

# GLOBAL CHANGES IN PRECIPITATION MINUS EVAPORATION



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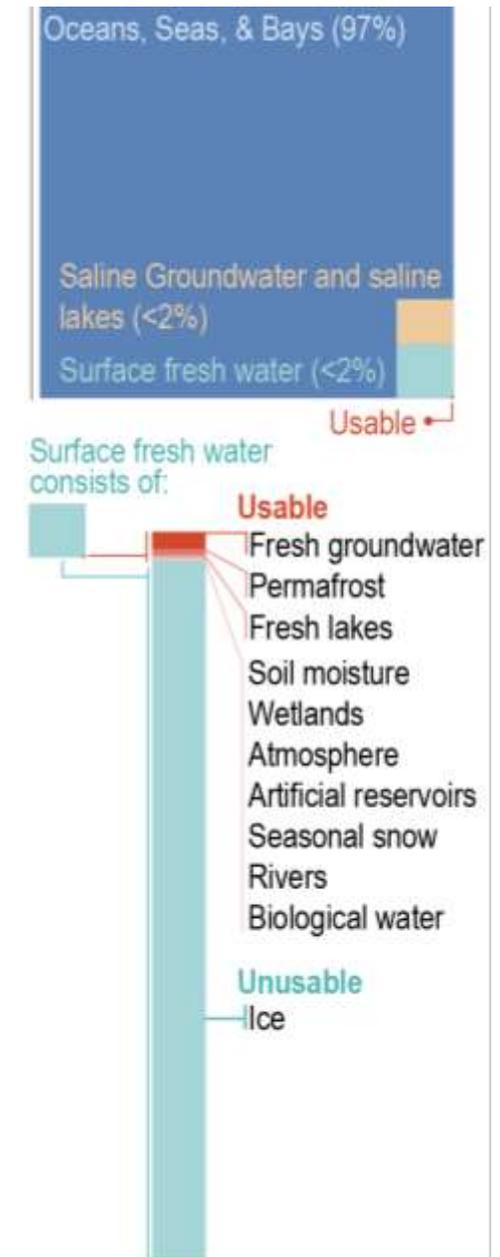
Tropical Group, 4th March 2023

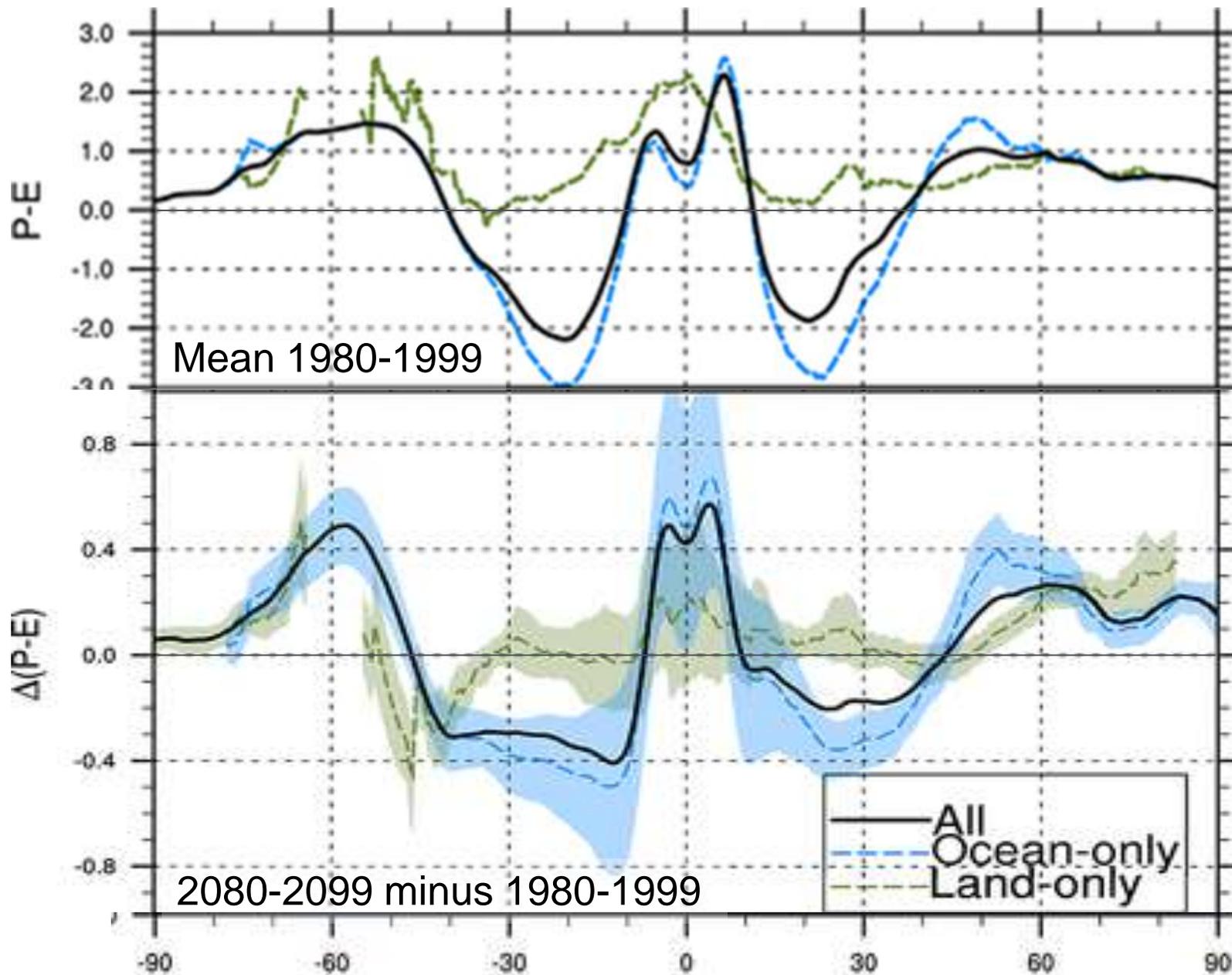


# INTRODUCTION

- Precipitation minus Evaporation (P-E) determines surface freshwater flux
  - Freshwater availability (land)
  - Surface salinity and circulation (ocean)
- Amplified P-E patterns reflect intensification of the water cycle: [IPCC, 2021 SPM]

*“Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.”*
- P-E maximum reflects wet season/months, precipitation driven
- P-E minimum driven by lack of precip, high evaporation, drying ground – diagnostic of dry period onset intensity

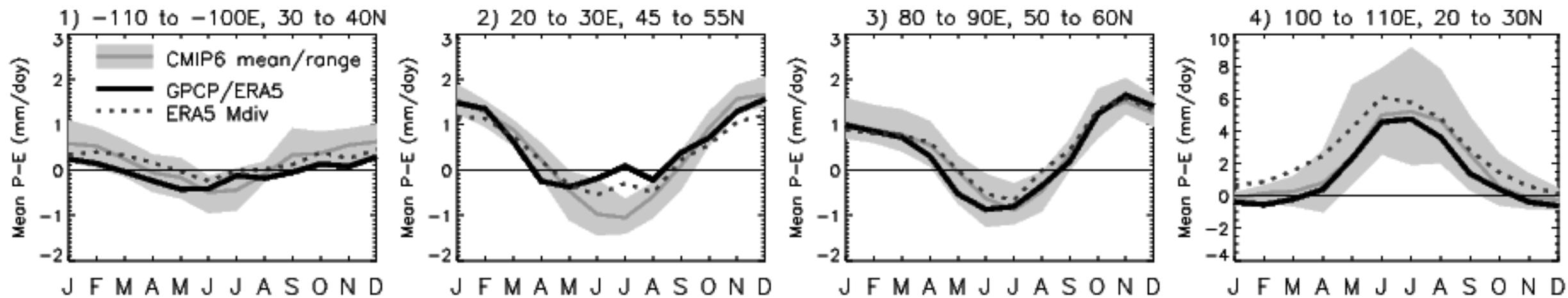




## Wet wetter, dry drier?

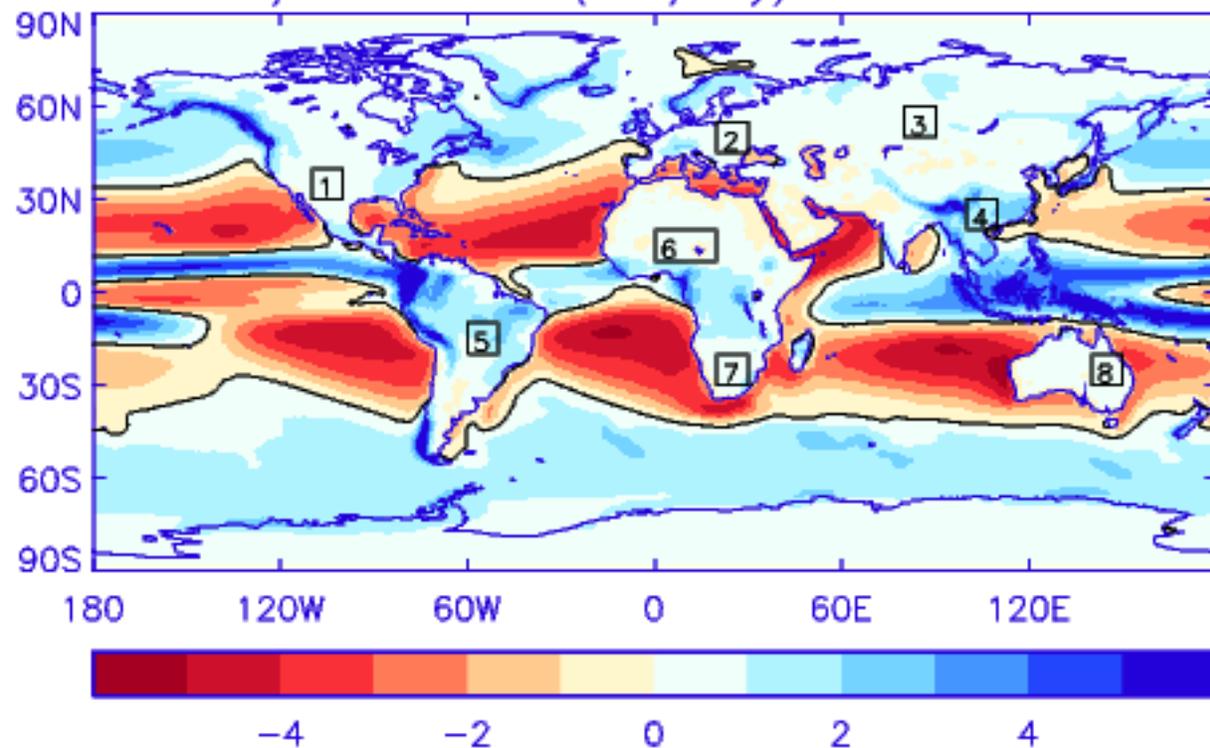
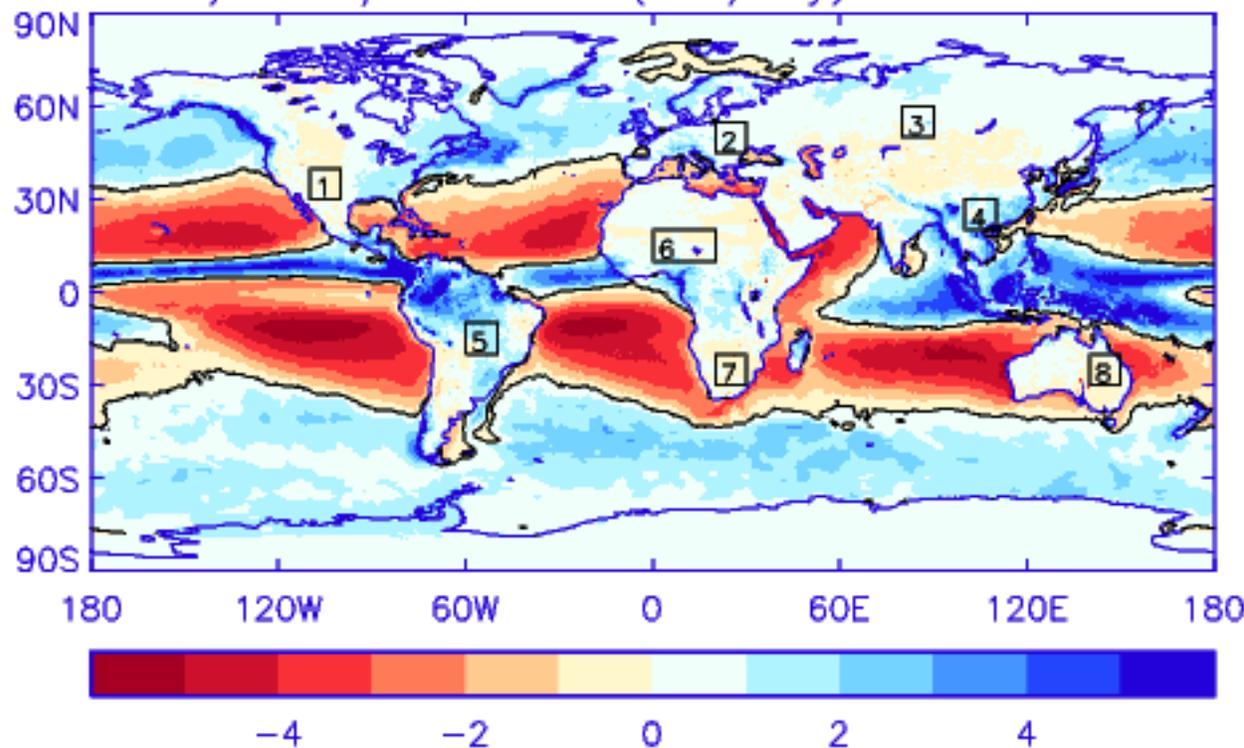
- P-E zonal mean
- P-E zonal mean projected change  
Greve & Seneviratne (2015) GRL

See discussion in Douville et al. (2021) IPCC, Ch 8 (e.g. Section 2.2)

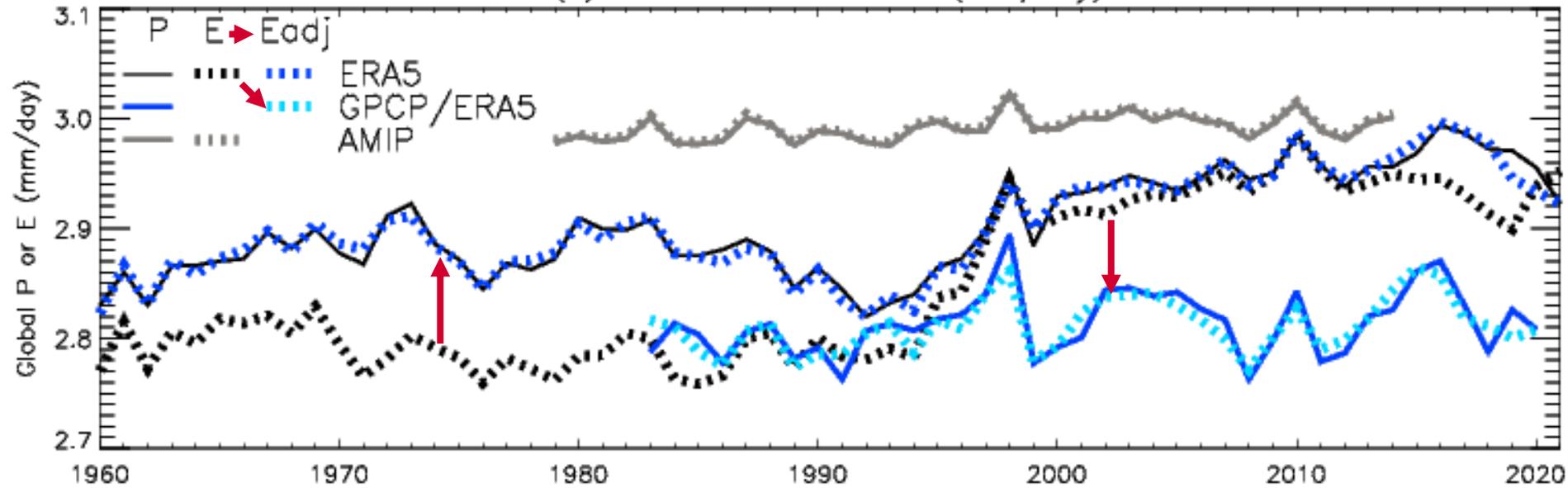


a) GPCP/ERA5 P-E (mm/day) 1995-2014

b) CMIP6 P-E (mm/day) 1995-2014

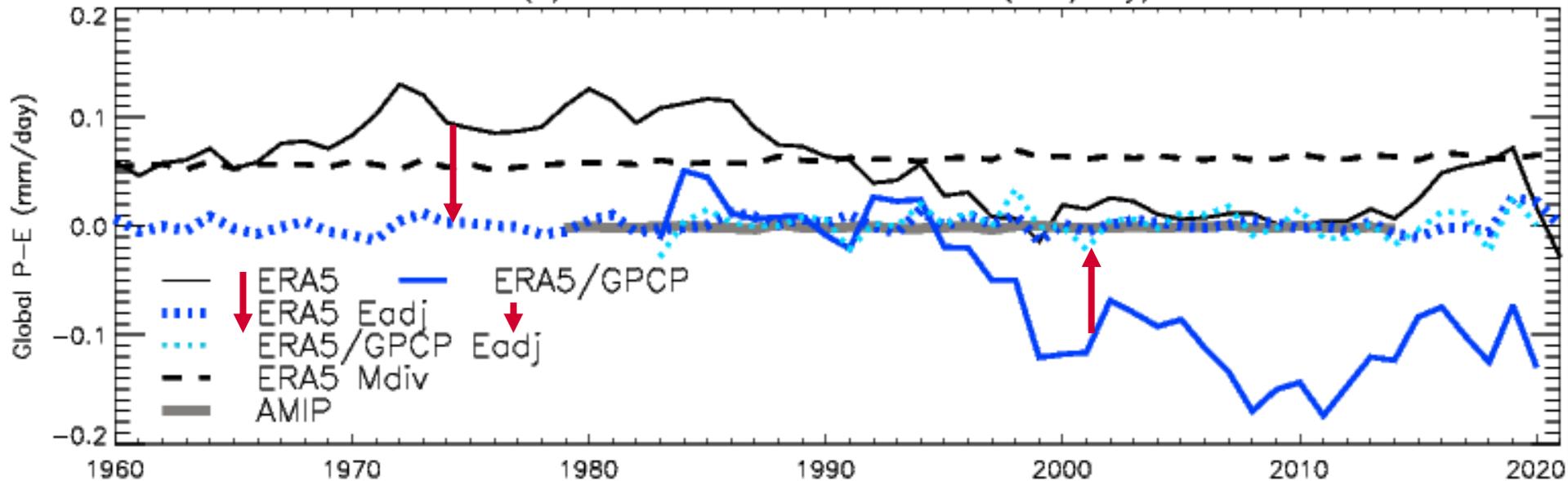


(a) Global mean P and E (mm/day)



Constrain to  
Global mean  
 $P-E=0$

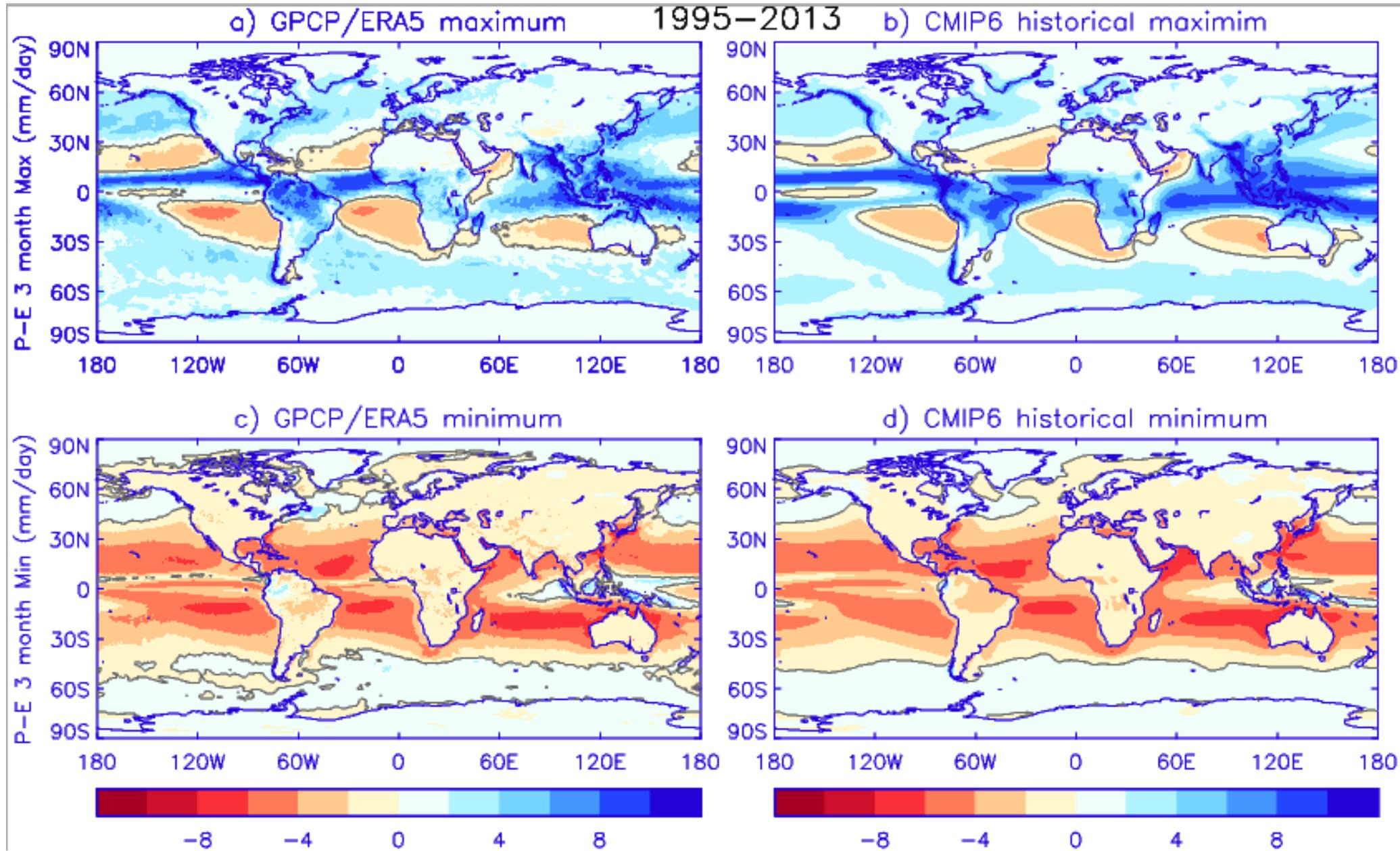
(b) Global mean P-E and Mdiv (mm/day)



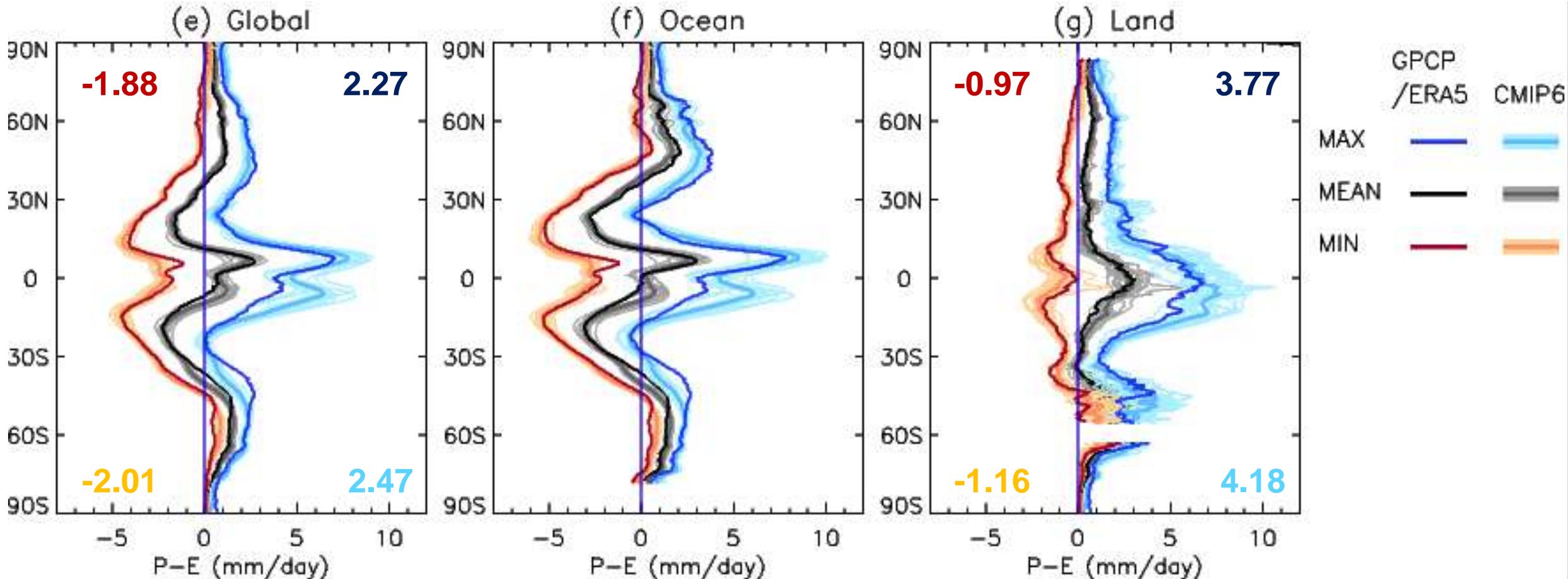
Scale ocean  
P-E

- larger magnitude
- observing system changes
- Land changes looked suspect when scaled

Mean of annual maximum seasonal (3-month) P-E



# Mean of seasonal maximum seasonal (3-month) P-E

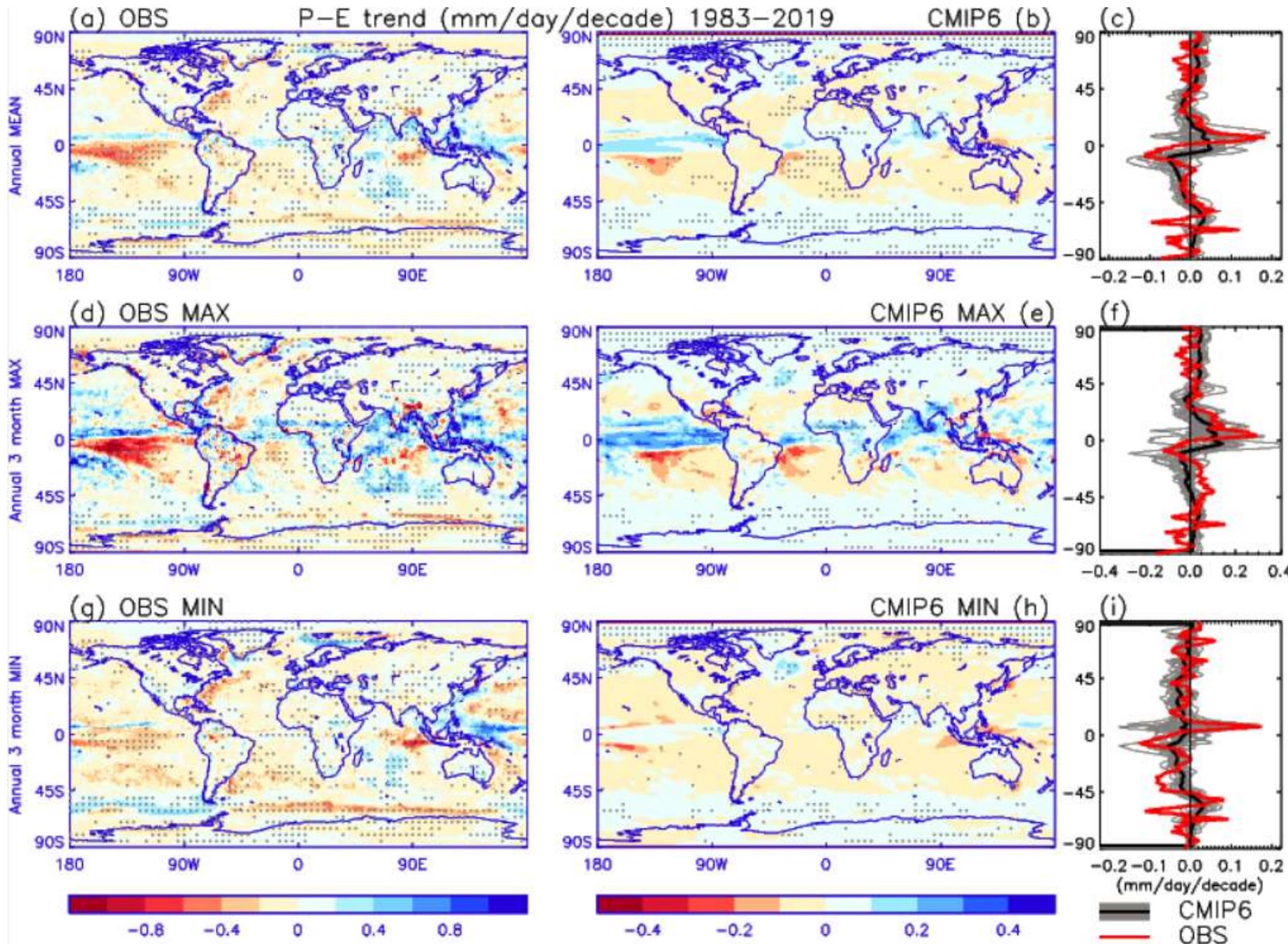


MRI-ESM2-0; ACCESS-ESM1-5: 2.6 mm/day

MRI-ESM2-0; CNRM-ESM2-1: -2.15 mm/day

BCC-ESM1: 4.9 mm/day

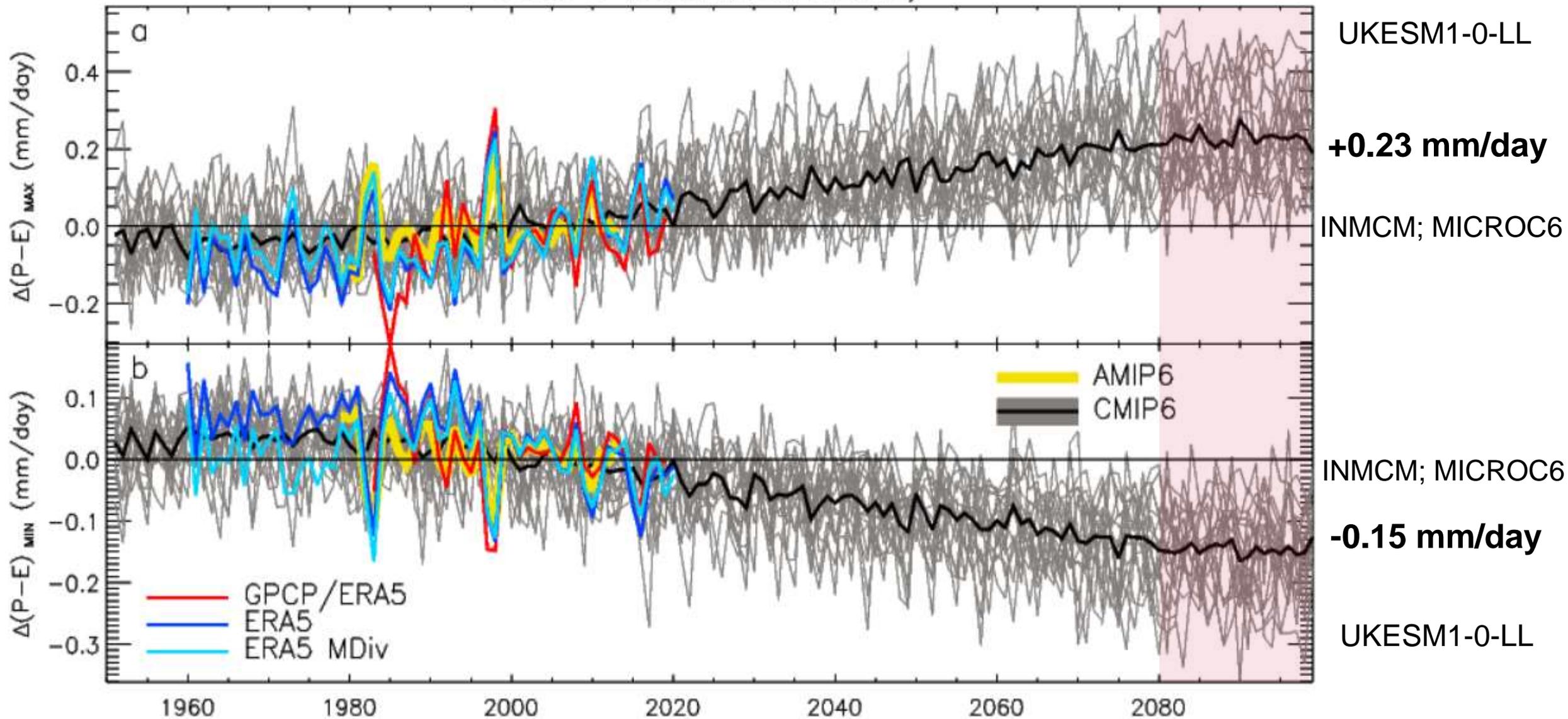
CanESM5; GFDL-ESM4 : -1.5 mm/day



P-E Trends:  
Seasonal  
1983-2019

OBS CMIP6

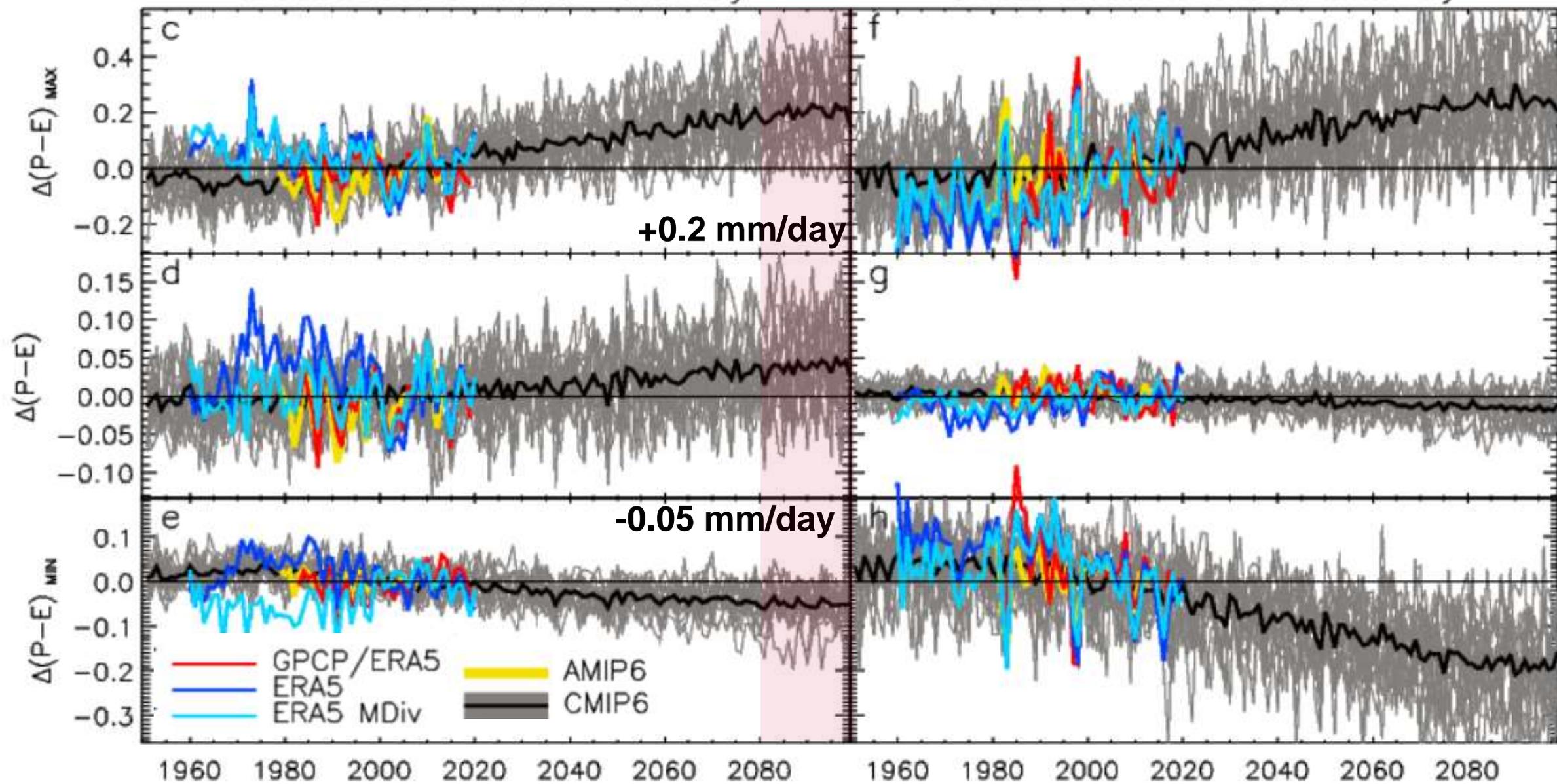
### Global 3 month mean anomaly



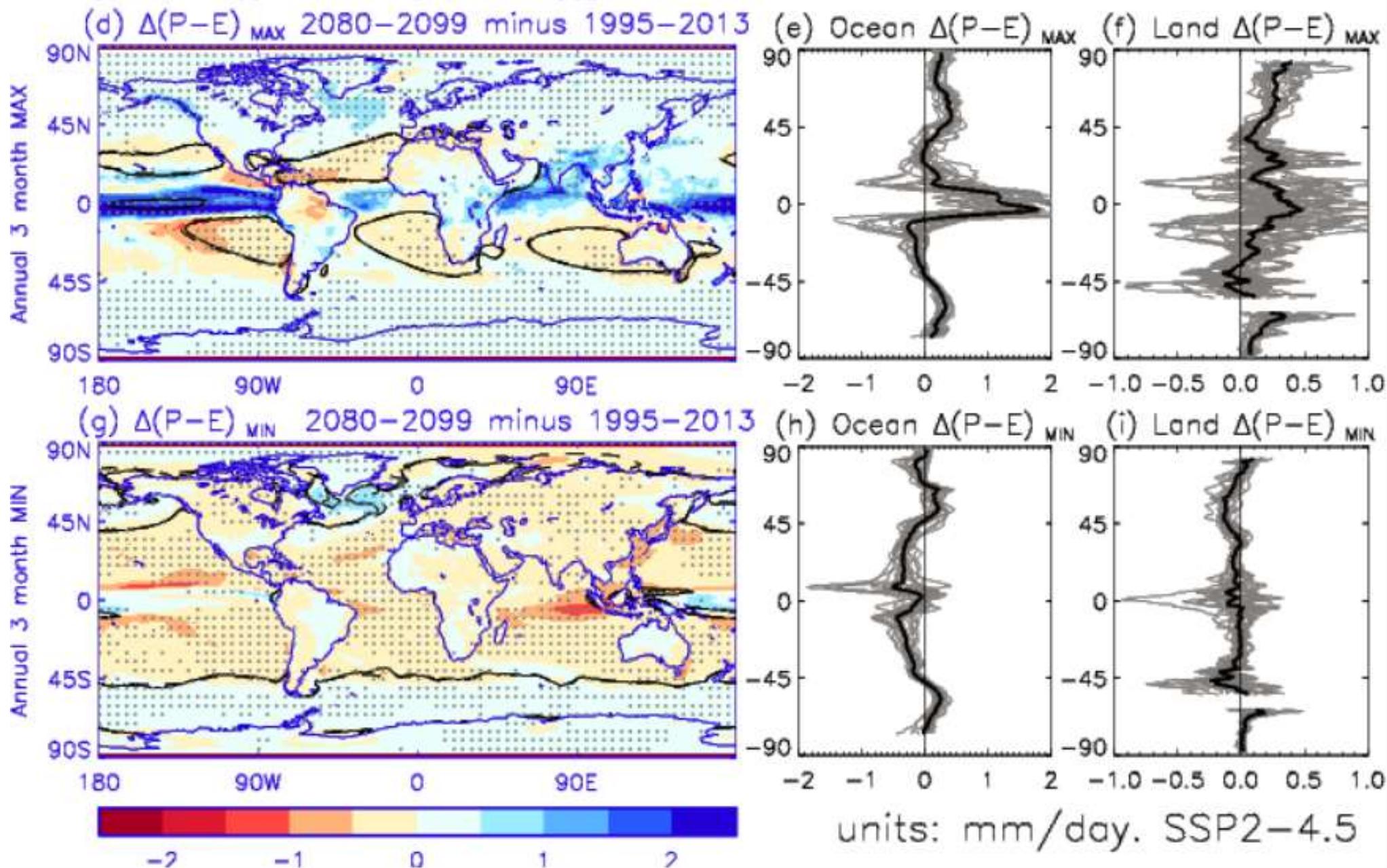
Similar to changes in wettest vs driest regions precip [Liu & Allan \(2013\) ERL](#); [Schurer et al. \(2020\) ERL](#)

Global Land 3 month anomaly

Global Ocean 3 month anomaly



# FUTURE CHANGE



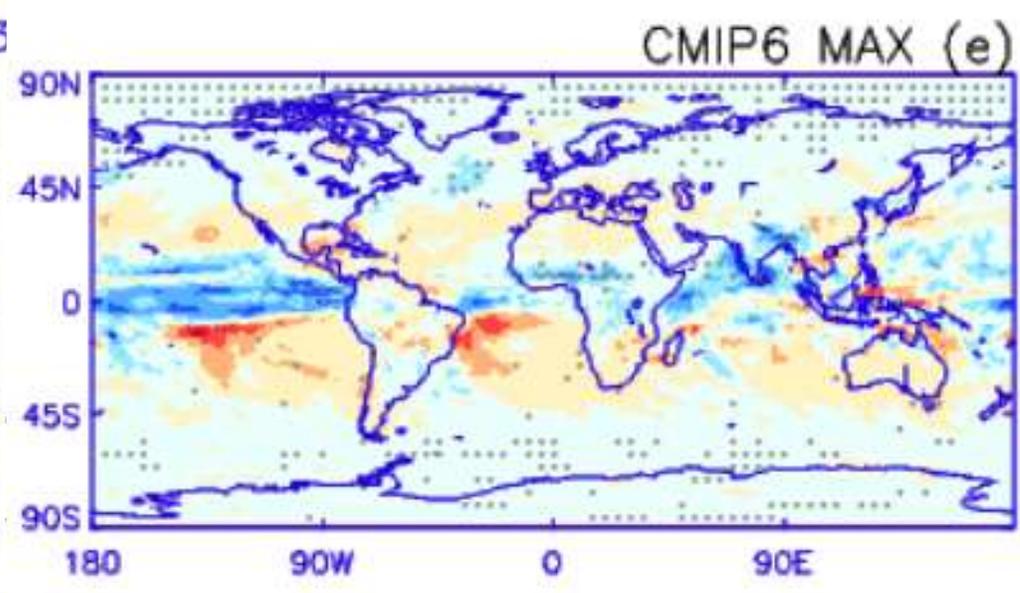
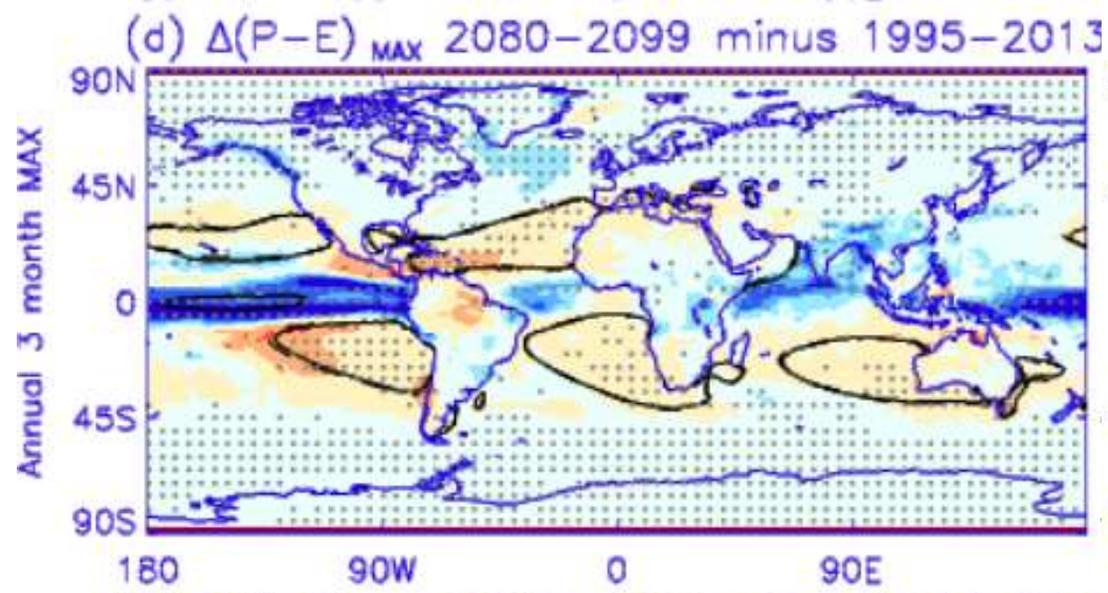
MAX

MIN

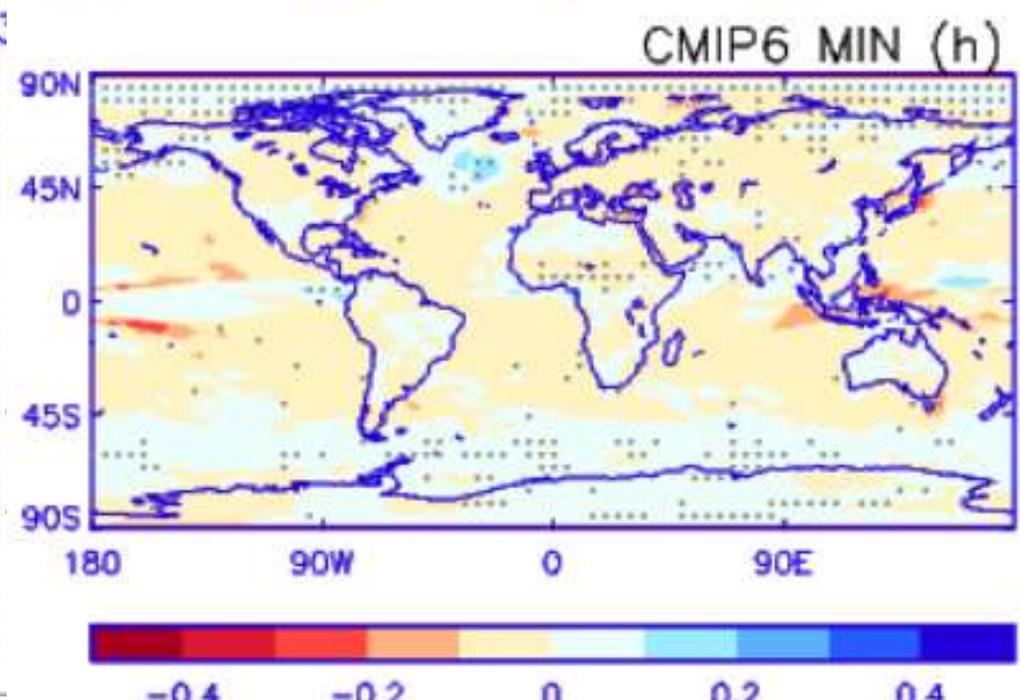
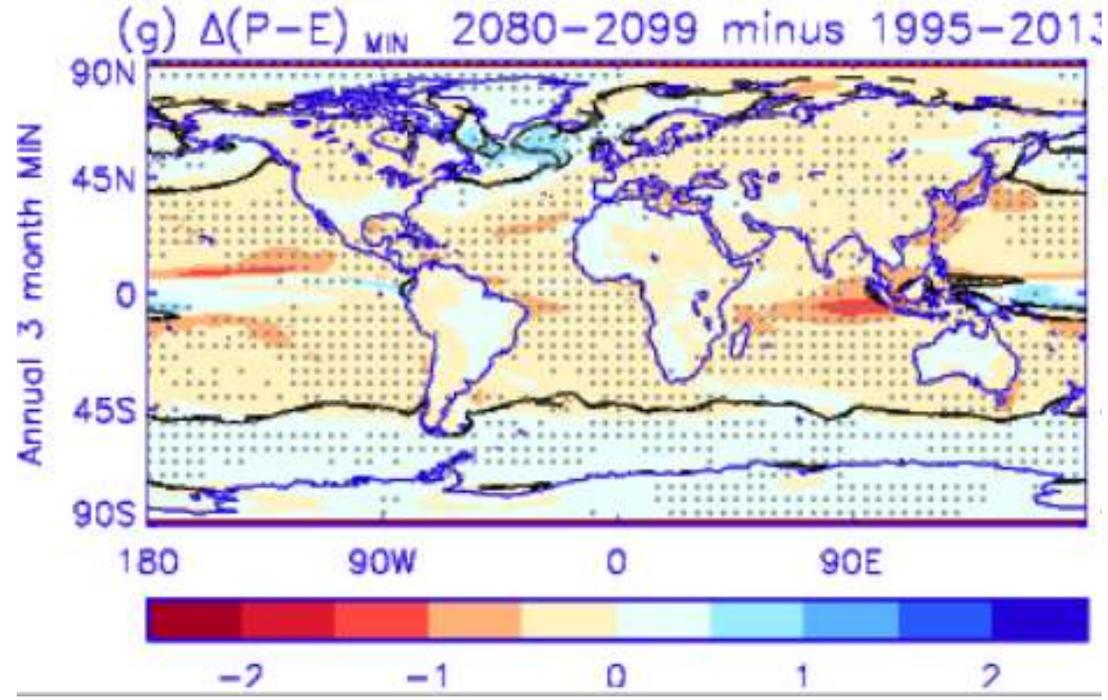
# FUTURE CHANGE

# PRESENT TRENDS

University of Reading



MAX



MIN

# Conclusions

- Amplification of P-E signal over ocean well understood
- P-E changes over land not well understood
- Seasonal amplification of P-E patterns?
  - Wet season  $P > E$ ; Dry season (onset)  $E > P$
  - Intensification of wet season (+4.2 → +4.4 mm/day global land)
  - More intense dry season onset over northern continents but not apparent over tropics? (-1.15 → -1.2 mm/day global land)
  - See also IPCC (2021) TS Box 8.2; Chapter 8, Section 8.2
- Emerging regional signals of hydrological change? e.g. Wainwright et al. (2022) GRL
  - Changing atmospheric circulation crucial but low confidence (e.g. IPCC (2021) Fig. 8.21)