Numerical Simulations of Two Local Thunderstorms over Central Oahu during the Warm Season

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ABSTRACT

In this study, two unusual warm season (May-October) afternoon local thunderstorm cases (7-8 June 2003 and 13 October 2013) over Oahu were investigated. For both events, heavy showers produced small stream and drainage ditch flooding. The first event also recorded an F0 tornado. For the second event, a funnel cloud with small hailstones was reported. Both events were initiated over central Oahu during the afternoon hours under favorable large-scale settings including: the presence of an upper-level trough with a low-level weak shear line northwest of Hawaii; a deep moist layer with high (40 mm) total precipitable water (TPW) associated with a moist tongue; absence of trade wind inversion in a conditional unstable atmosphere; and relatively large (> 1500 J kg^{-1}) convective available potential energy (CAPE).

Our results show that with proper treatment of lower boundary conditions over land, the high-resolution (~ 1.5 km) Advanced Research Weather Research and Forecasting (WRF-ARW) model is capable in predicting this type of events. The simulated island-induced local circulations in the afternoon hours are in agreement with surface observations. The simulated evolutions of radar reflectivities compare favorably with the observed radar echoes. The storms are initiated by the low-level convergence of onshore flows over central Oahu during the afternoon hours. The model sensitivity tests attest that under weak low-level flow and favorable large-scale settings, the island-induced circulations play a key role for the development of this type of events.