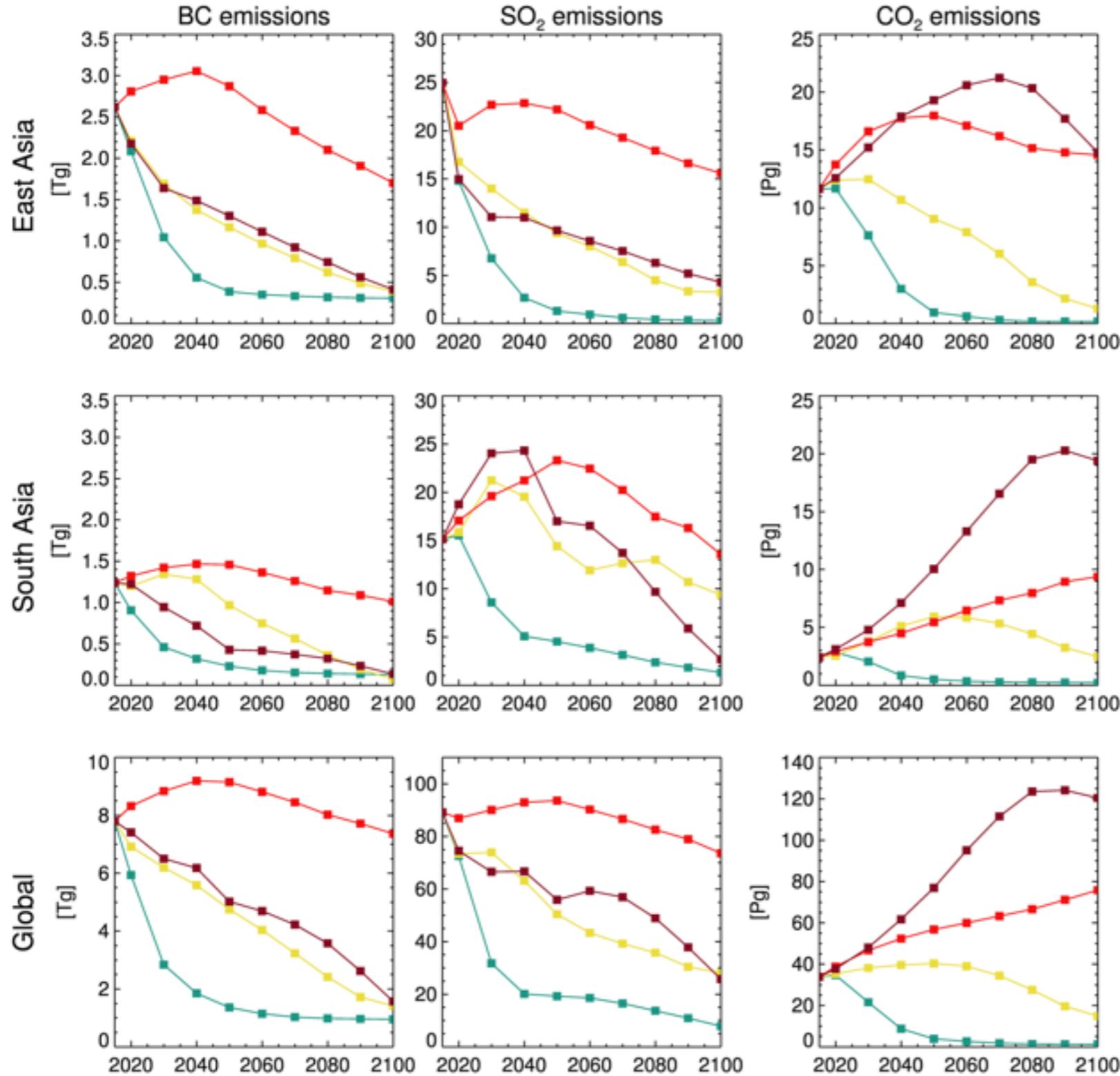


# Accelerated increases in global and Asian summer monsoon precipitation from future aerosol reductions

Laura Wilcox, Zhen Liu, Bjørn Samset, Ed Hawkins, Marianne Lund, Kalle Nordling, Sabine Undorf, Massimo Bollasina, Annica Ekman, Srinath Krishnan, Joonas Merikanto, and Andrew Turner

# Future aerosol in the Shared Socioeconomic Pathways



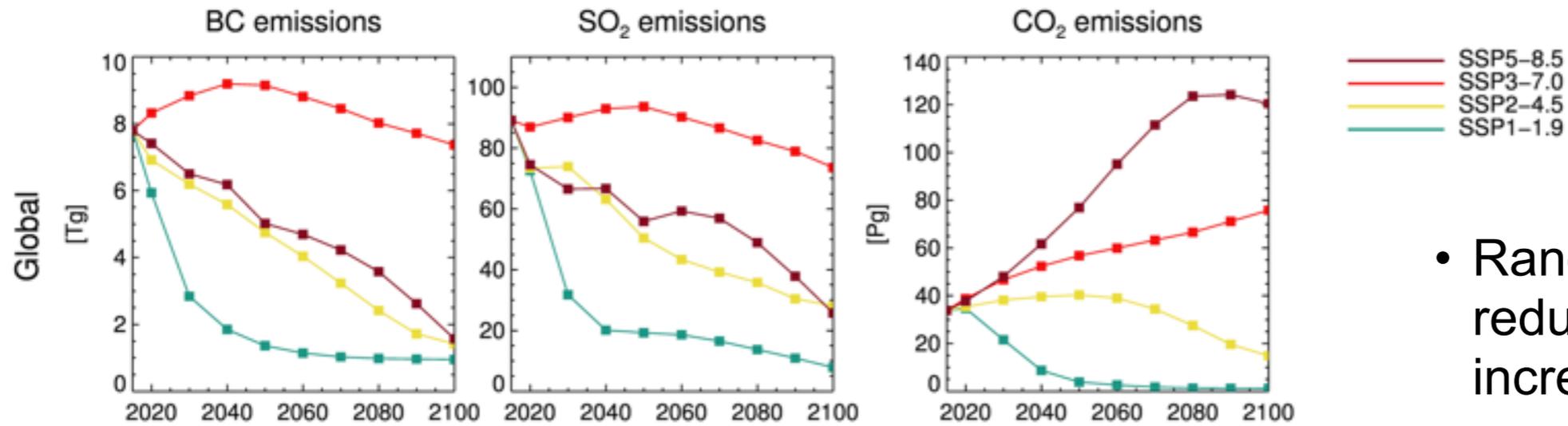
— SSP5-8.5  
 — SSP3-7.0  
 — SSP2-4.5  
 — SSP1-1.9

- Range from rapid reductions to initial increases (to 2050)
- Similar aerosol pathways in SSP2-4.5 and SSP5-8.5, but very different CO<sub>2</sub> changes
- **Does aerosol play a dominant role in near-term climate change?**

Wilcox et al., 2020, ACPD

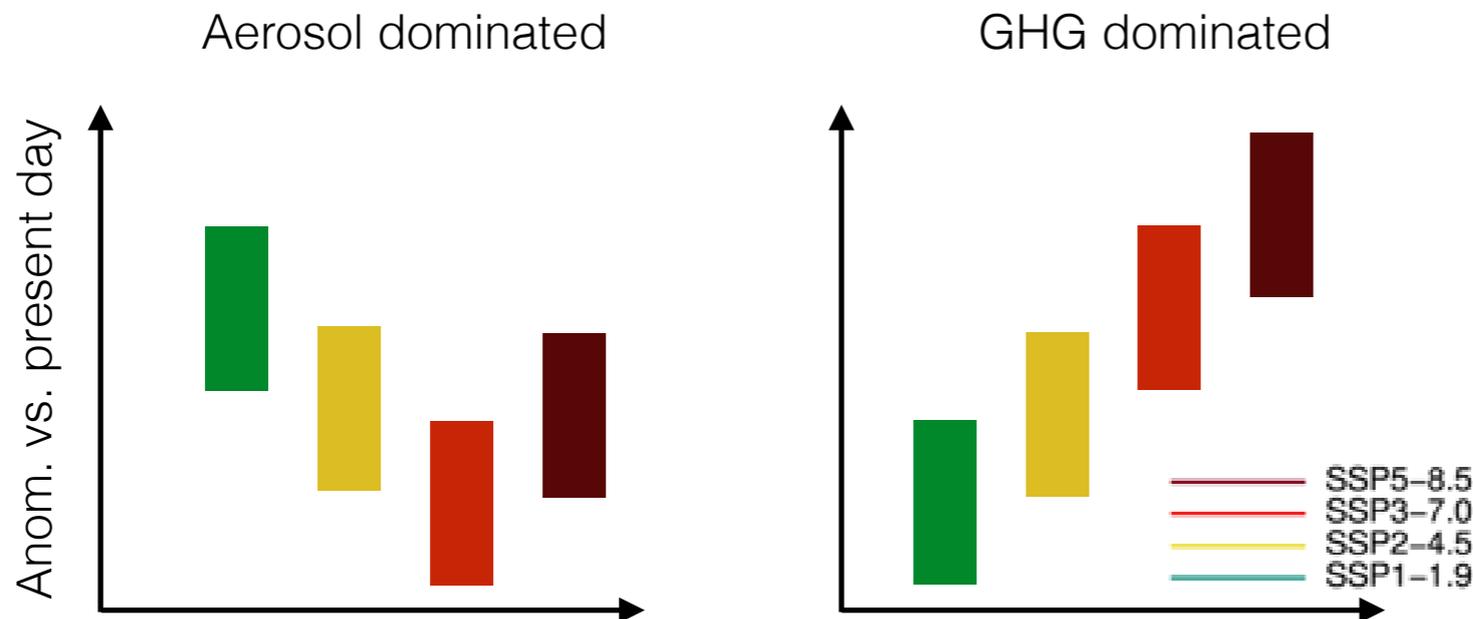
# Future aerosol in the Shared Socioeconomic Pathways

## Global emissions:



- Range from rapid reductions to initial increases (to 2050)
- Similar aerosol pathways in SSP2-4.5 and SSP5-8.5, but very different CO<sub>2</sub> changes
- **Does aerosol play a dominant role in near-term climate change?**

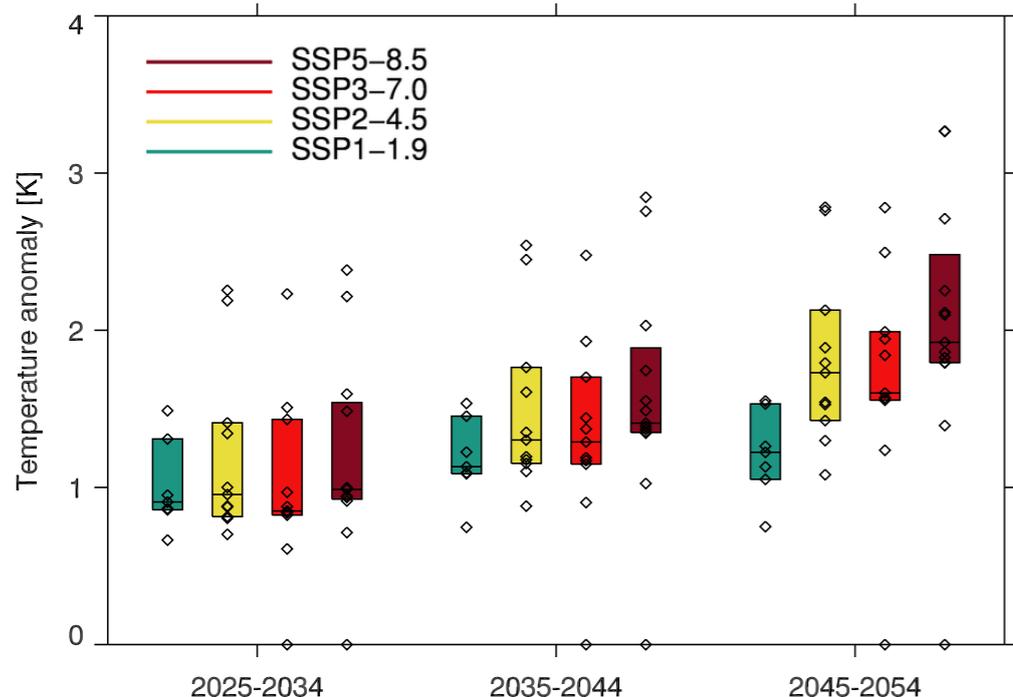
## Anticipated response:



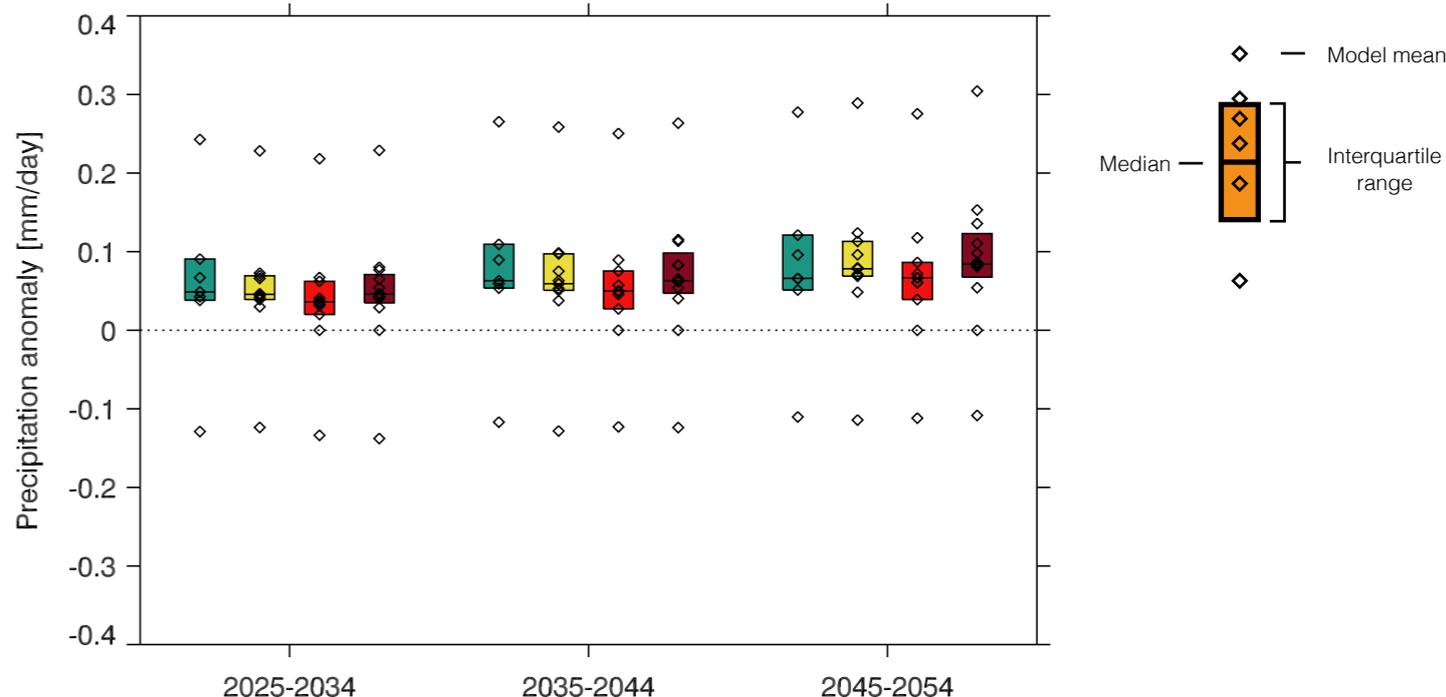
Wilcox et al., 2020, ACPD

# Global mean responses

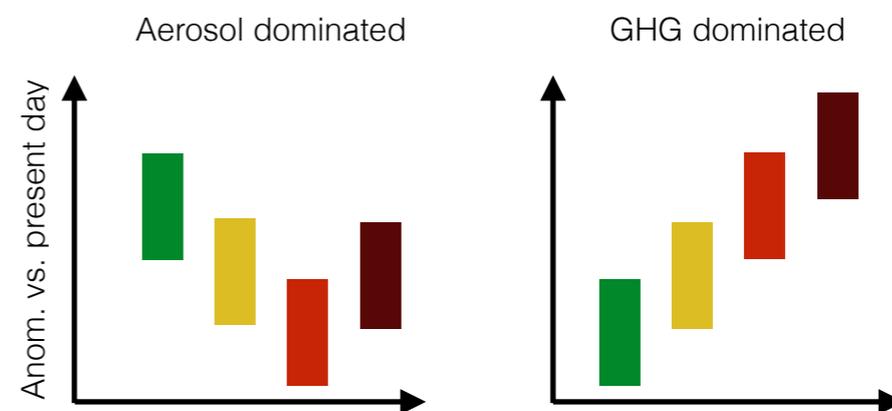
## Temperature vs. 1980-2014



## Precipitation vs. 1980-2014



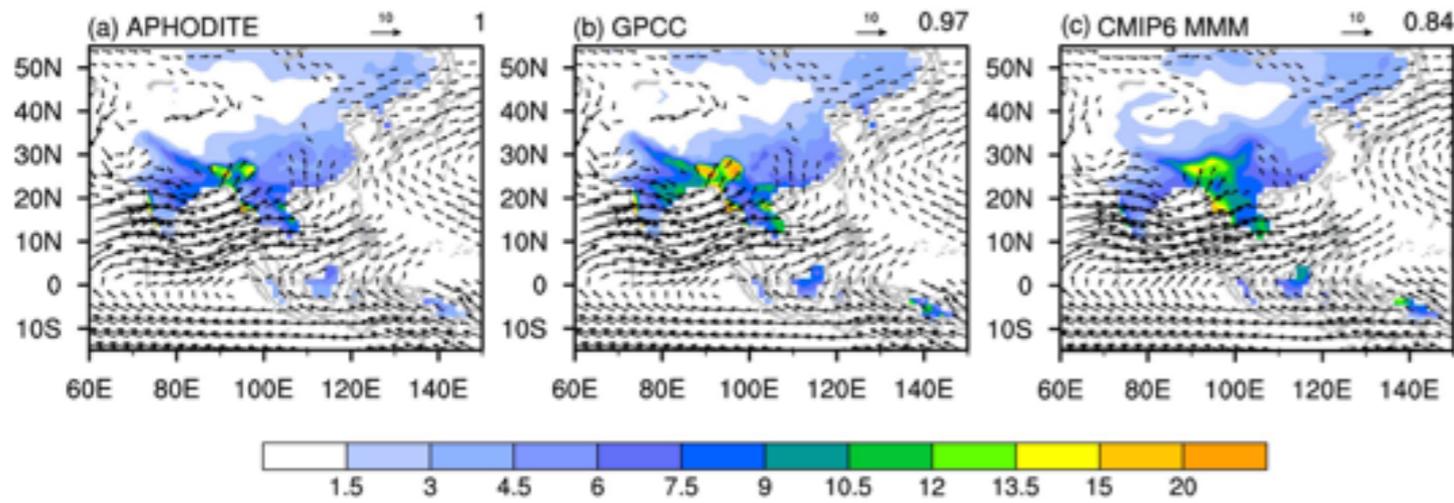
- Little aerosol influence on global temperature
- Global precipitation increases are faster in scenarios with faster aerosol reductions



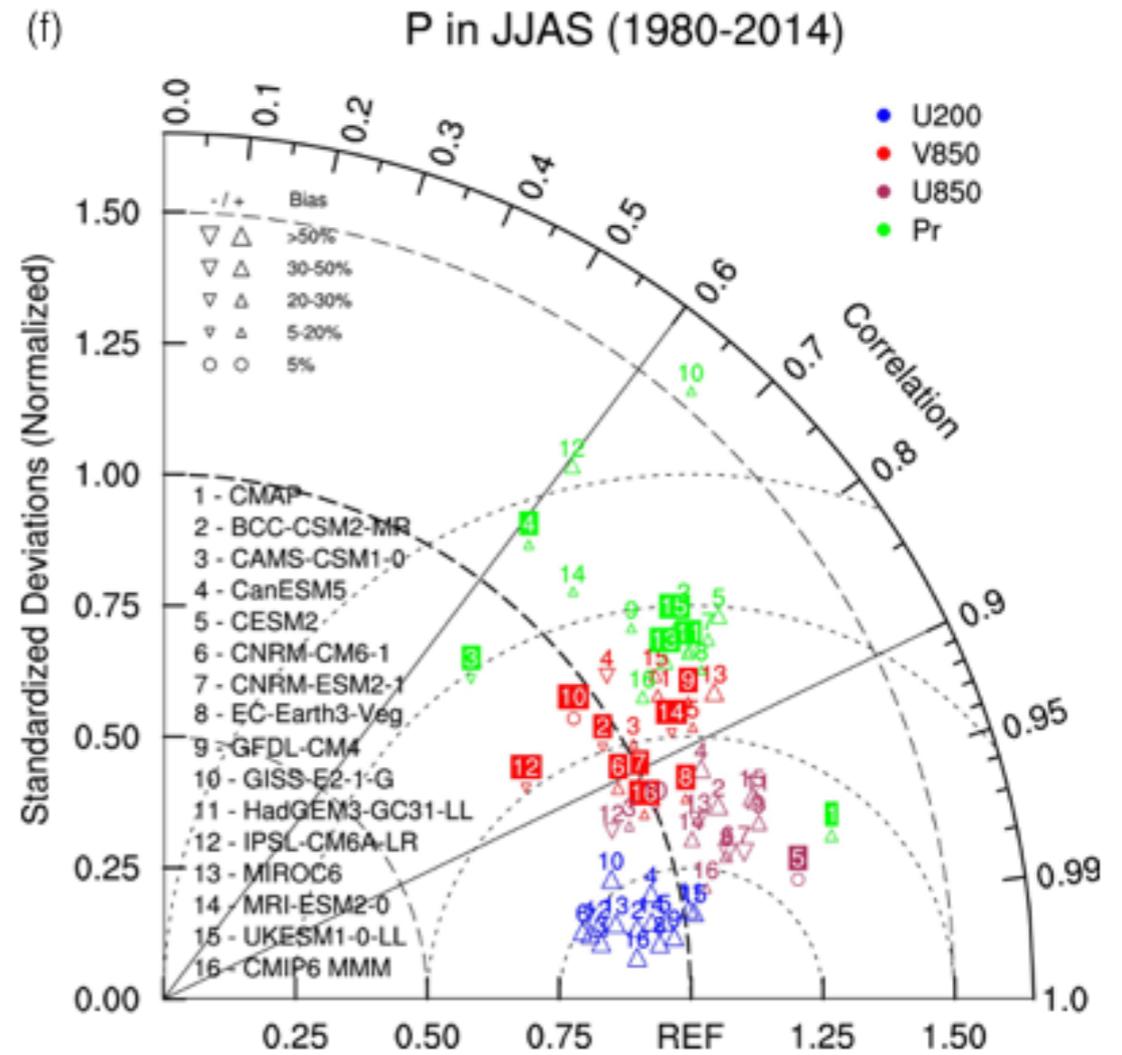
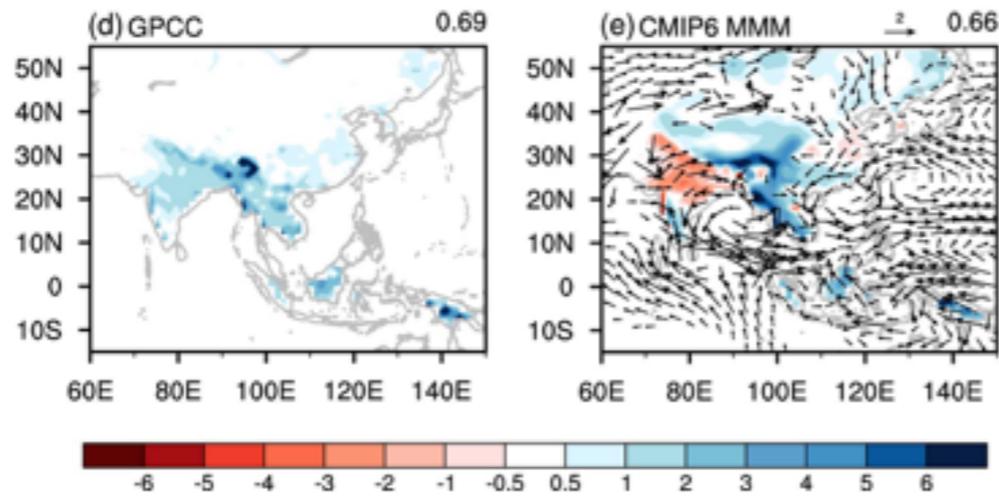
Wilcox et al., 2020, ACPD

# A quick look at Asian precipitation in CMIP6

P and 850-hPa wind in JJAS (1980-2014)



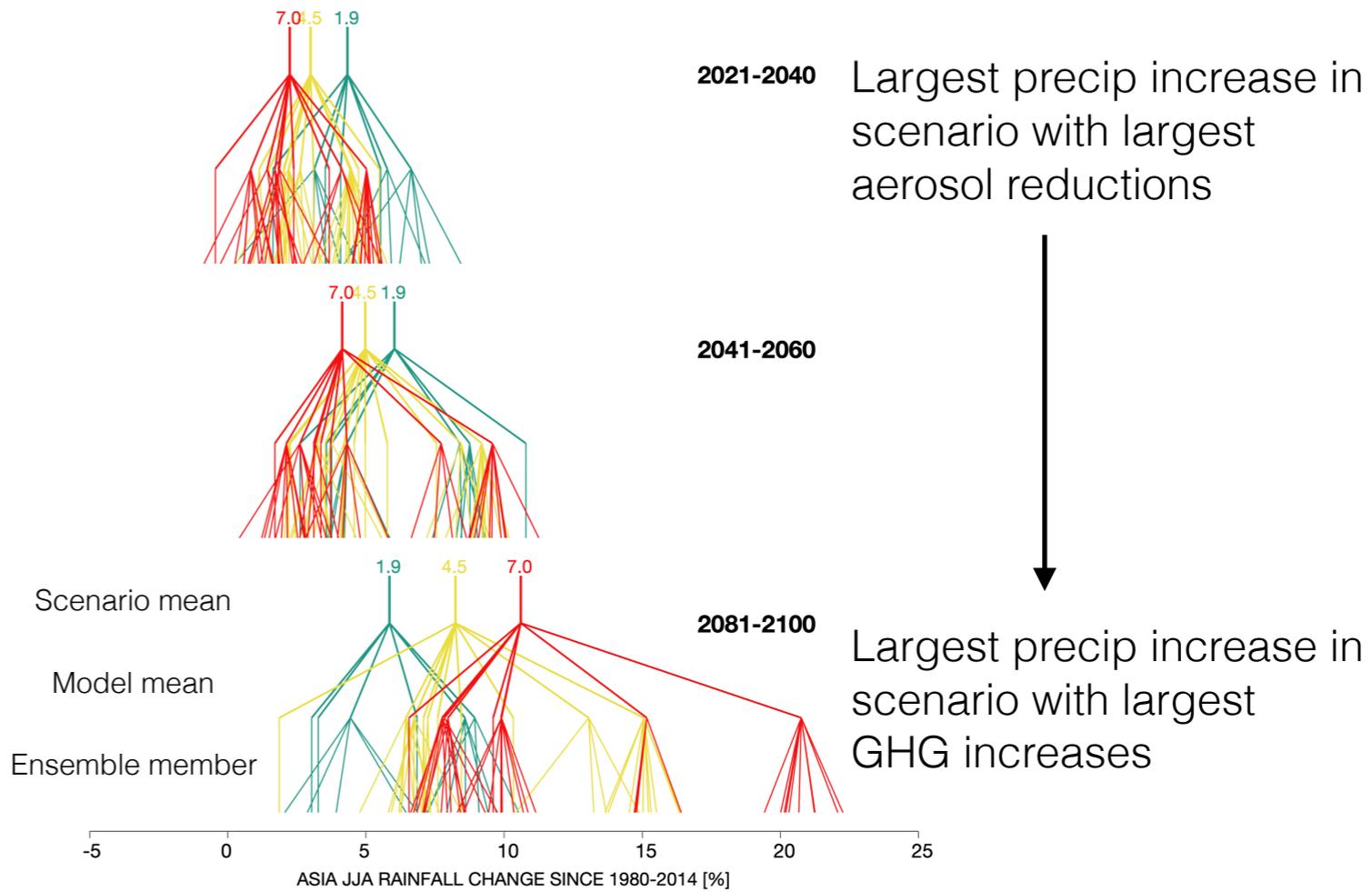
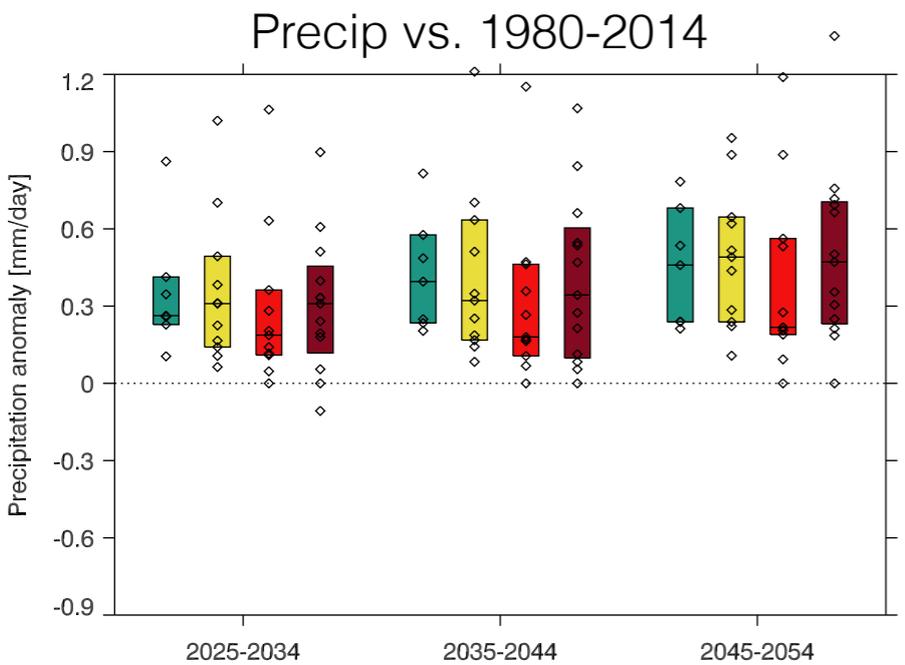
P and 850-hPa wind bias in JJAS (1980-2014)



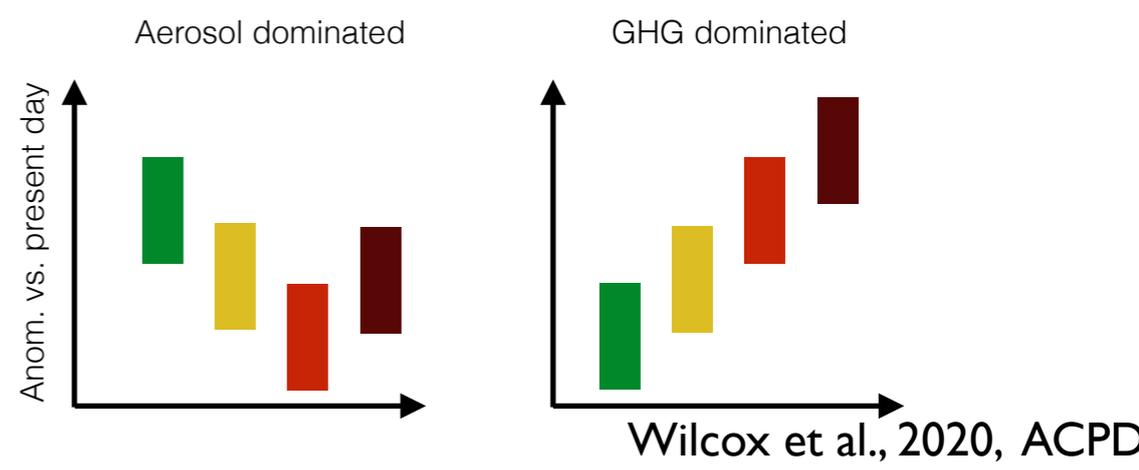
- Dry over India and northeast China, wet elsewhere
- Monsoon circulation too weak and too zonal
- Anomalies between models and observations comparable to size of anomalies between different observational datasets

Wilcox et al., 2020, ACPD

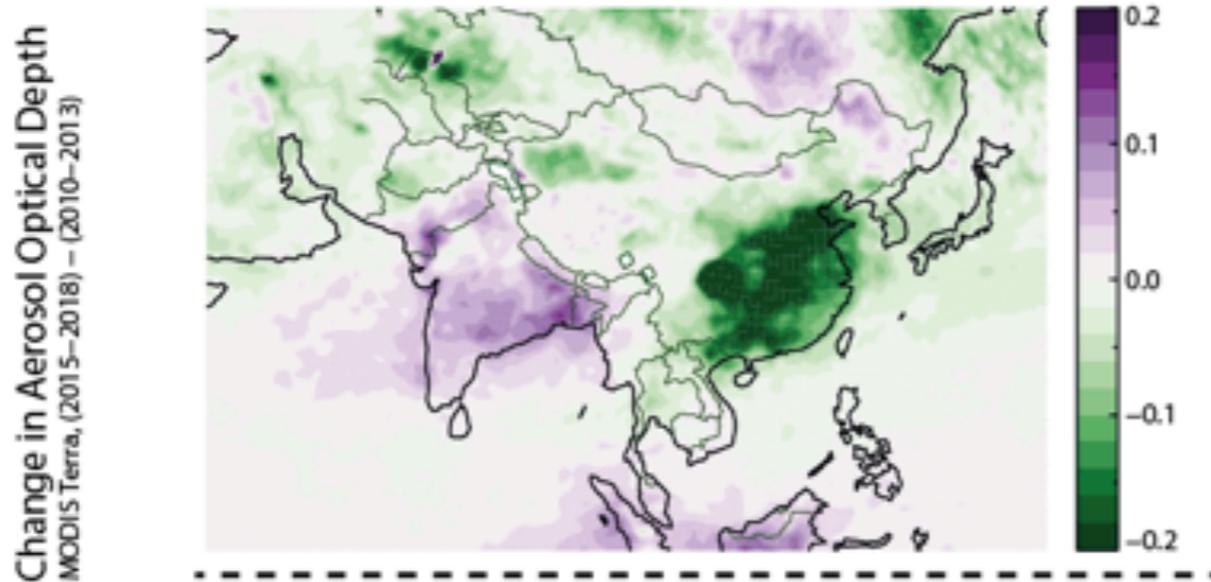
# Asian summer (JJA) monsoon responses



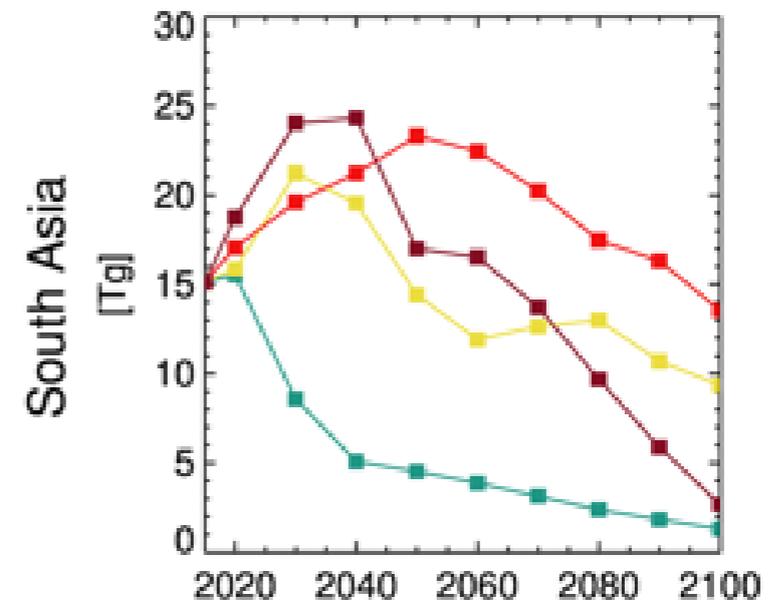
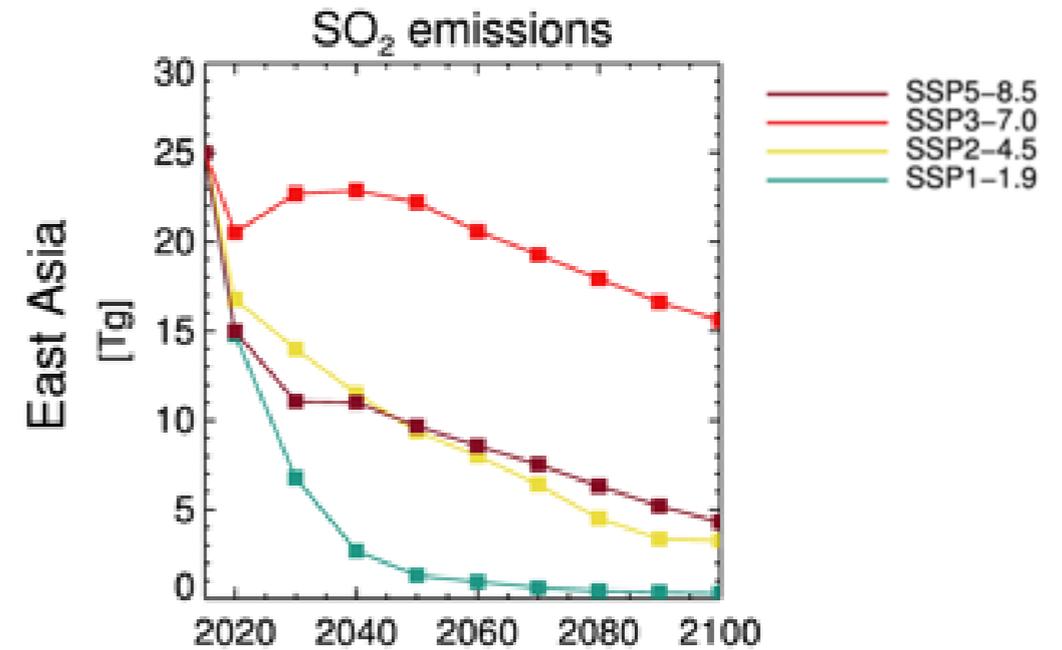
- Aerosol changes are the dominant influence on Asian summer monsoon precipitation until the 2040s
- GHG changes dominate by 2100



# The Asian dipole

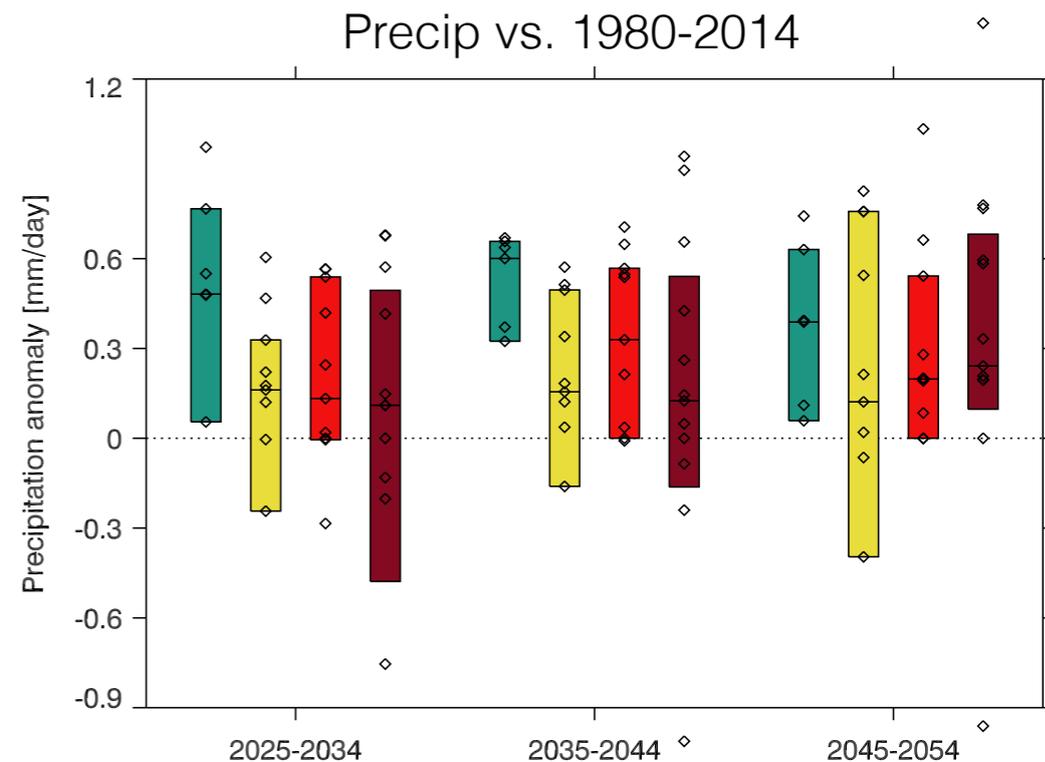
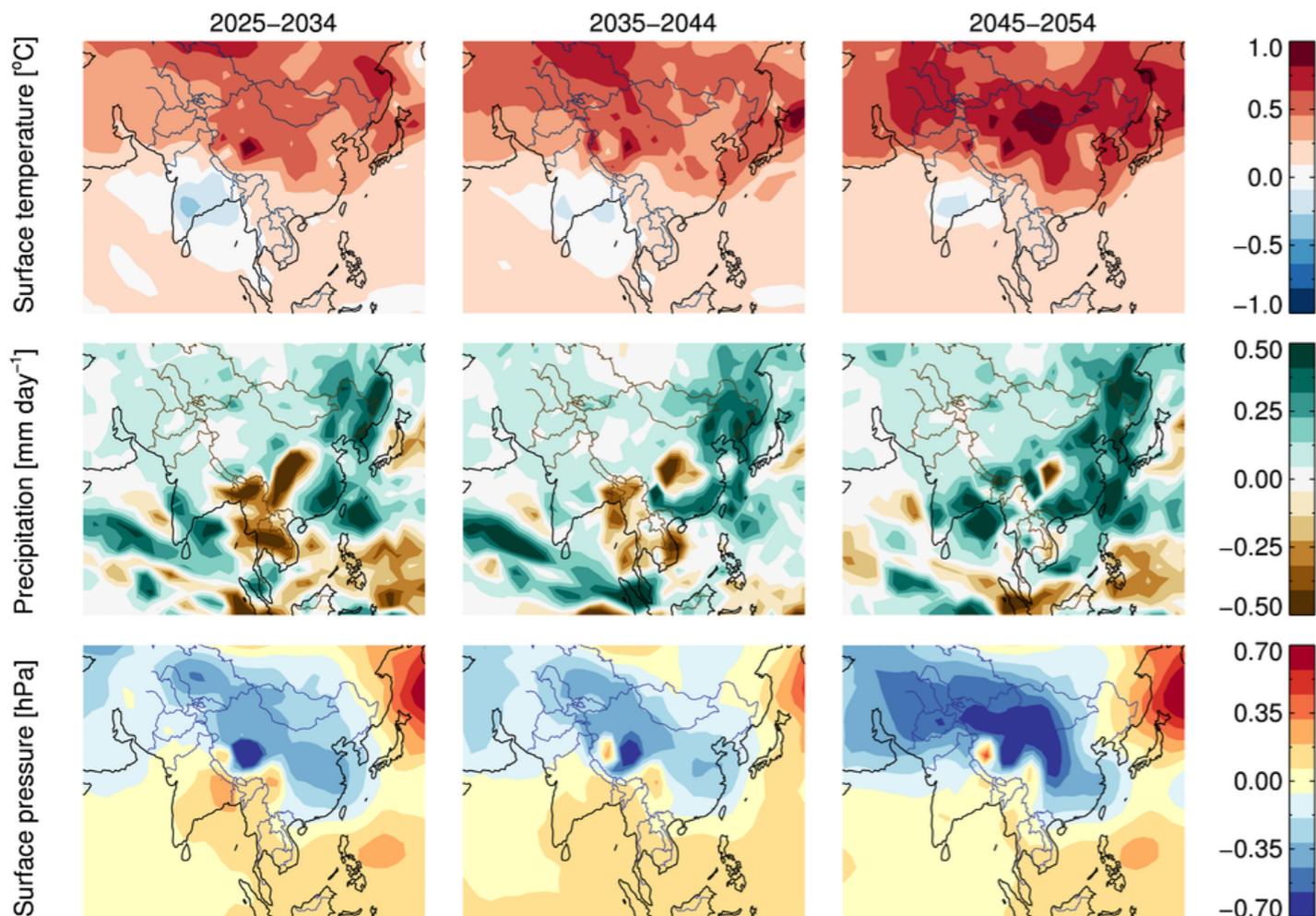


- Recent observations show a rapid reduction in Chinese aerosol optical depth alongside a continued increase in optical depth over India
- This pattern continues until 2040-2050 in **SSP2-4.5** and **SSP5-8.5**



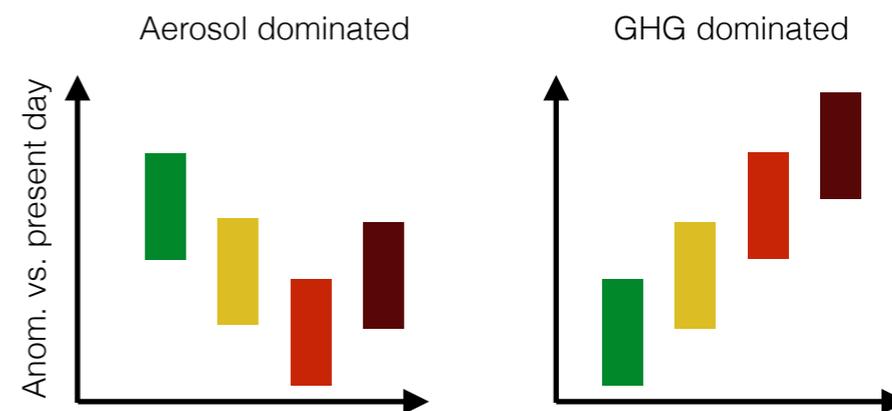
Samset et al., 2019, Nat. Geosci.; Wilcox et al., 2020, ACPD

# South Asian summer (JJA) monsoon responses



Anomalies for 10 year periods vs. 1980-2014 from an anthropogenic aerosol only version of SSP2-4.5 (SSP2-4.5-aer) with CanESM5

- Precipitation increase suppressed over South Asia in SSPs with dipole aerosol patterns



Wilcox et al., 2020, ACPD

# Conclusions

- Large uncertainty in future aerosol emission pathways
  - ▶ Unlikely to be important for global temperature
  - ▶ Potentially important for near-term changes in global and regional precipitation, and regional temperature changes
- Faster precipitation increases in scenarios with faster anthropogenic aerosol reductions
  - ▶ Greenhouse gases become the dominant factor in differences in the response between scenarios in the mid-late 21st century
- Near-term increases in South Asian summer monsoon precipitation are suppressed in scenarios where decreases in Chinese aerosol occur alongside continued increases over India