Evaluating Uncertainty in Aerosol Forcing of Tropical Precipitation Shifts

Science Question

- Anthropogenic aerosol emissions cause the location of tropical rainfall to shift in CMIP5. What is the influence of aerosol radiative forcing values on the amplitude of tropical precipitation shifts (ITCZ)?

Key Accomplishments

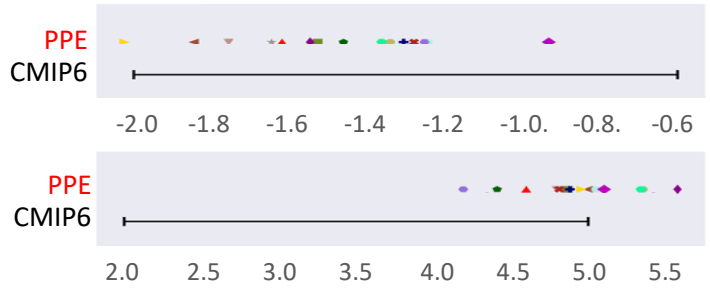
- We analyzed a HadGEM3-GC3.05 perturbed physics ensemble (PPE) with a comparable range of aerosol forcing to CMIP5 (Fig. 1)
- Members with stronger aerosol radiative forcing values lead to larger northward shifts of tropical precipitation in the future, counteracting southward shifts induced by other mechanisms (Fig. 3)
- However, the tropical precipitation shifts does not respond well to the strength of the aerosol radiative forcing during the historical period (Fig. 2), contradicting the results from CMIP5.

Impact

- A broader analysis involving the CMIP6 multi-model ensemble and other single-model PPEs would help deepen our understanding of the relationship between precipitation response to warming and future aerosol forcing across multiple emission scenarios

Peace A, Booth B, Regayre L, Carslaw K, Sexton D**, Bonfils C**, Rostron J, 2022, Evaluating uncertainty in aerosol forcing of tropical precipitation shifts. *Earth Syst. Dynam.*, 13, 1215–1232, 2022 10.5194/esd-13-1215-2022

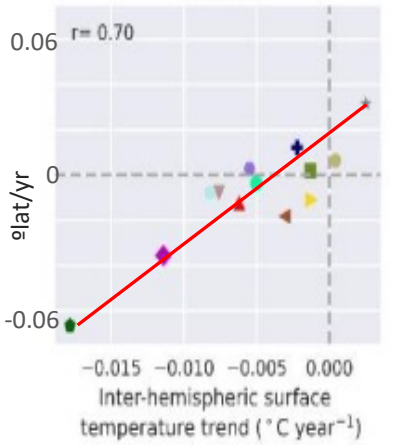
Fig. 1



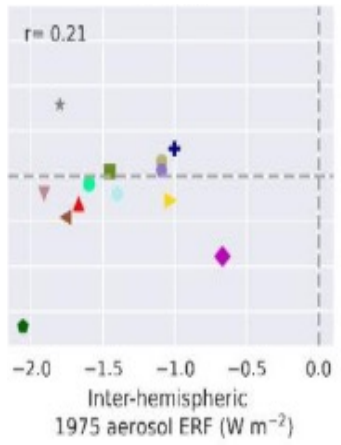
Range of aerosol ERF values (W/m²)

Range of climate sensitivity values (K)

Fig. 2: Historical (1950-1985)

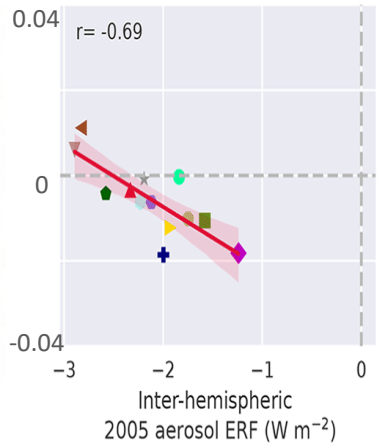


The southward ITCZ shift between 1950 and 1985 responds well to the inter-hemispheric temperature contrast…



… but not well to the strength of the aerosol radiative forcing

Fig. 3: Future (2006-2060)



Members with strong aerosol forcing produce stronger north-ward ITCZ shift (counteracting more, in a tug-of-war, the southward shift caused by other mechanisms (eg, sea-ice feedbacks and changes in AMOC strength))

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