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Impact of land data assimilation on meteorology and air quality

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Land surface characteristics such as soil temperature and soil moisture significantly affect heat and moisture budgets, thus impacting the atmospheric boundary layer dynamics related to meteorology and air quality. General circulation models and reanalysis data at coarse resolution fail to represent the heterogeneous land surface characteristics accurately. Biases in land surface forcing data accumulate as errors and lead to incorrect surface water and energy partitioning. This study explores the sensitivity of land data assimilation in improving land surface characteristics and thus, meteorology and air quality for Chicago metro and surrounding rural and natural regions. Numerical simulations using urbanized version the chemistry-based Advanced Research Weather Research and Forecasting (uWRF-CHEM) model were performed to evaluate the impact of assimilating coarse meteorological forcing (precipitation, solar and longwave radiation, and surface wind, moisture, temperature) to simulate the evolution of land surface states (e.g., soil moisture and temperature etc.) at high spatial and temporal resolution. The sensitivity study showed significant changes in surface fluxes of moisture and temperature that altered surface velocities and intercepted solar radiations. Results showed improvements in near-surface temperature, winds and ozone magnitudes, and their spatial and temporal distribution with land data assimilation.