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Exploring convective and sea-breeze dynamics using ensembles of idealised CRM simulations

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We report on continuing work using large ensembles of simulations by the WRF model in a CRM configuration with different idealised boundary and initial conditions, to work toward a better understanding of the role of mesoscale and boundary-layer dynamics in unorganised deep convection. Runs employ an idealised domain that is homogeneous except for a heated "island" in the middle, and are mostly 2-D. The WRF model with fully parameterised physics can successfully reproduce the greater intensity of land-based convection in general relative to that over oceans, a key benchmark. Heterogeneity of the surface appears to be the primary reason for the greater intensity, but is not accounted for in standard parameterisations of deep convection although some are beginning to account for cold-pool dynamics and gust front effects. Sea breeze and gust fronts created by this heterogeneity are crucial in determining the location of subsequent convective onset, and the timing of collisions strongly affects convective intensity. To better understand the propagation of these currents we use further simplified, dry runs of WRF with varying degrees of complexity in the boundary and initial conditions. These range from the most idealised, "lock-release" case common in laboratory studies, to more meteorological cases with realistic diurnal solar heating of a land surface. We find that the well-known Benjamin formula typically used to predict frontal propagation works for idealised currents studied previously, but fails badly for those with more realistic surface heating, due to the introduction of internal structure within the cold current as it evolves. We argue that this is the main reason that observed fronts often propagate much more slowly than predicted.