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Quantifying the effect of Asian circulation biases on the climate response to aerosol forcing

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Asian climate, and the summer monsoon in particular, represents one of the long-standing biases in climate models. Such dynamical biases can affect a model's ability to represent observed changes in Asian climate in response to changes in aerosol emissions. However, the accumulation and distribution of aerosol can be very diverse across models, even when the same emissions are prescribed. This can make inter-model differences that arise for other reasons, such as differences in the model representation of the atmospheric circulation, difficult to identify.

We use Easy Aerosol experiments to isolate the impact of background circulation on the simulated response to aerosol forcing. These experiments, performed with six atmosphere-only models, use idealised representations of aerosol forcing, which removes the effect of different aerosol distributions on simulated responses. The only differences between the model simulations are the model dynamics. Exploiting this, we identify systematic relationships between each model's circulation biases, such as the position of the ITCZ or in the strength of the Asian summer monsoon, and its simulated responses to aerosol forcing.

This quantification of how mean-state uncertainty translates into dynamical response uncertainty will aid the understanding of the role of model biases in climate projections, and offers the potential for reducing uncertainty in projections of Asian climate via observational constraint.