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Impact of Uncertainties in Land Surface Processes on Subseasonal Predictability of Heat Waves Onset Over the Yangtze River Valley

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Land surface processes are strongly associated with heat waves (HWs). However, how the uncertainties in land surface processes owing to inaccurate physical parameters influence subseasonal HW predictions has rarely been explored. To examine the impact of parameter errors of land surface processes on the uncertainty of subseasonal HW predictions, five strong and long-lasting HW events over the middle and lower reaches of the Yangtze River (MLYR) are investigated. Based on the Weather Research and Forecasting (WRF) model, the conditional nonlinear optimal perturbation related to parameters (CNOP-P) approach is employed to address the aforementioned issues.

Numerical results demonstrate that the CNOP-P type errors of physical parameters cause large prediction errors for five HW event onsets. Two types of CNOP-Ps are obtained for HW events, called the type-1 CNOP-P and the type-2 CNOP-P. The type-1 (type-2) CNOP-P causes an approximately 3 °C (2 °C) warm (cold) bias during the HW period. Surface sensible and latent heat flux errors, especially flux exchange between vegetation canopy and canopy air, provide considerable uncertainty in subseasonal HW predictions. The type-1 (type-2) CNOP-P exhibits an underestimation (overestimation) of transpiration. Furthermore, it should be noted that the type-1 CNOP-P results in a substantial difference in soil moisture, a phenomenon that is demonstrated to be challenging to observe in the type-2 CNOP-P. The results indicate that understanding vegetation-atmosphere dynamics is crucial for improving subseasonal HW predictions. Jointly lowering soil-atmosphere and vegetation-atmosphere uncertainty can notably improve subseasonal HW prediction skills.