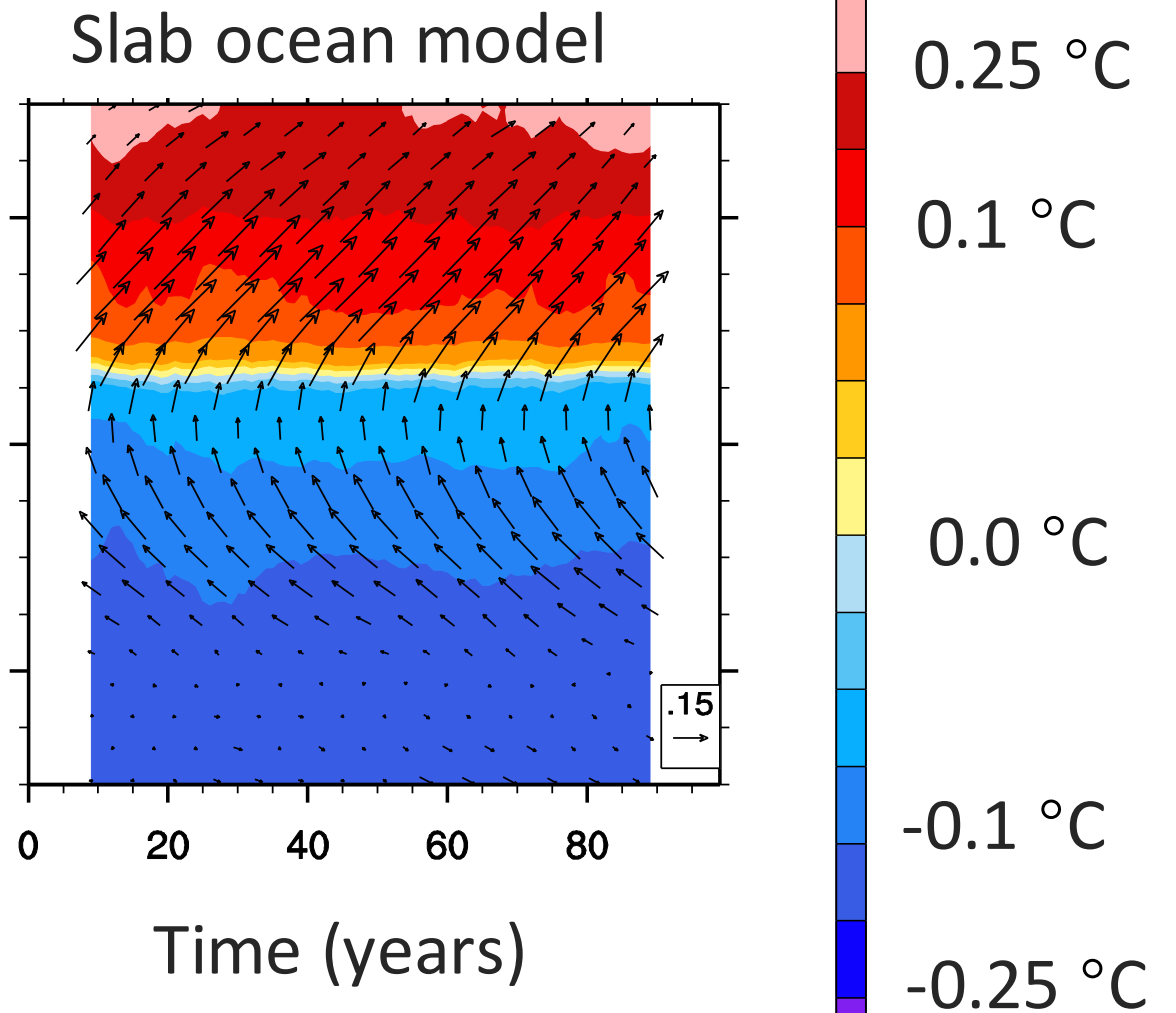
Hemispheric asymmetry

Zonal-mean Tropical SST and Surface Wind Responses Minus Tropical Mean

~ 20 years

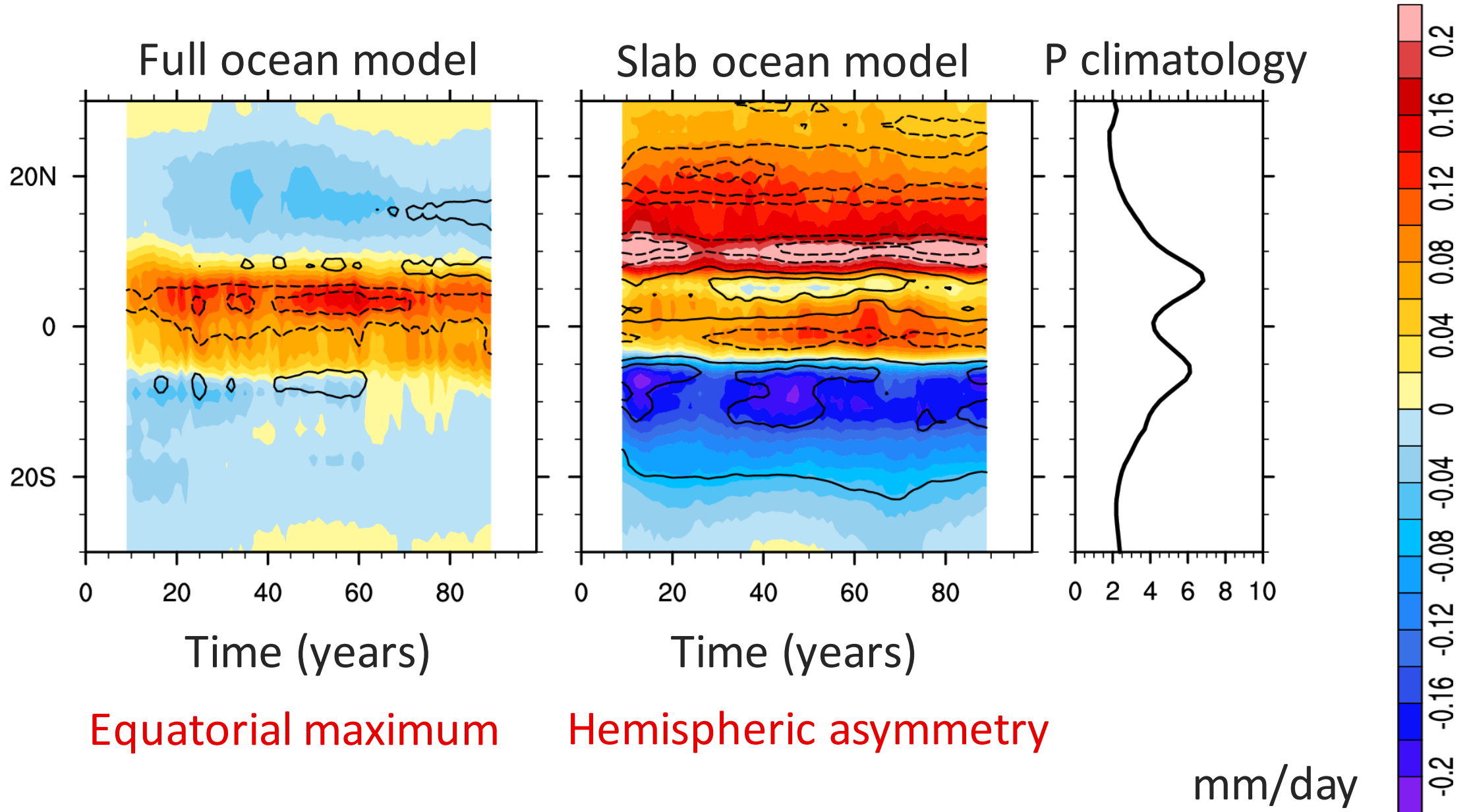


Equatorial maximum



Hemispheric asymmetry

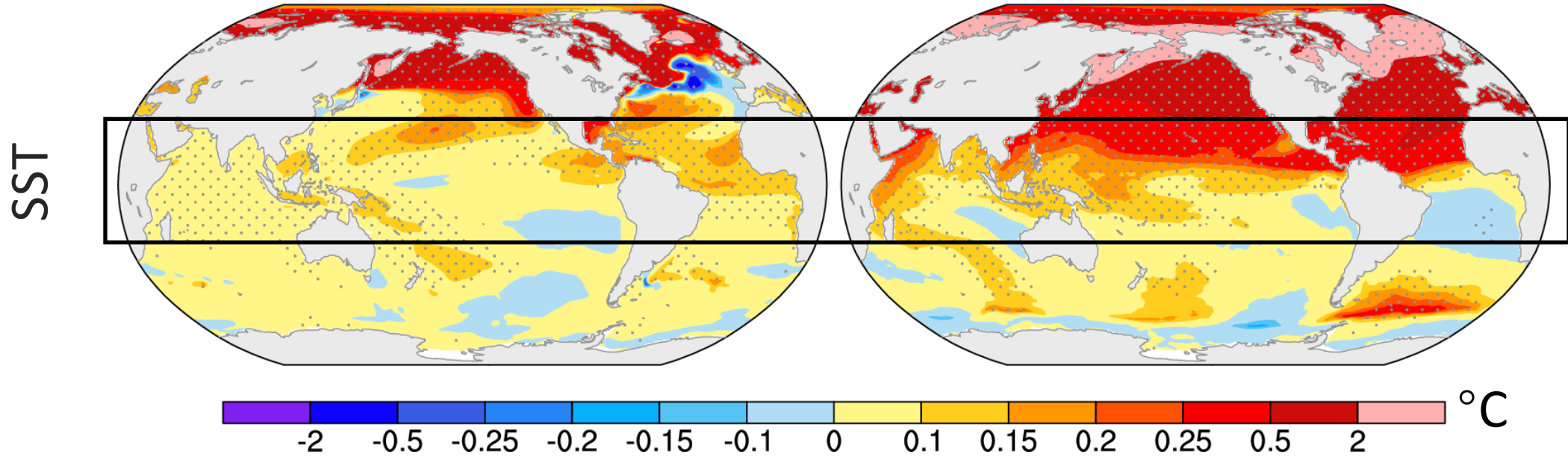
Tropical precipitation (color) & surface wind divg (contours)



Initial Response (years 6-25)

Full ocean model

Slab ocean model

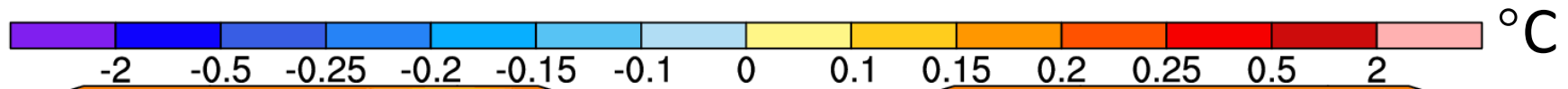
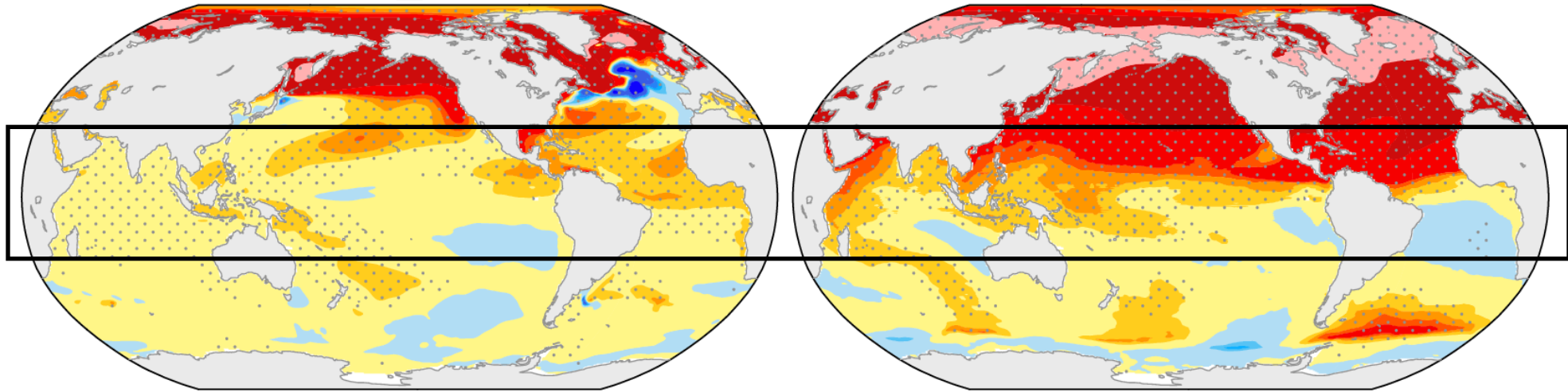


Initial Response (years 6-25)

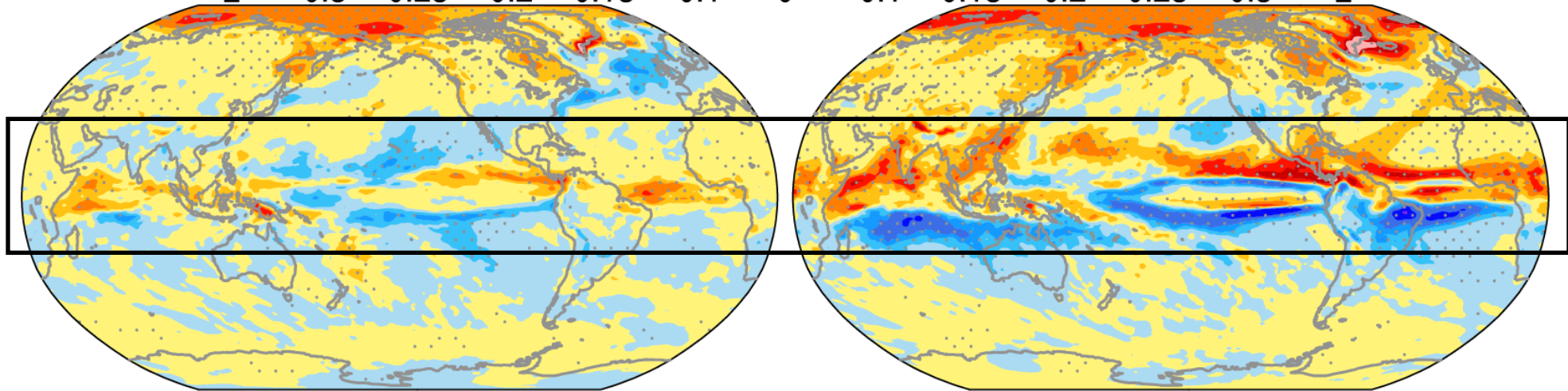
Full ocean model

Slab ocean model

SST



Precipitation

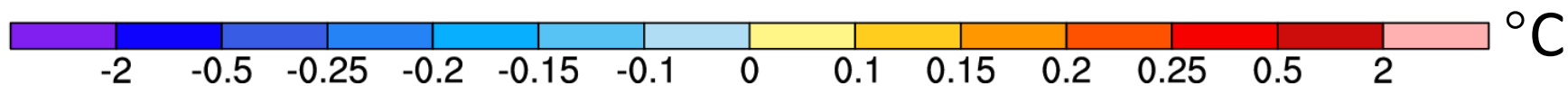
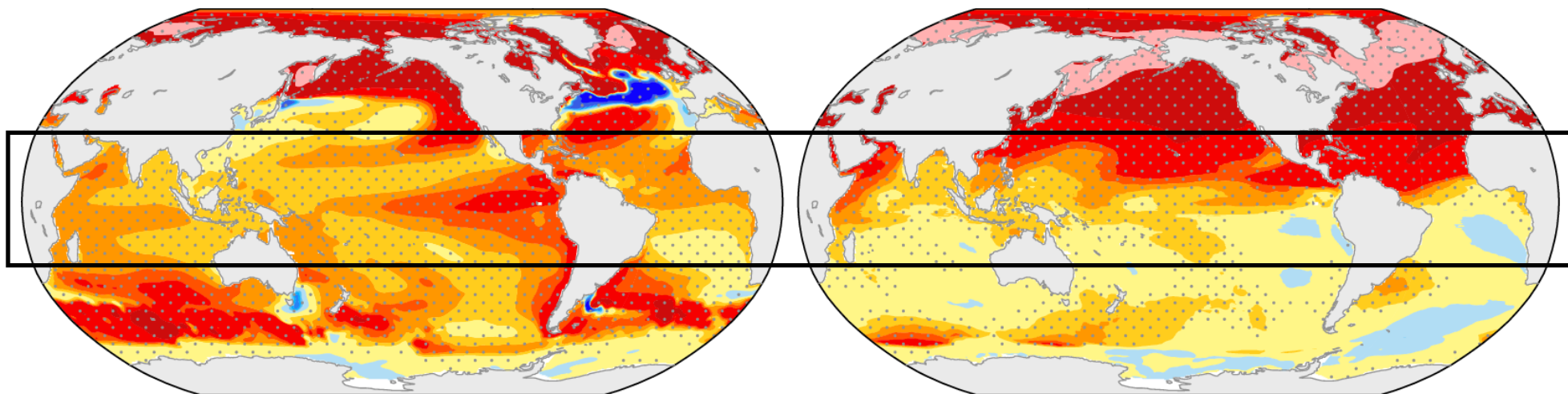


Equilibrium Response (years 81-100)

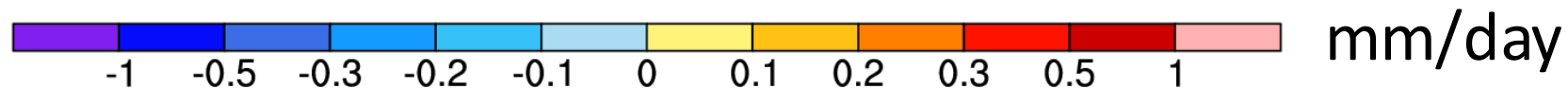
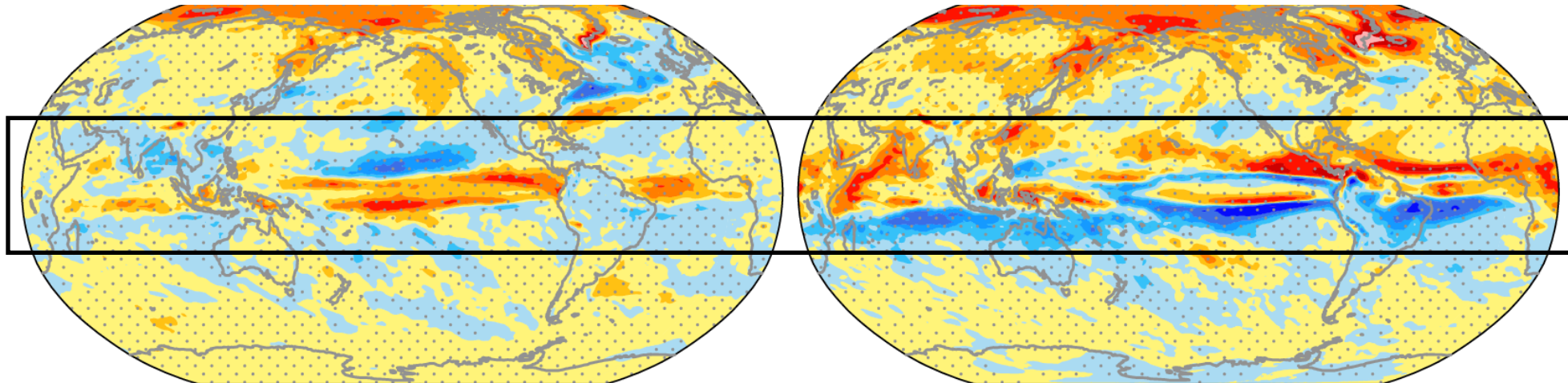
Full ocean model

Slab ocean model

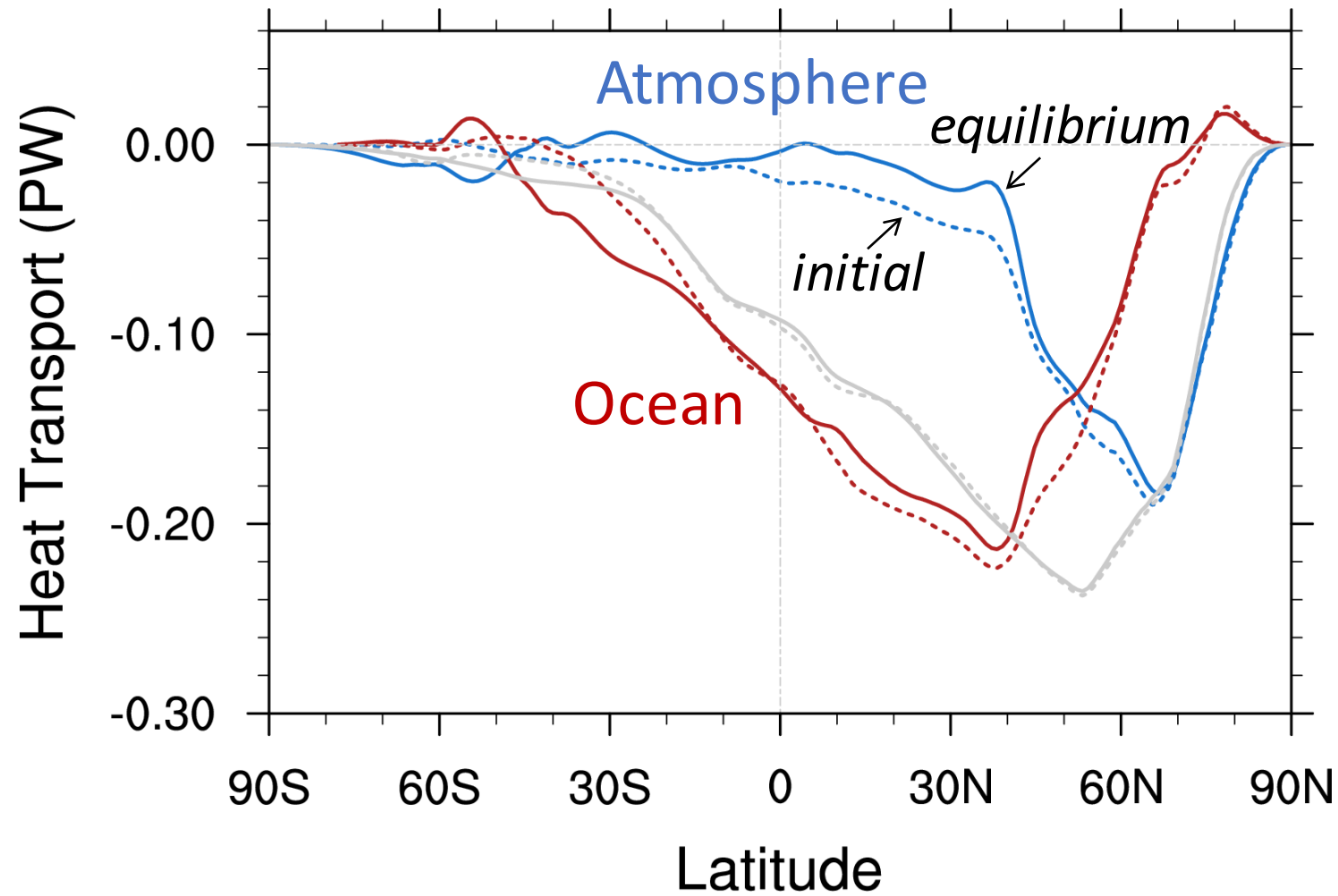
SST



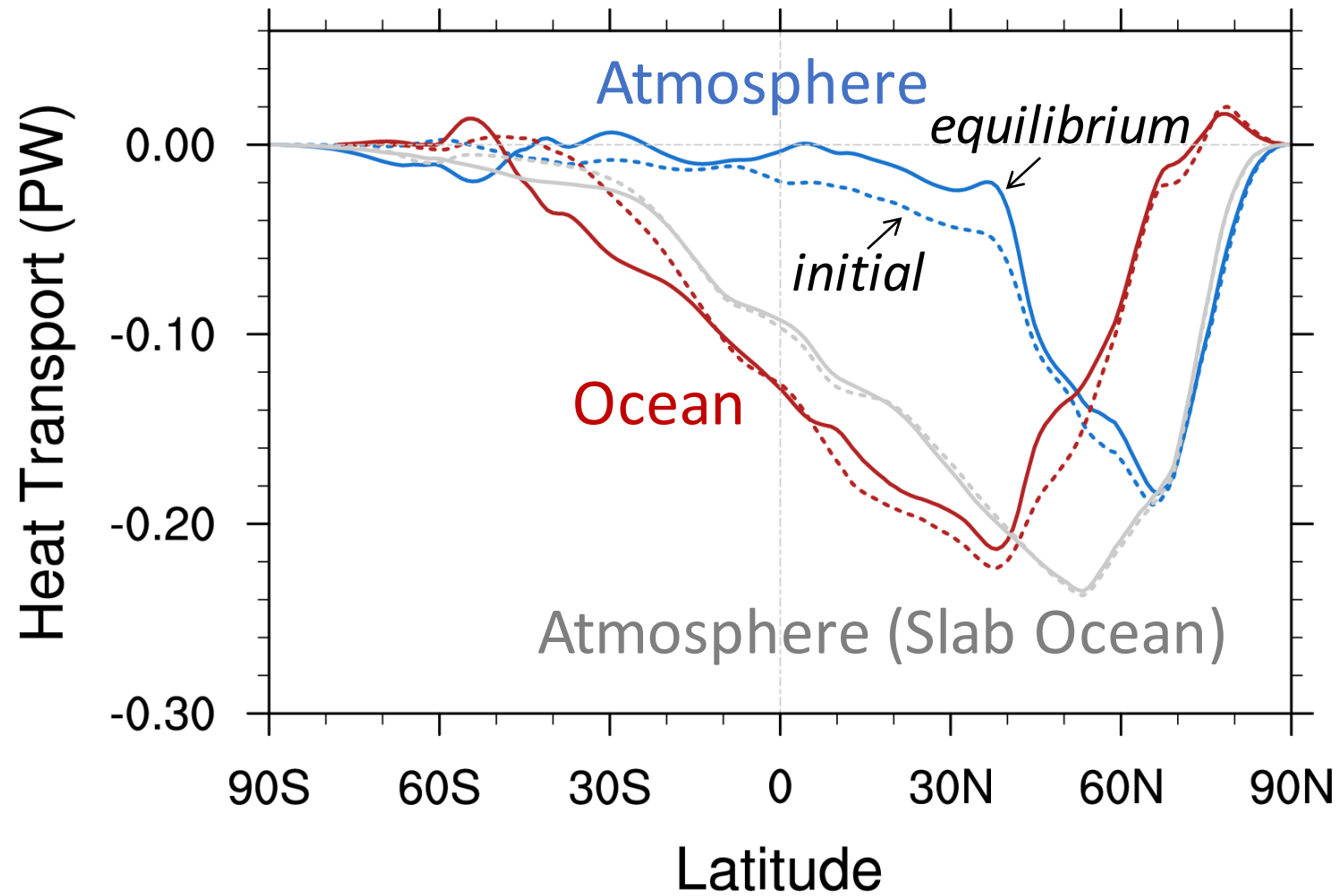
Precipitation



Meridional Heat Transport: Full Ocean Model



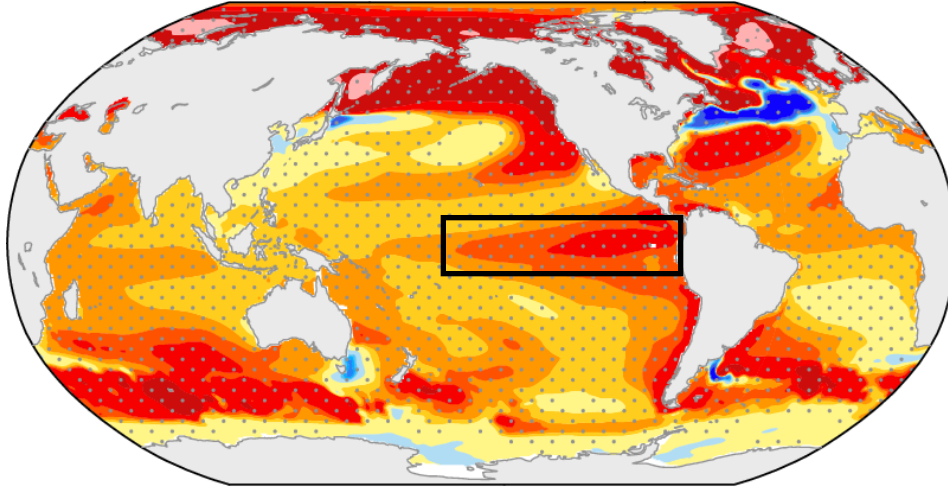
Meridional Heat Transport: Full Ocean Model



Equatorial Pacific Mixed Layer Heat Budget

Full ocean model

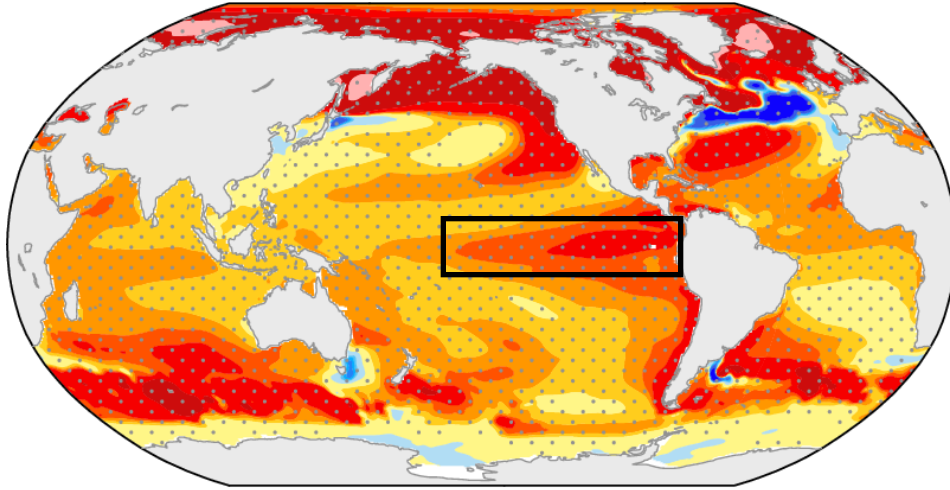
SST



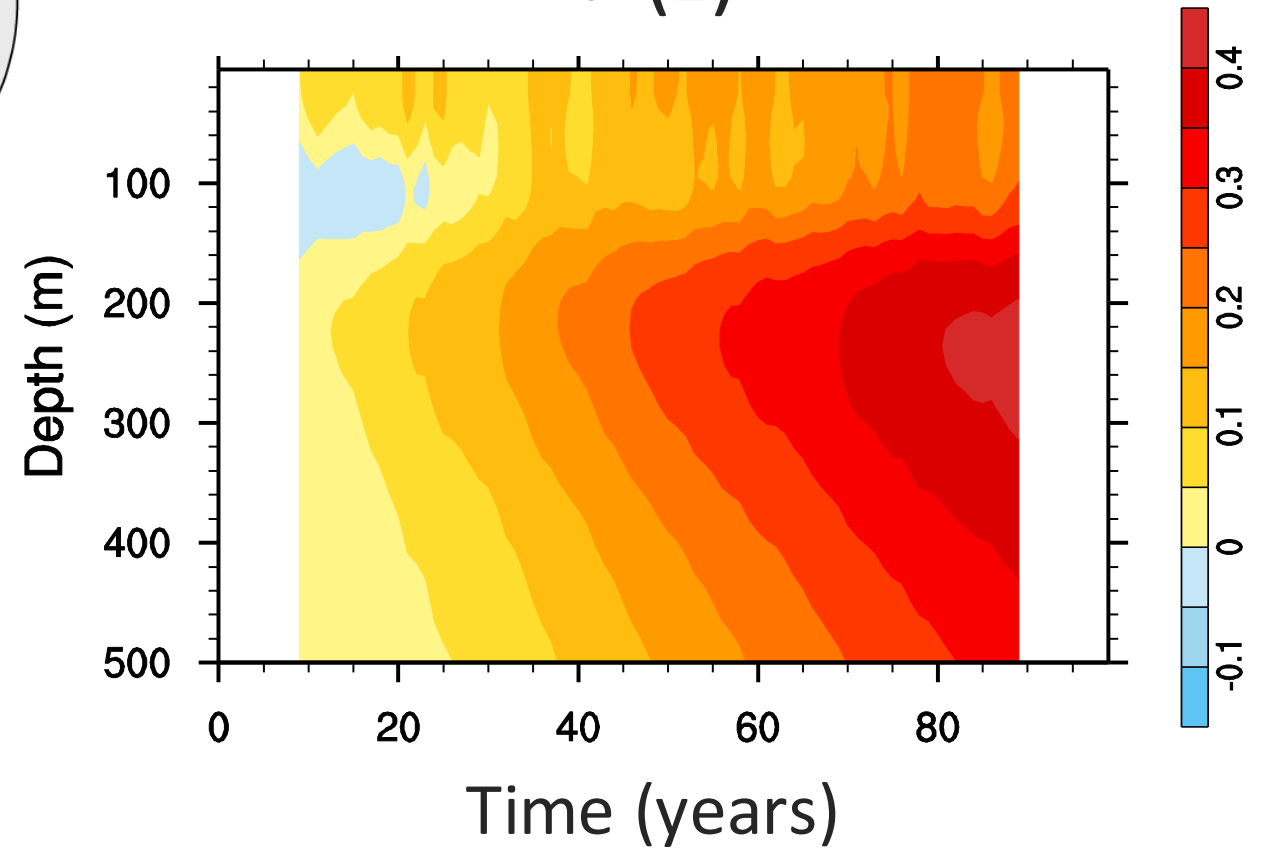
Equatorial Pacific Mixed Layer Heat Budget

Full ocean model

SST



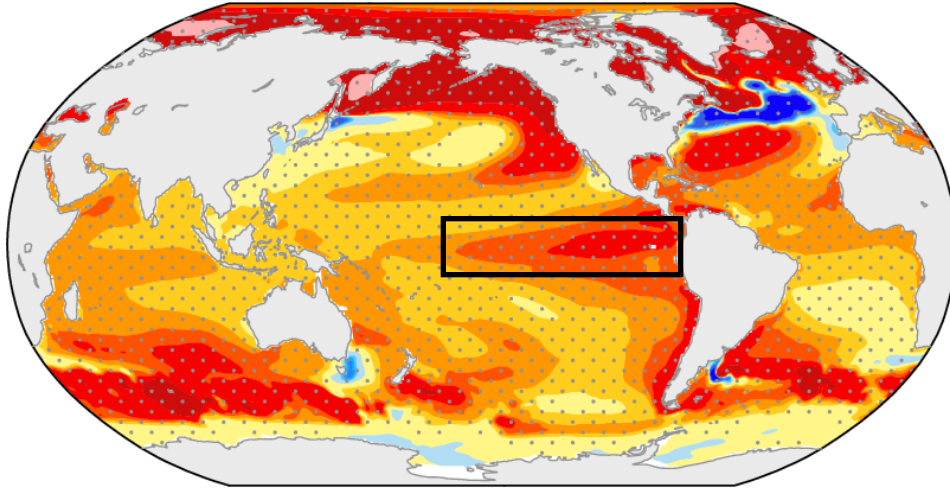
$T'(z)$



Equatorial Pacific Mixed Layer Heat Budget

Full ocean model

SST

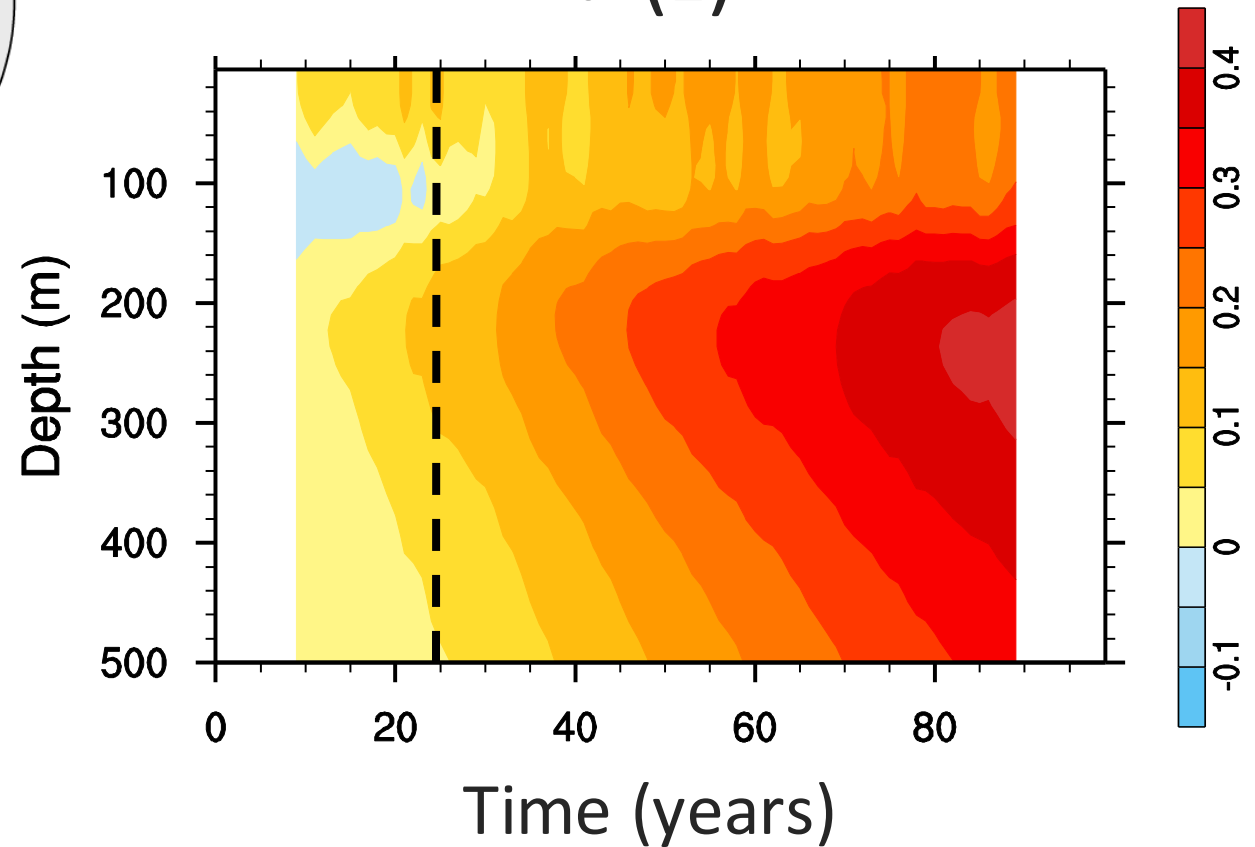


> 20 years

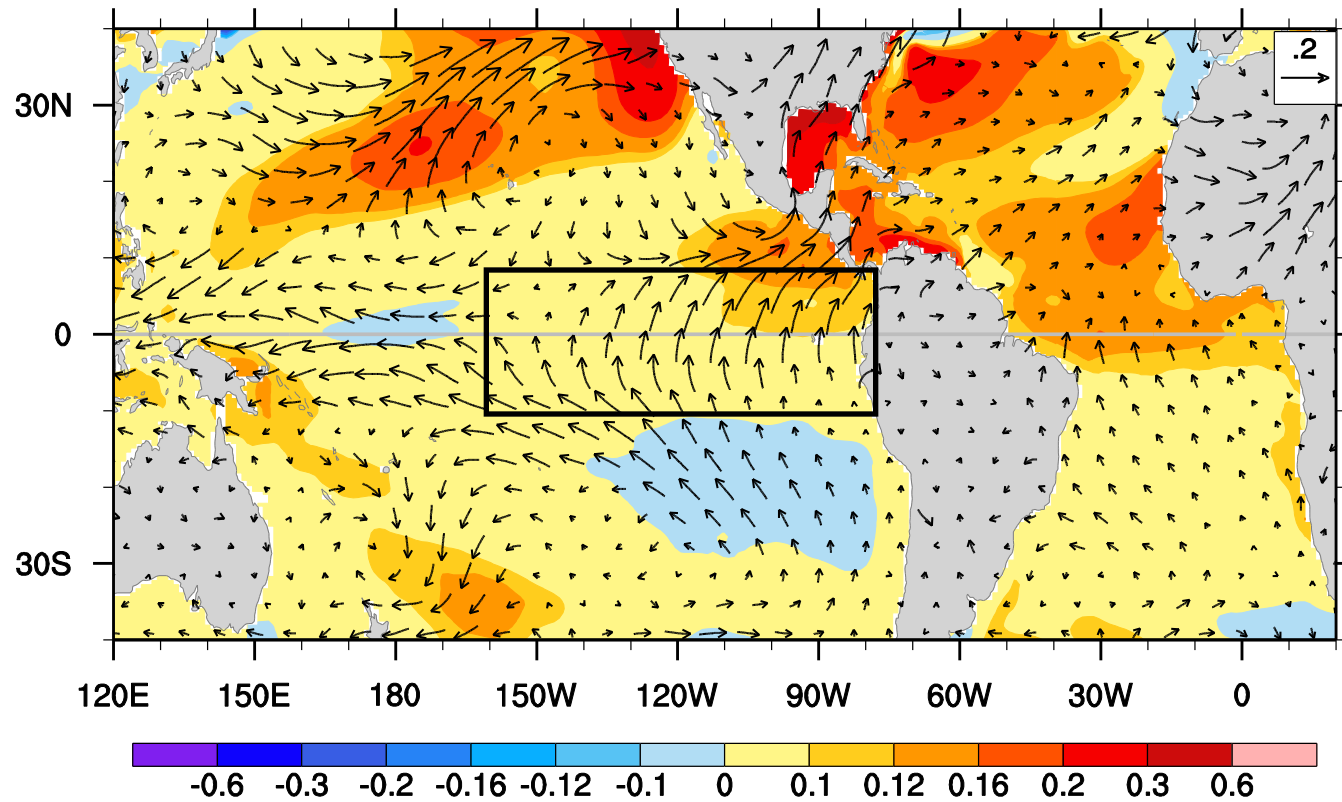
$$\bar{W} \, dT'/dz$$

Q_{net} and horizontal advection
are damping terms

$T'(z)$



Initial Response in Fully-Coupled Model



Summary

1) How long does it take for ocean dynamics to influence the Tropical Pacific response to Arctic sea ice loss? ~ 20 years

2) What processes are involved?

$$\overline{W} dT'/dz$$

but origin of subsurface warming remains to be understood

Summary

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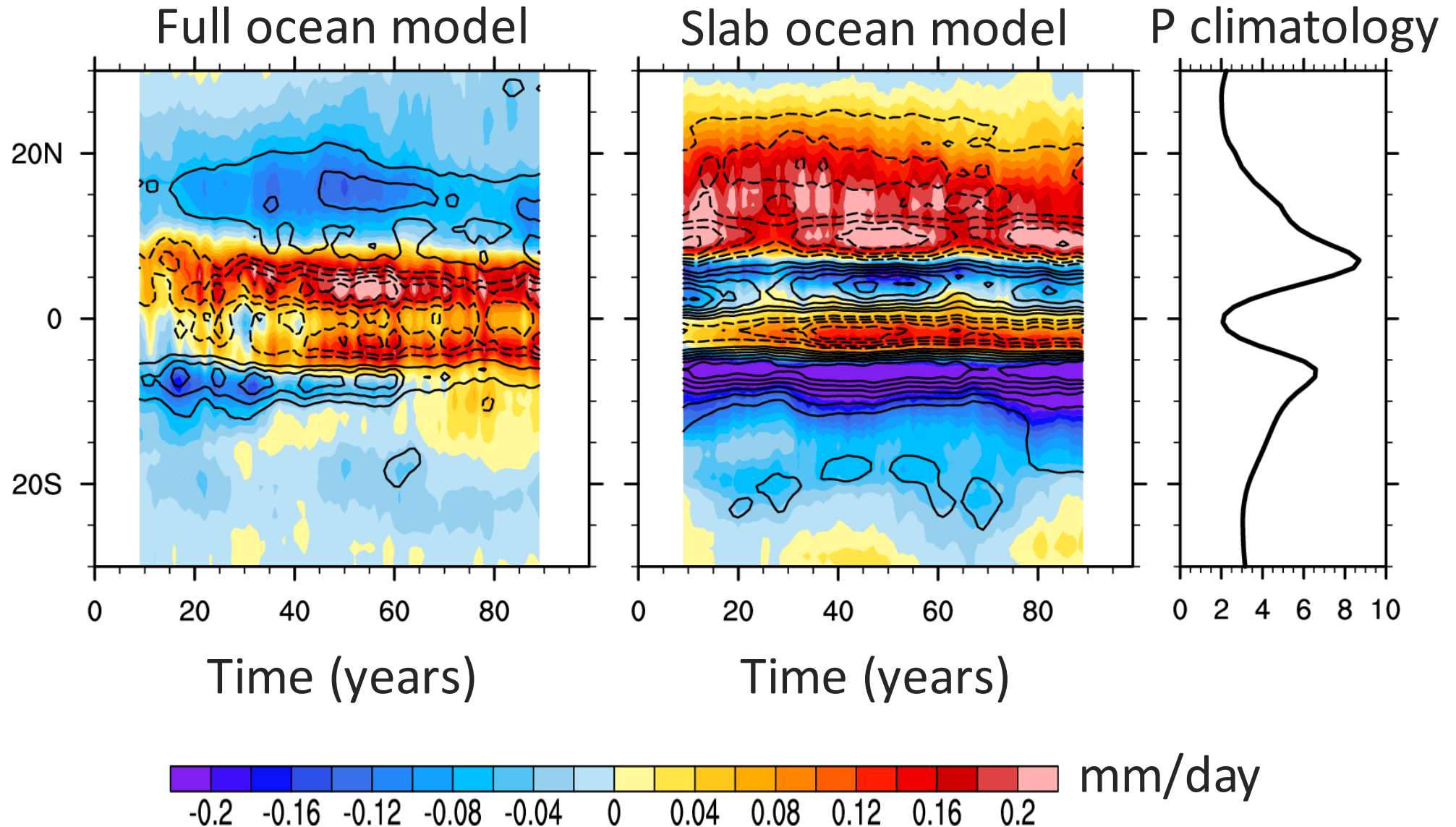
$$\bar{W} dT'/dz$$

but origin of subsurface warming remains to be understood

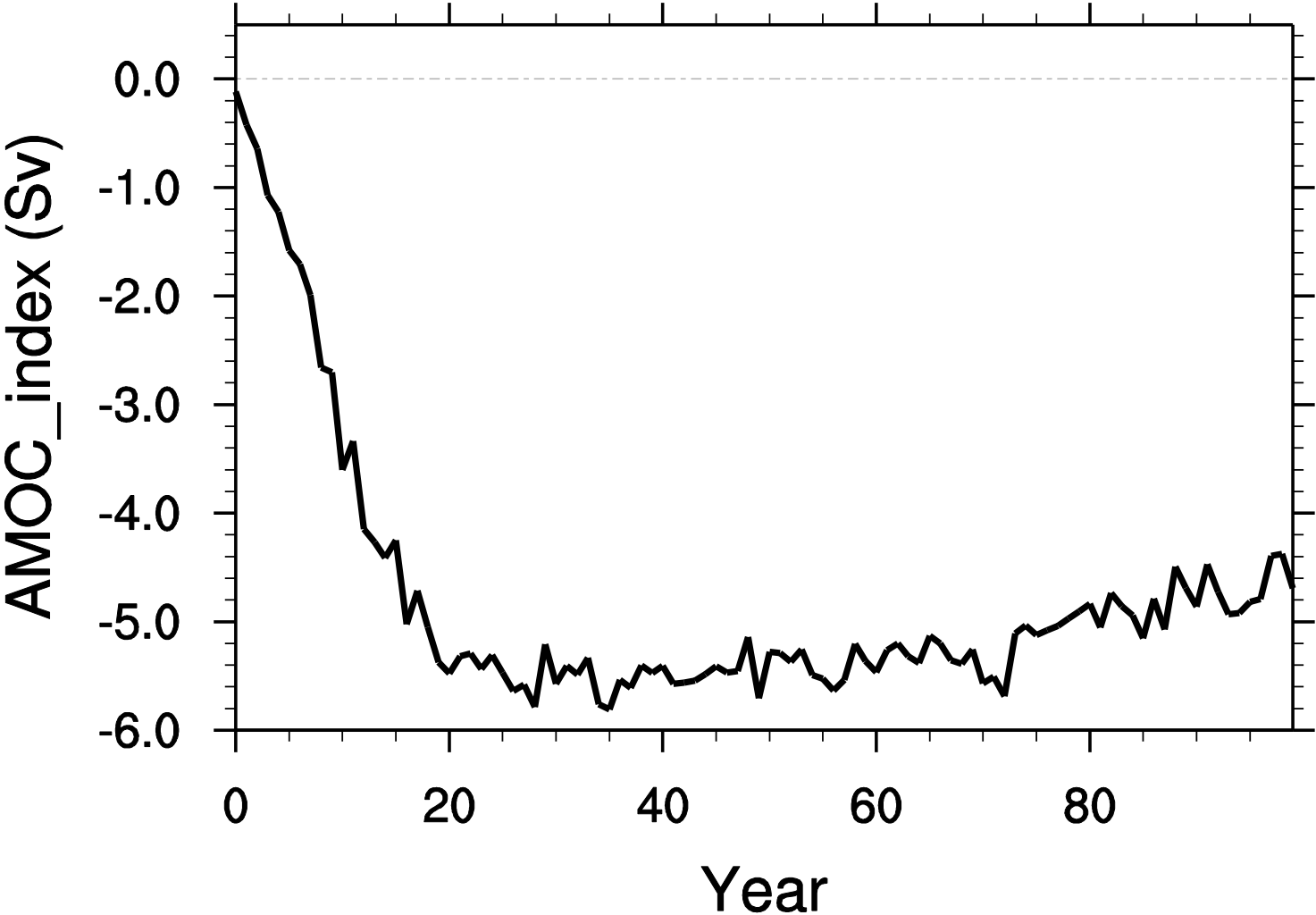
See Zhang and Delworth (2005) for related freshwater hosing experiments

Extra

Tropical Pacific precipitation (color) & sfc wind divg (contours)



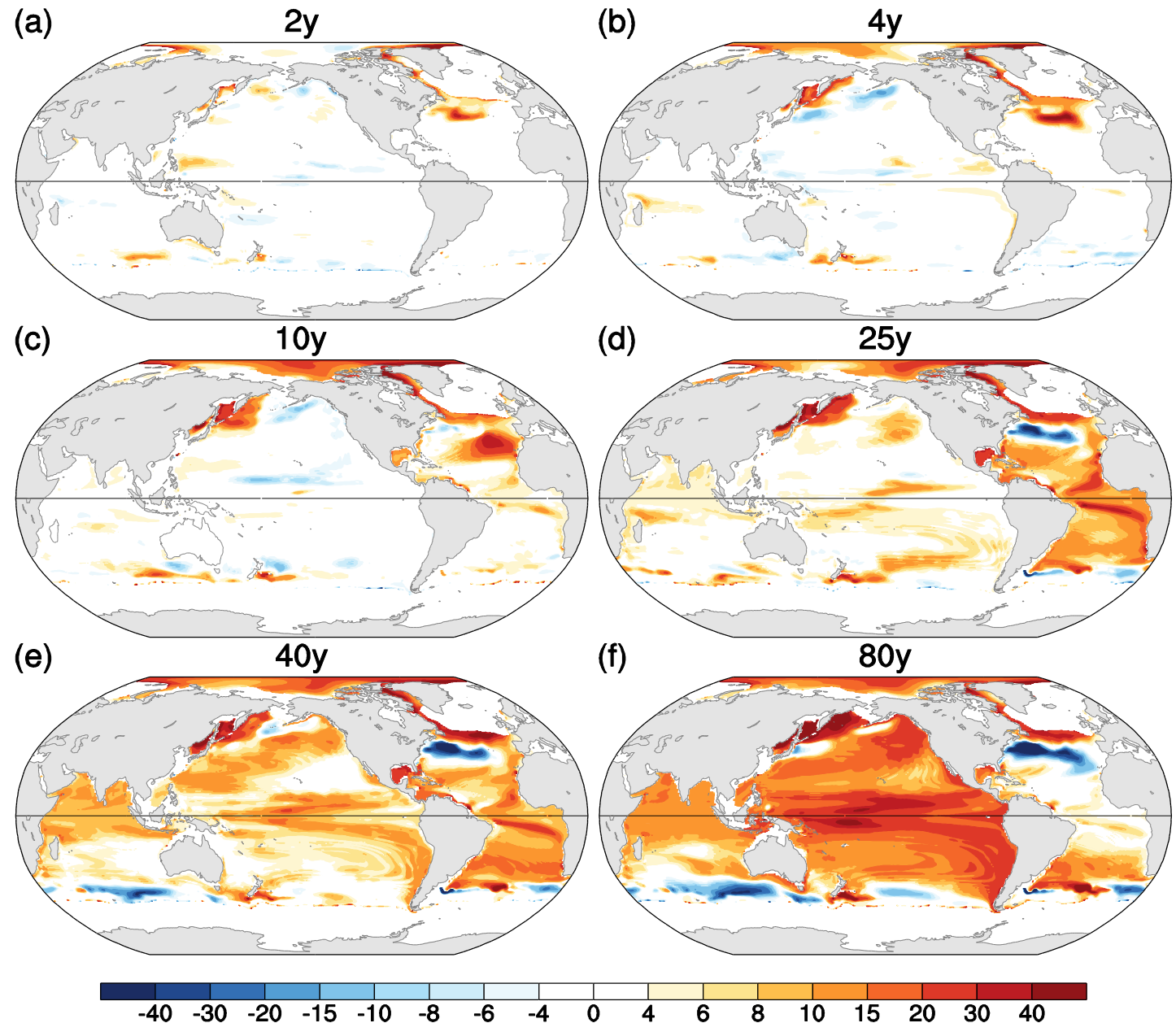
Response of AMOC



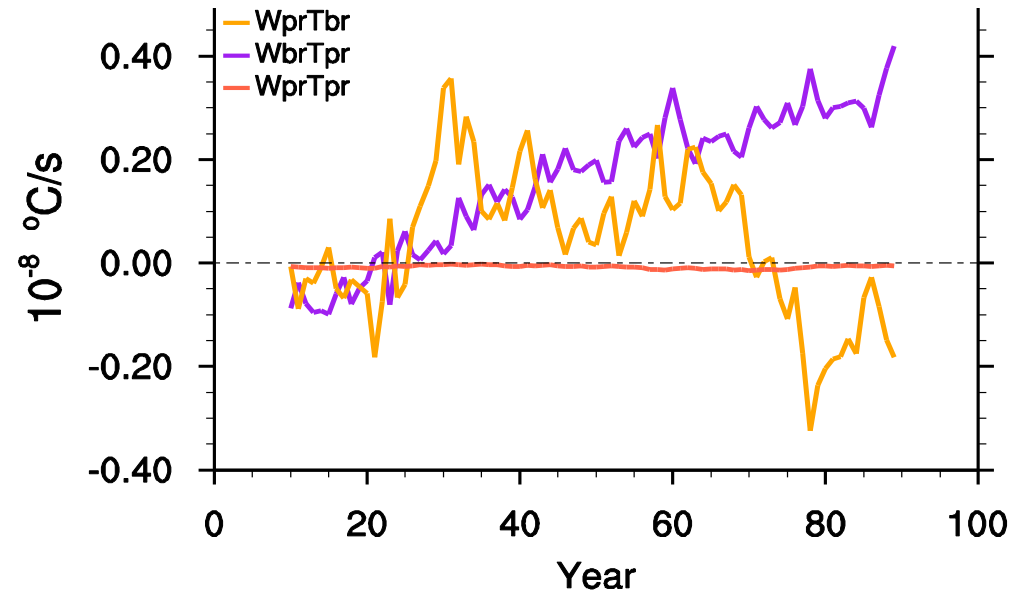
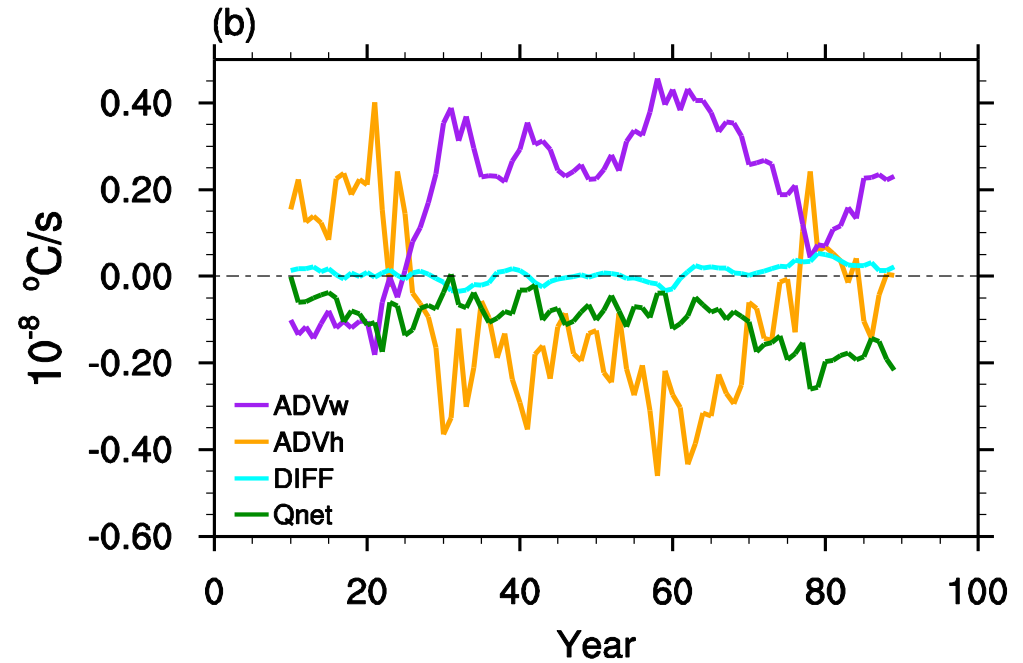
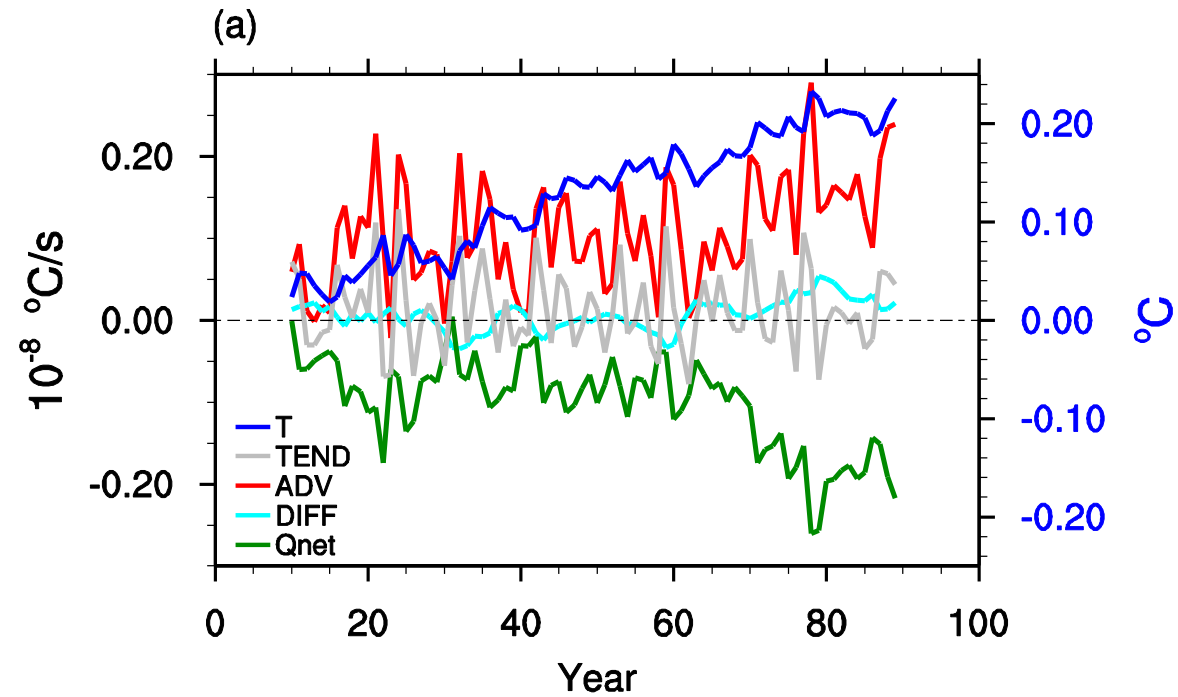
Response of the 26.5 kg/m³ isopycnal surface

Located at 300-400m
depth in the Eastern
Equatorial Pacific

Global adjustment to a
weakening of AMOC
(Timmermann et al., 2005)

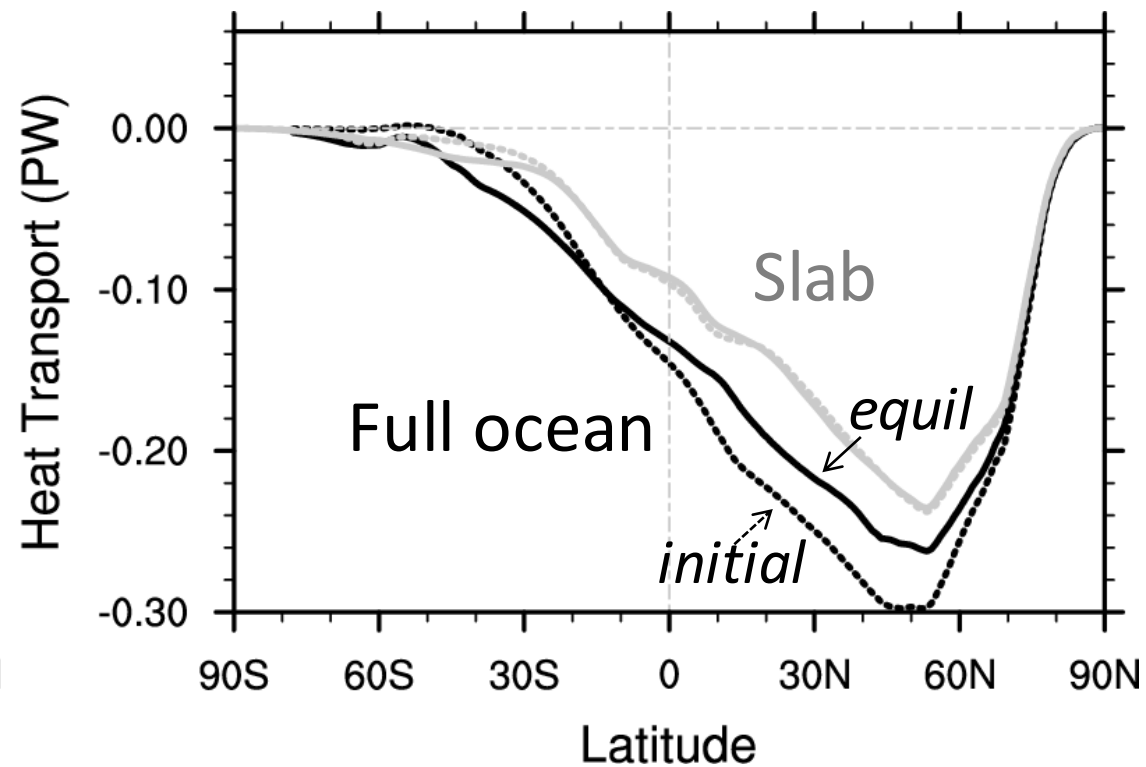
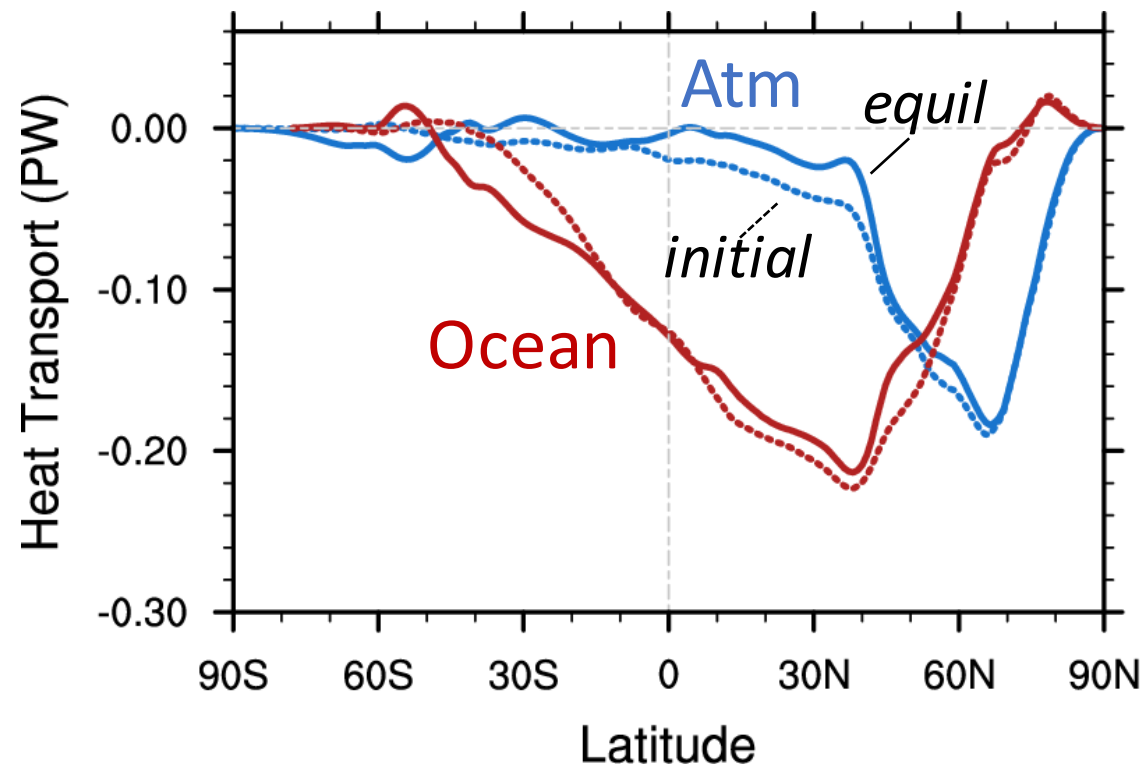


Equatorial Pacific Mixed Layer Heat Budget



Meridional Heat Transport

Full ocean model



Meridional Streamfunction

