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Coupling the high-complexity land surface model ACASA to the mesoscale model WRF

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Abstract. In this study, the Weather Research and Forecasting (WRF) model is coupled with the Advanced Canopy–Atmosphere–Soil Algorithm (ACASA), a high-complexity land surface model. Although WRF is a state-of-the-art regional atmospheric model with high spatial and temporal resolutions, the land surface schemes available in WRF, such as the popular NOAH model, are simple and lack the capability of representing the canopy structure. In contrast, ACASA is a complex multilayer land surface model with interactive canopy physiology and high-order turbulence closure that allows for an accurate representation of heat, momentum, water, and carbon dioxide fluxes between the land surface and the atmosphere. It allows for microenvironmental variables such as surface air temperature, wind speed, humidity, and carbon dioxide concentration to vary vertically within and above the canopy.

Surface meteorological conditions, including air temperature, dew point temperature, and relative humidity, simulated by WRF-ACASA and WRF-NOAH are compared and evaluated with observations from over 700 meteorological stations in California. Results show that the increase in complexity in the WRF-ACASA model not only maintains model accuracy but also properly accounts for the dominant biological and physical processes describing ecosystem–atmosphere interactions that are scientifically valuable. The different complexities of physical and physiological processes in the WRF-ACASA and WRF-NOAH models also highlight the impact of different land surface models on atmospheric and surface conditions.

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