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Development of satellite land and atmosphere coupled data assimilation system in the Tibetan Plateau

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Land surface heterogeneities are important for accurate estimation of land-atmosphere interactions and their feedbacks on water and energy budgets. To physically introduce existing land surface heterogeneities into a land-atmosphere coupled model, a Land Data Assimilation System was coupled with a mesoscale model (LDAS-A) to assimilate low frequency satellite microwave observations and the combined system was applied in the Tibetan Plateau. During the model forecast, assimilated land surface conditions suffered substantial errors and drifts owing to predicted model forcings (i.e., rainfall and solar radiation). To overcome this operational pitfall, we developed the Coupled Atmosphere and Land Data Assimilation System (CALDAS) by coupling the LDAS-A with a cloud microphysics data assimilation system. CALDAS assimilated lower frequency microwave data to improve representation of land surface conditions, and merged them with higher frequency microwave data to improve the representation of atmospheric conditions over land surfaces. CALDAS was validated for the Tibetan Plateau using surface, radiosonde and satellite observations. The simulation results show that CALDAS effectively improved cloud distribution that showed high correlations with satellite observations. CALDAS also improved biases in cloud conditions and associated rainfall events, which contaminated land surface conditions in the LDAS-A model simulation. Improvements in predicted clouds resulted better land surface model forcings (i.e. solar radiation and rainfall), which maintained assimilated surface conditions in accordance with observed conditions during the model forecast. Improvements in both atmospheric forcings and land surface conditions enhanced land-atmosphere interactions in the CALDAS model, as confirmed by radiosonde observations. Further improvements in model performance and applicability will be future directions of this research. Key words: satellite microwave remote sensing, land data assimilation, cloud microphysics data assimilation, land-atmosphere interactions.