

Development of An Open-Source Automatic Calibration Tool for the Next Generation Water Resources Modeling Framework

H31V-1793

OWP OFFICE OF WATER PREDICTION

Xia Feng^{1,2}, Nels Frazier^{1,3}, Matt Williamson¹, Ahmad Jan^{1,3}, Peter La Follette^{1,3}, Rachel McDaniel¹, Yuqiong Liu^{4,5}, Luciana Kindl da Cunha^{6,1}, Mike Johnson^{3,1}, Jason Ducker^{1,3}, Brian Cosgrove⁵, Trey Flowers¹ and Fred L. Ogden¹

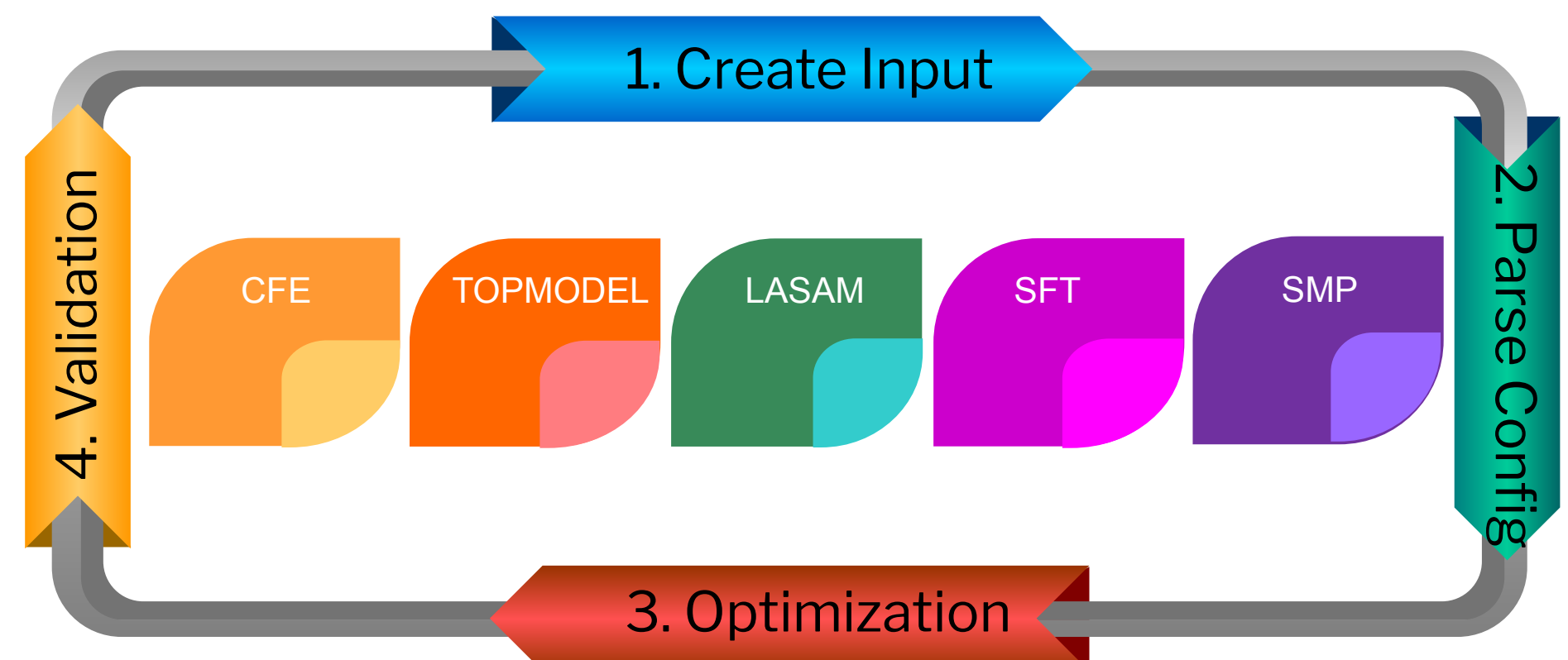
¹ NWS/Office of Water Prediction/National Water center, ² University of Alabama, ³ Lynker Tech, ⁴ LEN Tech, ⁵ NWS/Office of Water Prediction and ⁶ WEST Consultants

Motivation and Objective

- The Office of Water Prediction's Next Generation Water Resources Modeling Framework (NextGen) uses standards to provide model-agnostic interoperability for a wide range of models and process modules.
- NextGen allows flexible design of experiments to select performant models and module components and a rapid path toward operationalizing a mosaic of models over geographically varying regions.
- To facilitate model parameter estimation, OWP has developed an open-source Python based software tool that automatically calibrates the parameters of the NextGen models against the observation data.

Major Capabilities and Features

Automatic Calibration of Multiple Formulations



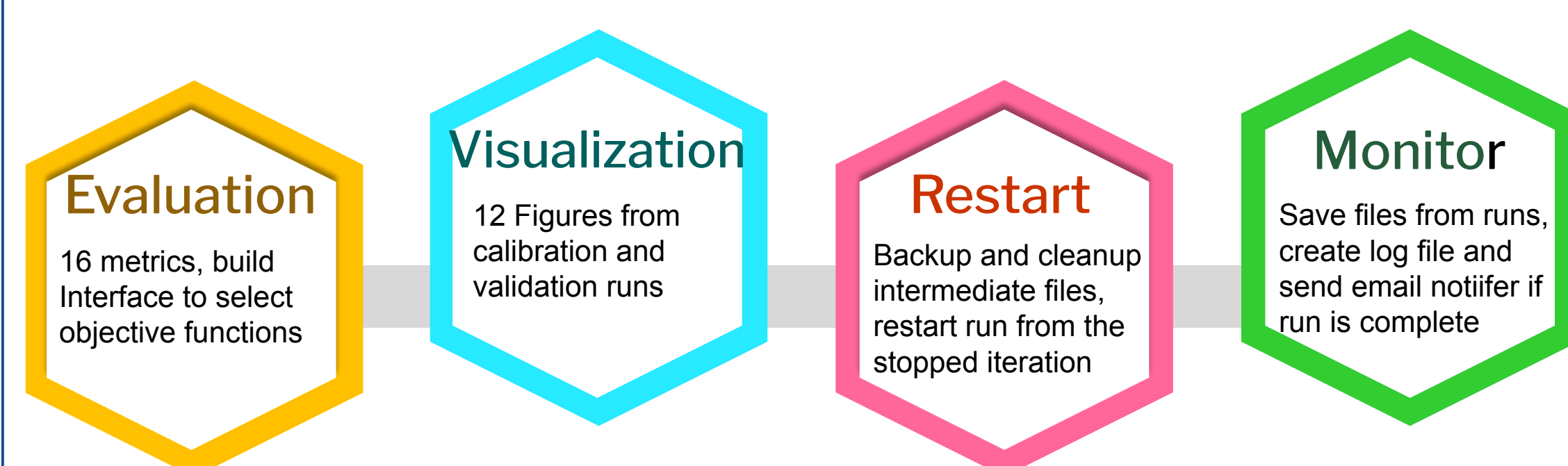
Three Calibration Strategies



Three Optimization Algorithms



Functional Utilities



Flexible Model-Agnostic Calibration Tool Developed for the NextGen Framework

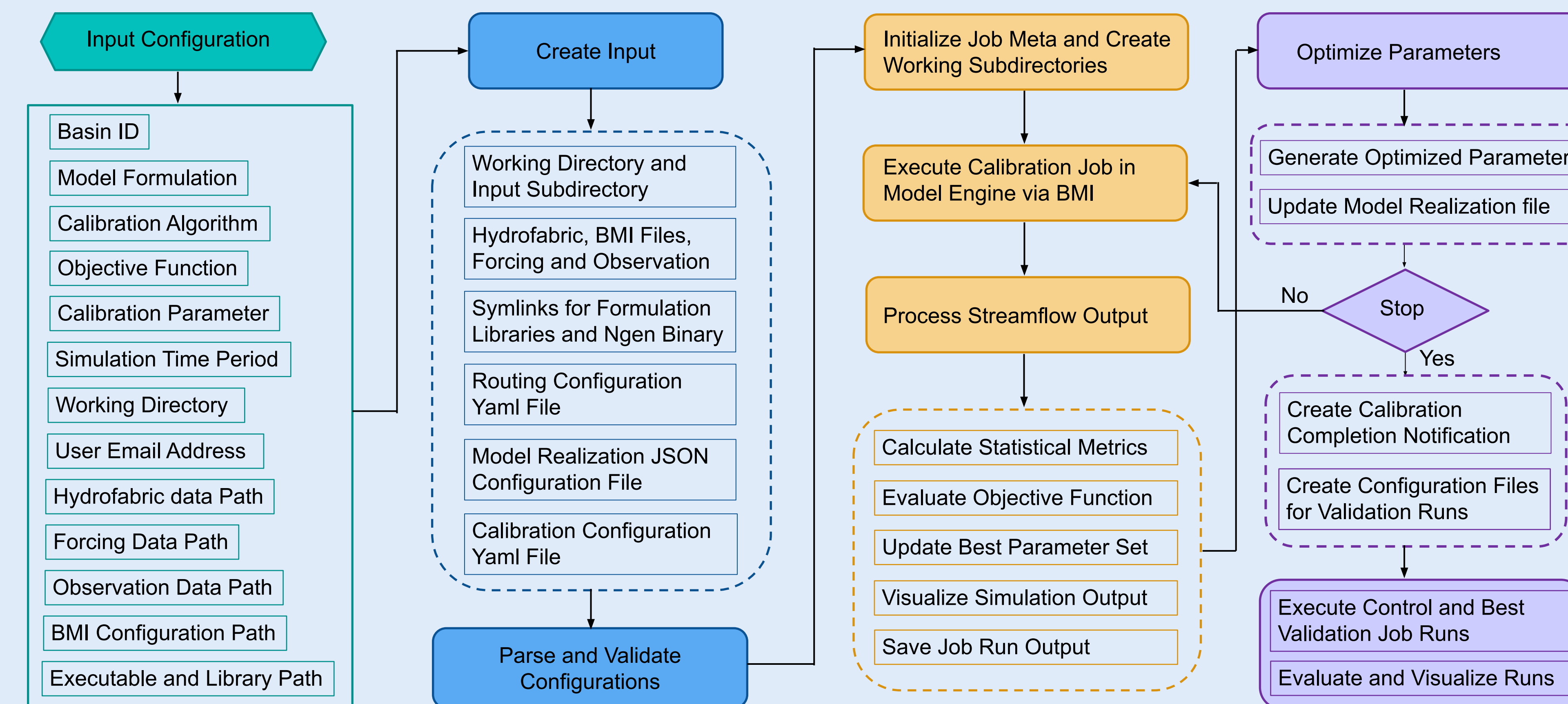


Figure 1. NextGen Calibration Workflow Operated in Python.

Results for Calibration Simulation A

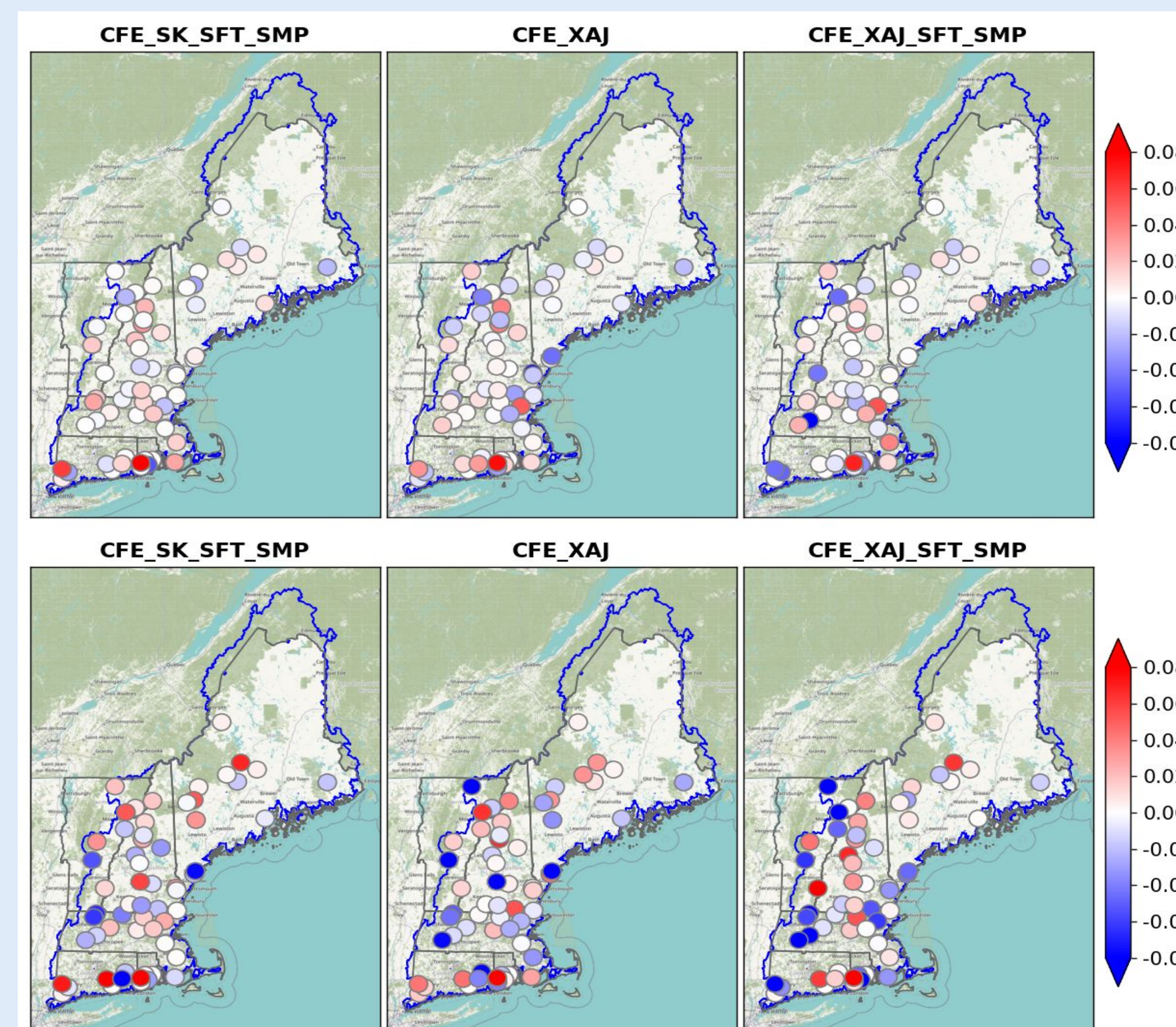


Figure 2. Difference of KGE between each run and CFE_SK during calibration (top) and validation (bottom) period over sixty basins in the HUC01 region.

- Differences among all runs are larger in the validation period than during the calibration period.
- Overall, the CFE_SK_SFT_SMP run has higher KGE than the other runs during different time periods.

Results for Calibration Simulation B

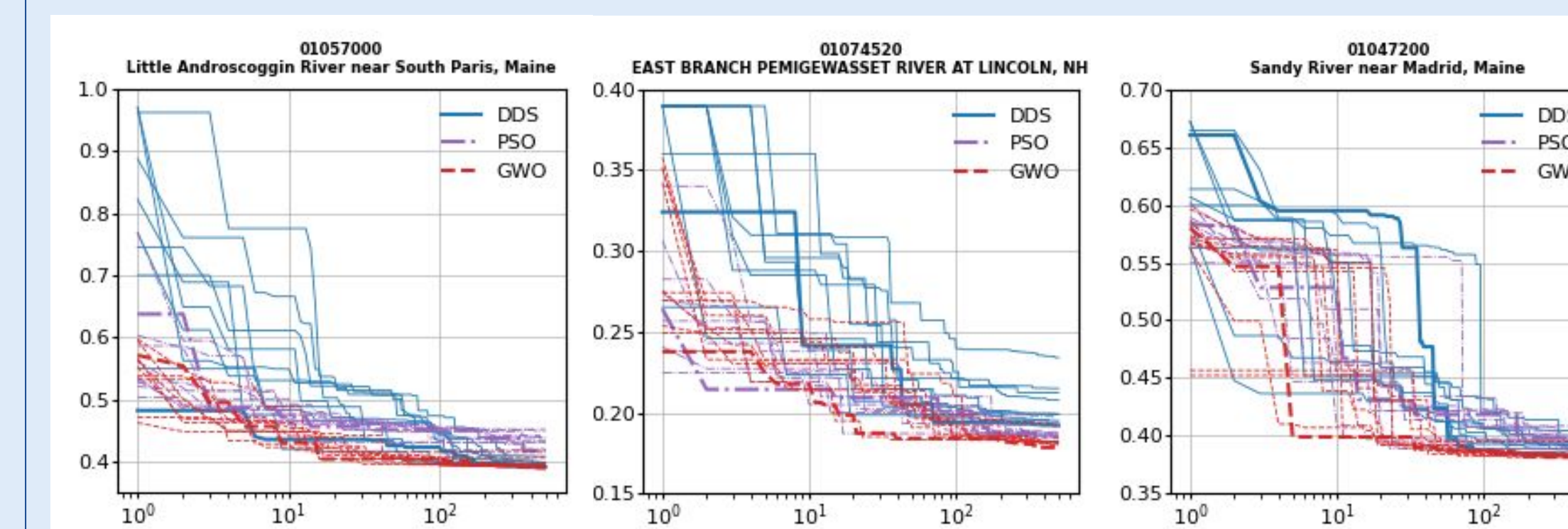


Figure 3. Convergence curve (1-KGE) from different algorithms.

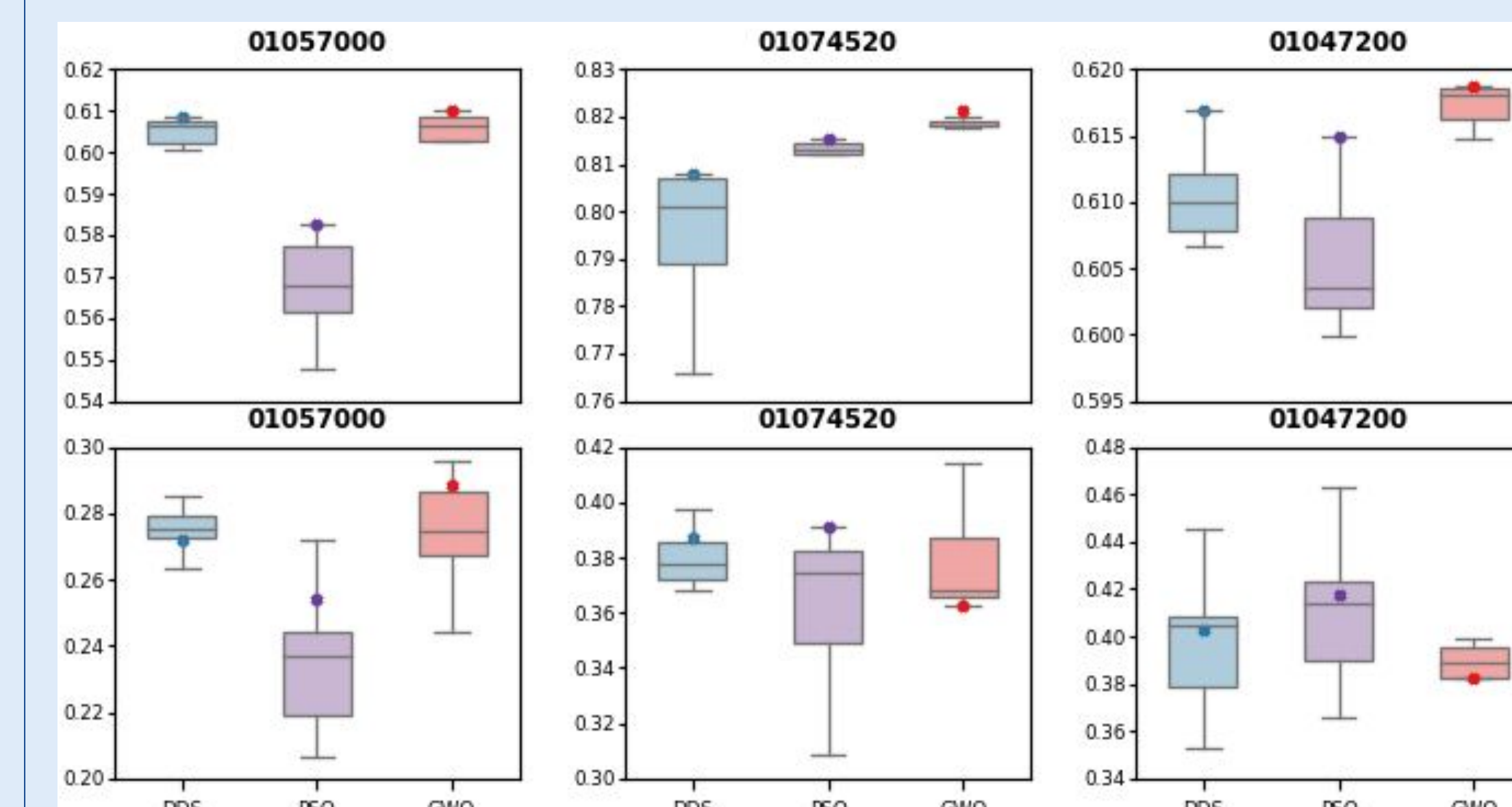


Figure 4. KGE of all trials and best trial (denoted by dot) from all algorithms during calibration (top) and validation (bottom) period.

- GWO outperforms the other two optimization algorithms during calibration period while PSO is superior to the other two algorithms for two basins in validation period.

Calibration Simulations

The capabilities of calibration tool are exhibited from the following two perspectives:

- A. Ability to calibrate different formulations
- B. Ability to calibrate parameters using multiple optimization algorithms

Table 1. Calibration Setup for Simulation A.

Formulations	Run Name	N. Params
CFE, Schakke, Noah-OM	CFE_SK	11
CFE, Schakke, Noah-OM, SFT, SMP	CFE_SK_SFT_SMP	11
CFE, Xinanjiang, Noah-OM	CFE_XAJ	13
CFE, Xinanjiang, Noah-OM, SFT, SMP	CFE_XAJ_SFT_SMP	13

Table 2. Calibration Setup for Simulation B.

Algorithms	N. Params	N. Trials	N. Cores
DDS	10	10	1
GWO	10	10	10
PSO	10	10	10

Common settings: KGE as objective function, 500 iterations, AORC forcing data, 2016-2021 calibration period, 2013-2016 validation period.

Conclusions and Discussions

- A model-agnostic and automatic calibration tool is developed for parameter optimization for NextGen.
- This tool has modular structure and user-friendly interface, it can be expanded and extended with more functionalities to meet different application needs.
- Representativeness of calibration results needs further testing using more basins with varied climatic and physiographic characteristics, and different calibration settings like parameters, different variables such as soil moisture or snow, different time period, etc.

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CONTACT

Website: <https://water.noaa.gov>
Email: xia.feng@noaa.gov

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