Uncertainty in Hydrologic Extreme Event Predictions: Roles of Model Errors and Observations

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Hydrological models used in predicting flood hazards are affected by uncertainty in parameters, processes representation, and state conditions at the beginning of the forecast period (initial conditions). Observations are used to constrain both the model errors (structural and parameteric) and model states. There are now extensive ground-based and remotely-sensed observations that provide an unprecedented variety of information. The information is often noisy and only indirectly linked to the states. Data assimilation techniques allow the exploitation of the information content of noisy observations and uncertain models. There are particular challenges to hydrologic data assimilation that are mostly due to the multiple time-scales associated with the governing processes as well as due to the intermittent shocks to the dissipative system whenever precipitation storms occur. There are also different approaches to data assimilation for the purposes of obtaining the statistically-optimal estimate of model states and parameters. Among different assimilation techniques, Ensemble Kalman Filtering and Smoothing represent efficient tools to deal with non-linear dynamical models. We present here the application of the techniques and assess the observability and controllability of some hydrological models operationally in various settings.