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Application of deep recurrent neural networks for modeling surface and sub-surface flow at high temporal resolution

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Recent increase in climate change has resulted in rise of hydrologic extreme events, which demands better understanding of flow patterns in catchment. Modeling surface and sub-surface flow at high temporal resolution helps to understand catchment dynamics. In this study, we simulated surface and sub-surface flow in a Laotian catchment at 6-minute resolution. We used one physically based model called Hydrological Simulated Program-FORTRAN (HSPF) and developed two deep learning-based models. One deep learning model consisted of only one long short-term memory (LSTM), whereas the other model simulated processes in each hydrologic response unit (HRU) by defining one separate LSTM for each HRU. The models consider environmental data as well as changing landuse in catchment and predict surface and sub-surface flows. Our results show that simple LSTM model outperformed other models for surface runoff prediction, whereas the HRU-based LSTM model better predicted patterns and slopes in sub-surface flow in comparison with other models.