Quantifying the response of anvil cloud fraction to sea surface warming in SCREAM-RCE

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The Simple Cloud-Resolving Atmosphere Model (SCREAM) is run in a small planet radiative-convective equilibrium (RCE) configuration to elucidate the physical mechanisms controlling domain mean anvil cloud fraction and simultaneously scrutinize physical soundness of the new model. SCREAM-RCE exhibits near fixed anvil temperature (FAT) (Hartmann and Larson, 2002) and Iris (Bony et al., 2016) responses to warming in keeping with a majority of cloud resolving models run in RCE (Wing et al., 2020). A moisture budget analysis in and around deep convective cores reveals that the observed response of anvil fraction to warming is due to a reduction in upper-level large scale divergence characteristic of the stabler moist adiabat imposed by warmer deep convection (Bony et al., 2016). Interestingly, we find that the physical mechanism behind the coupling of divergence and cloud fraction is convective outflow moistening the anvil layers which permits in situ ice formation rather than direct detrainment of ice particles from the convective core. We interpret our results with a simple anvil length scale model which argues that cloud fraction scales with the drying timescale of detraining cloudy air.

References

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