The value of tightly-integrated hydrologic and river-operations models on water resources planning and management

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Examples of hydrologic/river-operations modeling couplings found in the scientific literature typically adopt “feed-forward,” or explicit, approaches. Under this formulation, the hydrologic model passes information regarding groundwater/surface-water (GW-SW) fluxes to the river-operations model, but as has been demonstrated with the release of MODSIM-MODFLOW, multiple back-and-forth iterations between the models are necessary to achieve a synchronized solution with a closed mass balance. After the release of MODSIM-MODFLOW, work has been underway to integrate MODSIM with the hydrologic model GSFLOW. GSFLOW is the integration of MODFLOW with the Precipitation-Runoff Modeling System (PRMS) code. Through its integration with MODSIM, the physically-based distributed-parameter model GSFLOW can more readily simulate water resources planning and management in the context of reservoir operations and river diversions for meeting agricultural and municipal supply. MODSIM simulates complex administration of water-right and agreements in large-scale surface-water networks commonly governed by the prior appropriation doctrine (i.e., “first in time, first in right”). Application of MODSIM-GSFLOW to two western basins, including the Carson River Basin in California and Nevada the Deschutes River, Oregon, has enabled direct exploration of groundwater management action on river-operations, and conversely, the impact of alternative surface-water management scenarios on groundwater flow dynamics. Moreover, presented results show the impact of projected climate warming on individual water-rights binned by decade, though finer temporal resolution (i.e., by year) is possible. Although junior water rights experience the largest surface-water right shortfalls expressed as a percentage, the largest future shortfalls by volume are realized by mid-priority water rights, with impacts to even the most senior water-righted land parcels.