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Integrated Surface and Subsurface Hydrologic Models and environmental tracers : A promising combination

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Integrated Surface and Subsurface Hydrological Models (ISSHM) are designed to simulate the terrestrial portion of the hydrologic cycle. ISSHMs typically simulate coupled two-dimensional surface water flow and three-dimensional variably-saturated groundwater flow, along with associated mass and energy transport. ISSHMs represent water exchange between the surface and subsurface domains using physically-based equations. Therefore, they do not rely on artificial boundary conditions between the two domains. Unlike groundwater flow-only models, for example, they do not require groundwater recharge as an input parameter. Instead, ISSHMs use hydroclimatic variables, such as liquid and solid precipitation, as inputs and redistribute water in the surface and subsurface domains according to their hydraulic properties. ISSHMs are increasingly being used to integrate available data for a hydrologic system, reproduce hydrological observations and forecast potential changes in the hydrogeological regime following natural or anthropogenic modifications. ISSHMs provide a unified approach in simulating both surface water and groundwater at the catchment scale, which is typically the scale of interest for water management.

Interest in using ISSHMs to identify the origin of water in natural systems and also quantify flow trajectories and exchange fluxes between surface water and groundwater reservoirs is growing. Environmental tracers in hydrology are often used for the same purposes, so combining ISSHMs and environmental tracers to study complex hydrosystems has great potential. This talk will review different approaches that can be used with ISSHMs to track the origin and flow of water in hydrosystems, with an emphasis on the HydroGeoSphere (HGS) model. These approaches include simulations of flow only, particle tracking, water age, and advective-dispersive mass transport. The Hydraulic Mixing Cell (HMC) combined with HGS will also be covered since it represents a very promising approach for identifying the origin of water in specific locations within a hydrosystem. For example, it can be used to identify the source of water in a stream. Examples where HGS has been combined with environmental tracers will be presented. Challenges and opportunities related to ISSHMs will also be discussed.