Integrated groundwater-surface water hydrologic modeling at the continental scale and its applications

Mary Michael Forrester, Colorado School of Mines,
Reed Maxwell, Colorado School of Mines,
Basile Hector, IRD, The Institute for Geosciences and Environmental research (IGE),
Laura Condon, Syracuse University

Key words: integrated hydrology, continental, scaling

Groundwater storage and evapotranspiration are important components of the water cycle at a range of scales, and accurately quantifying water flux and storage is critical to national, regional and local decision making and water resource management. Both groundwater storage and evapotranspiration are, however, notoriously difficult to observe. Possible observations range from the point scale, such as groundwater monitoring wells and eddy flux towers, to coarse resolution remote sensing products, but interpolating point observations and downscaling large scale data to make regional scale decisions can be uncertain and ill-informed. There is growing literature that supports the application of large-scale, physically-based hydrologic and land surface models to bridge the scale gaps at which observations are applied and decisions are made. Here we present the preliminary results of an integrated, physically-based hydrologic model that spans the entire contiguous United States (CONUS) at hyper-resolution, and we discuss a modern-day scenario that diagnoses groundwater controls on surface fluxes and energy.

Maxwell et al. describe the first iteration development of the CONUS ParFlow model [1], a parallel, integrated groundwater-surface water hydrologic model that captures states and fluxes of the terrestrial water cycle over a 6.3 million square kilometer area at 1-km lateral resolution. ParFlow simulates variably saturated subsurface flow, transient water table dynamics, surface water routing, infiltration and exfiltration, and the hydrologic model has been coupled to the Common Land Model to capture fully integrated surface energy [2]. The CONUS model has previously been used to analyze continental-scale patterns of water table depth and its mechanistic relationships with topographic indices [3, 4], recharge and evapotranspiration [5].

The work presented here expands the previous CONUS domain to the North American coastlines, spanning the entire continental United States. We also simulate modern water years and take advantage of recent remote sensing observations and other national-scale hydrologic modeling products to facilitate comparisons and validation of water and energy fluxes. The coastline CONUS model presents numerous opportunities: We discuss the model's ability to simulate and track continental-scale natural and anthropogenic disturbance events; guide and draw connections between observations at multiple scales; and quantify groundwater storage and evapotranspiration at the national level.

References

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