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Regionalization of catchment behavior to improve predictions in ungauged basins: a global exercise.

Streamflow (Q) prediction in ungauged basins is perhaps the most fundamental challenge faced by the hydrologic sciences. A promising, recently introduced approach is to constrain the uncertainty in Q predictions by regionalization of hydrologic signatures of catchment response behavior. Here we present a new, conceptual global land surface scheme (Global Land-surface Evaporation: the Amsterdam Methodology – Runoff - GLEAM-R) that is the first attempt to apply this method at the global scale. GLEAM-R is built on GLEAM, a well-validated global evapotranspiration model based on the Priestley and Taylor equilibrium equation and the analytical model of rainfall interception developed by Gash. The development of GLEAM-R was governed by the design philosophies of parsimony and transparency. The model has five storage compartments, seven calibration parameters, and a daily temporal and 0.25 deg spatial resolution. Observed Q records from 5531 catchments around the world were used to establish empirical links between catchment attributes (related to climate, topography, soil, and geology) and hydrologic signatures. Eight hydrologic signatures were used, each quantifying different aspects of catchment response behavior (e.g., runoff coeffcient, baseflow recession constant, and baseflow index). Next, the obtained relationships were used to compute global maps of hydrologic signatures and associated standard errors. GLEAM-R was run for the period 2003{2007 for 200 candidate parameter sets generated by Latin hypercube sampling, yielding 200 realizations of Q predictions. Likelihood weights were assigned to each Q realization on a per-pixel basis by calculating hydrologic signatures for each realization and comparing the result to the global maps of hydrologic signatures (and associated standard errors), thereby allowing differentiation between behavioral and non-behavioral realizations. From the likelihood-weighted distribution of Q predictions the median and the uncertainty range were calculated. A comparative evaluation of GLEAM-R and four GLDAS models against the observed Q records showed mixed yet promising results.