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Combining data assimilation and a genetic algorithm for real-time flood forecasting with a distributed hydrologic model

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Real-time flood forecasts can be improved using an adaptive model that takes into account the errors between predictions and observations. Data assimilation procedures update the estimation of the initial state of the system and correct the model from the new observations. But there are many sources of uncertainty in the forecast process and the model parameters can change in each time step. A genetic algorithm has been developed to implement a looped process. The best parameter combinations are selected in each time step by means of an objective function and mutations are performed over the selected parameters with random disturbances.
The forecast model uses the deterministic and distributed RIBS (Real-time Interactive Basin Simulator) model. The RIBS model was calibrated by a probabilistic multi-objective global optimization methodology that identifies a probability distribution, instead of a unique value, to represent each model parameter. The forecast starts with a random sample of basin states represented by parameter values generated from the probability distributions given as calibration result. After measured rainfall and discharge data are received, the ensemble of basin states is propagated in time, and then reduced selecting those states which better represent the observed discharges. Mutations are performed over these selected basin states and a new operational loop is started. This methodology was applied to a hydrological basin located in Spain, comparing the results for different rainfall events. The process is computationally intensive, because it is required to simulate many replicas of the ensemble using a distributed rainfall-runoff model, and it is therefore well suited to test the applicability of the potential of the Grid technology to hydrometeorological research.