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A Probabilistic Physics-informed Deep Learning Model for Rainfall-runoff Prediction across Continental United States

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This research investigated the applicability of a probabilistic physics-informed Deep Learning (DL) algorithm, i.e.,deep autoregressive network (DeepAR), for rainfall-runoff modeling across the continental United States (CONUS). Various catchment physical parameters were incorporated into the probabilistic DeepAR algorithm with various spatiotemporal variabilities to simulate rainfall-runoff processes across Hydrologic Unit Code 8 (HUC8). We benchmarked our proposed model against several physics-based hydrologic approaches such as Sacramento Soil Moisture Accounting Model (SAC-SMA), Variable Infiltration Capacity (VIC), Framework for Understanding Structural Errors (FUSE), Hydrologiska Byråns Vattenbalansavdelning (HBV), and the mesoscale hydrologic model (mHM). These approaches were implemented using Catchment Attributes and Meteorology for Large-sample Studies (CAMELS), Maurer datasets. Analysis suggested that catchment physical attributes such as drainage area have significant impacts on rainfall-runoff generation mechanisms while catchment fraction of carbonate sedimentary rocks parameter’s contribution were insignificant. The results of the proposed physics-informed DeepAR simulation were comparable and somewhat superior to the well-known conceptual hydrologic models across CONUS.