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A Fully-Integrated Framework for Terrestrial Water Cycle Simulation: Application to the San Joaquin Valley, California

Jason Davison (1,2), Hyoun-Tae Hwang (1,2), Edward Sudicky (1), and John Lin (3)

(1) University of Waterloo, Waterloo, Ontario, Canada, (2) Aquanty Inc., Waterloo, Ontario, Canada, (3) University of Utah, Salt Lake City, Utah, USA

Groundwater reservoirs are drastically decreasing from the increased stresses of agricultural, industrial, and residential use. Across the world, groundwater levels continue to decline due to the expansion of human activities and the decrease in groundwater recharge. Methods commonly used to project the future decline in subsurface water storage involve simulating precipitation patterns and applying them independently to hydrological models without feedback between the atmospheric and the groundwater/surface water systems. However, it is becoming increasingly evident that this traditional methodology, which ignores the critical feedbacks between groundwater, the land-surface, and the atmosphere, is inappropriate at basin or larger scales. To improve upon conventional methods, we coupled HydroGeoSphere (HGS), a fully-integrated, physically-based, 3D surface/subsurface flow, solute and energy transport model that also accounts for land surface processes, to the Weather Research and Forecasting (WRF) model. WRF is a well-known nonhydrostatic finite-difference mesoscale weather model. Our flexible coupled model, referred to as HGS-WRF, directly links the water and energy fluxes between the surface/subsurface to the atmosphere, and allows HGS to maintain a finer unstructured mesh, while WRF uses a coarser mesh over the entire domain. We applied HGS-WRF to the San Joaquin Valley in central California and expect to see an increase in skill of energy and moisture fluxes between domains. Overall, the inclusion of atmospheric feedbacks in hydrologic models will increase their predictive capabilities and help better inform water managers.