

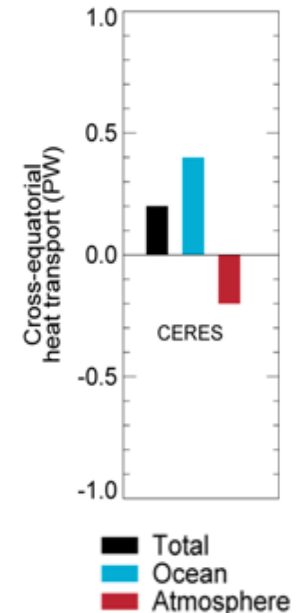
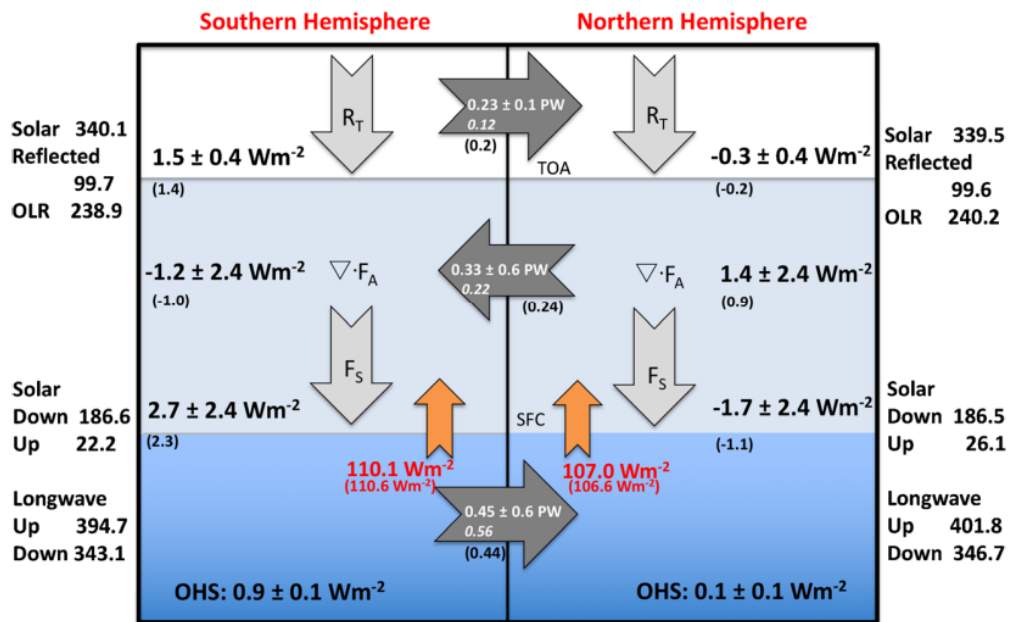
Energy transports and the ITCZ: GMMIP diagnostics?

Hawcroft, MK et al, 2016. Southern Ocean albedo, inter-hemispheric energy transports and the double ITCZ: global impacts of biases in a coupled model, *Climate Dynamics*, published online



Background

- Observations show the atmosphere transports energy from NH to SH and ocean from SH to NH, with a net northward total energy transport

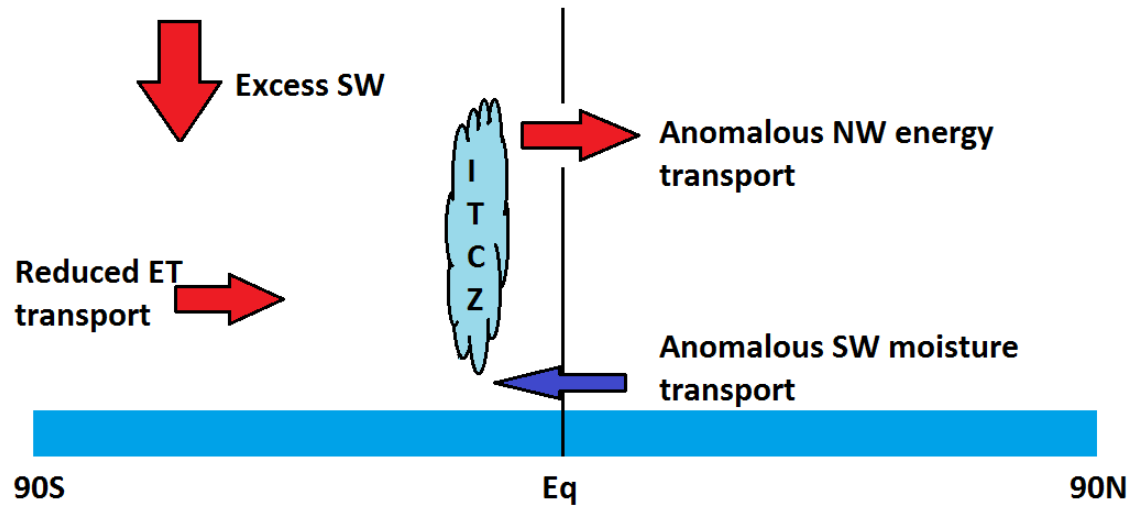


Stephens et al. (2016)



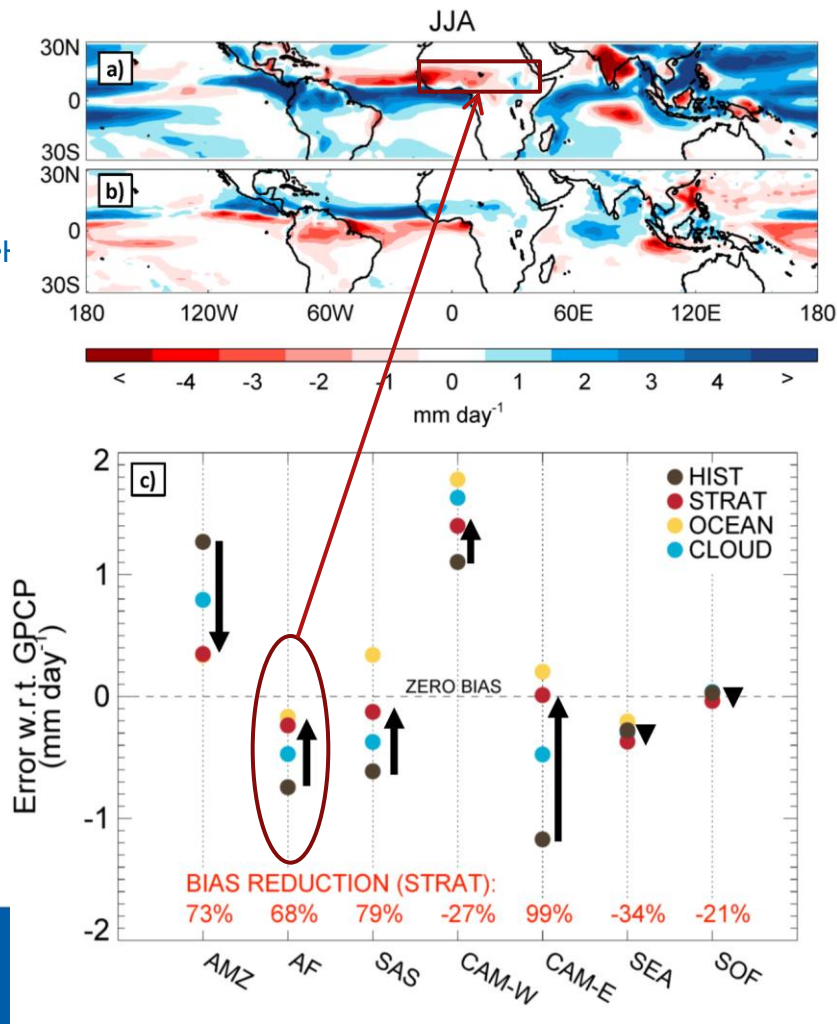
Background

- Many studies show changing inter-hemispheric albedo shifts the ITCZ (e.g. Kang et al., 2008, 2009, Voigt et al., 2014).
- In many models, the Southern Hemisphere storm track is too dark (Bodas-Salcedo et al., 2014)



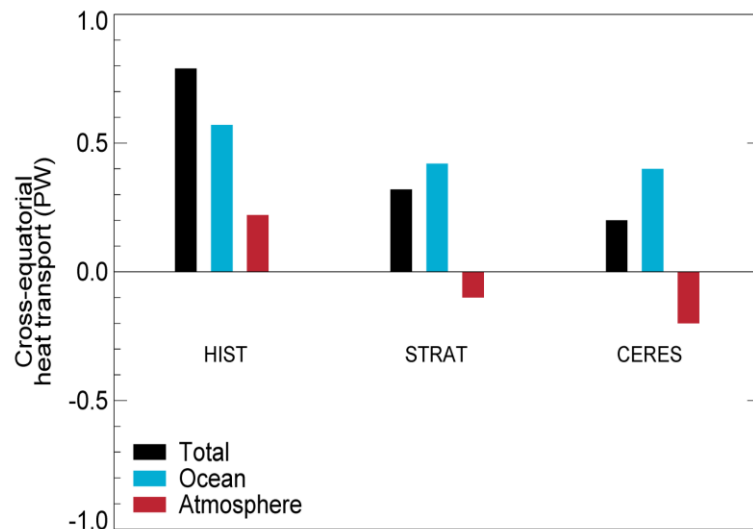
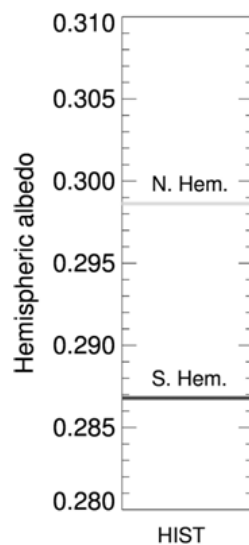
Existing work: Haywood et al. (2016)

- Uniformly brightening the SH to equilibrate hemispheres improves xEqET, shifts the ITCZ and improves the WAM



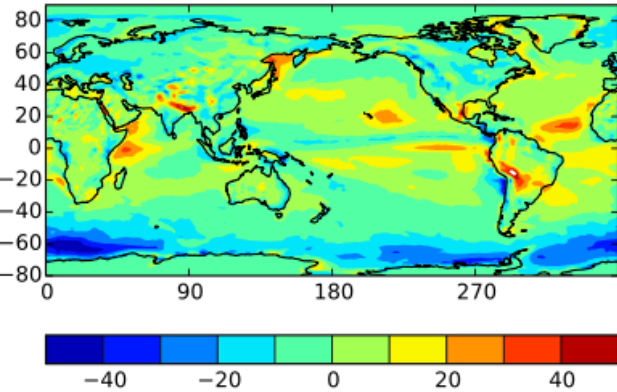
Hist

Strat



Southern Ocean SW biases

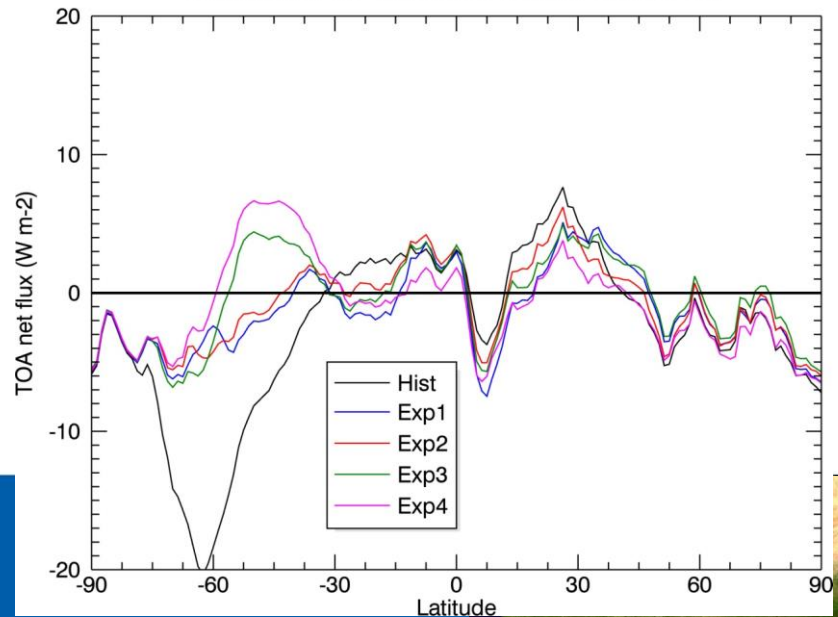
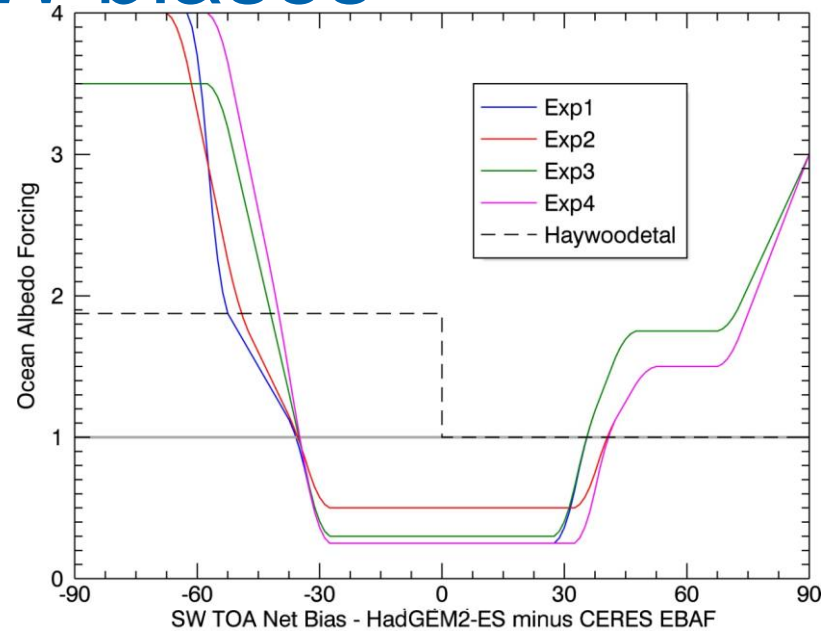
SW CLIM - CERES



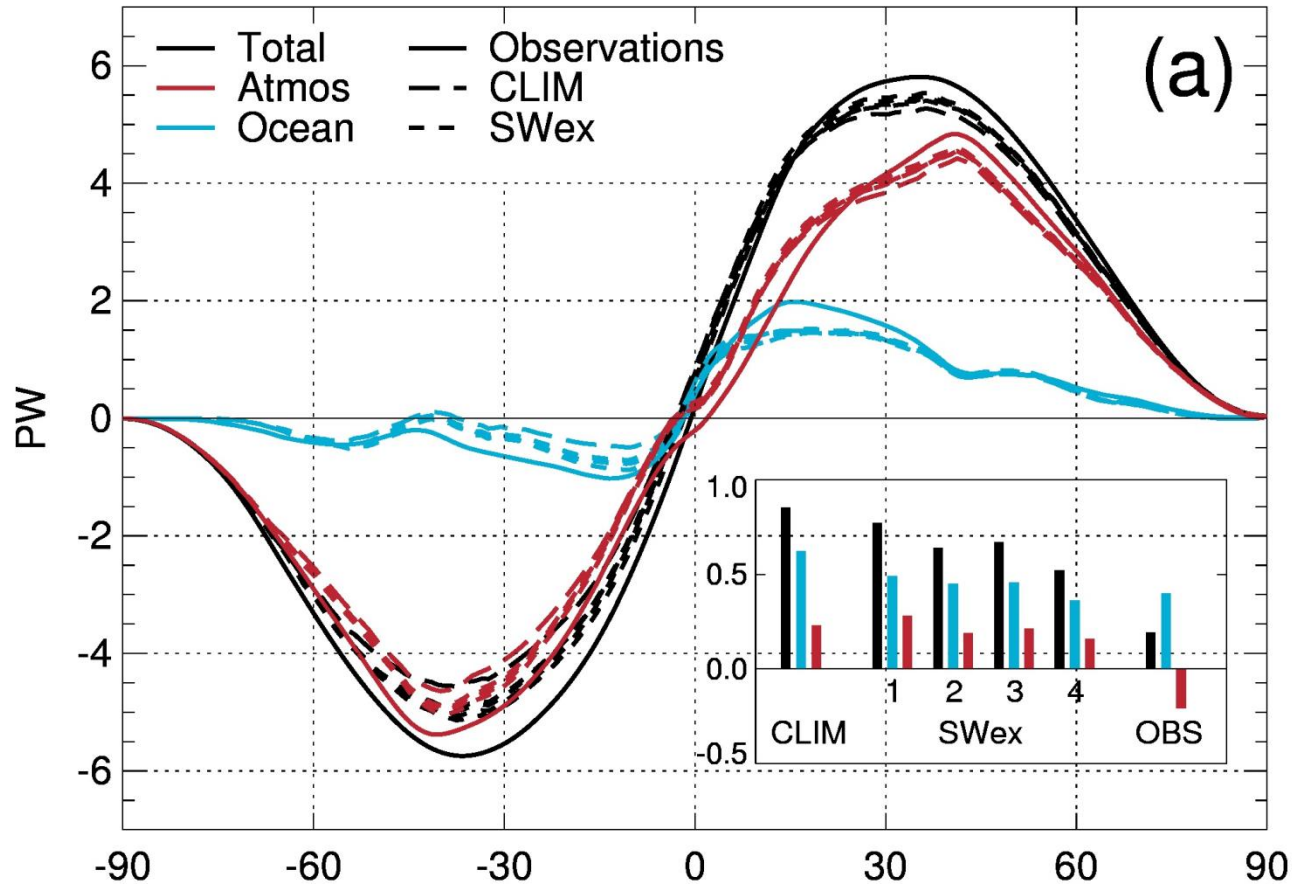
Adjustments to ocean albedo

Correcting SW biases

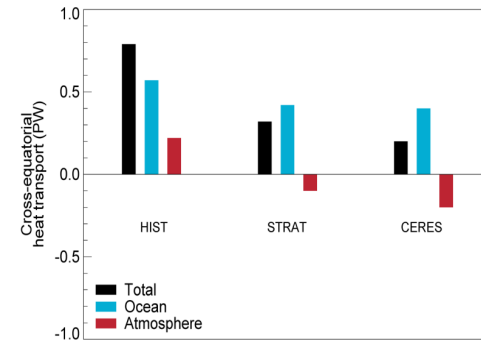
TOA balance within $\sim 0.5 \text{ W m}^{-2}$ of observations



Energy transport changes



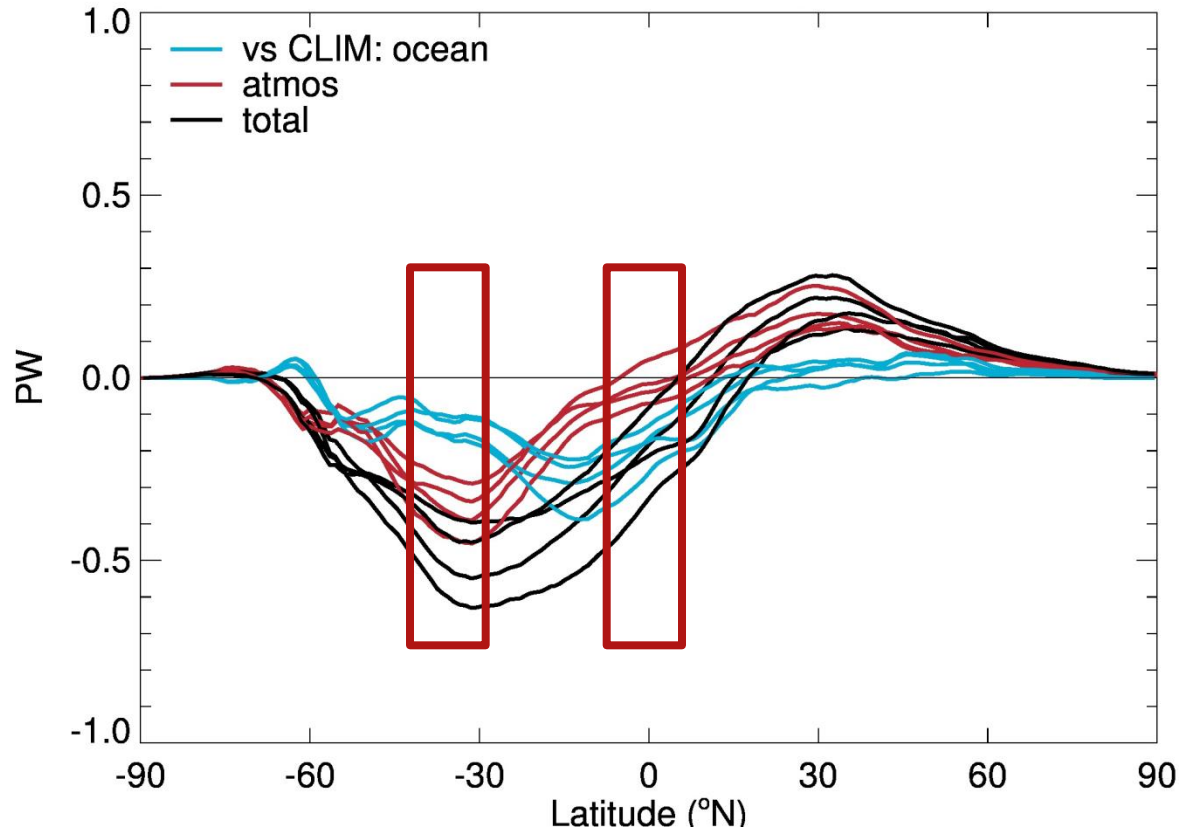
Total, atmosphere and ocean all improve BUT not as dramatic a change at the equator



Obs: G. Stephens/J. Fasullo/M. Balmaseda



Energy transport changes

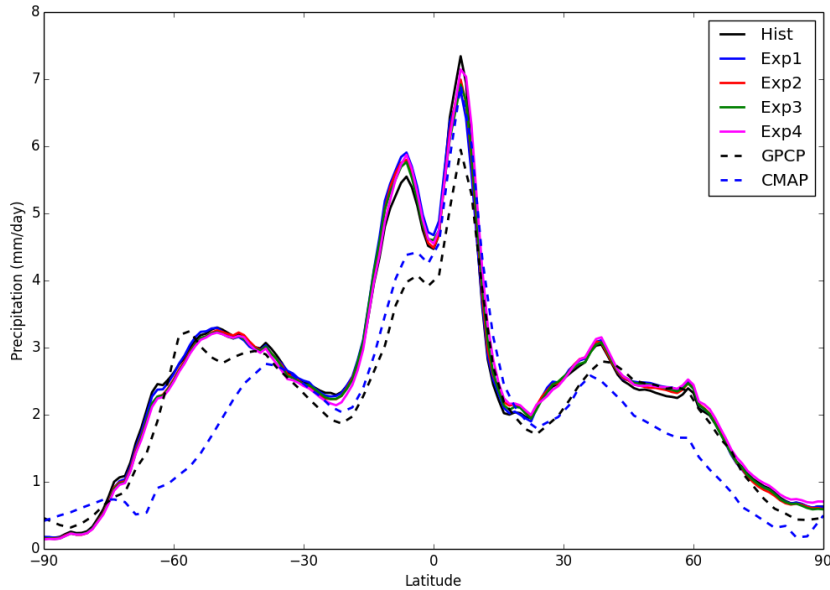


In tropics, most of the energy transport change is in the ocean
In the mid-latitudes, it is mostly in the atmosphere



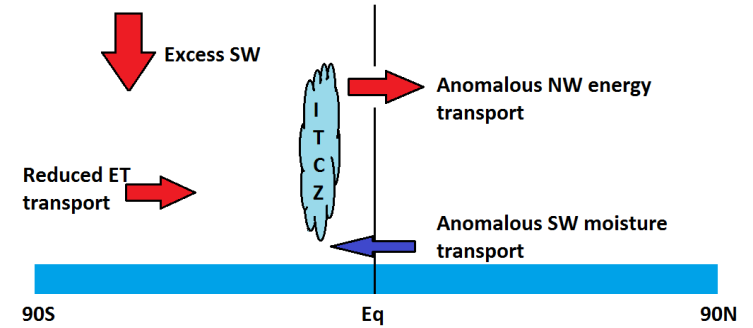
What about the ITCZ?

Global zonal mean precipitation

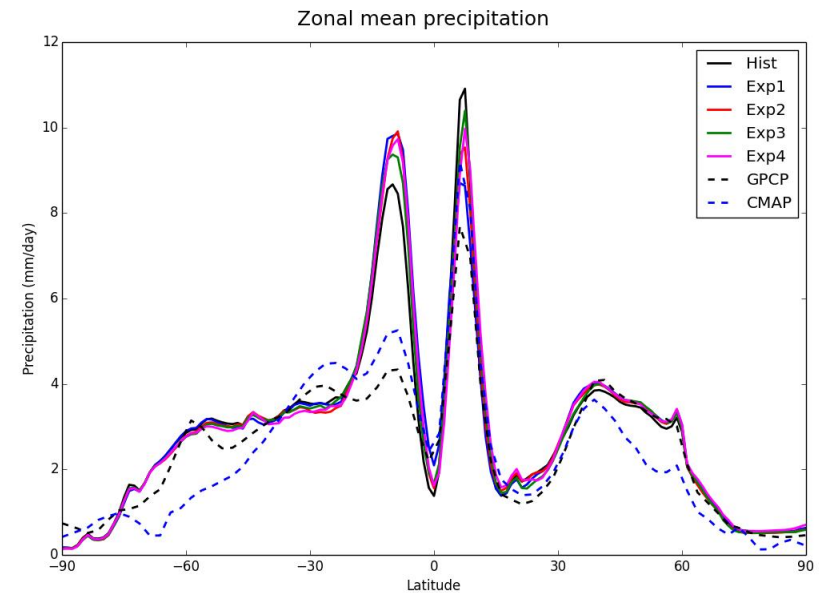


Double ITCZ slightly worse

No significant change in Atlantic sector/WAM.



Pacific zonal mean precipitation



What about other papers?

Kang et al., 2008	Slab ocean	
Kang et al., 2009	Slab ocean	
Frierson and Hwang, 2012	Slab ocean	Understanding of controls in atmosphere
Cvijanovic and Chiang, 2013	Slab ocean	
Voigt et al., 2014a	Slab ocean	
Voigt et al., 2014b	Slab ocean	
Haywood et al., 2016	Experimental design?	
Kay et al., 2016	Coupled – CESM-CAM5	Very similar results to this study



Ongoing research

To what extent are biases in models related to tropical/extratropical energy budget biases?

Adam et al. (2016) – sym/asym tropical pr biases vs net energy input/xEq energy transport

To what extent is the model response dependent on the latitude at which the forcing is applied?

Haywood et al. (2016) vs Hawcroft et al. (2016)/Kay et al. (2016)

How does the response vary by hemisphere?

Deser et al. (2015), Tomas et al. (2016)

