Phase 7 WSM Development – Dynamic Model for Hydrology

Modeling Workgroup Quarterly Meeting – April 2022

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[1] Penn State, [2] USGS, [3] UMCES, [4] US EPA, [5] VA DEQ – Chesapeake Bay Program Office

Purpose

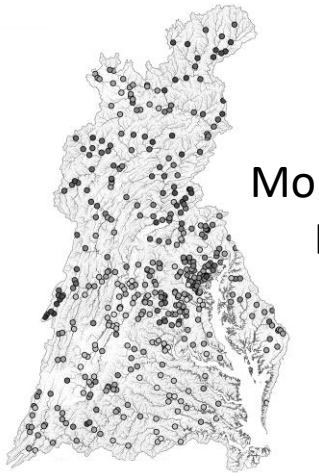
Dynamic Watershed Model

- Inputs for the estuarine models (MBM/MTMs)
- Watershed model calibration and scenario applications
- Support research and collaboration

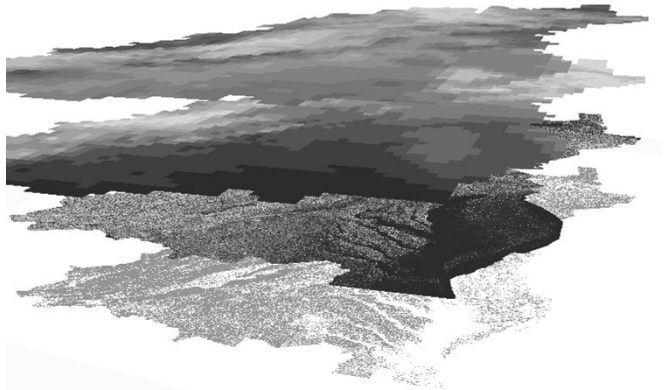
Presentation Outline

1. NHD scale Dynamic Model for Hydrology
   a) CalCAST *average annual* flow in Dynamic Model (CalCAST→DM)
   b) Expanded simulation period up to CY 2020
2. NHD streams and River segments
   a) Nested geography for river parametrization and simulation
   b) Upscaling of model outputs

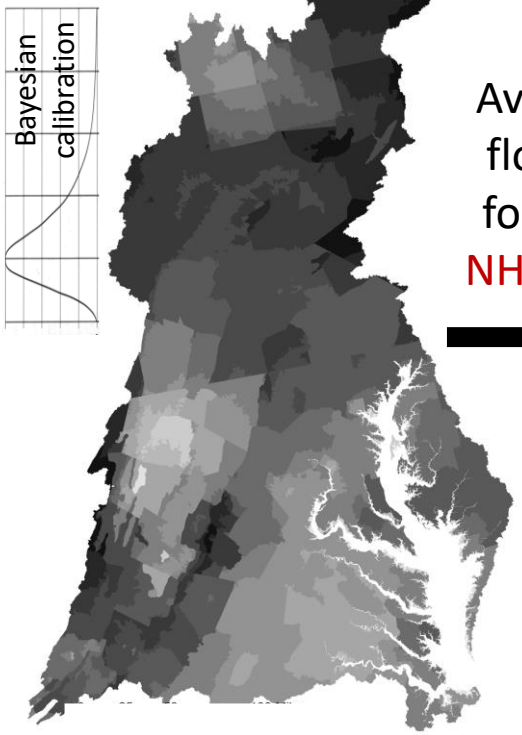
CalCAST→DM



Monitoring Data + Watershed characteristics & inputs



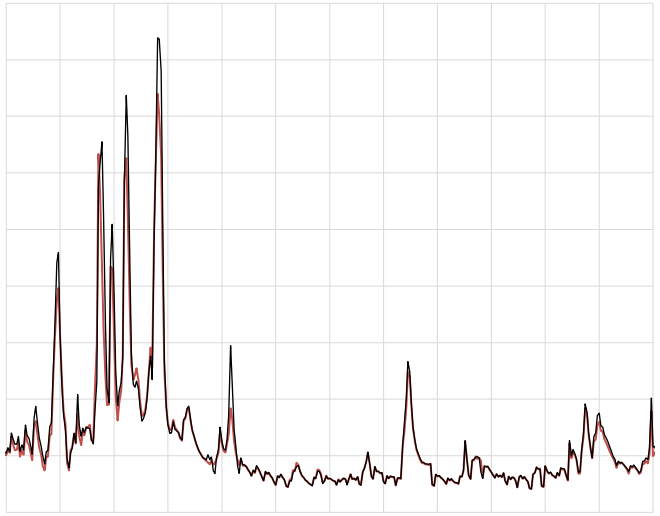
CalCAST spatial estimates



Average Annual flow estimates for land uses & NHD catchments

Dynamic Model hourly estimates

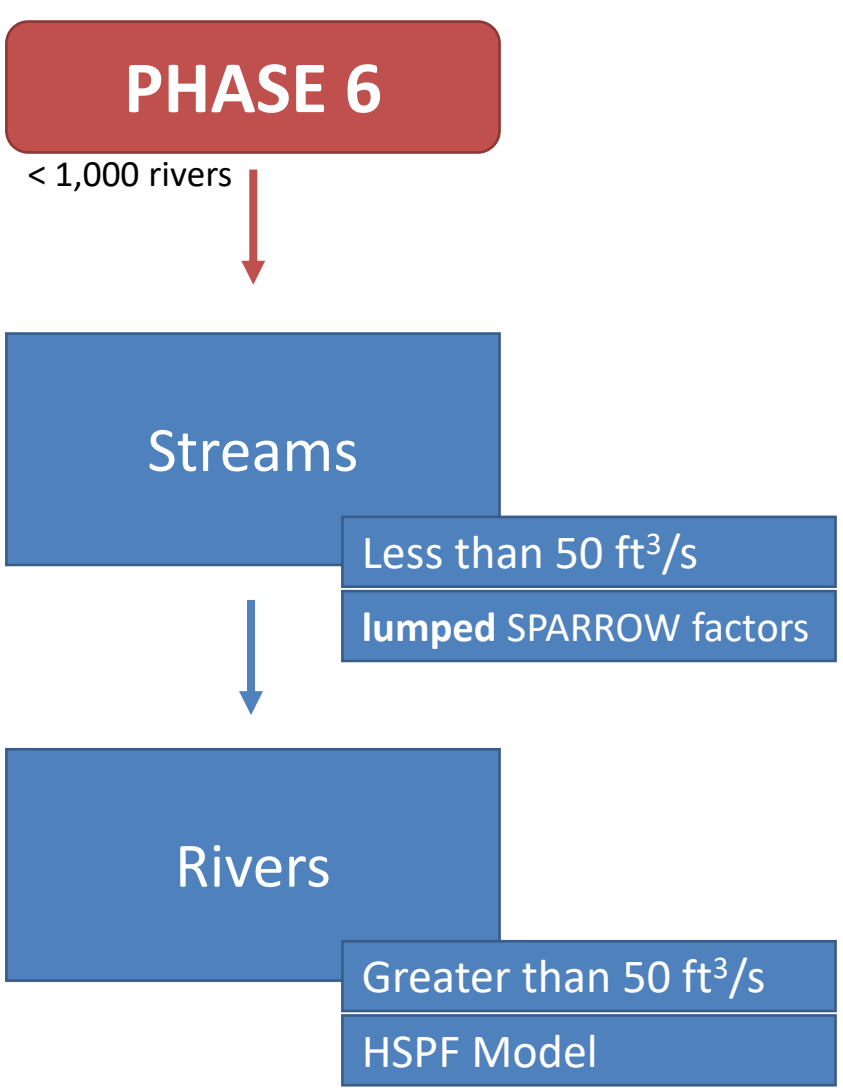
Meteorological inputs, DM parameters

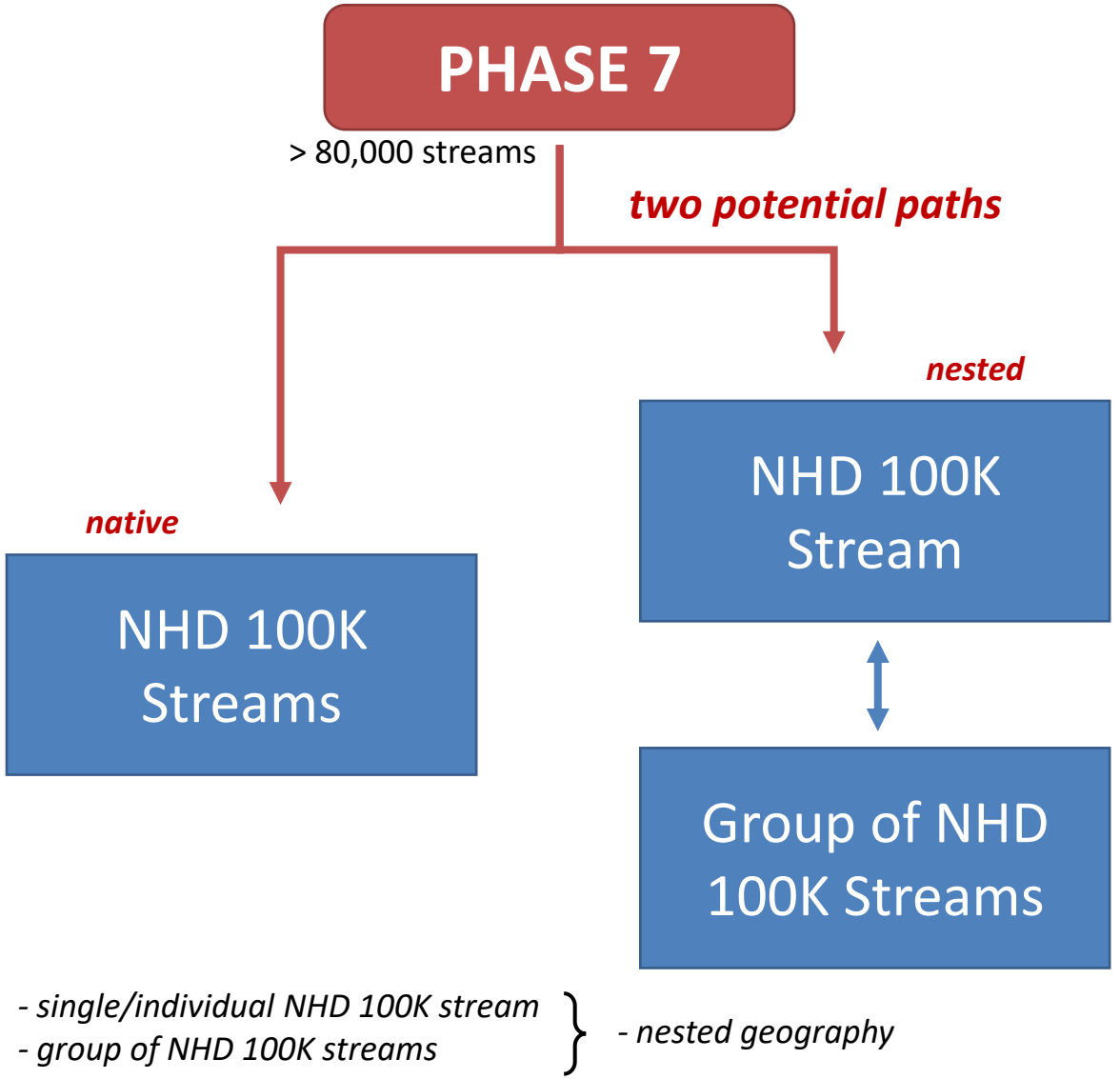


- NHD-scale DM hydrology prototype was previously developed using CalCAST *annual* flow estimates[1].
- We are now using CalCAST *average annual* flow for improving DM performance.

[1] https://www.chesapeakebay.net/channel_files/41566/20211005_-_bhatt_-_phase_7_wsm_development_-_time_averaged_and_dynamic_hydrology_linkage.pdf

River Segmentation





River Simulation

HSPF

Complex model and requires estimation of several model parameters.

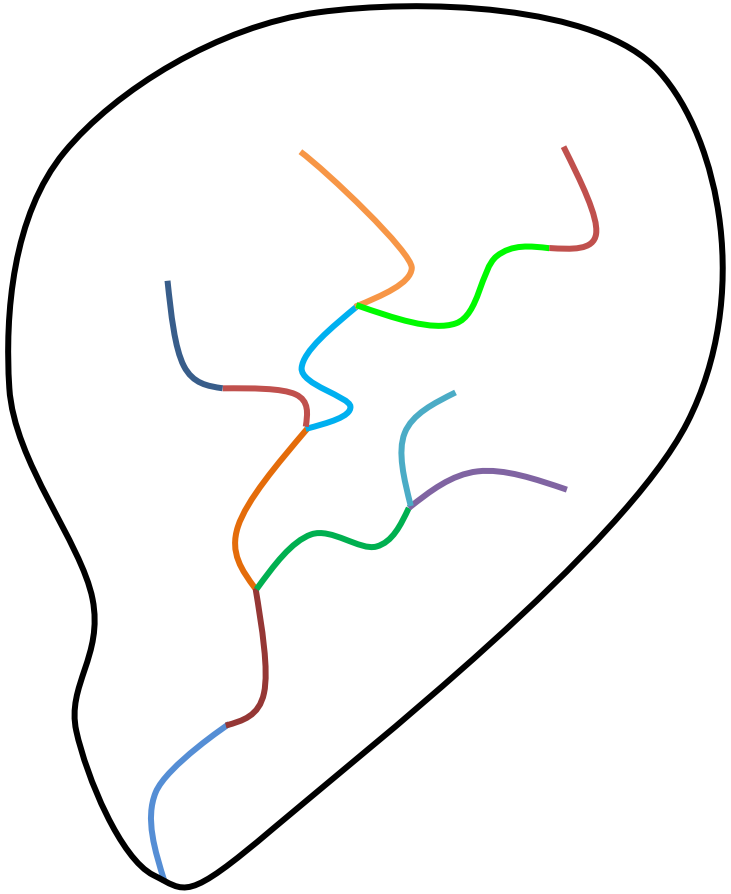
Simple Routing

Potential for providing better agreement with the time-averaged model, CalCAST.

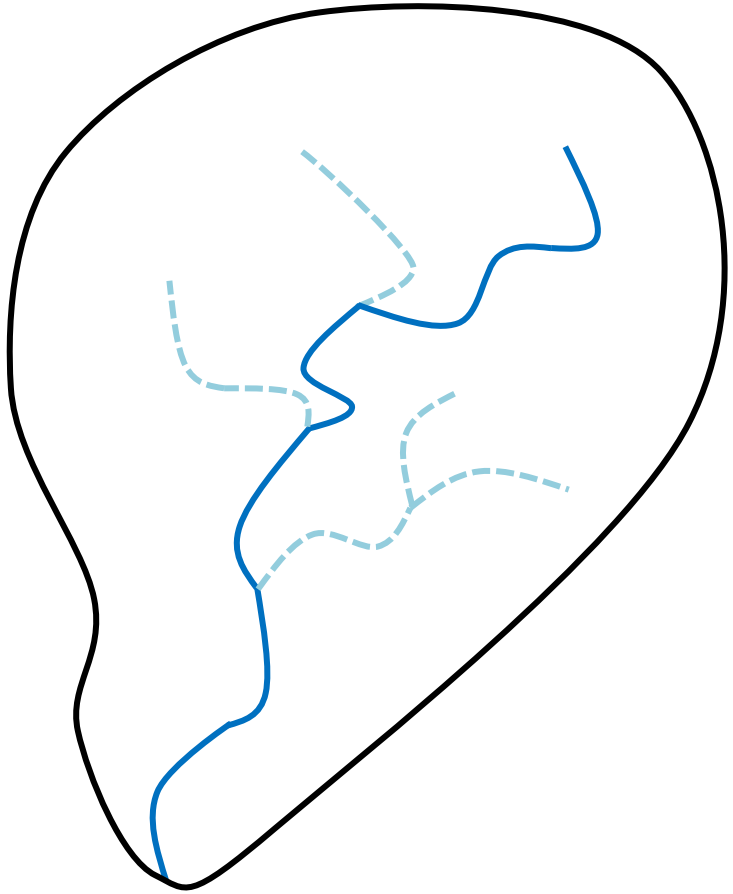
Hybrid

A combination of Simple Routing and HSPF (and a better understanding of trade-offs).

Dynamic Model: Nested geography, Hybrid simulation

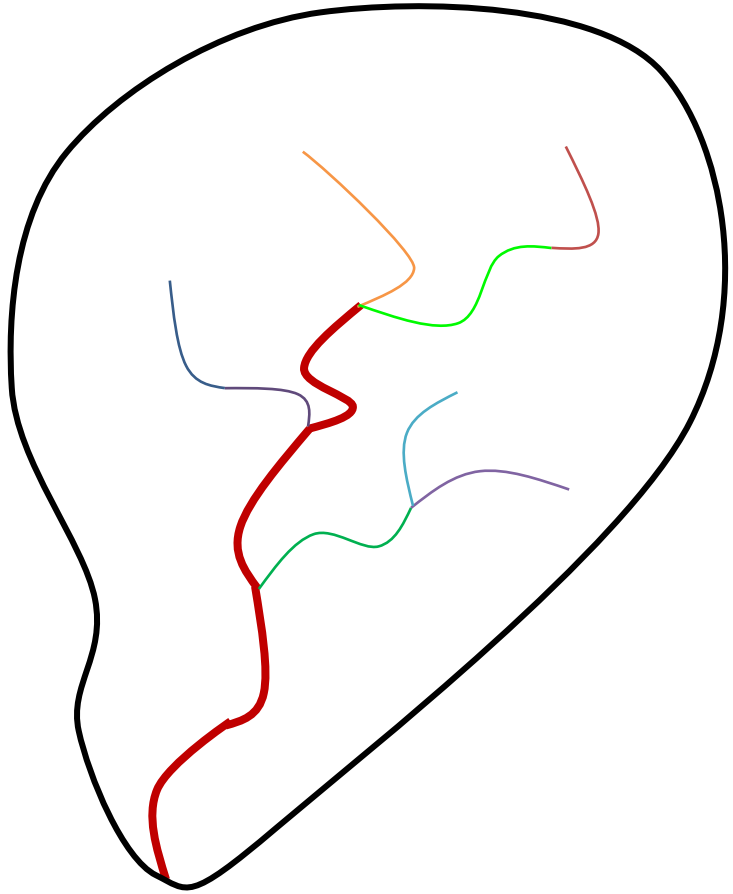


NHD streams



Phase 6

+ lumped factor for streams
+ HSPF river simulation



Nested geography, Hybrid DM simulation

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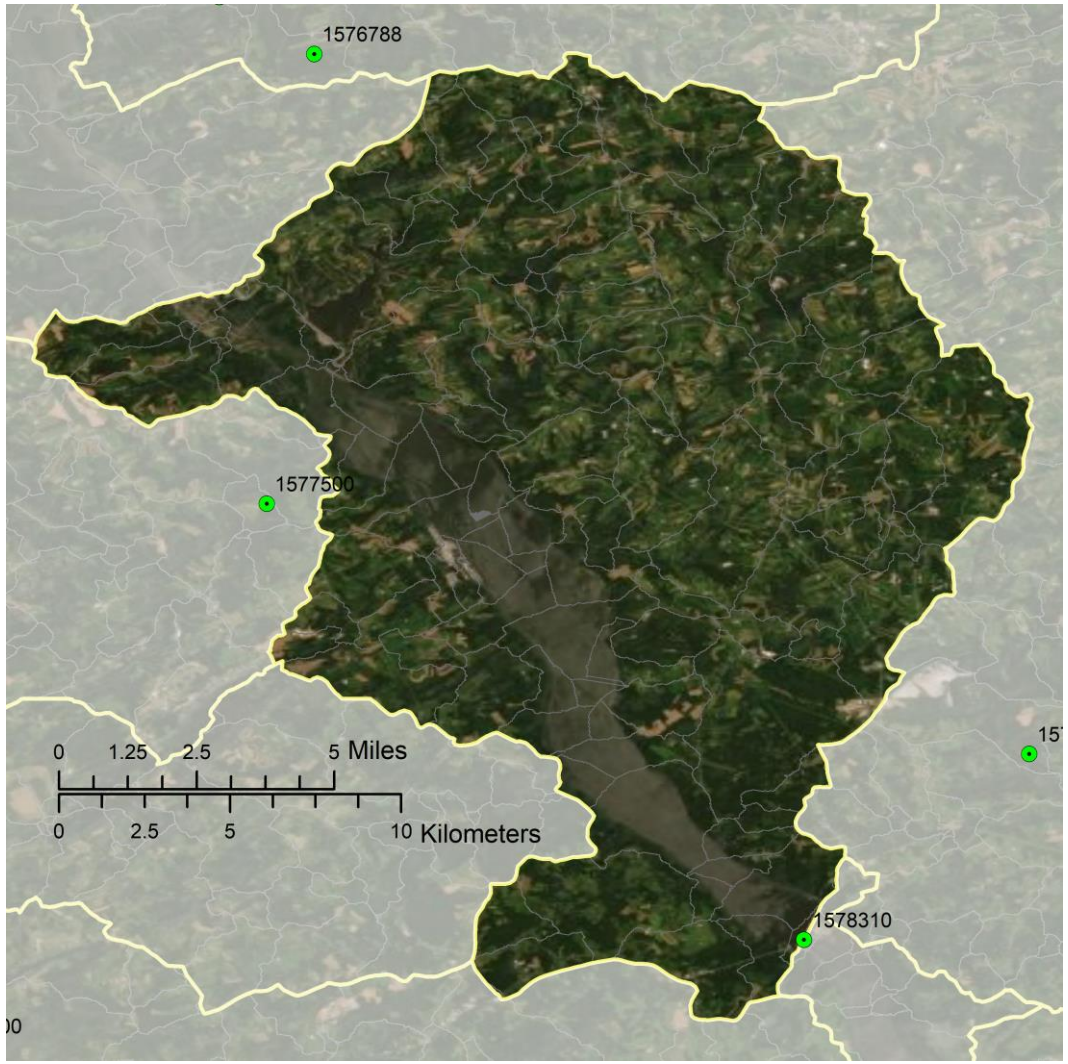
+ disaggregate CalCAST average annual flow (land use catchment scale) into hourly time series
+ aggregate time series of edge of stream delivery for each stream
+ perform downstream routing for NHD streams using simple model
+ perform river simulation for a group of NHD streams using HSPF



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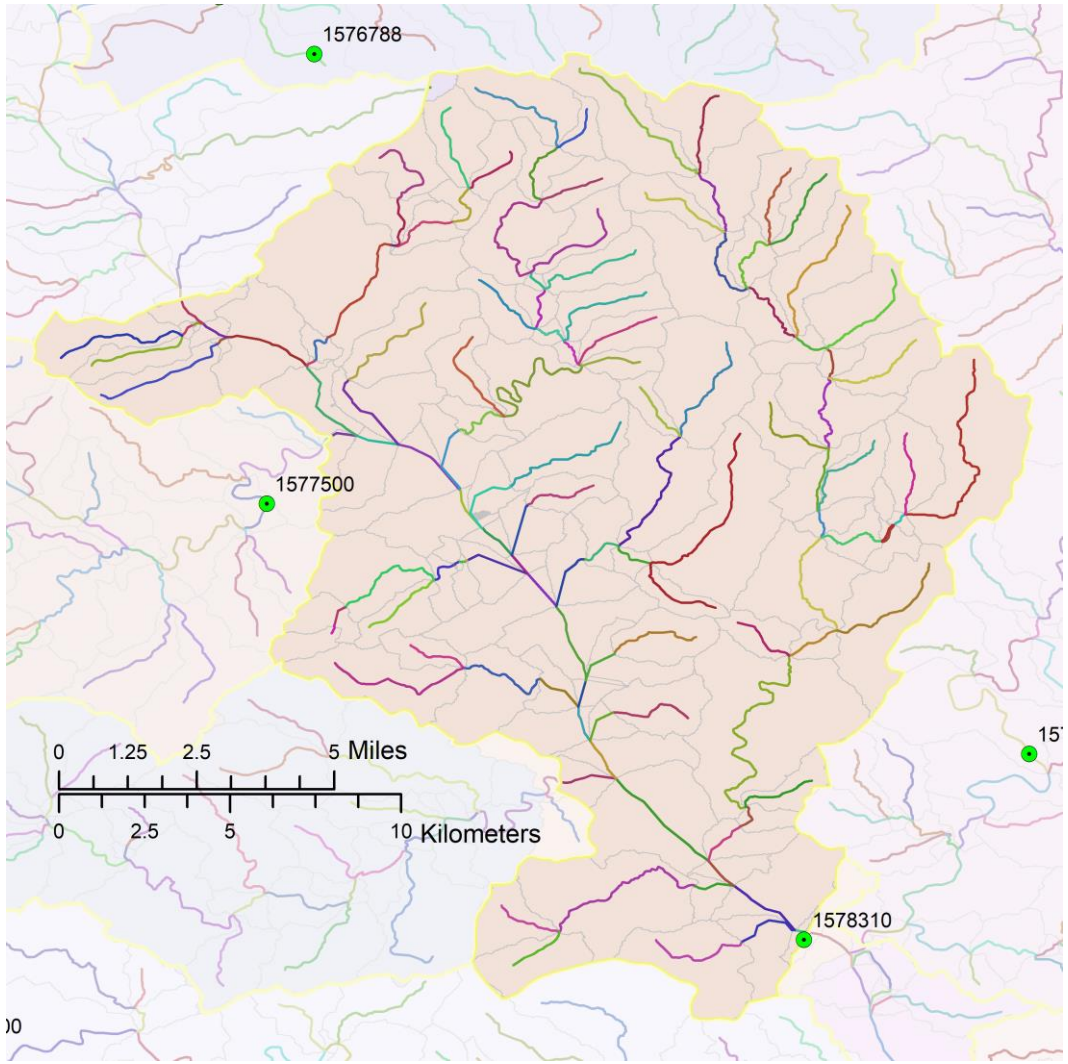

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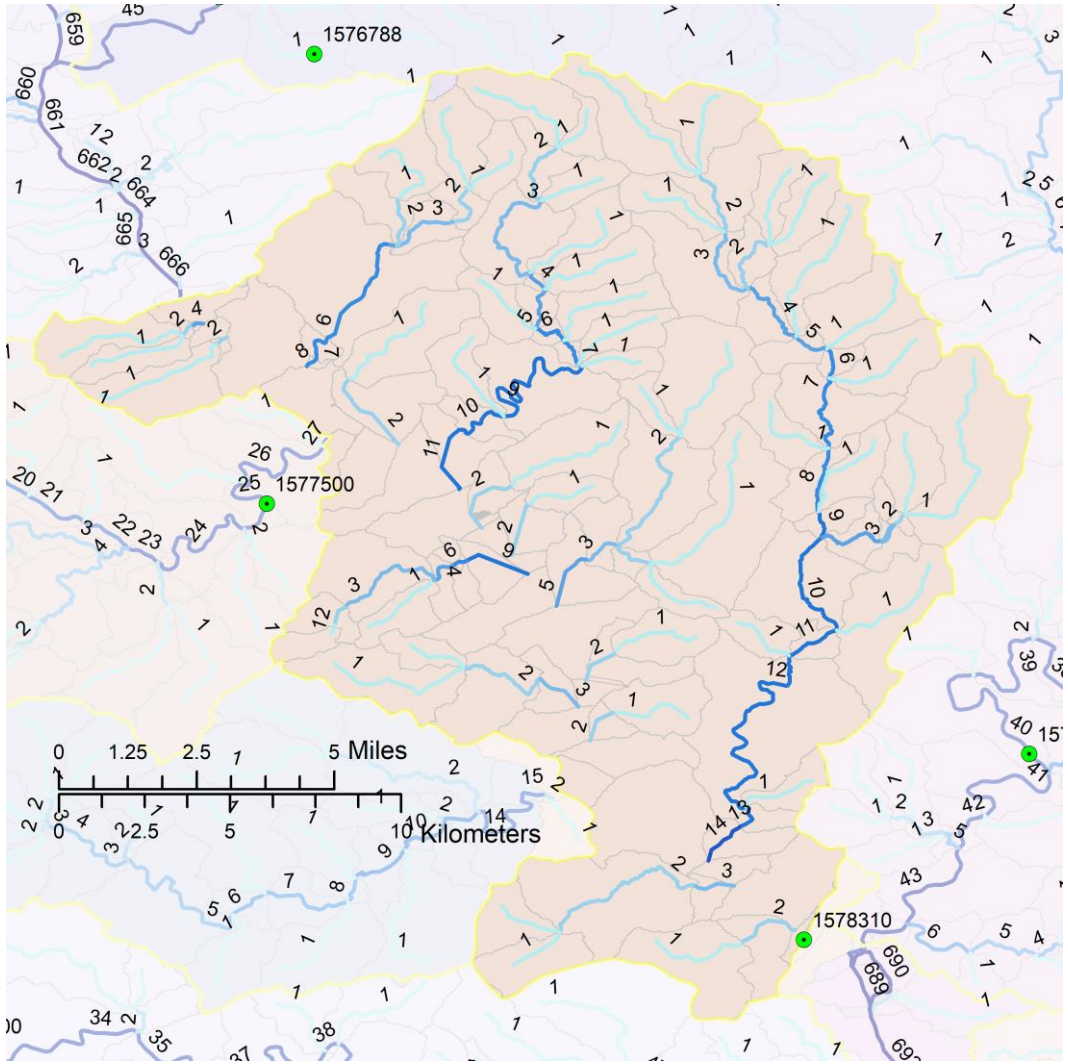

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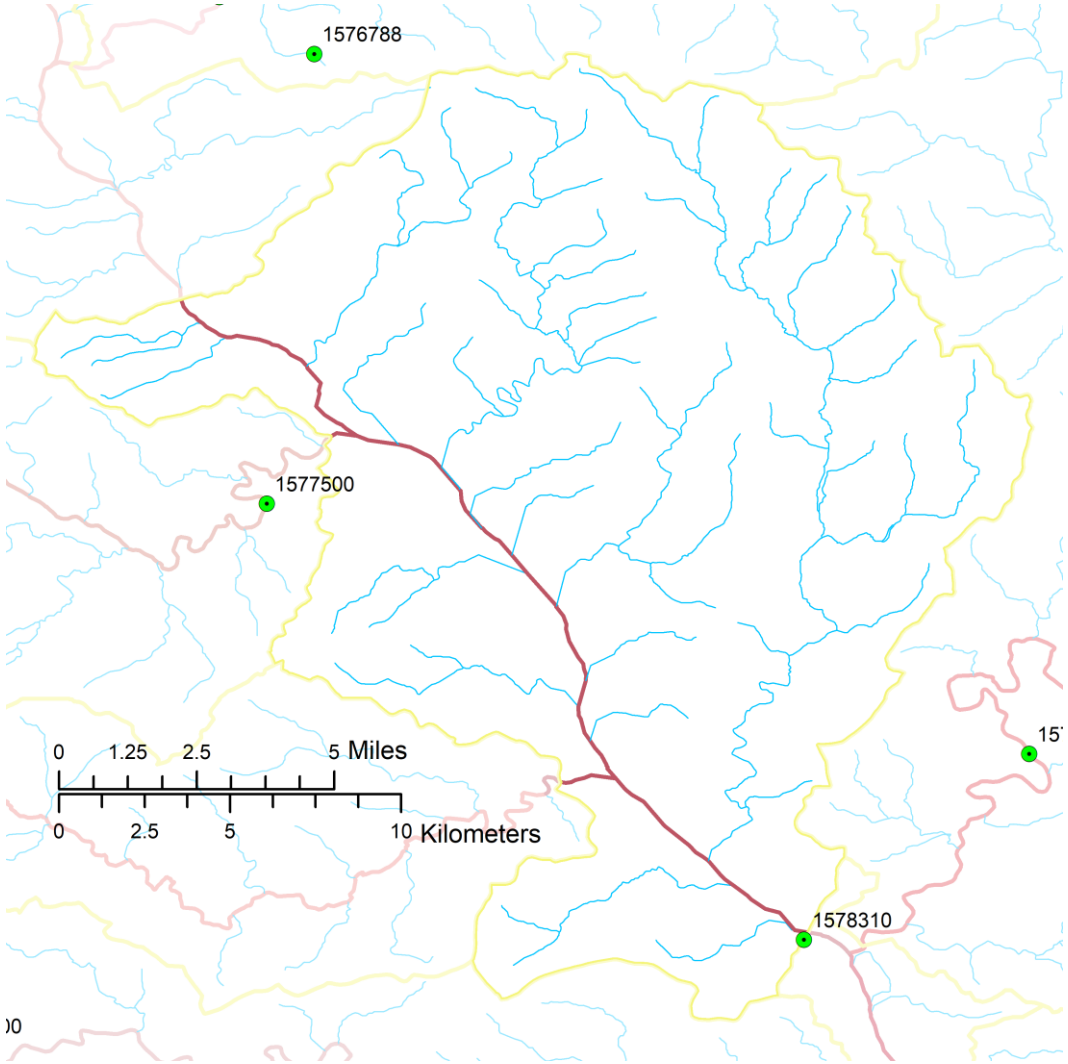
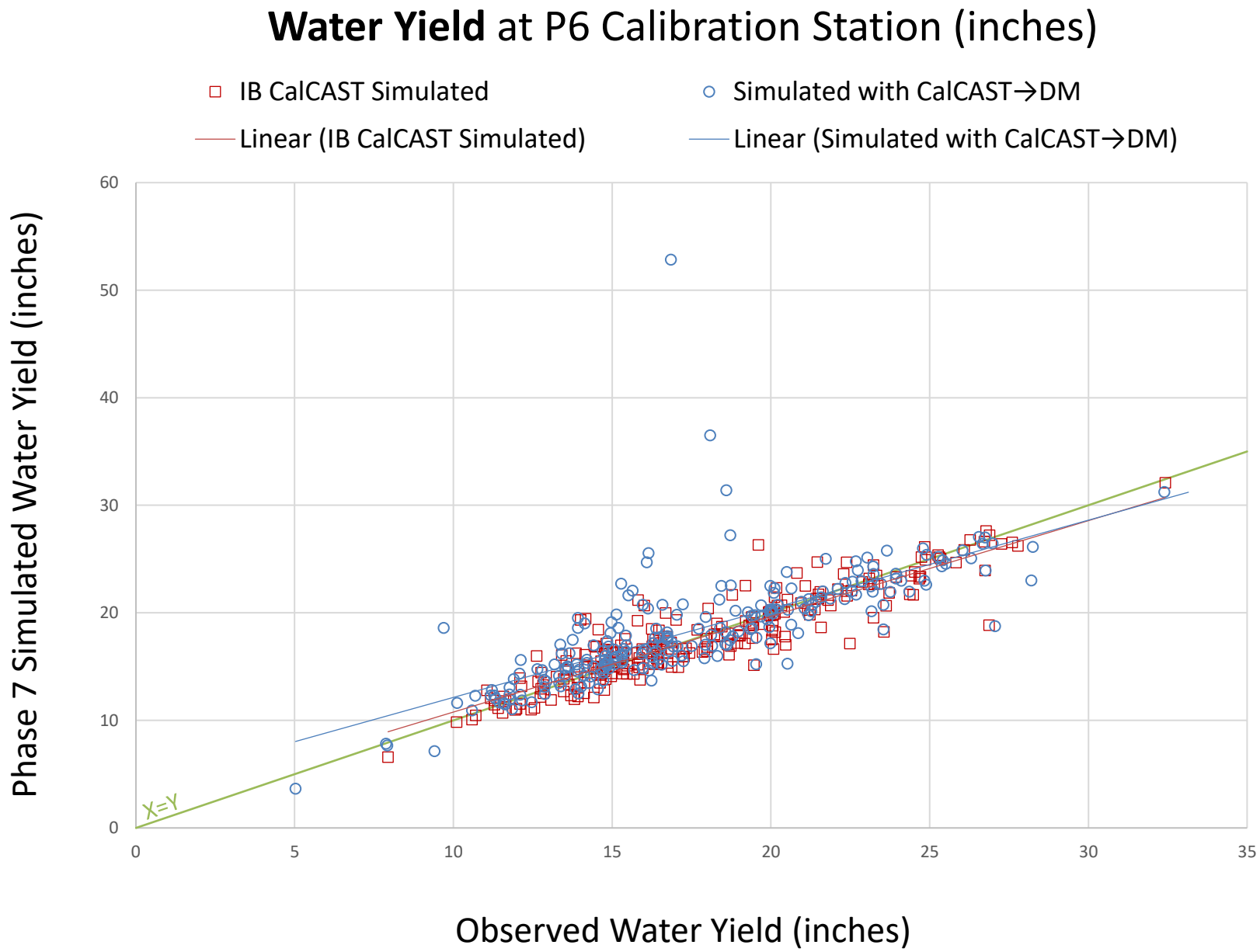


BEFORE

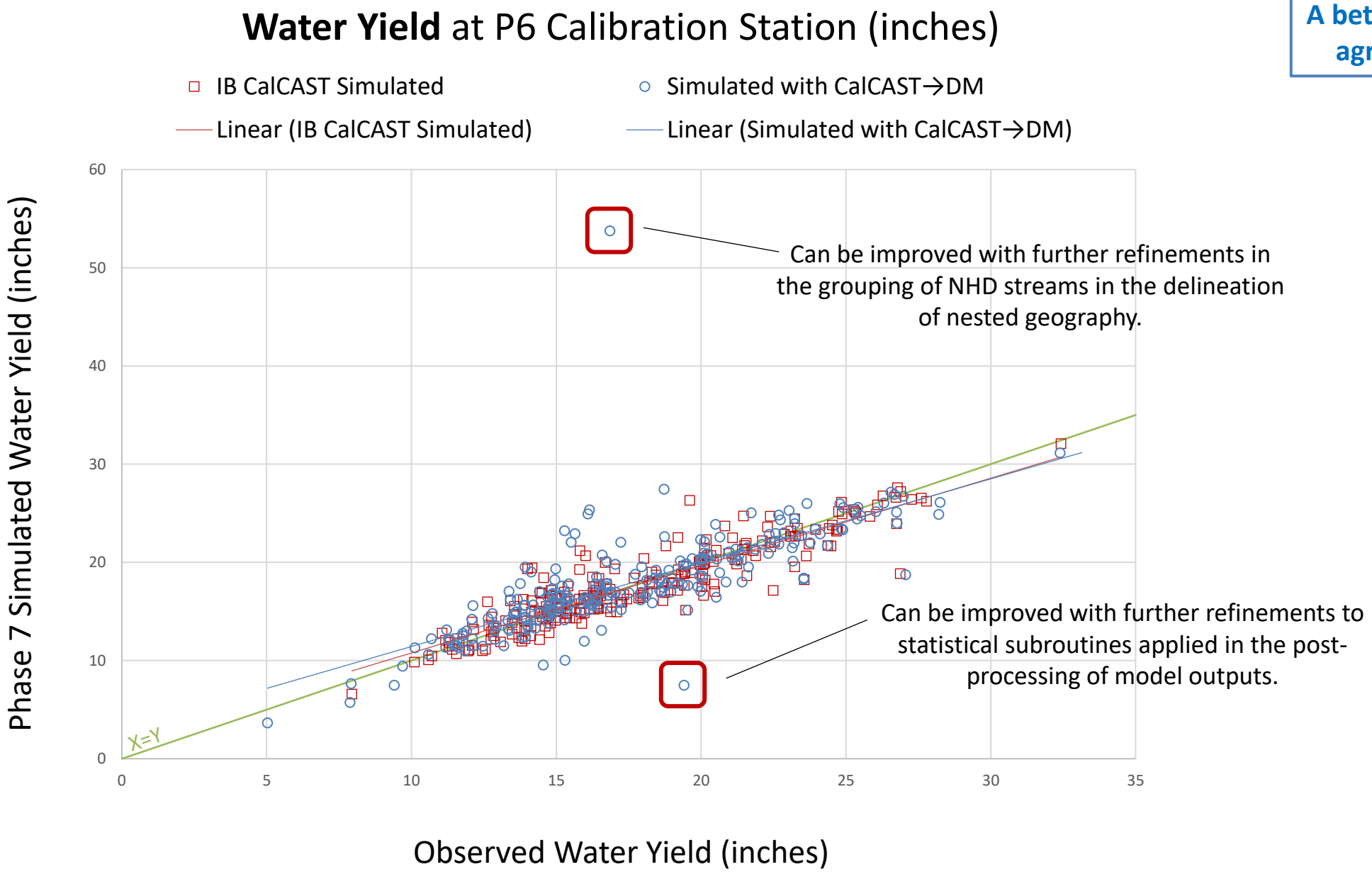
Results



Results

NOW

A better overall agreement



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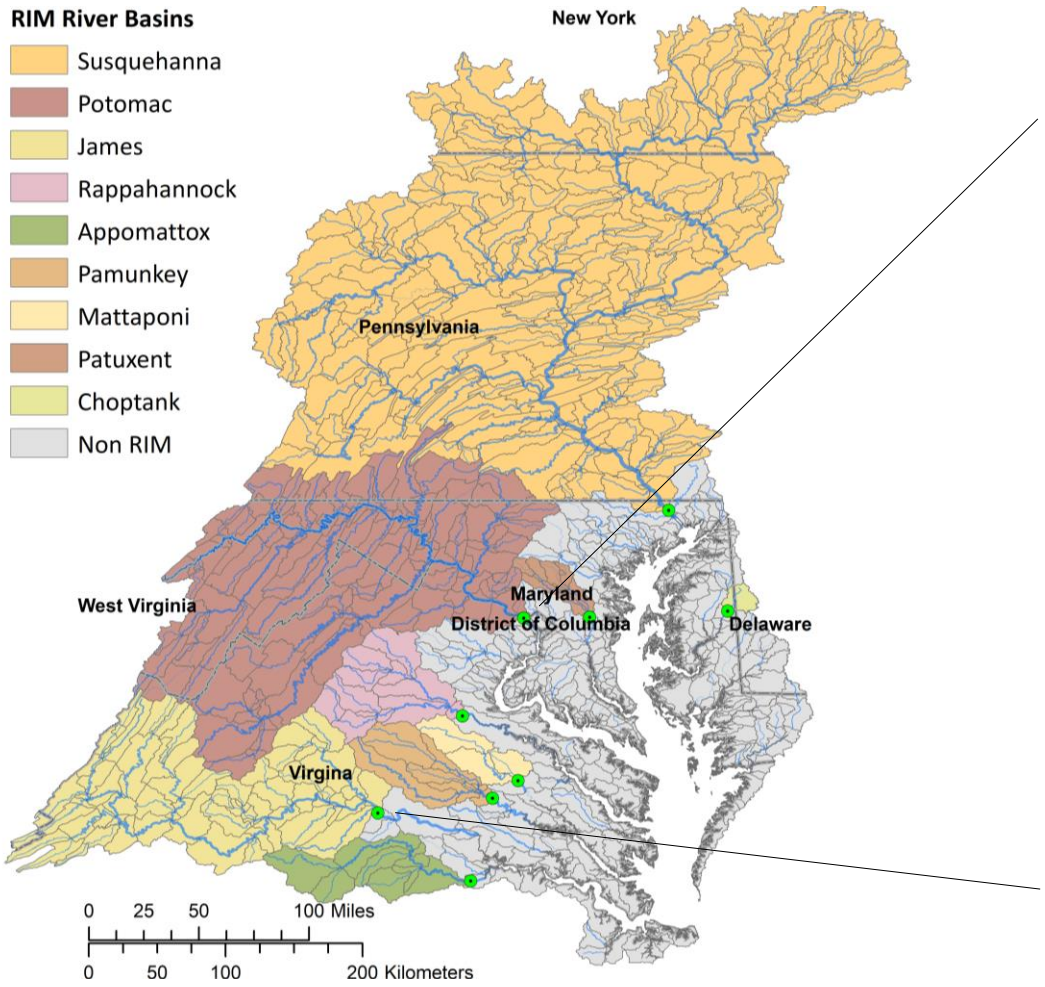
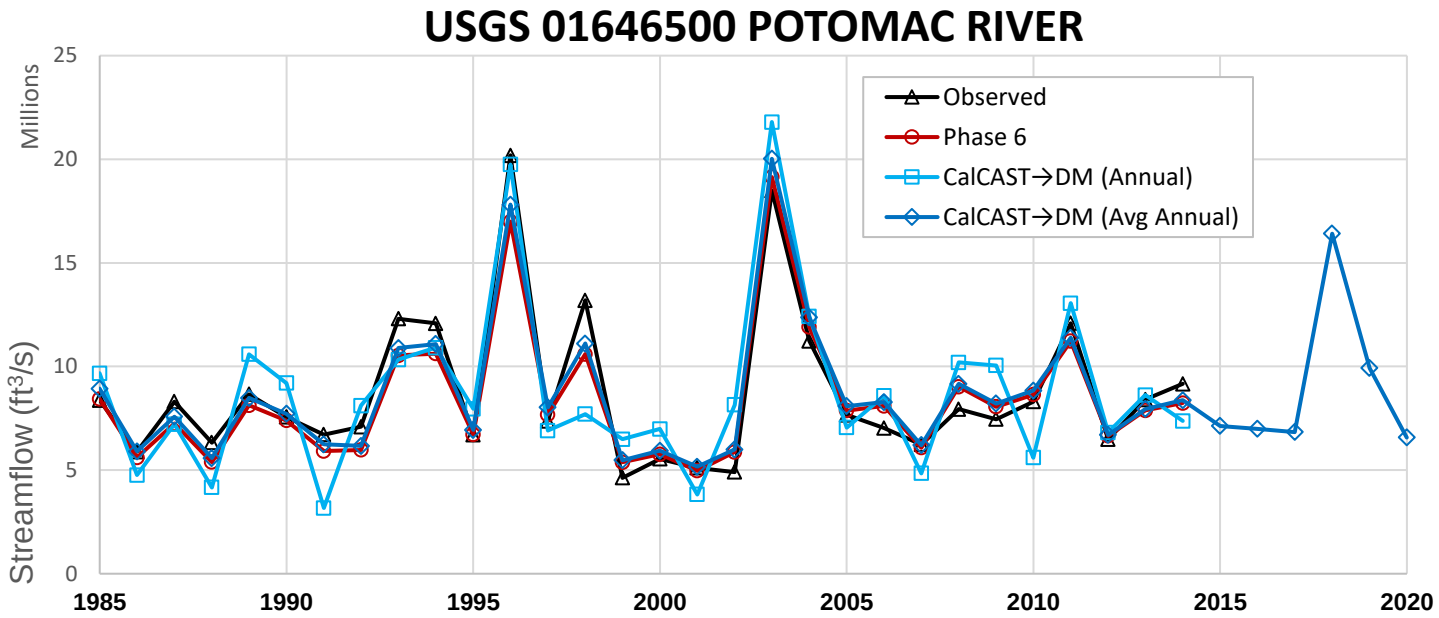
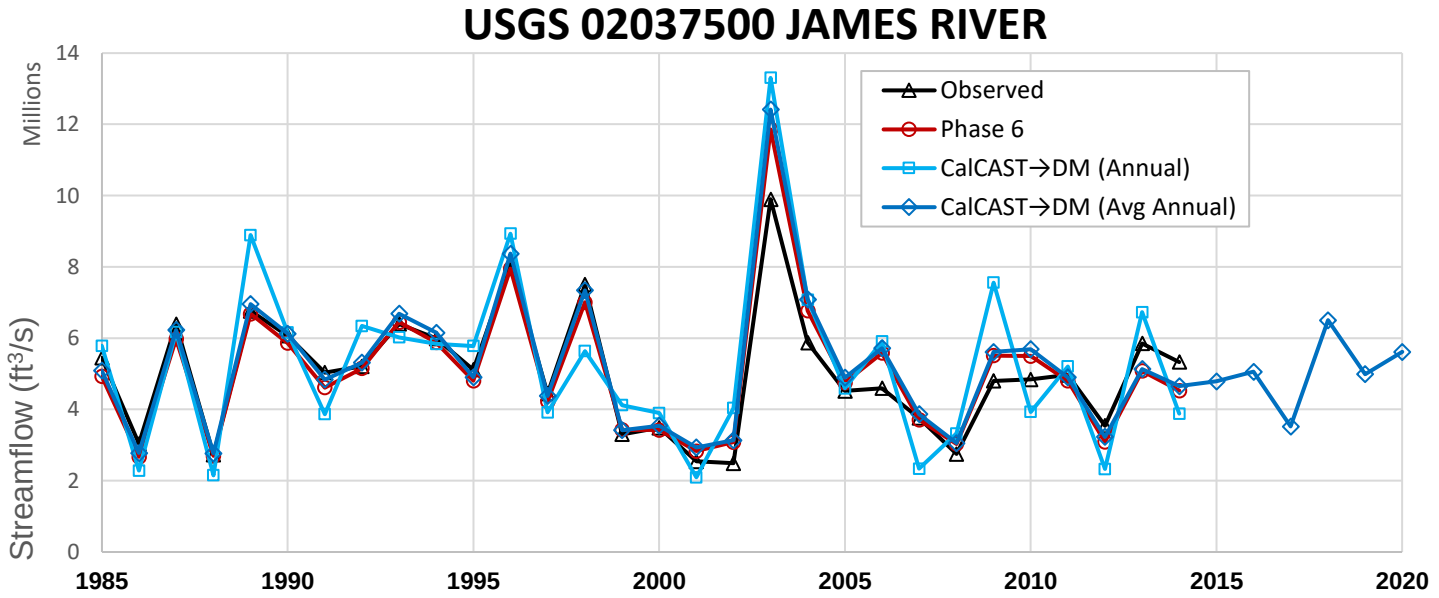
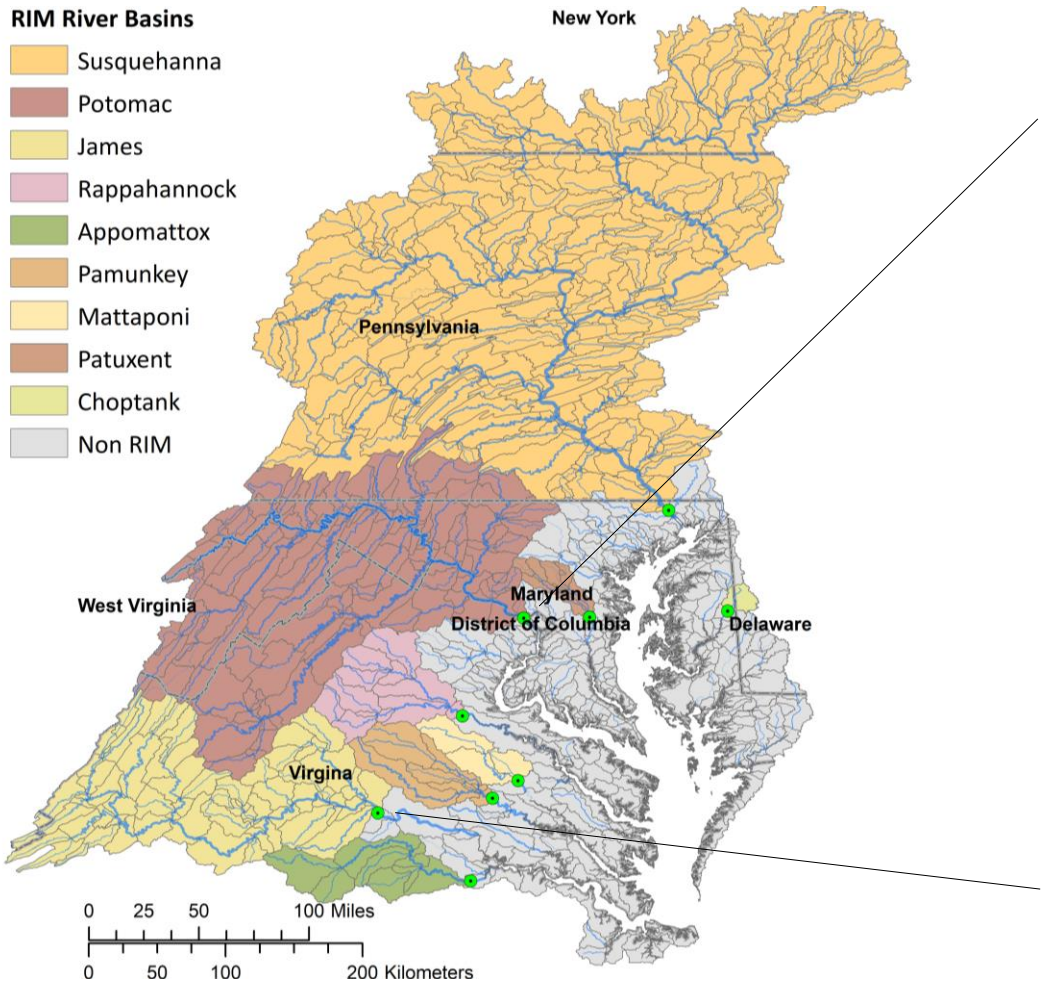


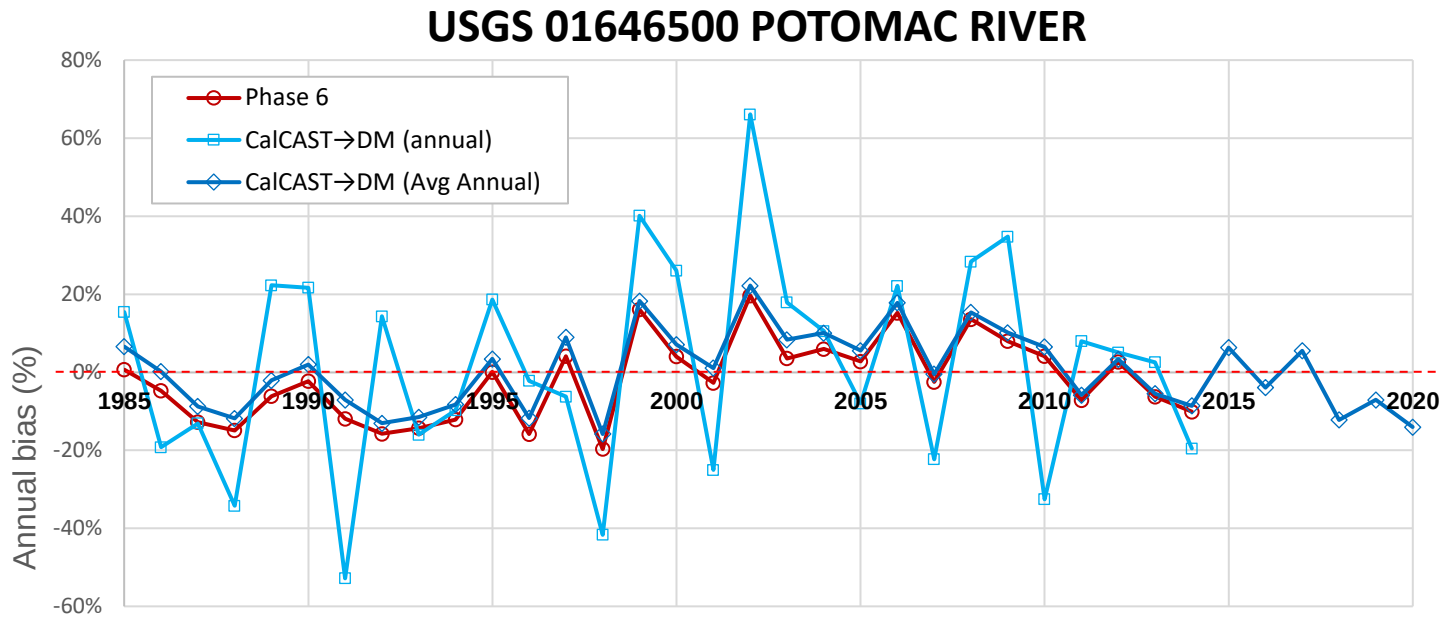


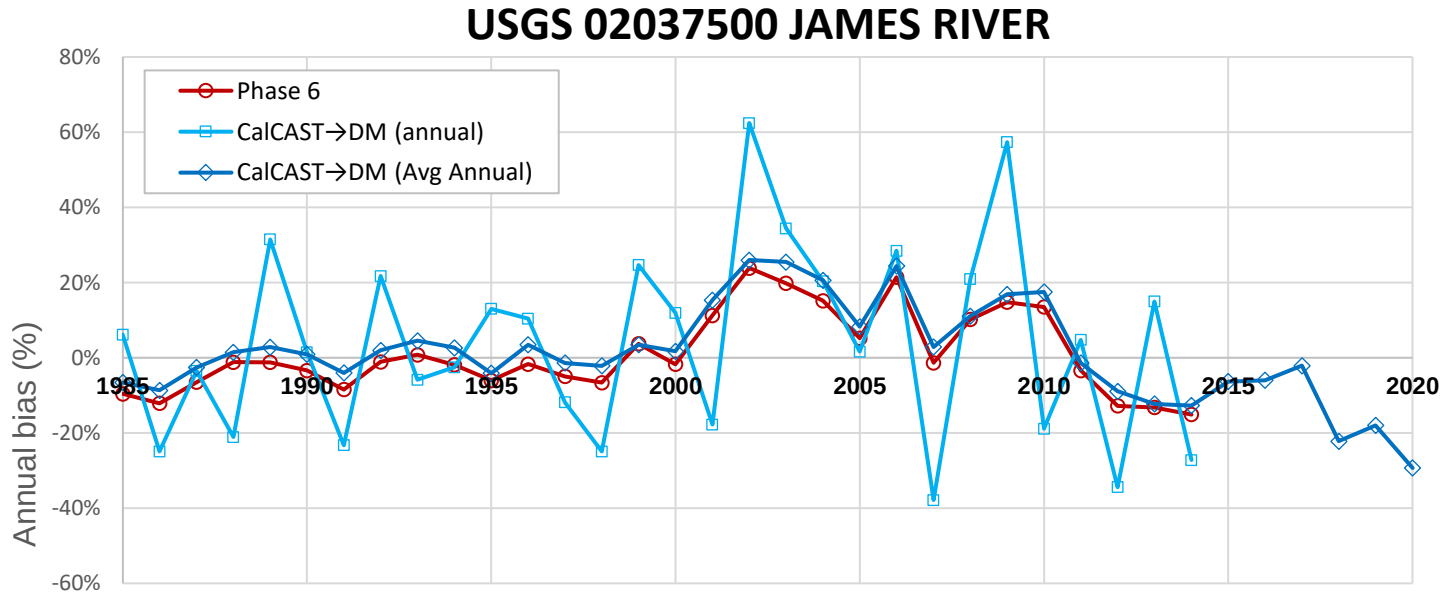


Note: CalCAST was calibrated for average annual flow.

Results







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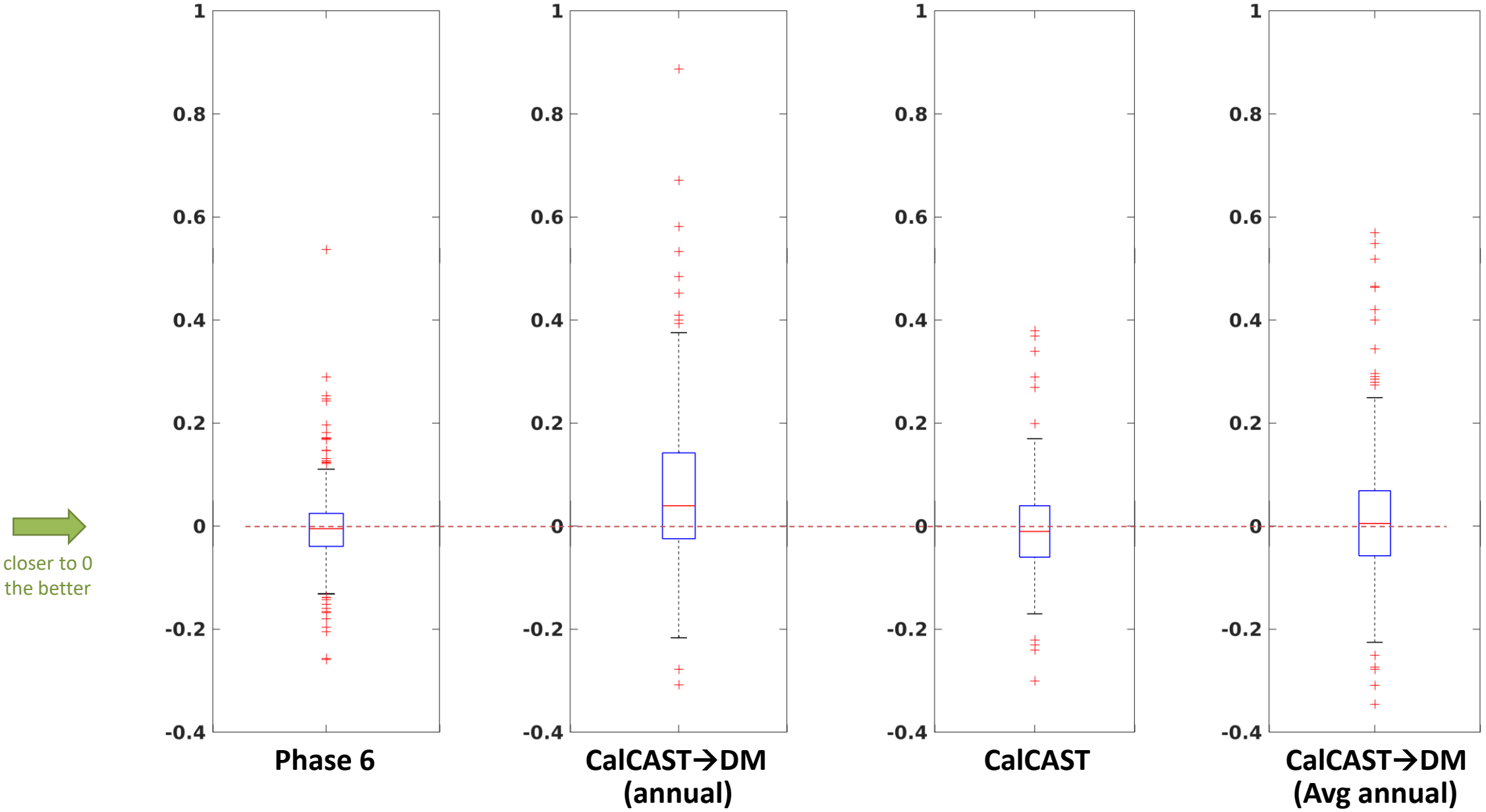
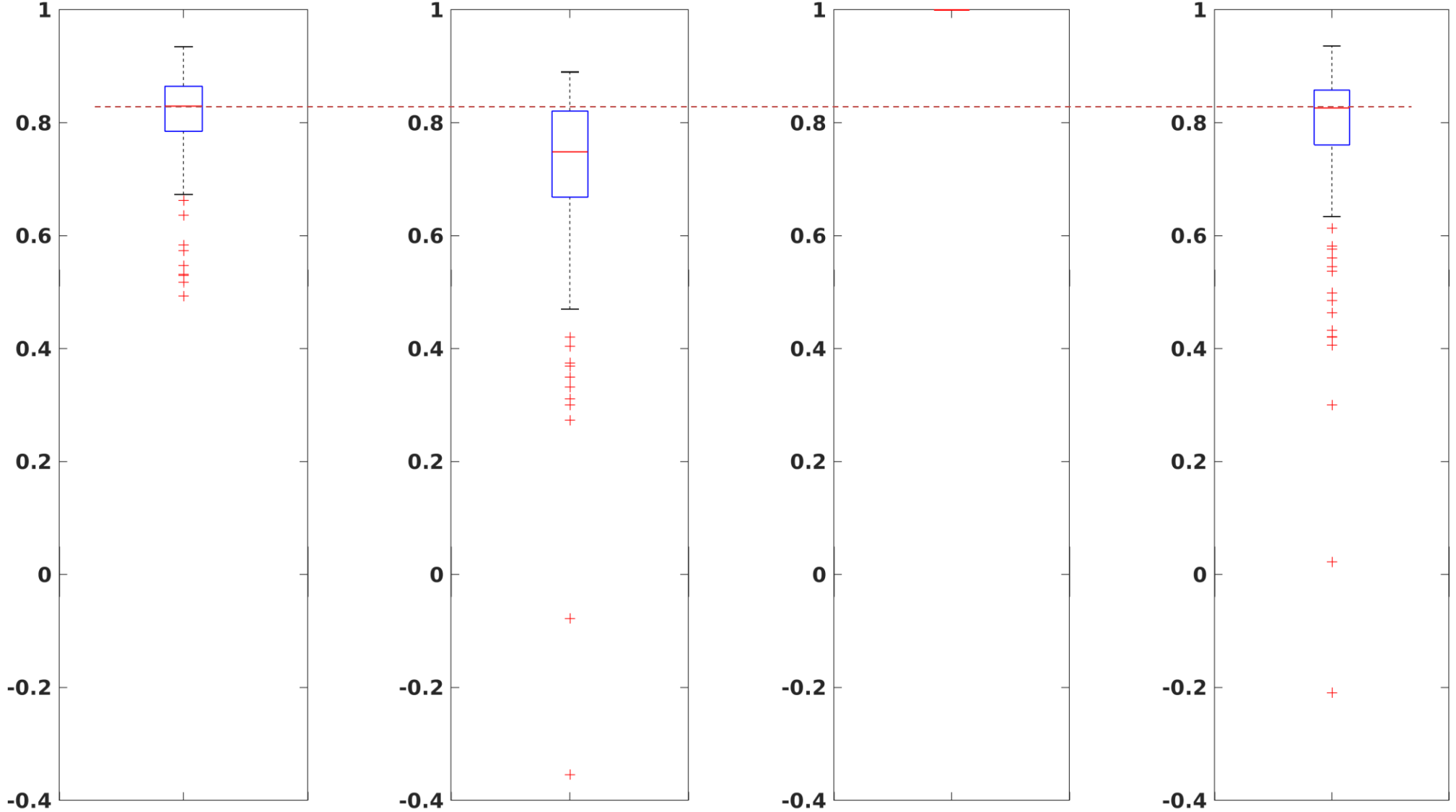
Biases in streamflow at the monitoring stations



closer to 0 the better

Nash-Sutcliffe Efficiency (NSE) of monthly flow at the monitoring stations

closer to 1
the better



Summary and Next Steps

- We reviewed the progress made in the development of NHDplus scale Dynamic Watershed Model for hydrology:
  a) refinements in the incorporation of CalCAST flow in an NHDplus scale hydrology model prototype,
  b) expansion of the simulation period from 2014 to CY 2020, and
  c) a methods for nesting of NHD streams with Phase 6 river segments for modeling and analysis of model results.
- Further refinements are needed in nested segmentation, inclusion of additional CalCAST hydrologic response variables and how they are incorporated, and model parameter estimation and calibration.