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The sensitivity to initial soil moisture for three severe cases of heat waves over Eastern China

Pinya Wang and Jianping Tang
Nanjing University, School of Atmospheric Sciences, Nanjing, China (wpy19920601@163.com)

Using Weather Research and Forecasting model (WRF) simulations with different initial soil moisture (ISM) conditions, we investigate the sensitivity to ISM for the three severe heat wave events dominating eastern China in 2003, 2007 and 2013. The control simulation is able to reproduce the spatial distributions and the daily evolutions for each of the three heat waves but apparently underestimates their amplitudes, intensities and spatial extensions. An decreased ISM could cause an enhancement on heat waves with increased amplitudes, extents and intensities, while with insignificant influence on the spatial distributions and temporal variations. The responses of heat waves to the changing ISM are generally decreasing with the increasing ISM, dominated by the varied regimes in surface soil moisture-temperature relationship. Energy budget analyses indicate that the initial soil dryness locally strengthens the surface warming and drought through enhanced sensible flux as well as reduced latent cooling. The three heat waves are dominated by high-pressure systems in the upper troposphere. The reduced ISM forces positive anomalies of geopotential height at upper levels and negative anomalies at lower levels, leading to an enhanced thickness of the atmosphere. The enhanced atmospheric thickness strengthens the anomalous high-pressure systems, favoring the maintenance of severe heat waves. This acts as a positive feedback between atmospheric circulation, surface warming and land dryness.