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The Effect of an Increased Convective Entrainment Rate on Indian Monsoon Biases in the Met Office Unified Model

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Global circulation models (GCMs) are a key tool for understanding and predicting monsoon rainfall, now and under future climate change. However, many GCMs show significant, systematic biases in their simulation of monsoon rainfall and dynamics that spin up over very short time scales and persist in the climate mean state. We describe several of these biases as simulated in the Met Office Unified Model and show they are sensitive to changes in the convective parameterization's entrainment rate. To improve our understanding of the biases and inform efforts to improve convective parameterizations, we explore the reasons for this sensitivity. We show the results of experiments where we increase the entrainment rate in regions of especially large bias: the western equatorial Indian Ocean, western north Pacific and India itself. We use the results to determine whether improvements in biases are due to the local increase in entrainment or are the remote response of the entrainment increase elsewhere in the GCM. We find that feedbacks usually strengthen the local response, but the local response leads to a different mean state change in different regions. We also show results from experiments which demonstrate the spin-up of the local response, which we use to further understand the response in complex regions such as the Western North Pacific. Our work demonstrates that local application of parameterization changes is a powerful tool for understanding their global impact.