# Ensemble methods in northern Australian monsoon projections

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Future simulations of Australian summer monsoon rainfall from climate models of the Coupled Model Intercomparison Project Phase 5 (CMIP5) show a multi-model mean projection of little change, but with large uncertainty. Under the high emission Representative Concentration Pathway (RCP8.5) scenario, the model spread includes large increases and decreases. Exploring the range of monsoon rainfall projections within the CMIP5 ensemble provides insights into the causes of model disagreement. Previous work has found that those models simulating reduced monsoon rainfall tend to have larger biases in sea surface temperatures in the western equatorial Pacific, and are therefore less credible (Brown et al. 2016). In addition, the monsoon rainfall response is strongly correlated with the spatial pattern of sea surface temperature warming.

In the lower emission RCP4.5 and RCP2.6 scenarios, the influence of non-greenhouse gas forcing, including anthropogenic aerosols, becomes more important. The prescribed decline in aerosols over the 21st century produces a rainfall response that is of similar magnitude to increases due to greenhouse gases, with changes in the interhemispheric temperature gradient driving a northward displacement of tropical rainfall. Those models which include a representation of aerosol indirect effects therefore project drying under medium and low emissions scenarios, whereas models without the aerosol indirect effect project a wetter Australian monsoon.

Difference in climate model projections for Australian monsoon rainfall can therefore be explained by a combination of factors including model mean state biases, differences in the spatial pattern of warming, differences in climate sensitivity and the representation of aerosol-cloud interactions. This information will contribute to more robust projections with improved measures of uncertainty. The use of an ensemble of climate models is necessary to facilitate this approach, as a single model, even one with the most comprehensive model physics or highest resolution, cannot provide insight into the sensitivity of projections to particular processes or forcings.

# References

Brown, J.R, A. F. Moise, R. Colman, and H. Zhang (2016), Will a warmer world mean a wetter or drier Australian monsoon? *J. Clim.*, 29, 4577-4596, doi:10.1175/JCLI-D-15-0695.1.