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Testing the systematic response of a cloud-resolving model to forcing variations using TRMM observations over islands.

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The transition from weaker maritime to more intense continental deep convection is studied by examining the trends in TRMM radar and microwave (37 and 85 GHz) observations over islands of increasing size, and comparing this with equivalent observations simulated from runs of the WRF cloud-resolving model using offline radiation codes. The model configuration is idealized, with otherwise identical runs forced by surface hot spots of increasing size. Observed storms are essentially maritime over islands of < 100 km^2 and continental over islands >10,000 km^2, with a gradual transition in-between. The model reproduces these trends with reasonable accuracy for each observable, in both 2D and 3D configurations. This is true regardless of which of three microphysical schemes is used in WRF, although substantial mean biases occur with individual schemes, with differences particularly evident in graupel mixing ratios. Issues with running the TRMM simulator on 2D simulations are discussed, but appear to be less serious than sensitivities to model microphysics, which are similar in 2D and 3D, or model resolution. This supports the further use of 2D simulations to economically explore modeling uncertainties. The successful simulation of trends reported here supports previous suggestions that horizontal surface heterogeneity—rather than differences in humidity, aerosols, or other aspects of the atmospheric state—is the main reason that convection is more intense over land than ocean.