

# Do idealized climate change experiments capture the response of realistic experiments?

Brian Medeiros  
with Bjorn Stevens & Sandrine Bony

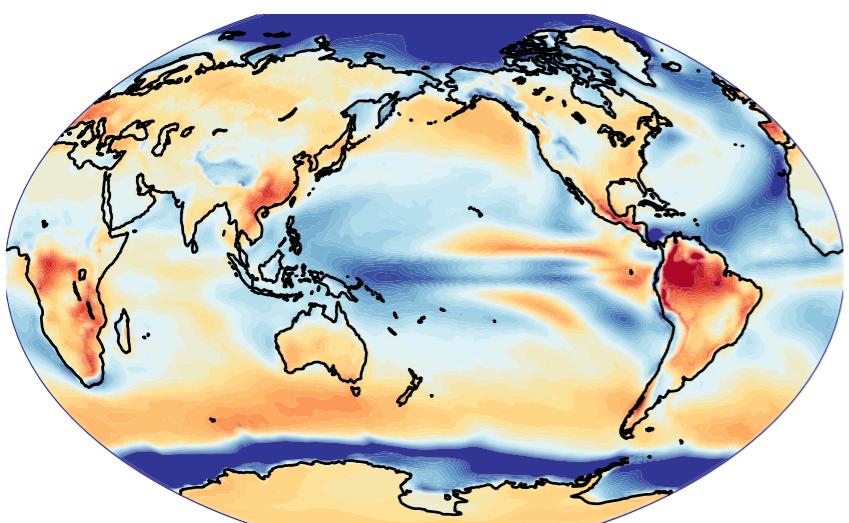


NCAR Earth System Laboratory,  
Climate & Global Dynamics Division,  
Atmospheric Modeling & Predictability

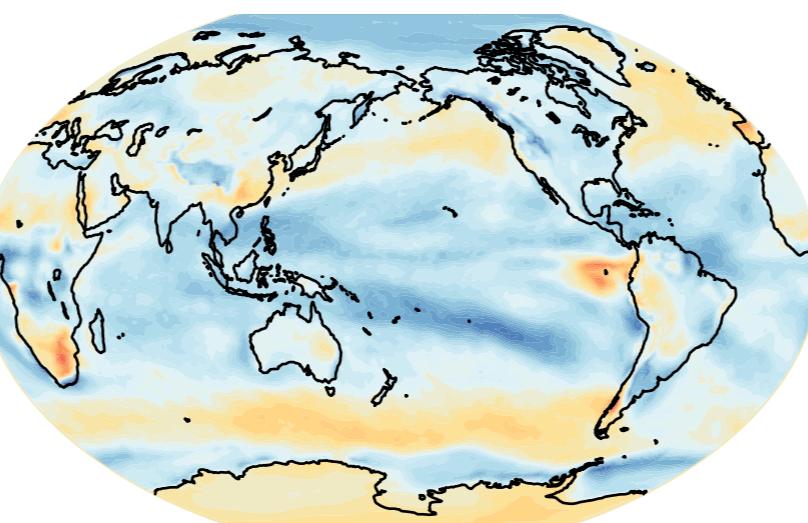


NCAR is sponsored by the  
National Science Foundation

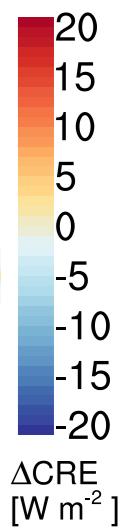
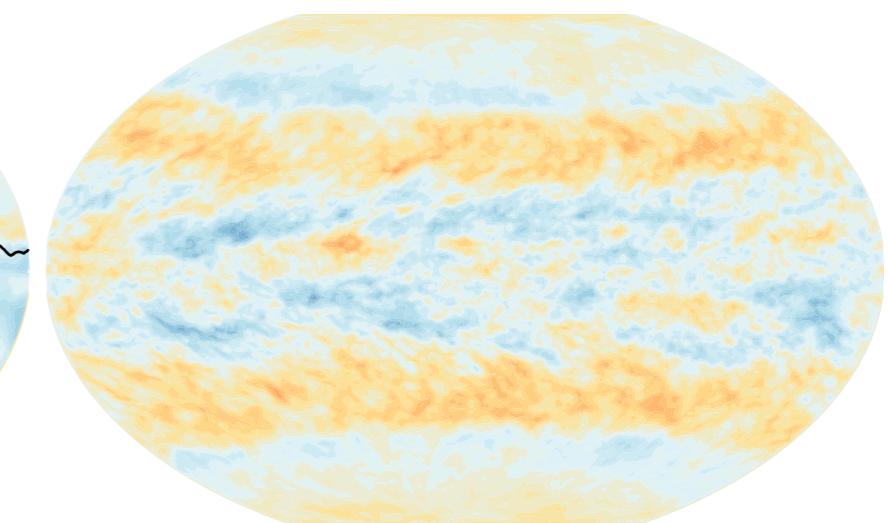
RCP8.5 – Historical  
(22nd C.) – (20th C.)



AMIP4K – AMIP  
(1979–2010) – (1979–2008)



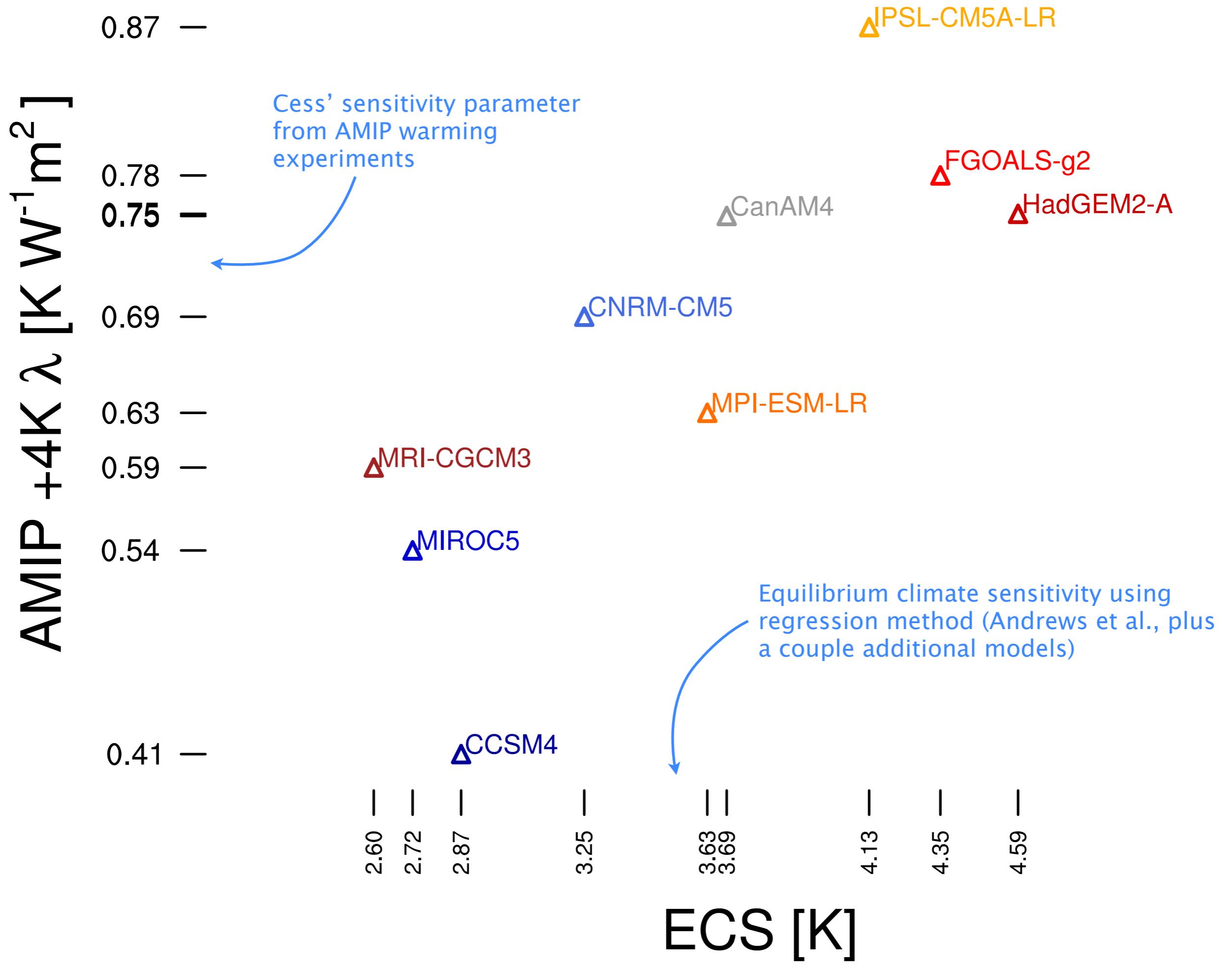
AQUA4K – AQUACONTROL  
4yrs



**ESM to AGCM,**  
no more sea-ice or SST feedbacks

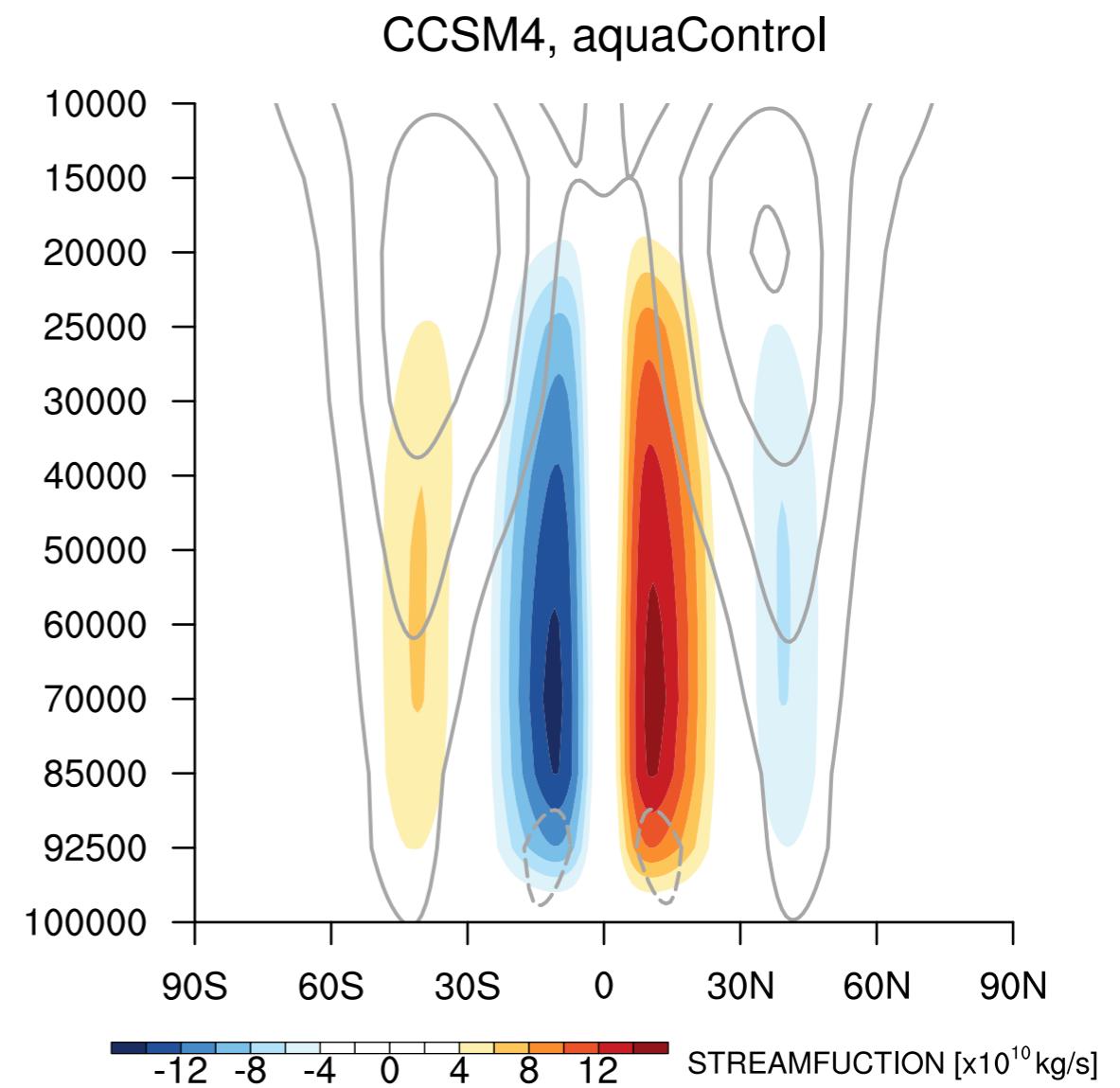
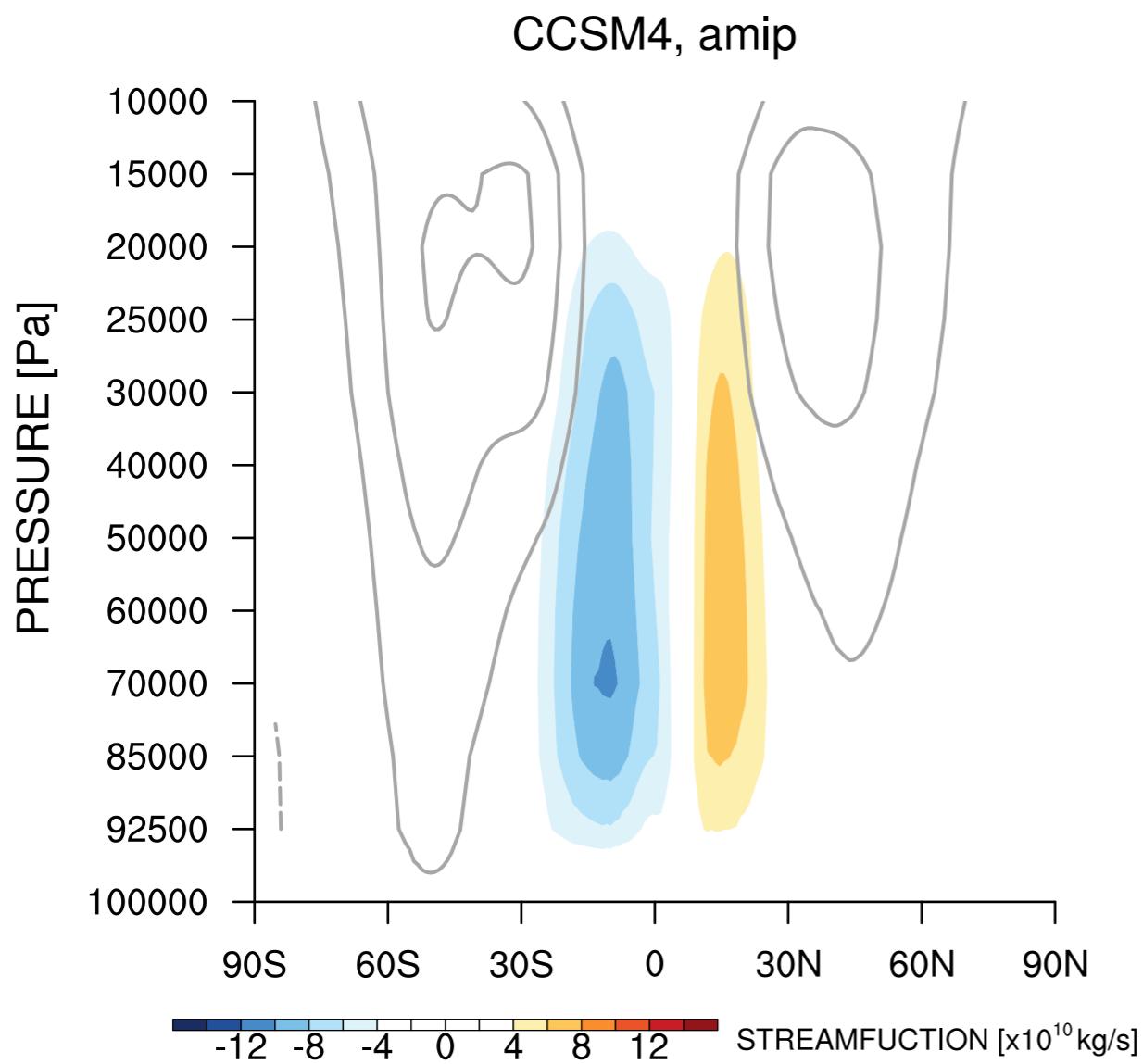
**AGCM to aquaplanet,**  
no more:  
land-sea contrast, topography,  
surface feedbacks, zonal  
asymmetry, sea-ice, seasons

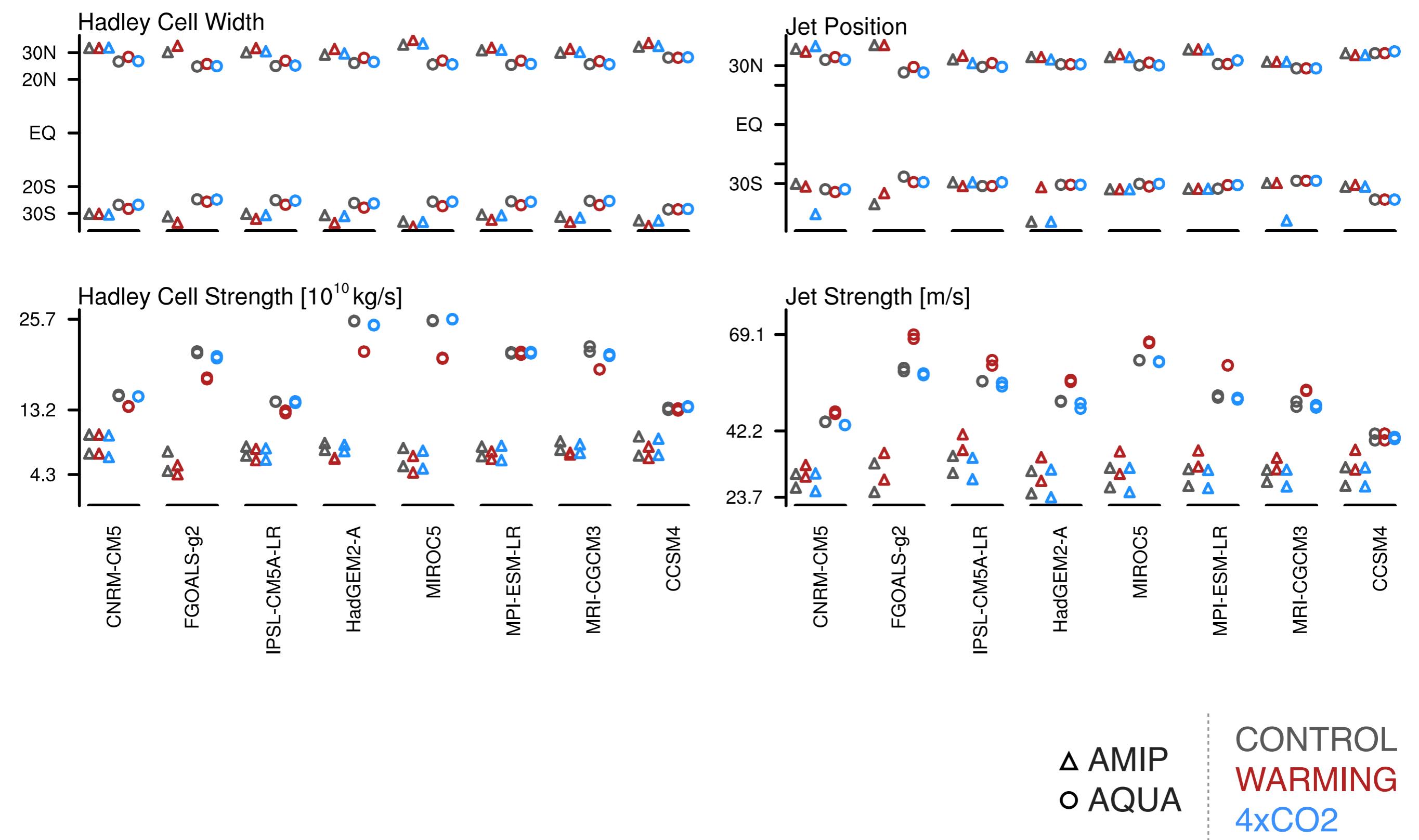
# **Are AMIP warming experiments useful?**



**Do aquaplanets predict AMIP results?**

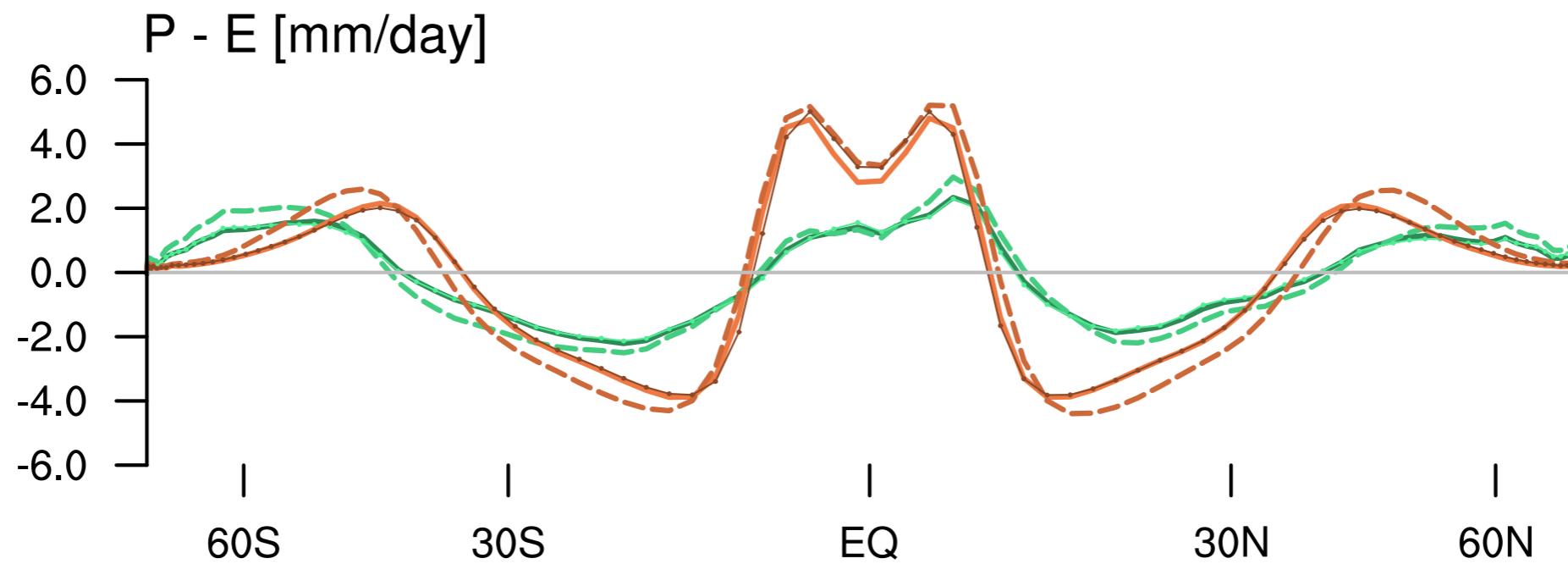
# Circulation



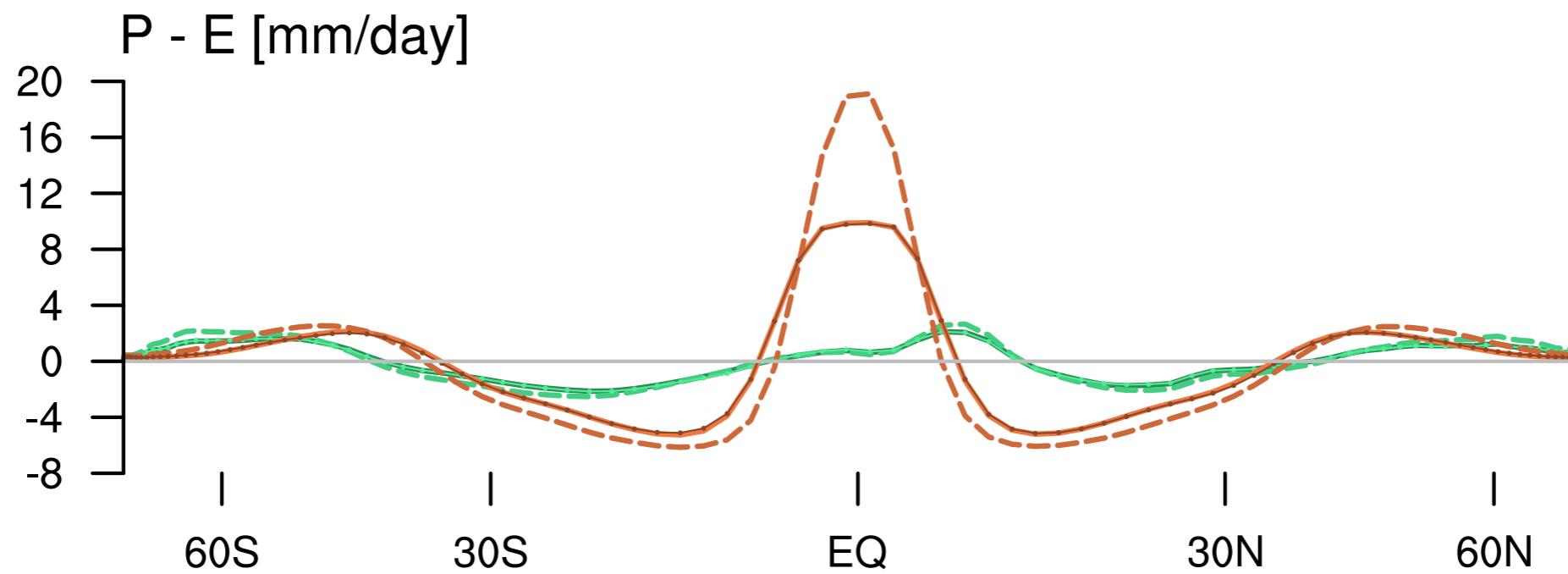


# Hydrologic Cycle

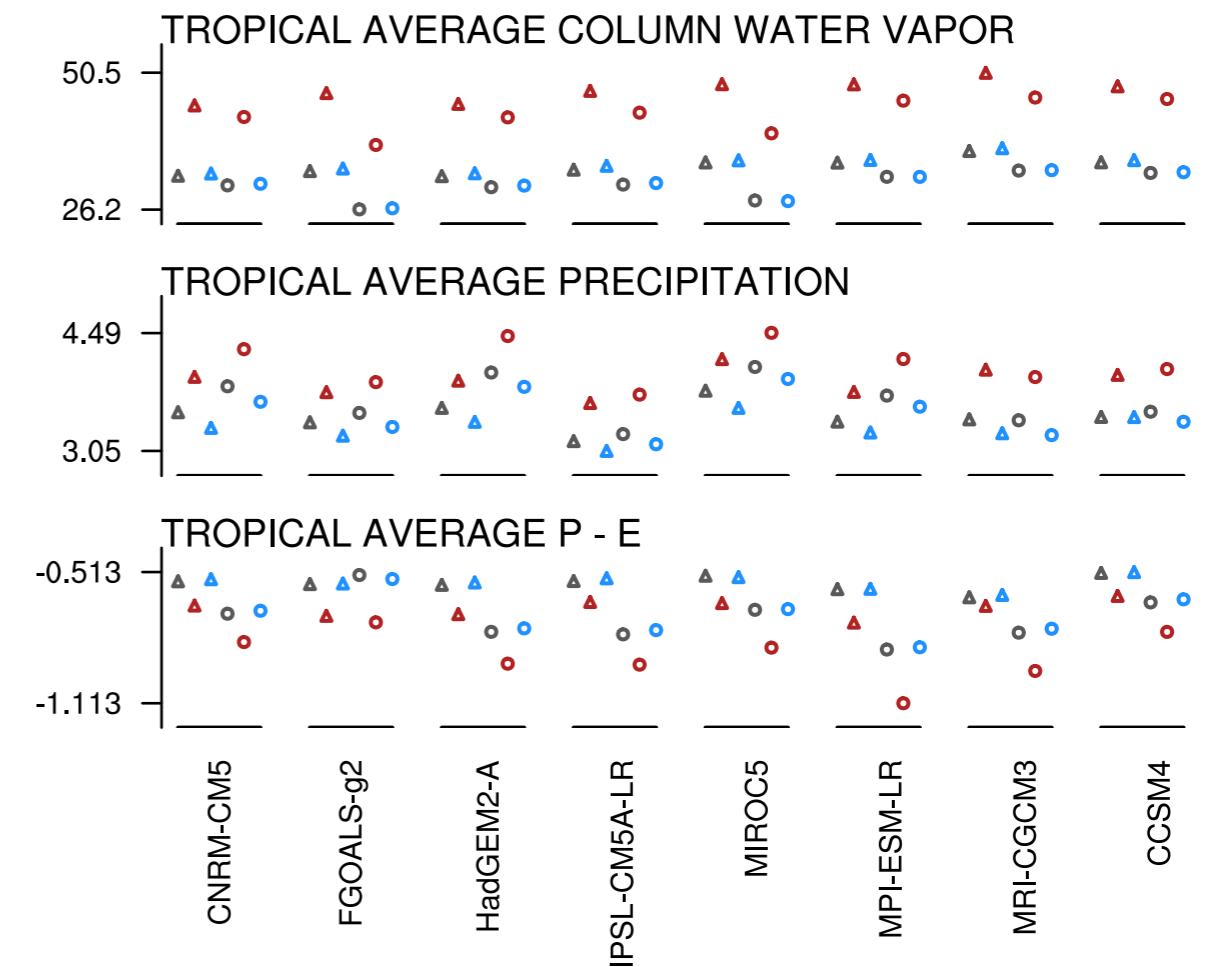
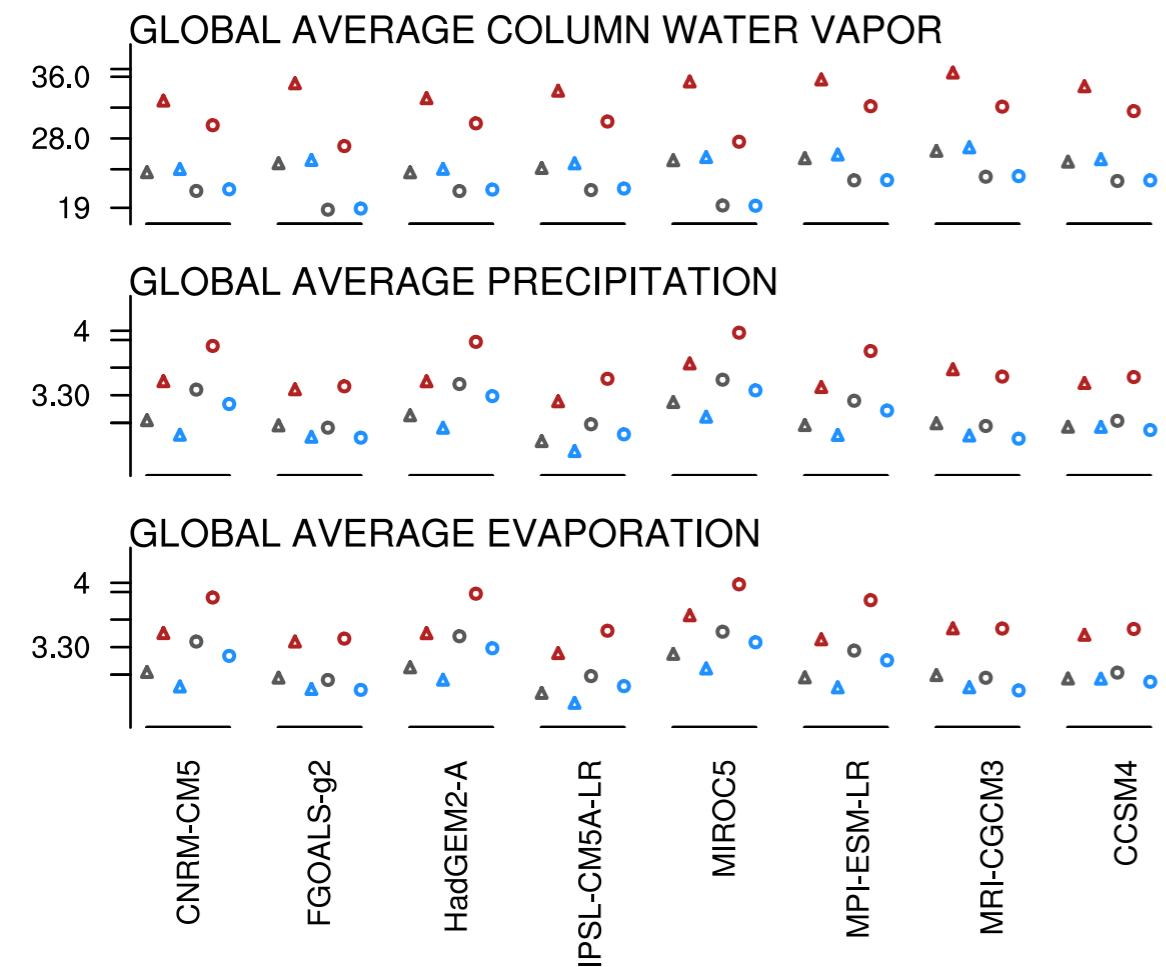
# IPSL-CM5A-LR



# MPI-ESM-LR



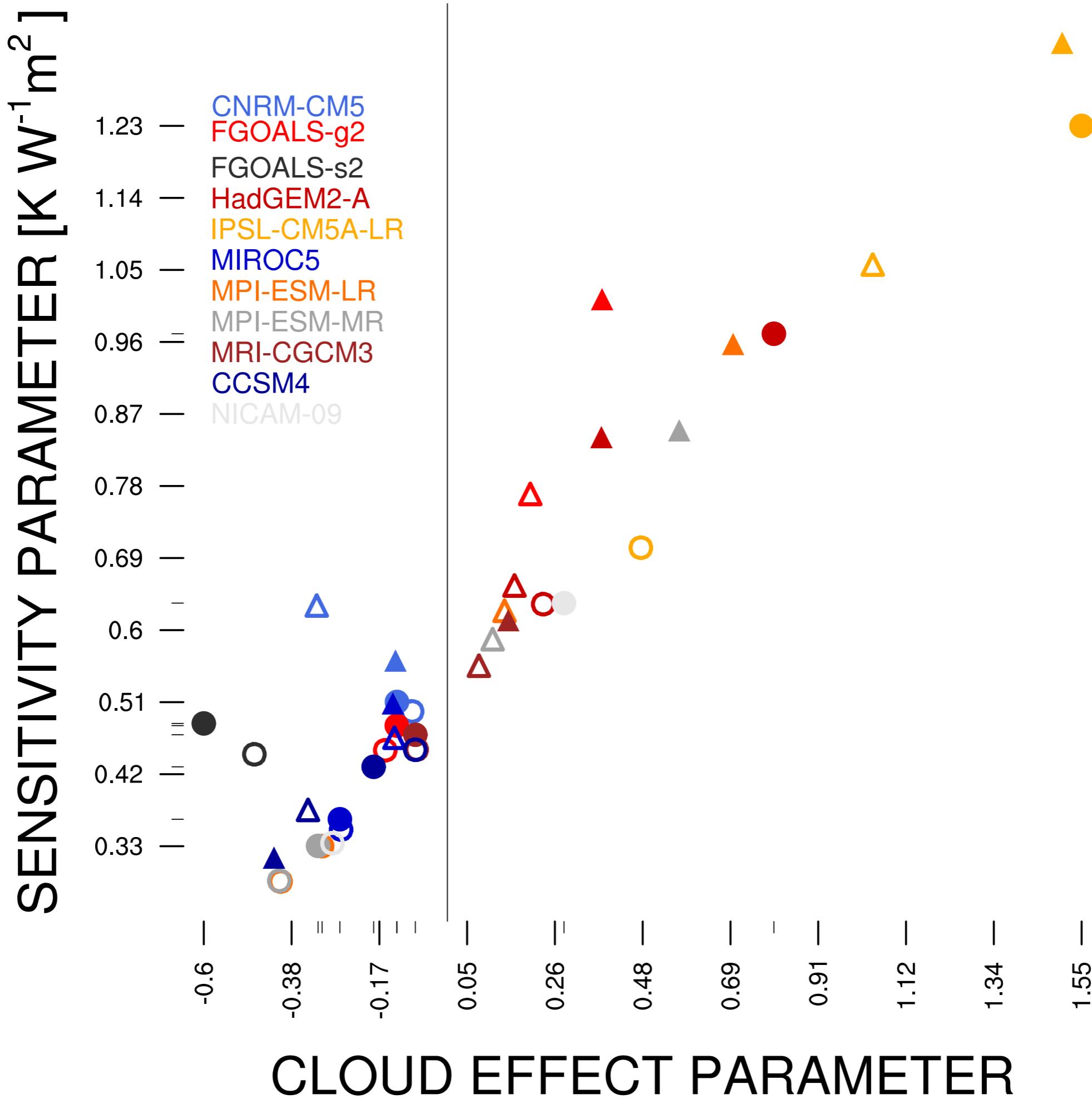
AMIP  
AQUA

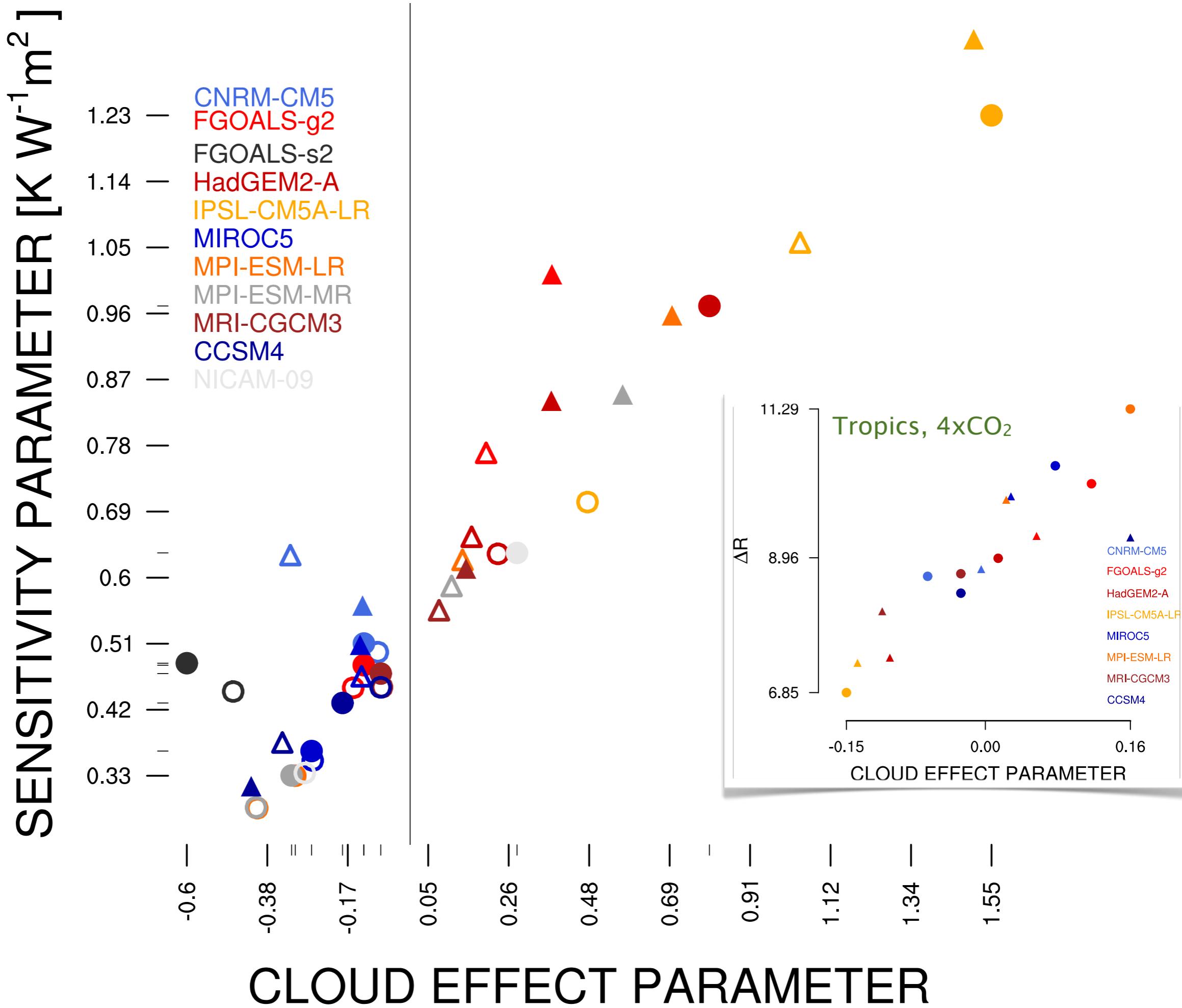


△ AMIP  
○ AQUA

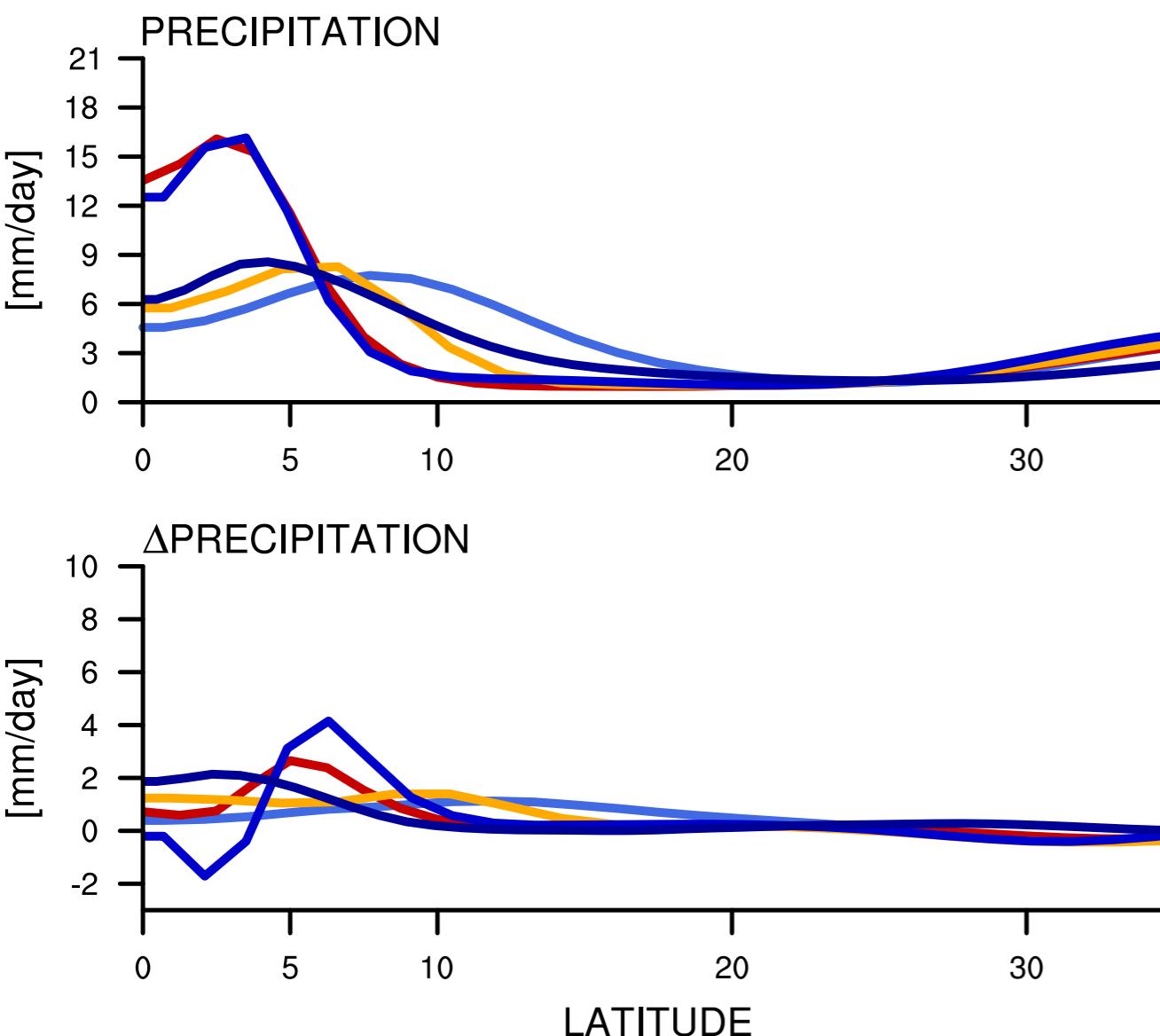
CONTROL  
WARMING  
4xCO<sub>2</sub>

**Cloud Response  
[especially tropical]**

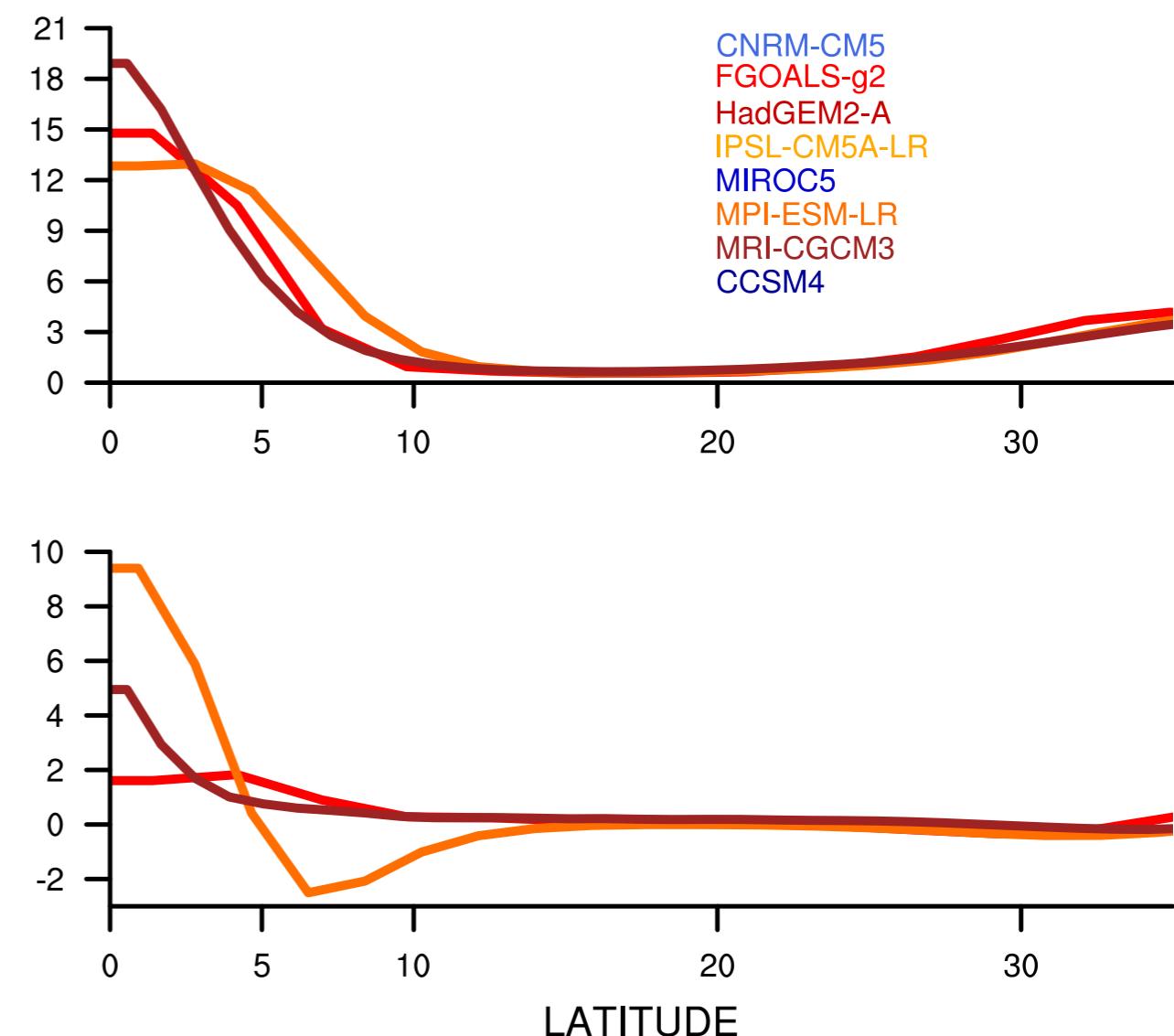


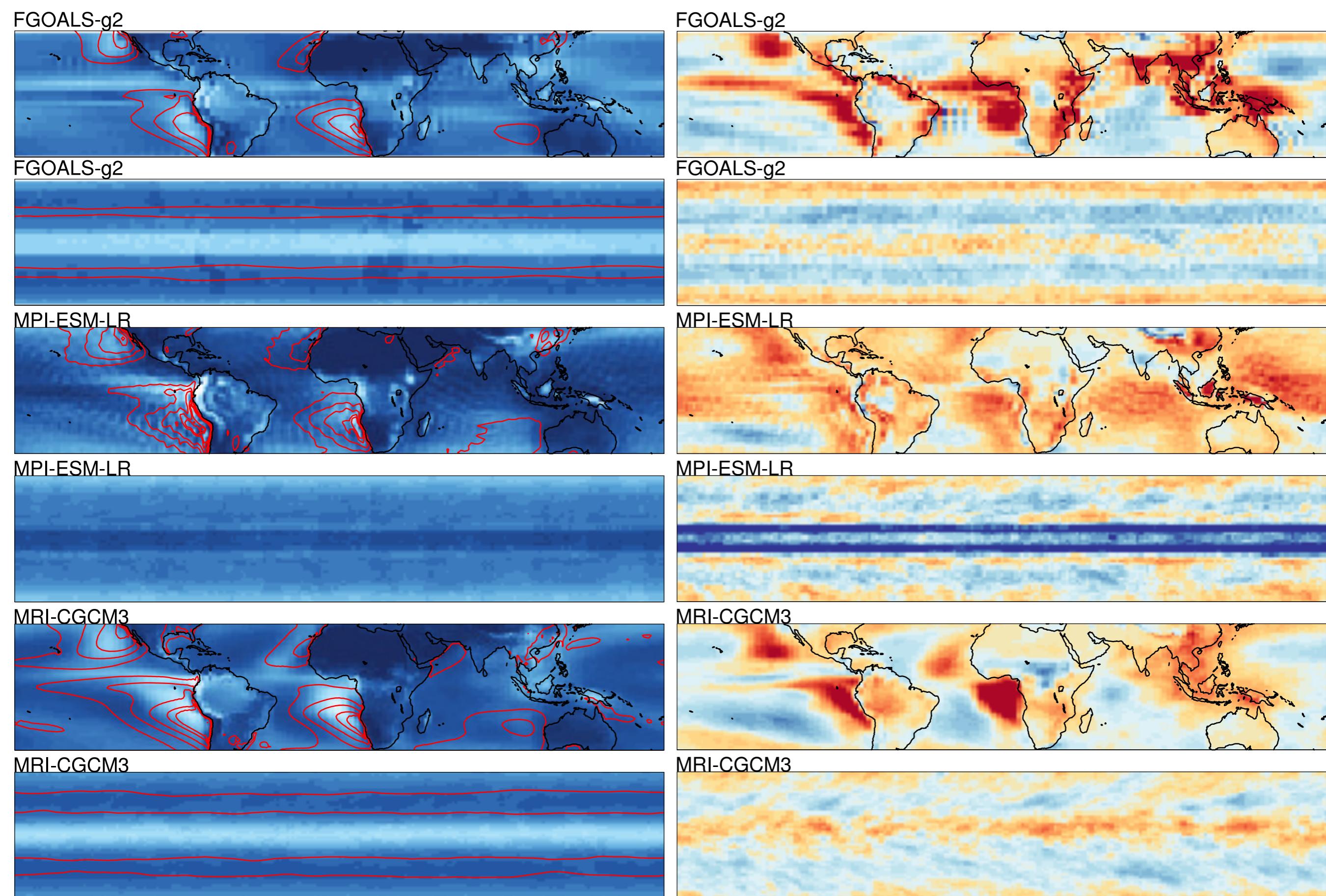


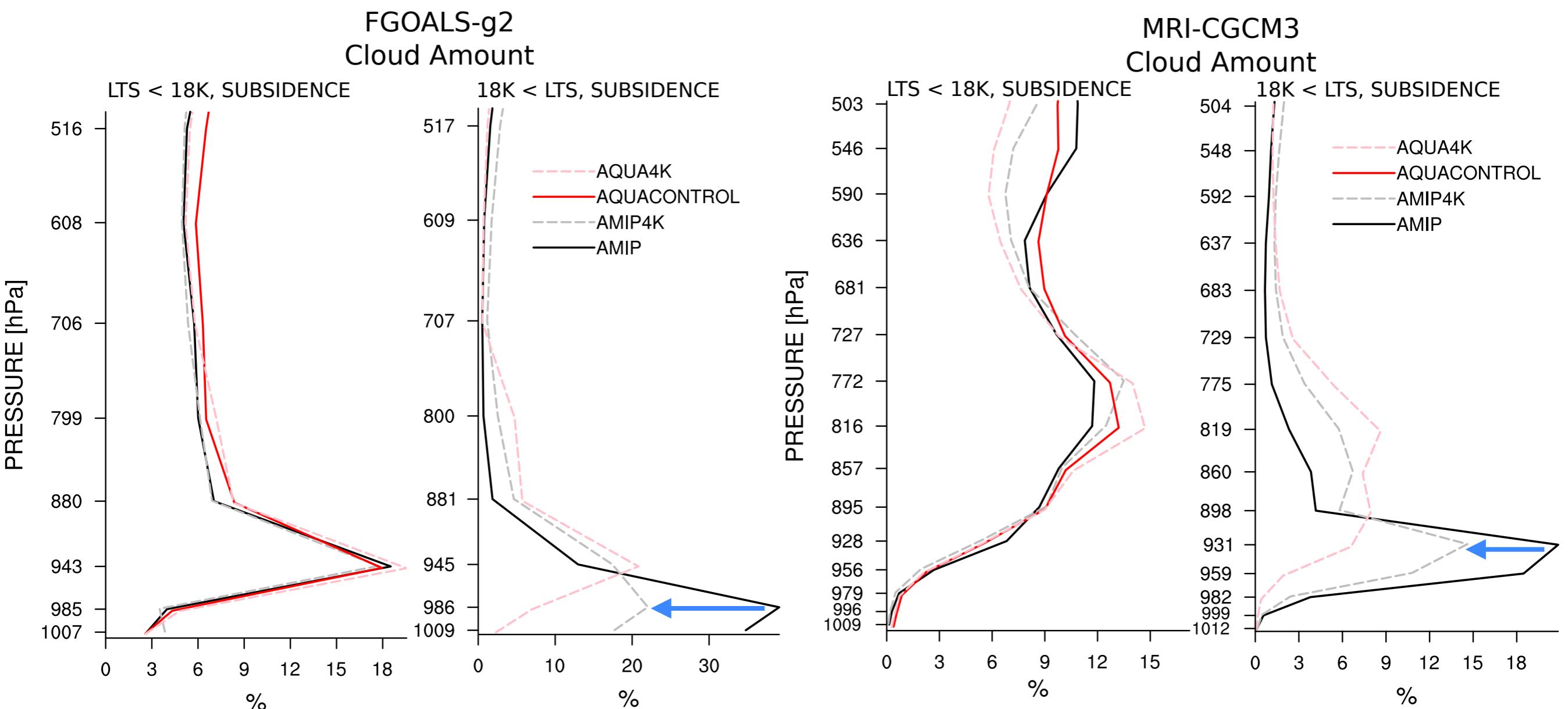
$\text{sign}(\Delta\text{CRE}_{\text{AMIP}}) = \text{sign}(\Delta\text{CRE}_{\text{AQUA}})$ :  
double ITCZ aquaplanet



$\text{sign}(\Delta\text{CRE}_{\text{AMIP}}) \neq \text{sign}(\Delta\text{CRE}_{\text{AQUA}})$ :  
single ITCZ aquaplanet

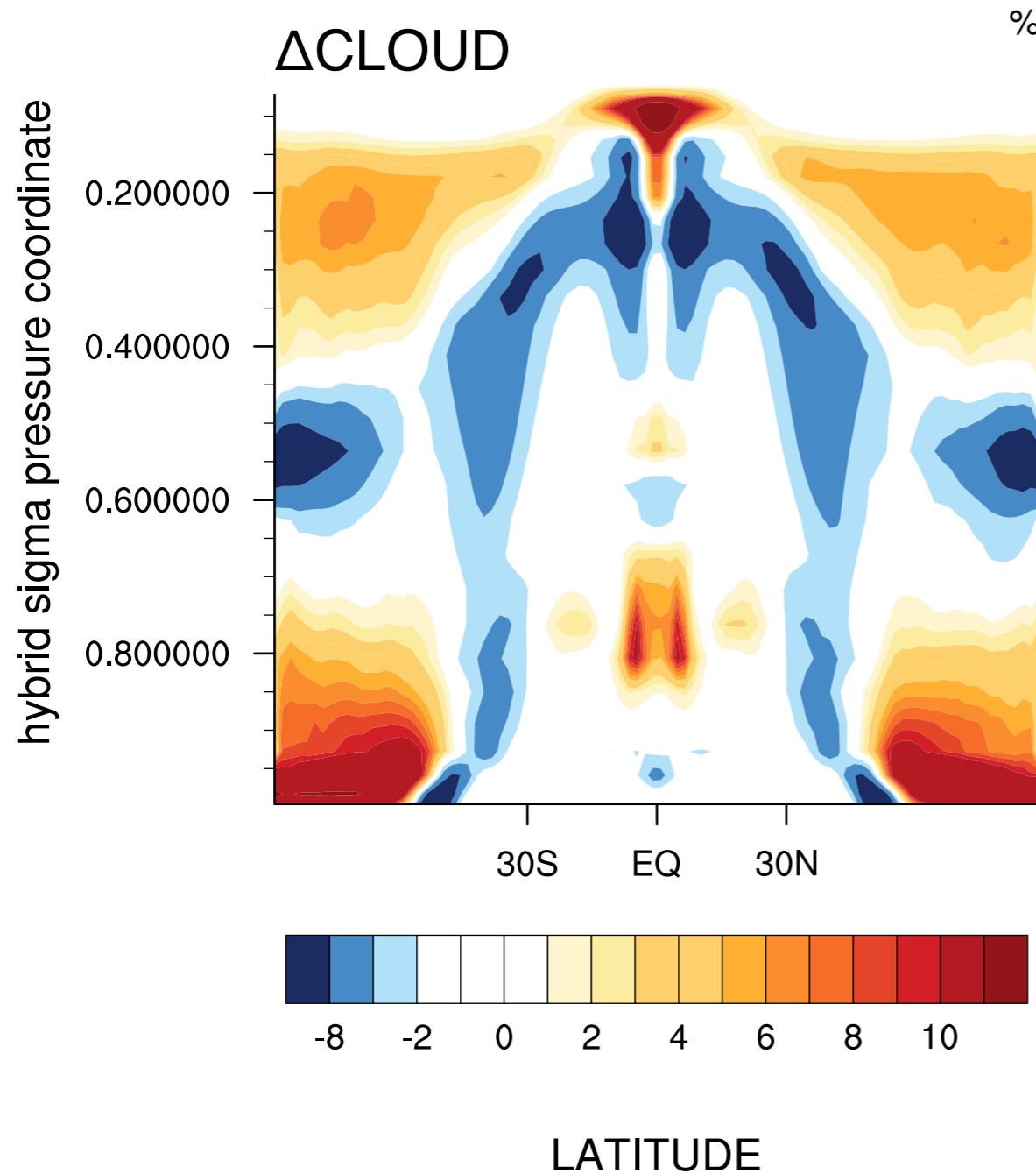




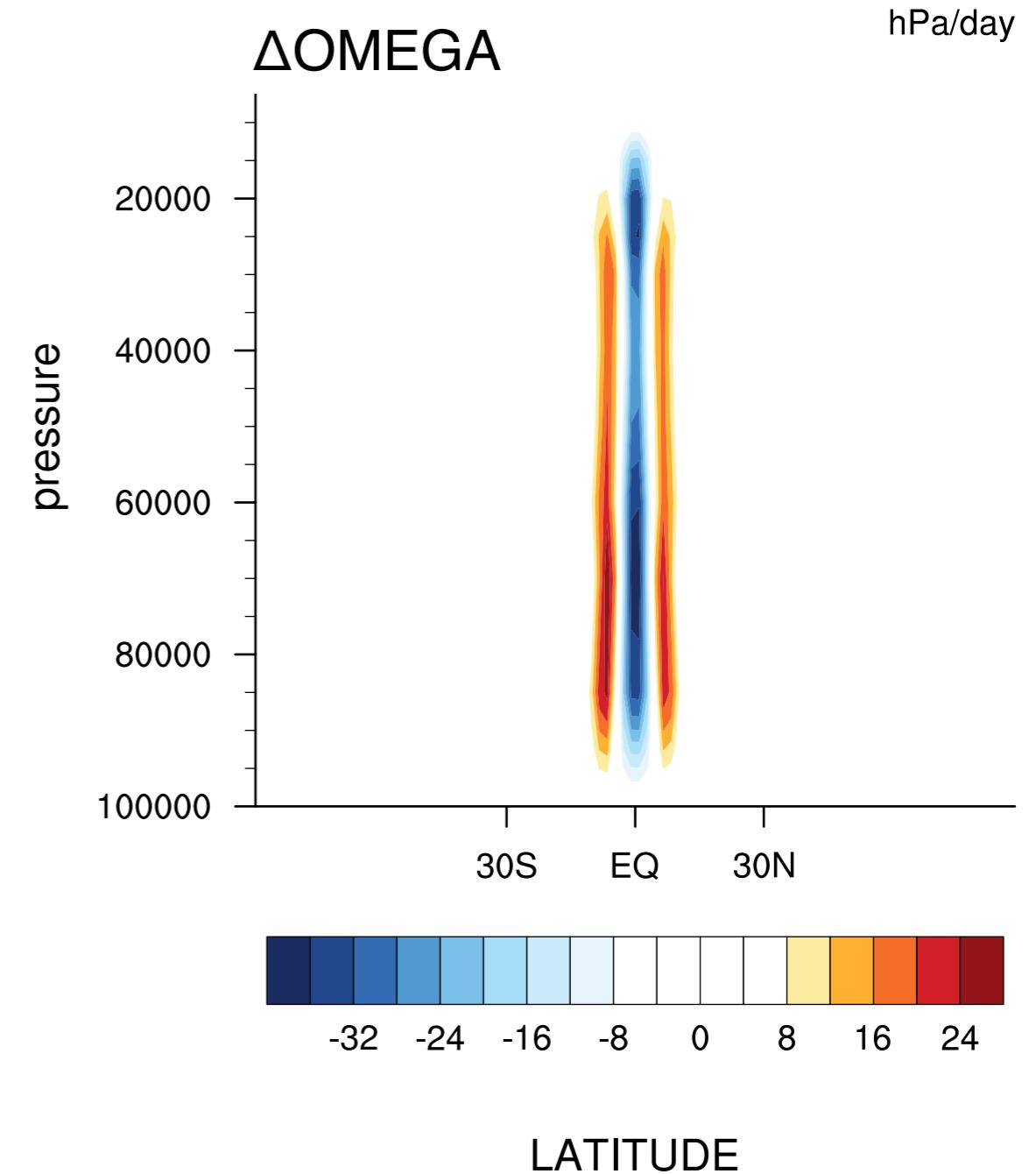


LTS > 18K accounts for more  
than half the tropical CRE  
change in these models.

MPI-ESM-LR, Cloud Area Fraction



MPI-ESM-LR, omega ( $=dp/dt$ )



Narrower ITCZ opens new  
areas of shallow cumulus.

- AMIPs shows correspondence with equilibrium climate sensitivity
- WARMING
  - Hadley Circulation weakens & widens.
  - Midlatitude Jet strengthens (no robust position change).
  - Column water vapor increases (~7%/K)
  - Precipitation increases (~2–3%/K)
  - Cloud response is varied, aqua predicts AMIP in 5/8 cases.
- TROPOSPHERIC ADJUSTMENT
  - Slight weakening of Hadley Circulation & Jet without movement
  - Continental warming => increase in column water vapor
  - Hydrologic cycle slowdown
  - Weak & varied cloud change; aqua predicts sign(AMIP) in 7/8 cases.
- Aquaplanets do capture many aspects of realistic configurations.
  - when they don't, an opportunity to better understand the model