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Influence of large-scale forcings and convective deepening on the seasonal cycle of cloudiness in the trades

Raphaela Vogel (1,2), Louise Nuijens (3), and Bjorn Stevens (1)

(1) Max Planck Institute for Meteorology, Hamburg, Germany (raphaela.vogel@mpimet.mpg.de), (2) LMD, Université Pierre et Marie Curie, Paris, France, (3) Delft University of Technology, Delft, Netherlands

We investigate how changes in the large-scale forcings and convective deepening influence the seasonal cycle of cloudiness at Barbados using large-eddy simulation. Prescribing mean seasonal forcing differences does not reproduce the presence of stratiform cloud layers near the inversion as observed at Barbados in winter. Instead, stratiform layers are sensitive to the inversion strength, which is strongly controlled by the depth of convection and by moisture-radiation interactions. In a suppressed regime with a shallow cumulus layer and a strong inversion, intermittent deeper convection induces stratiform cloud layers and strong radiative and evaporative cooling maintains the inversion. In a deeper convective regime with a deeper cumulus layer and a weaker inversion, deeper trade cumuli penetrate the inversion and increase precipitation, which weakens the inversion and inhibits stratiform layers. Making the large-scale forcing more winter-like by prescribing a drier free troposphere, stronger wind or cold-air advection mainly acts to deepen the cumulus layer and increase precipitation, which results in a less winter-like cloud profile with no stratiform layers. Because variations in total cloud cover are mainly controlled by variations in stratiform inversion cloudiness, our results suggest that a potential deepening of shallow convection under climate change might act to reduce cloud cover in the trades.