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Dominant source of uncertainty in CLM simulations of hydrological signatures: a CONUS-scale comparison between forcing and parametric uncertainty

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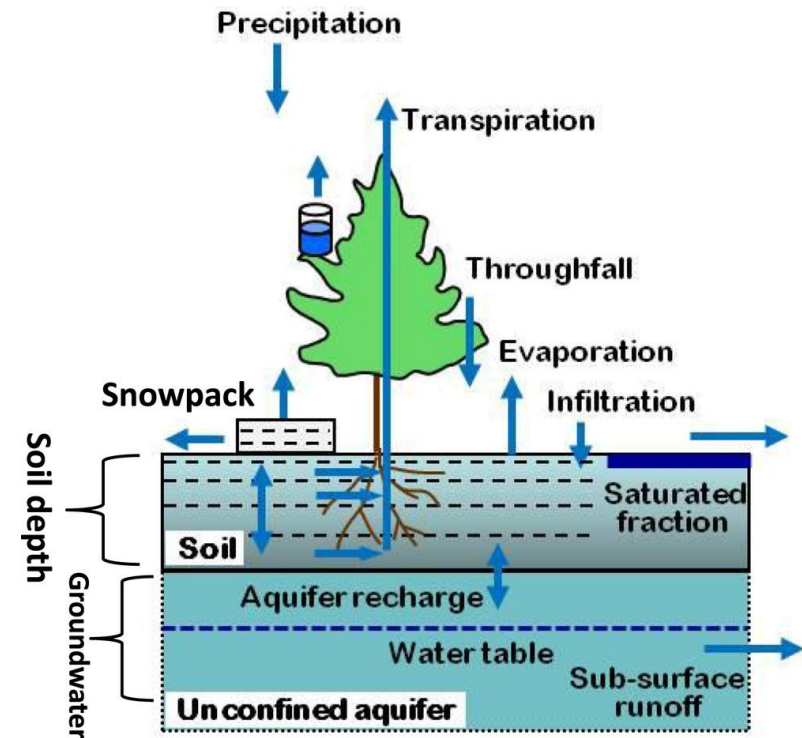
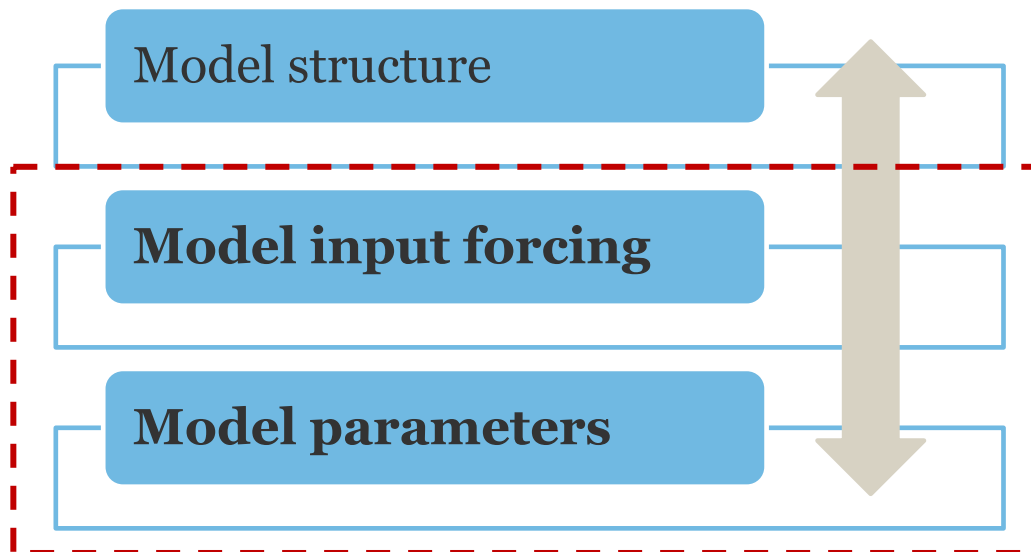
Pacific Northwest National Laboratory

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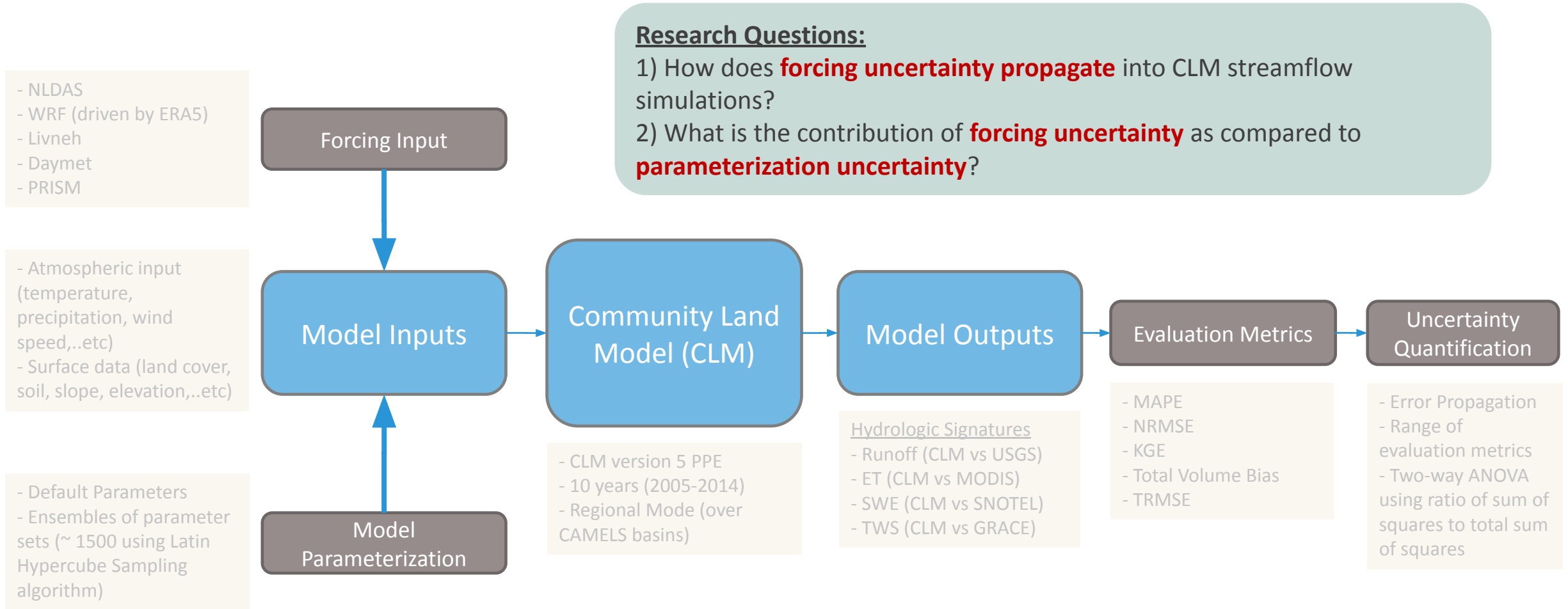
RESEARCH OBJECTIVE

How does forcing and parametric uncertainty influence key hydrologic processes across different time scales and over the CONUS?

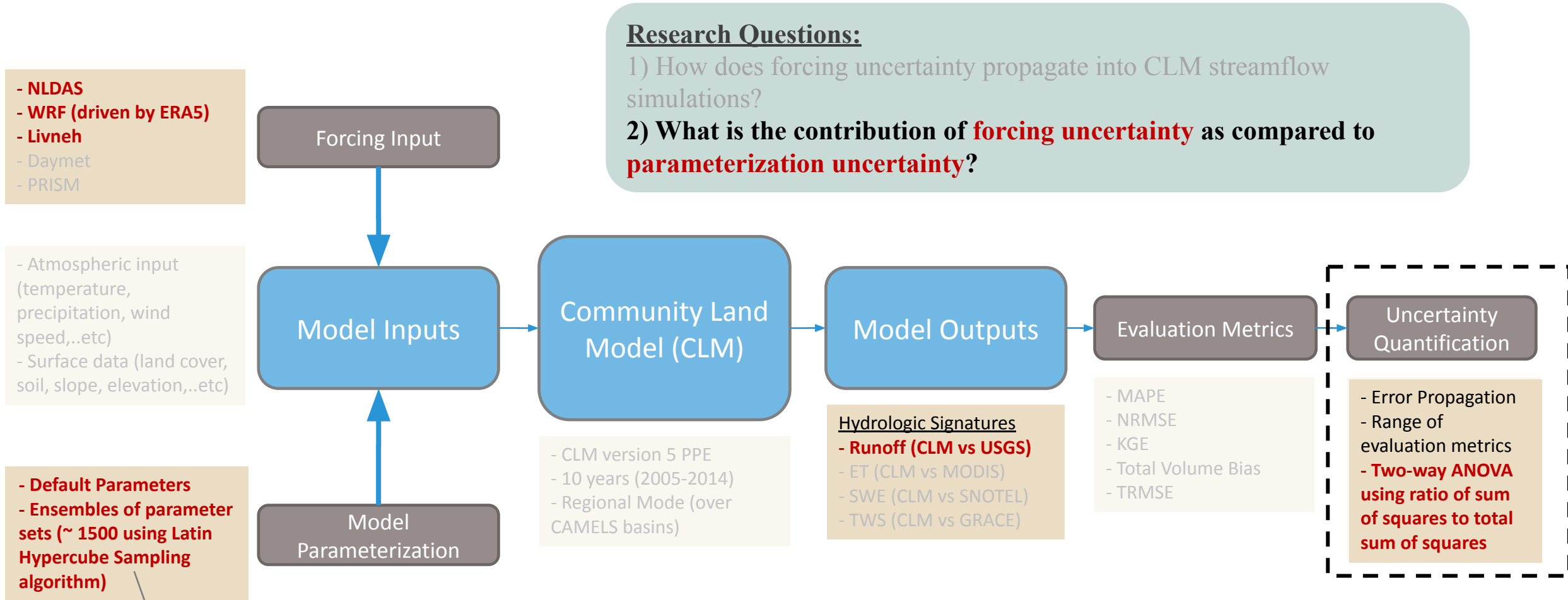
Sources of uncertainty in LSM

Xia et al. 2017

UNCERTAINTY ANALYSIS FRAMEWORK



UNCERTAINTY ANALYSIS FRAMEWORK



Research Questions:

1) How does forcing uncertainty propagate into CLM streamflow simulations?

2) What is the contribution of **forcing uncertainty** as compared to **parameterization uncertainty**?

Yan et al. (*in revision*): Large Ensemble Diagnostic Evaluation of Hydrologic Parameter Uncertainty in the Community Land Model Version 5 (CLM 5). *Journal of Advances in Modeling Earth Systems*.

UNCERTAINTY QUANTIFICATION

FORCING VS PARAMETERIZATION

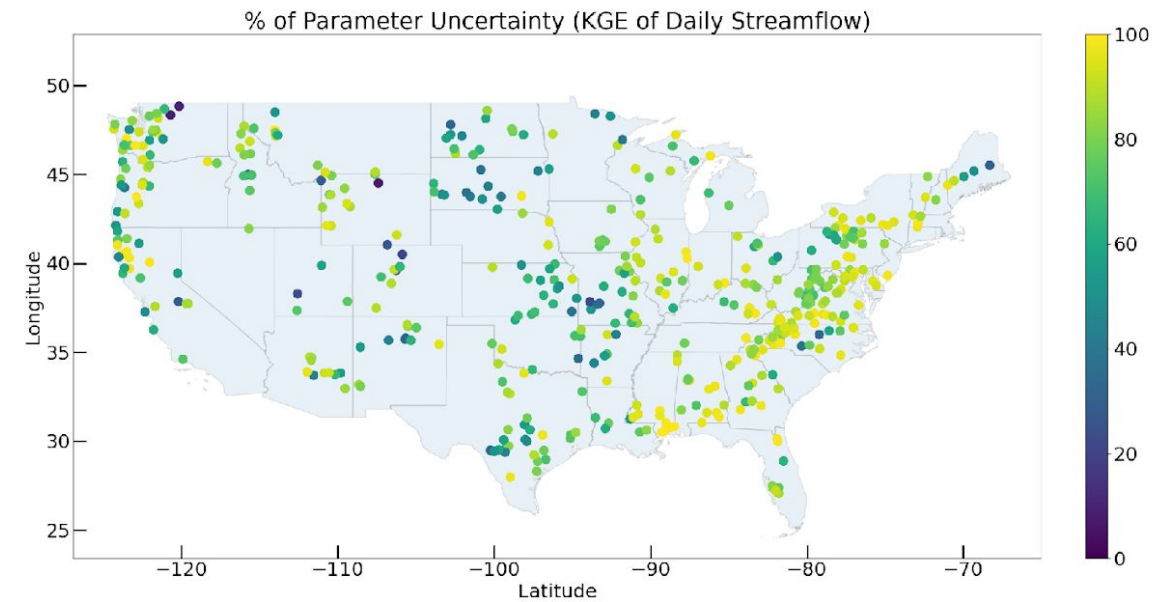
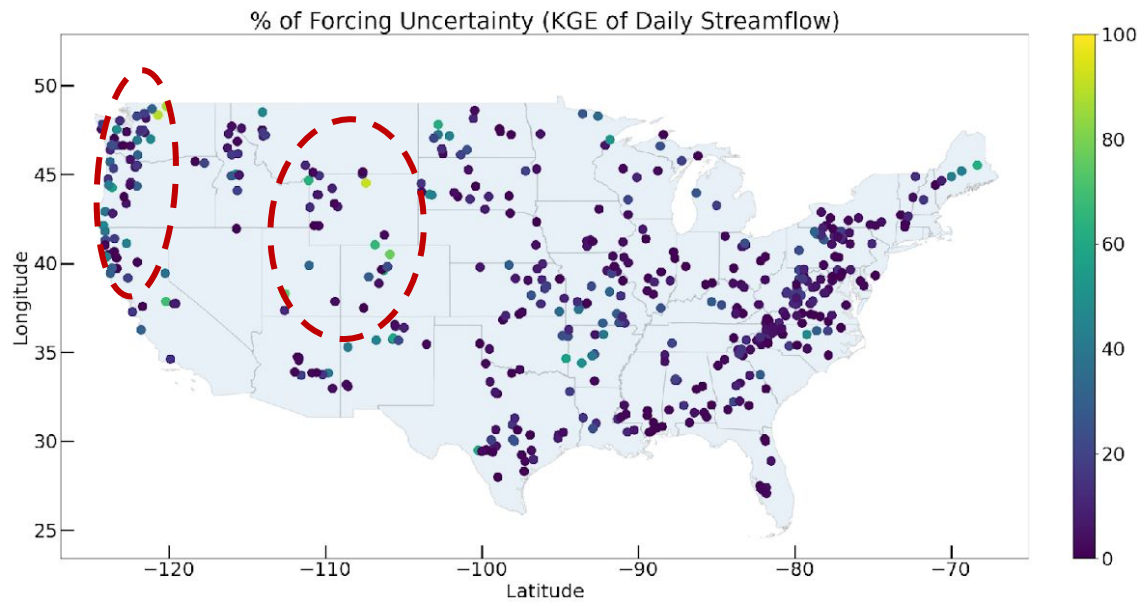
- Uncertainty Index based on ANOVA for KGE of daily streamflow

Uncertainty Index (UCI) for Forcing

$$UCI_F = \frac{SS_F}{TSS}$$

Uncertainty Index (UCI) for Parameterization

$$UCI_P = \frac{SS_P}{TSS}$$

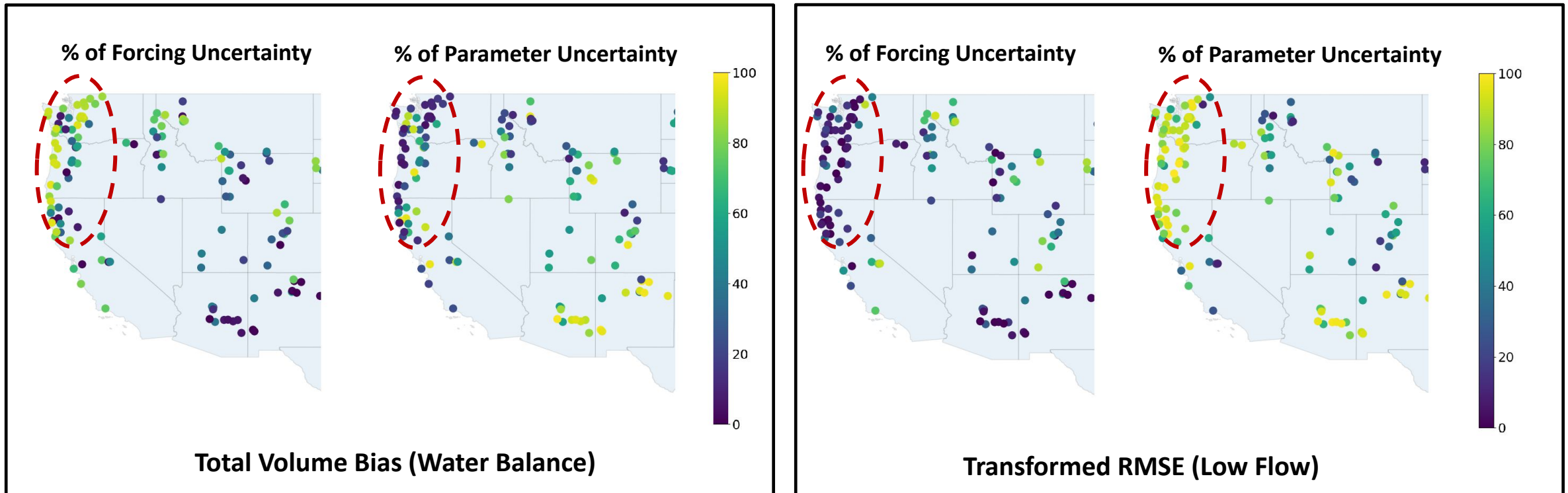


Parametric uncertainty contributes to the most variance in daily streamflow KGE

UNCERTAINTY QUANTIFICATION

FORCING VS PARAMETERIZATION

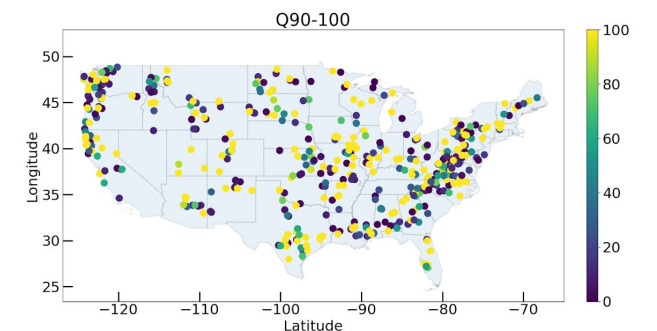
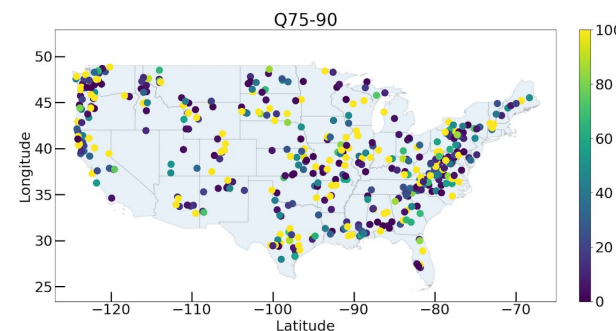
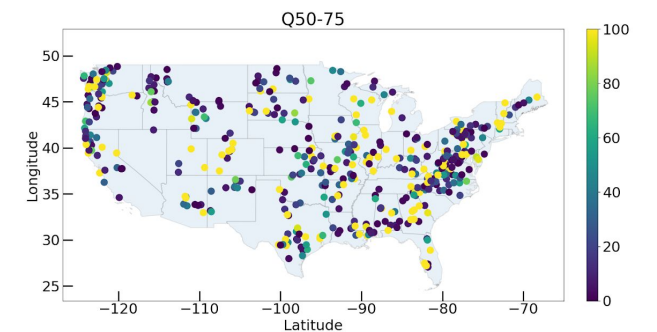
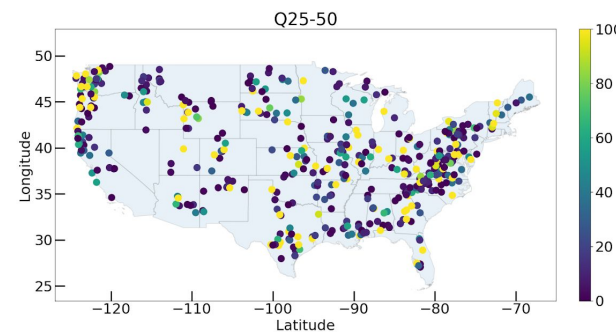
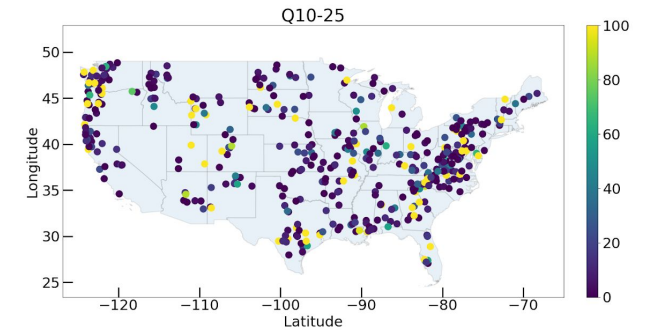
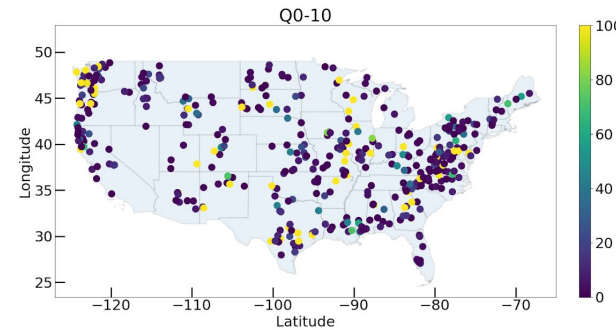
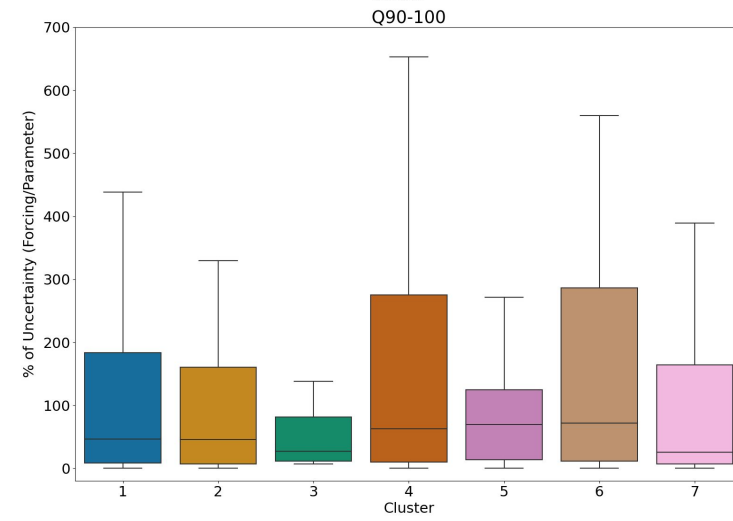
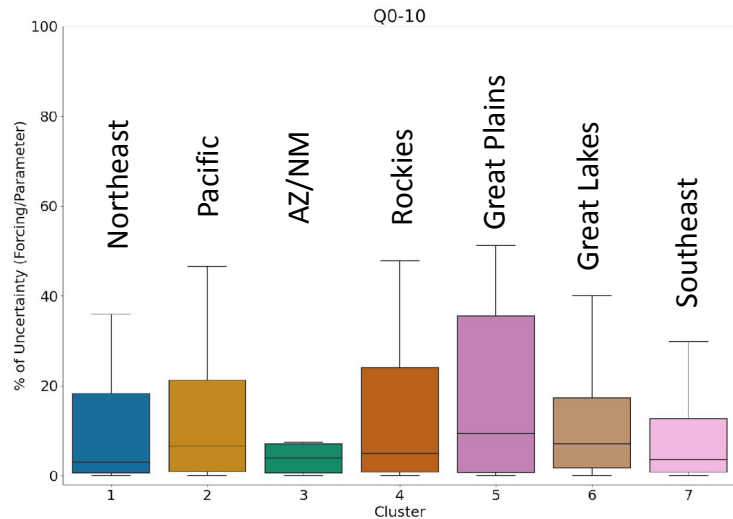
- Uncertainty Index based on ANOVA for Total Volume Bias (TVB) and transformed RMSE of daily streamflow



Forcing uncertainty has higher (lower) contribution to TVB (TRMSE) in Pacific Northwest

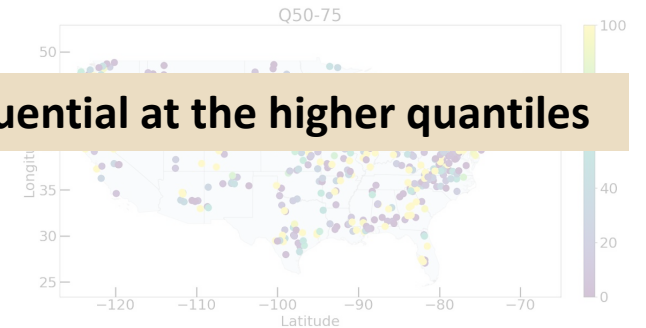
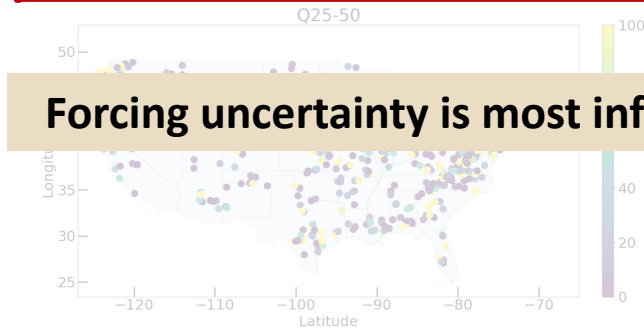
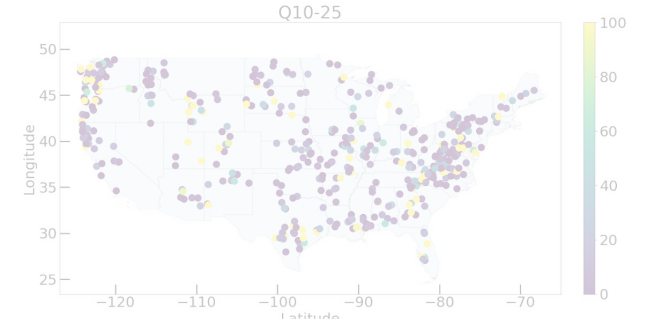
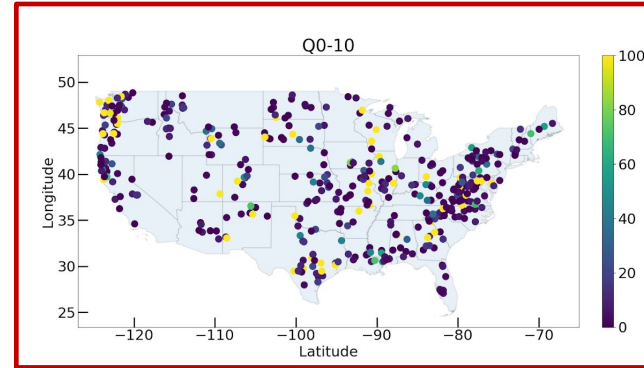
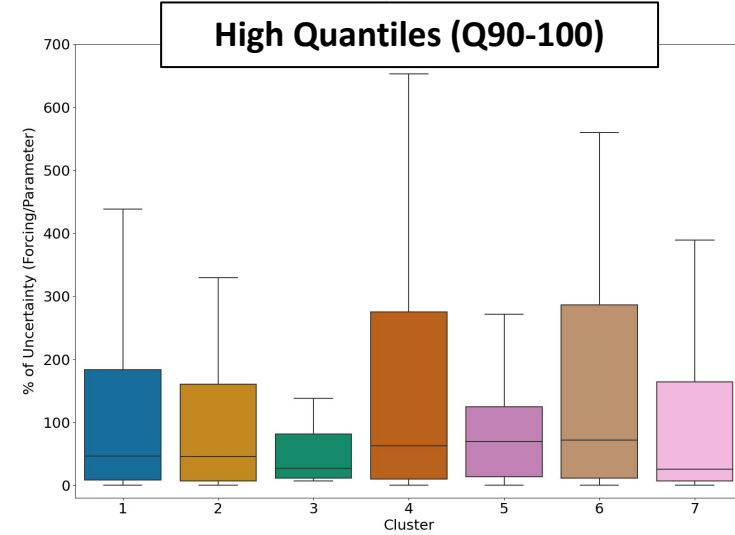
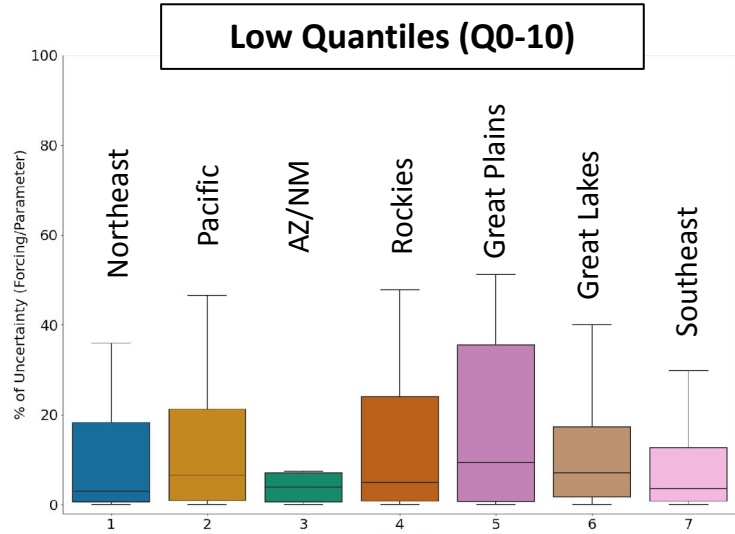
UNCERTAINTY ANALYSIS FORCING VS PARAMETERIZATION

- Forcing/Parameterization Uncertainty Index for **different flow regimes** based on Total Volume Bias (TVB)

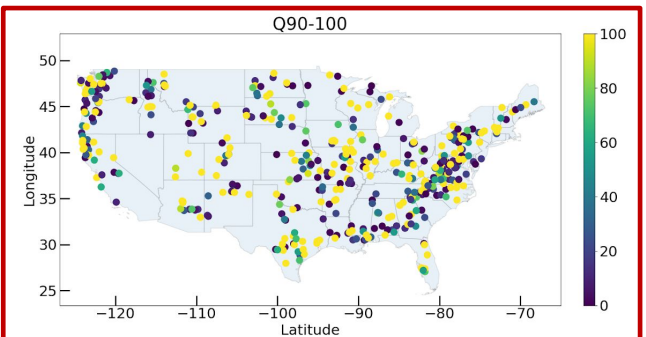
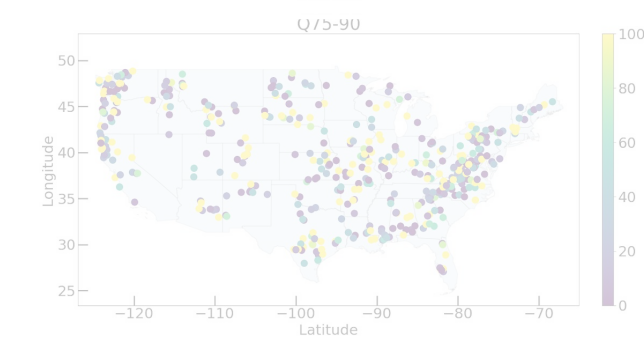


UNCERTAINTY QUANTIFICATION FORCING VS PARAMETERIZATION

- Forcing/Parameterization Uncertainty Index for **different flow regimes** based on Total Volume Bias (TVB)



Forcing uncertainty is most influential at the higher quantiles

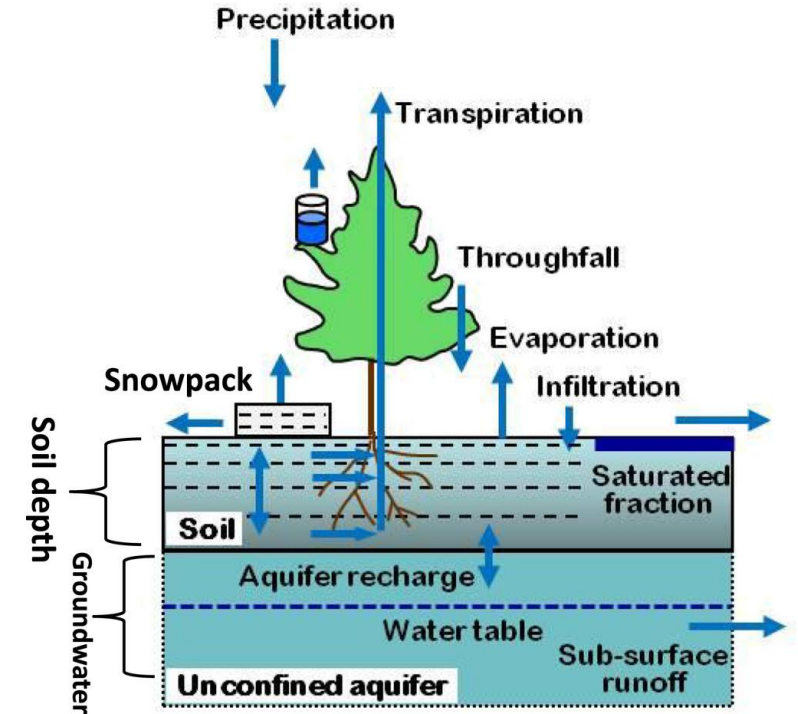


Concluding Remarks

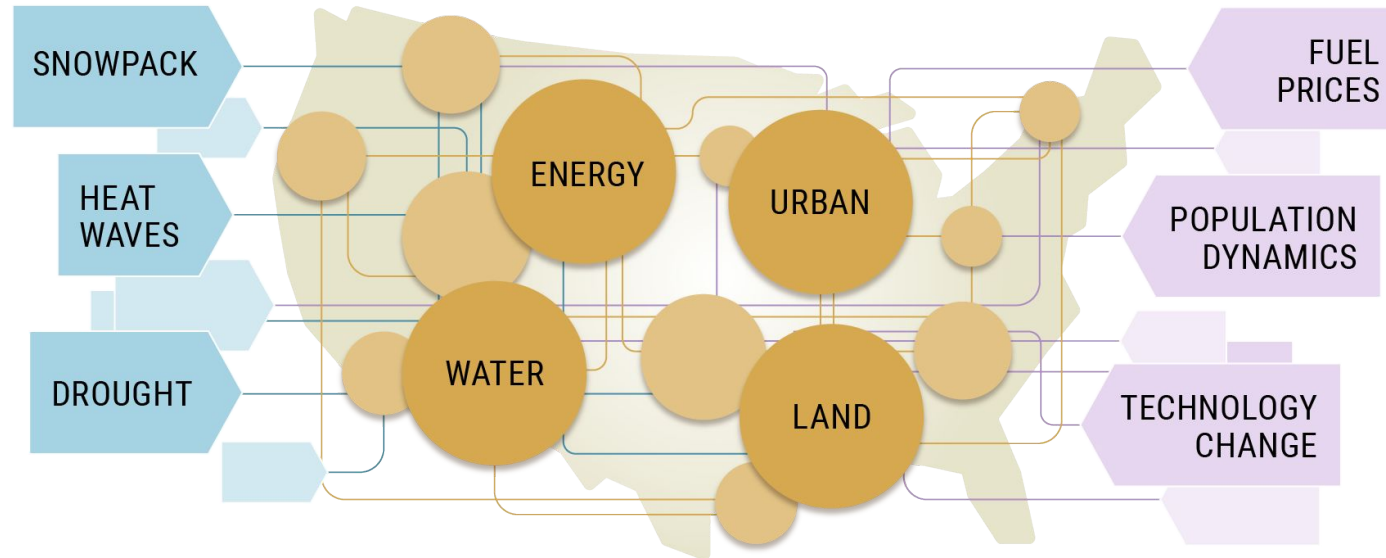
- **Dominant source of uncertainty** is dependent on hydrologic signature/evaluation metric.
- Uncertainty in lower streamflow quantiles is dominated by parameter uncertainty, while **forcing uncertainty** contributes more to **higher streamflow quantiles**.

Future Work

- Quantify the uncertainty in simulation of other land surface variables, e.g., **SWE, ET, TWS**.



INTEGRATED MULTISECTOR MULTISCALE MODELING



Thanks!

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