

Real-time Flood Extent Forecasting Using an Encoder-decoder ConvLSTM Integrated with Data Assimilation



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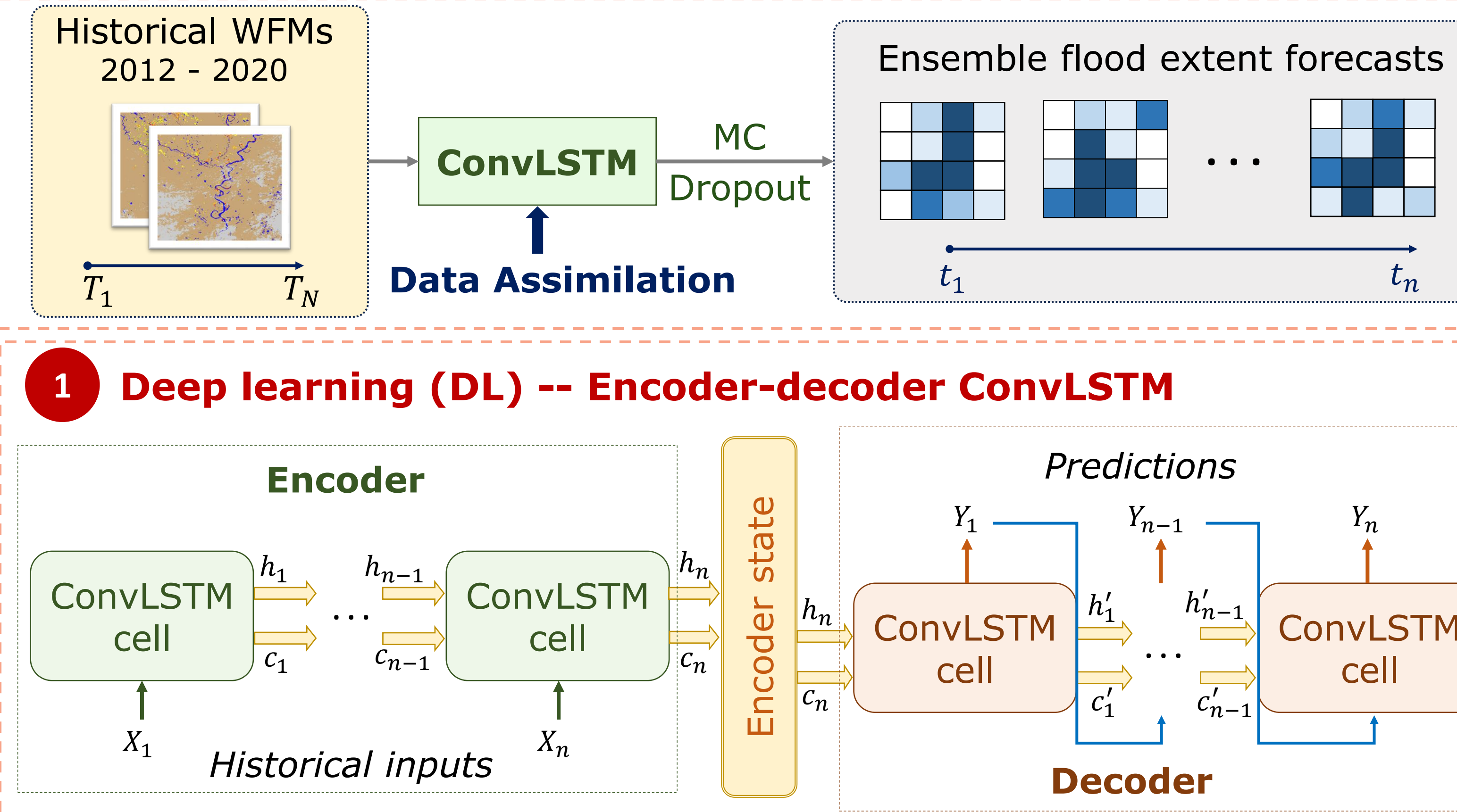


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Introduction

- Real-time flood extent forecasting** is crucial for flood management and disaster response, while traditional hydrodynamic modeling is limited by its sensitivity to uncertain inputs and high computational complexity.
- Deep learning (DL)** shows strong flood forecasting capability using VIIRS water fraction observations, while reducing computational cost.
- Data assimilation (DA)** is designed to integrate real-time satellite observations to enhance model's forecast skill.
- We present a hybrid approach that combines a Convolutional Long Short-term Memory (ConvLSTM) network and the Ensemble Kalman Filter (EnKF) algorithm for real-time flood forecasting over a large flood-prone river basin.

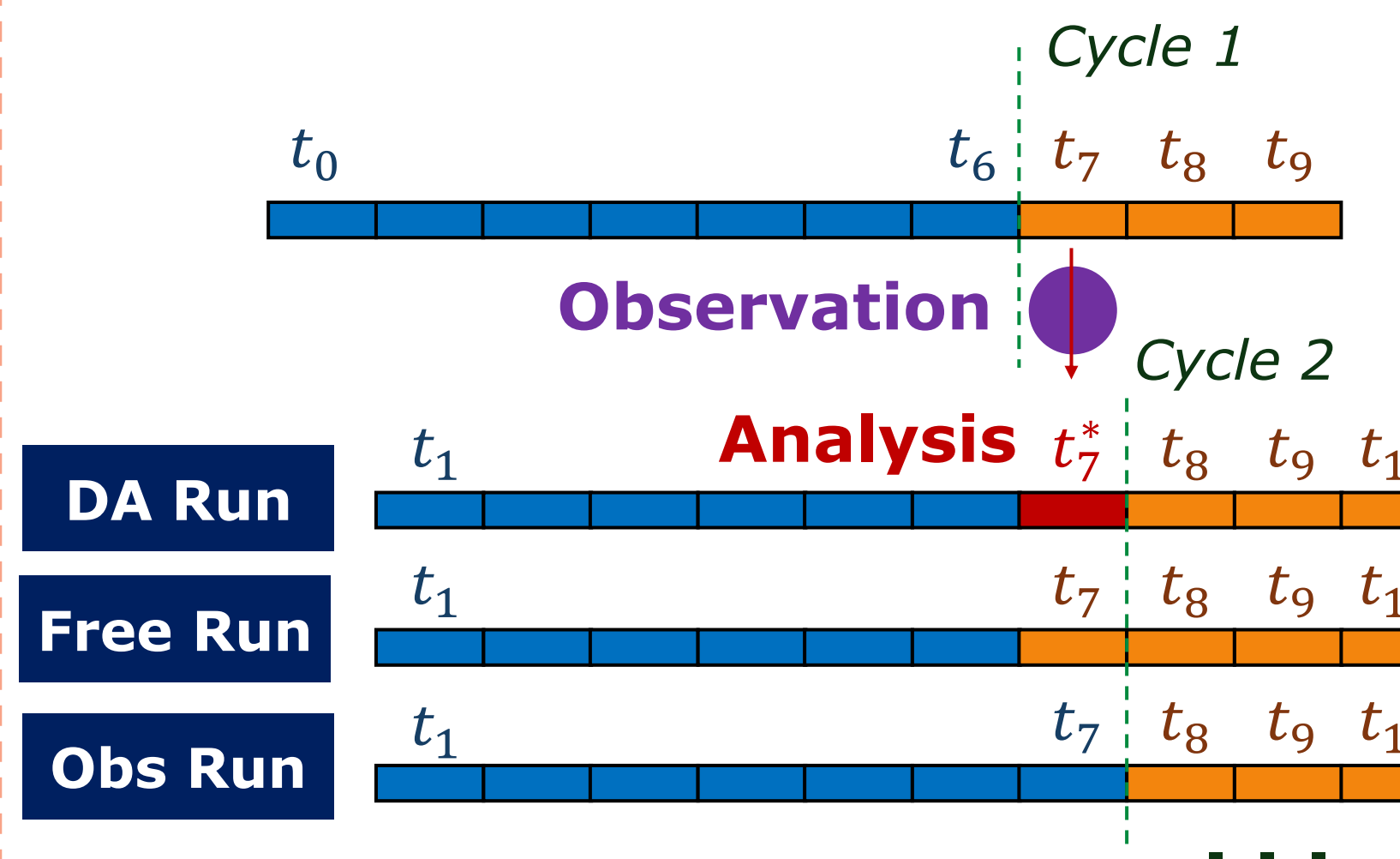
Method



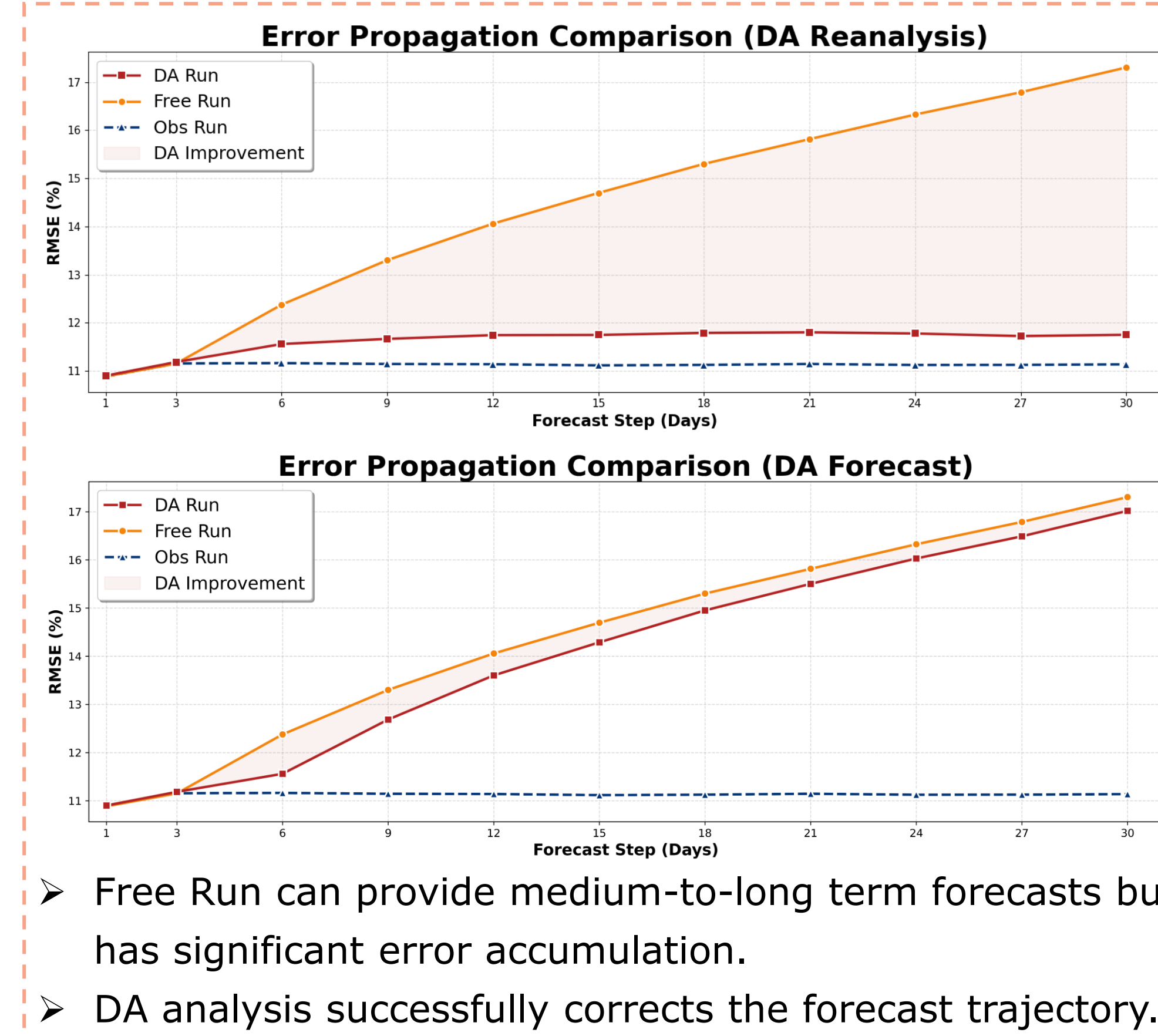
2 Data Assimilation (DA) -- EnKF

$$\hat{x} = x_m + K(y - H(x_b))$$

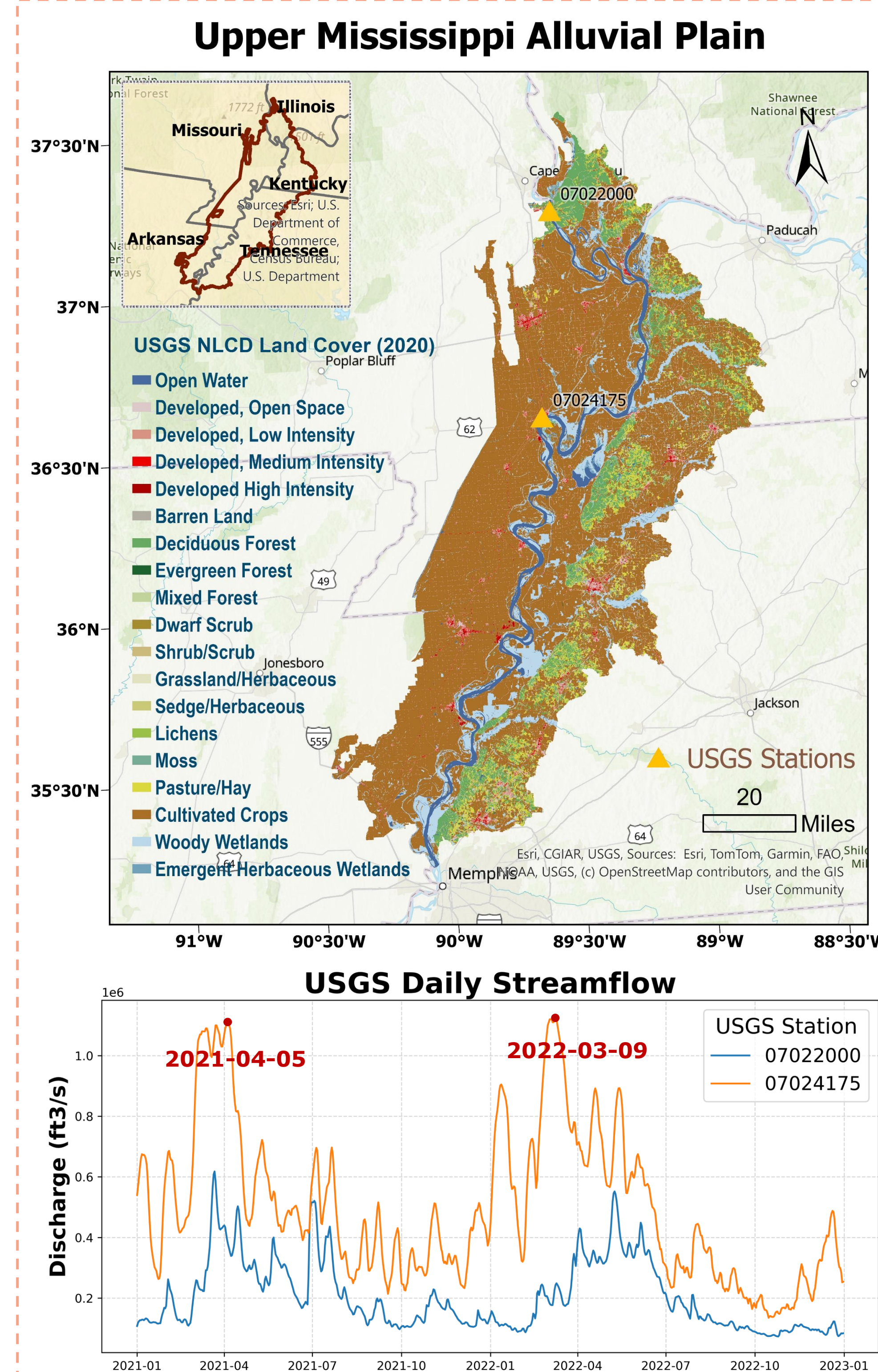
Combine model estimates x_m and observations x_b



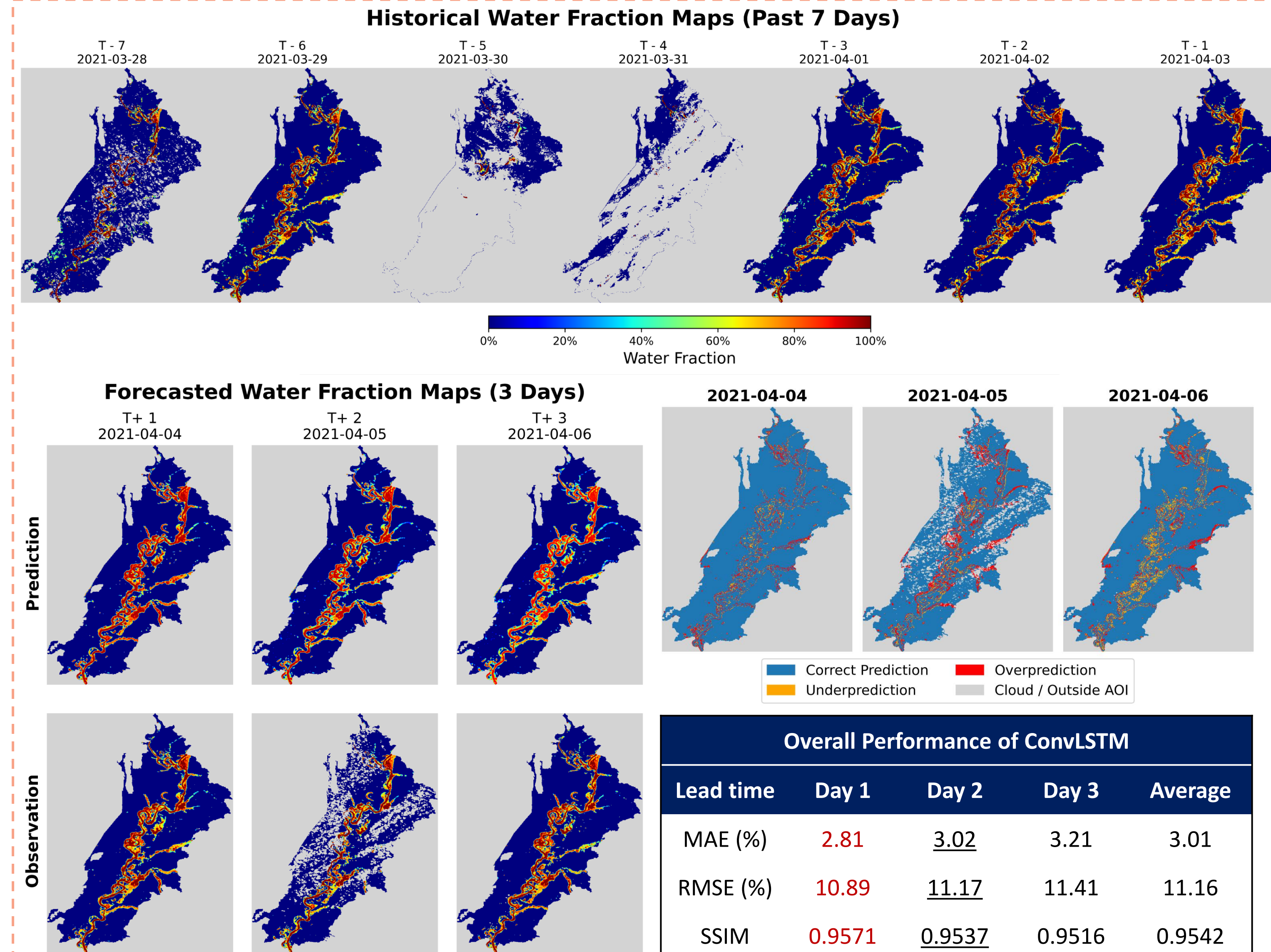
Forecast Error Propagation



Study Area & Study Case



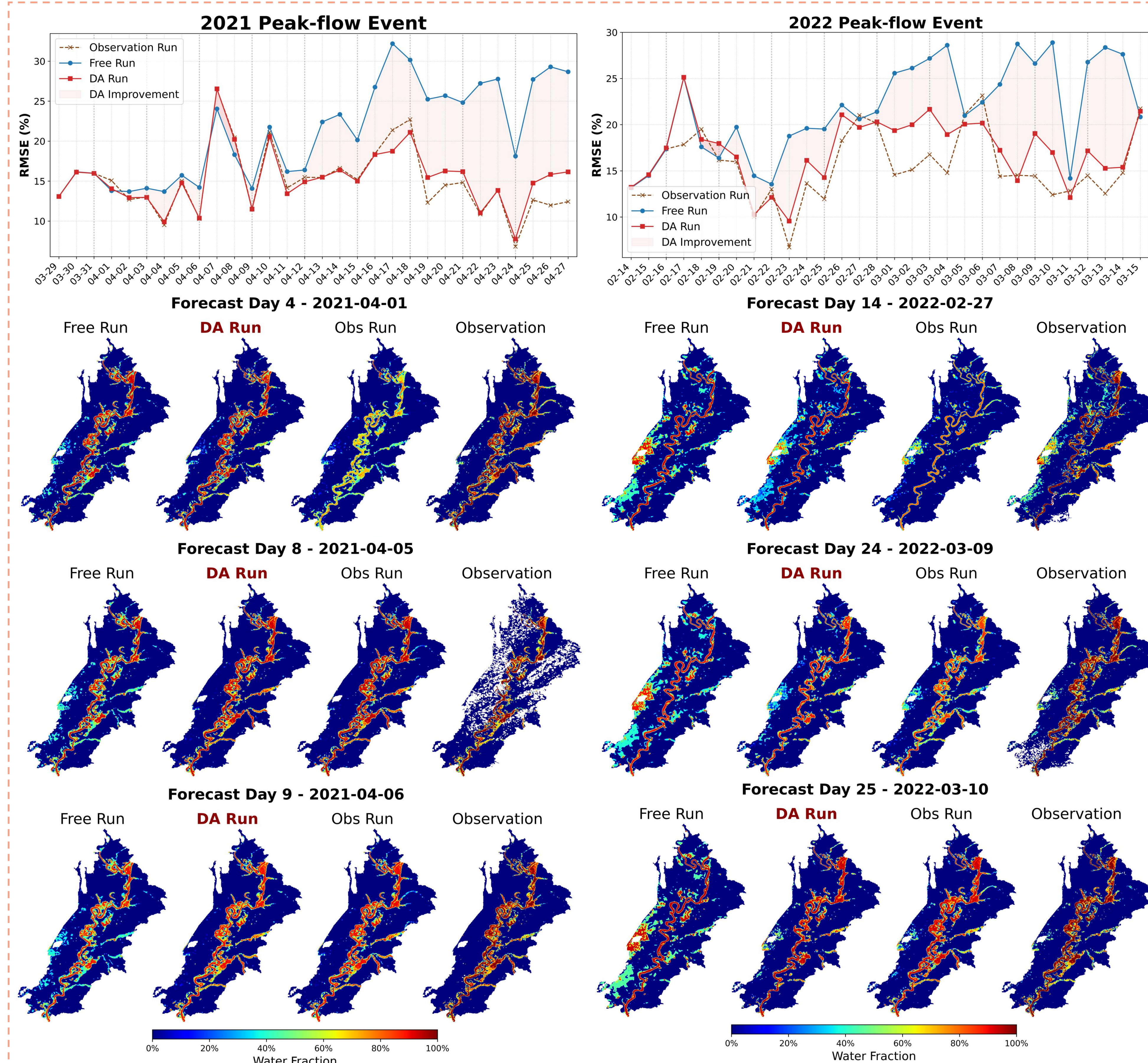
3-day Flood Extent Forecasting



Conclusion & Future Work

- Our proposed ConvLSTM model generates reliable short-term (3-day) flood extent forecasts using VIIRS water fraction observations. Future work will further investigate its forecast capability across varying lead times.
- The integration of data assimilation successfully enhances model's forecast skill by mitigating the error propagation in ConvLSTM's recursive forecasting (Free Run model).
- By balancing model predictions and satellite observations, the hybrid DA-DL framework demonstrated robust performance during two peak-flow events.

Peak-flow Event Forecasting



Acknowledgement

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