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A prefered scale for localised surface heating in deep convection and related entrainment and convective cooling in the Tropical Tropopause

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Abstract: Observations show substantial variations of the intensity of moist convection on land that are not explained by standard measures of convective instability. We have numerically simulated short-lived, deep convective storms in an initially unstable environment using the WRF model. Heterogeneous surface heating is applied to generate instability. We find that various measures of convective intensity, including peak vertical velocity of the core updrafts, are sensitive to three parameters independent of CAPE: the width of the heated region, the height to which surface heating penetrates in the boundary layer prior to deep convective onset, and the time-scale of the applied heating.

The surface heat low near storm center also scales with convective intensity. The last result is recovered using a linear Boussinesq model of a dry atmosphere. The two models indicate that a preferred horizontal heating scale, determined by a simple combination of the environmental buoyancy frequency, characteristic heating time scale, and thickness of the thermal boundary layer, exists for driving intense storms. This mechanism arises purely from convective-scale fluid dynamics and is unrelated to previously suggested explanations for intensity variations that involve turbulent entrainment or cloud microphysics.