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Influence of dynamical changes on the tropical cloud feedback using extratropical forcing

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The intermodel spread in the equilibrium climate sensitivity (ECS) determined from GCM simulations has been majorly ascribed to the spread in the cloud feedback, wherein the multimodel-mean net cloud feedback is found to be positive. It was previously identified that the largest source of intermodel spread in the net cloud feedback comes from the low cloud amount (> 680 hPa) modelled by the GCMs (1). However, recent evidence points to the importance of understanding the processes contributing to the tropical high-cloud feedback in order to constrain the uncertainty in the total cloud feedback (2). One of the key challenges that remains is understanding the coupling between the clouds and the large-scale circulation. In this work, we focus on the subtropical low (stratocumulus) clouds and tropical high (anvil) clouds. We perform idealised GCM simulations using the Met Office Unified Model with different prescribed sea-surface temperature gradients in the tropics and extratropics that emulate the sea-surface temperature response to increases in atmospheric CO_2. We also perform idealised simulations with an interactive slab ocean setup. Investigation of the influence of circulation changes on the tropical cloud feedback is done using a combination of simple mathematical frameworks. We then compare our GCM simulation results with those obtained using long-channel cloud-resolving model (CRM) simulations. Our results corroborate previous results that indicate that the cloud feedback at the tropics-wide scale is dominated by the local thermodynamical changes than by dynamical changes. However, interestingly, we find a decrease in the tropical low cloud amount in some of the GCM simulations with a slab ocean setup. The processes causing the decrease in the low cloud amount and/or the robustness of this result remains to be investigated.

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