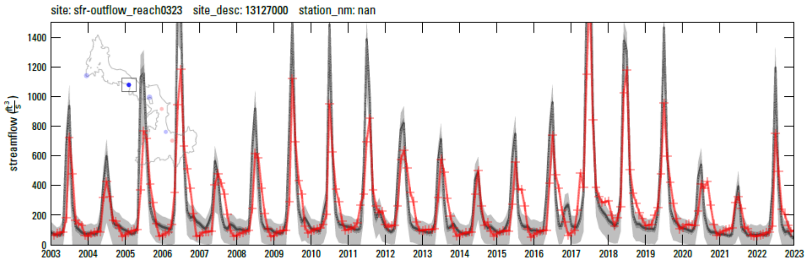

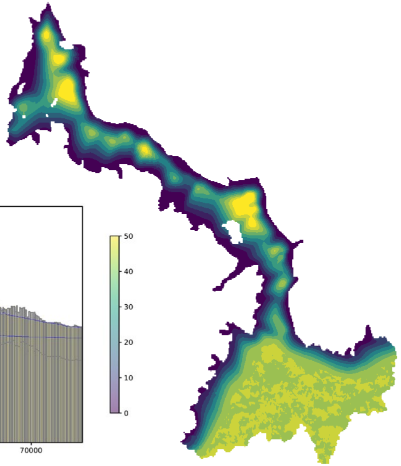

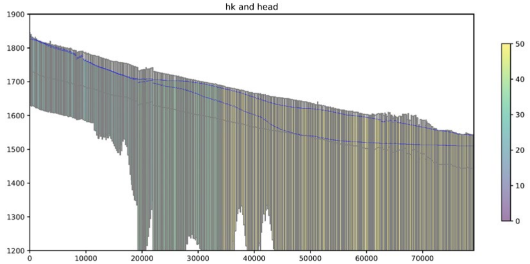

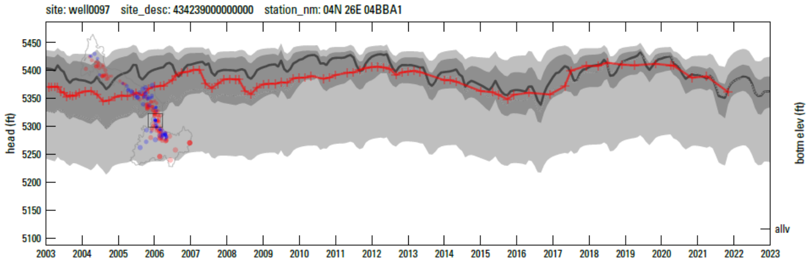

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Big Lost River Model

MTAC #5 Status Update
2024.02.14

Model status

- Implementation of conceptual model mostly complete
- Iterating through Prior parameter ensembles
- Reviewing observation data to define relative importance in the parameter estimation process
- Reviewing placeholder assumptions for unknown input stresses & aquifer characteristics (can we do better? Does it matter?)

Model changes

Implementation of conceptual model mostly complete:

- Second, deeper layer added in middle/lower basins
- Antelope Creek included in SFR routing network
- Farm calculator takes in precipitation, evapotranspiration, and stream diversion data, and produces monthly model inputs for incidental recharge, canal losses, and supplemental pumping.

Model status

Implementation of conceptual model mostly complete:

- 240 monthly transient stress periods Jan 2003 – Dec 2022
- Initial “Steady-state” stress period simulating temporal mean stresses of transient simulation period
- Routed surface flow in Big Lost River and Antelope Creek, gains and losses to aquifer, non-routed diversions remove flow from river
- Mackay Reservoir and Dam not yet simulated. Requires LAK and MVR packages.

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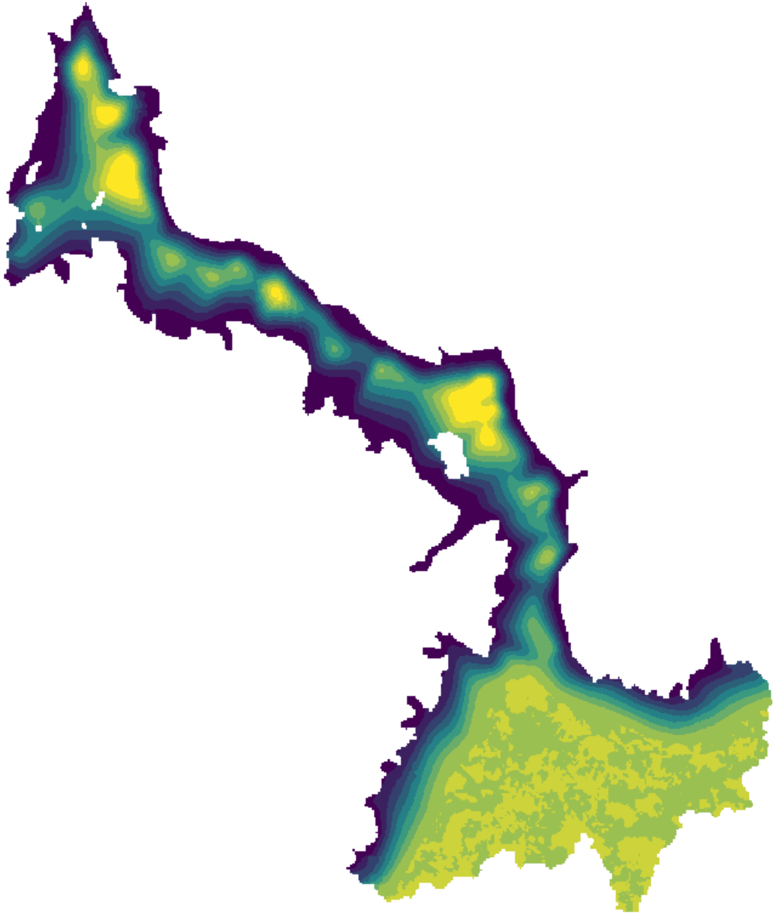

Basin geometry

Estimating depth to bedrock

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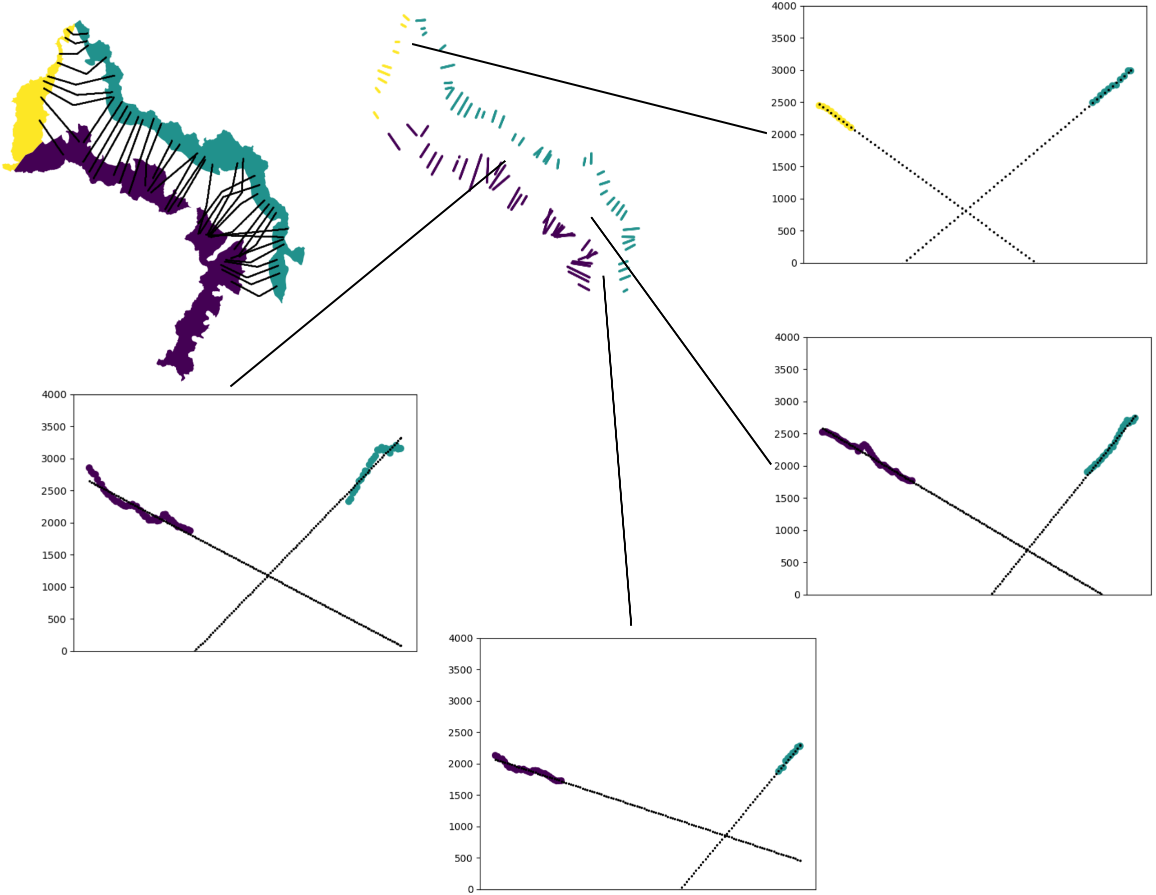

“The conditions existing below the valley floor are more likely to be a continuation of those exposed on the surface, i.e., a steep descending scarp along the face of the Big Lost River Range and a gently sloping ridges extending to meet this scarp from the west,” (Livingston, 1931).

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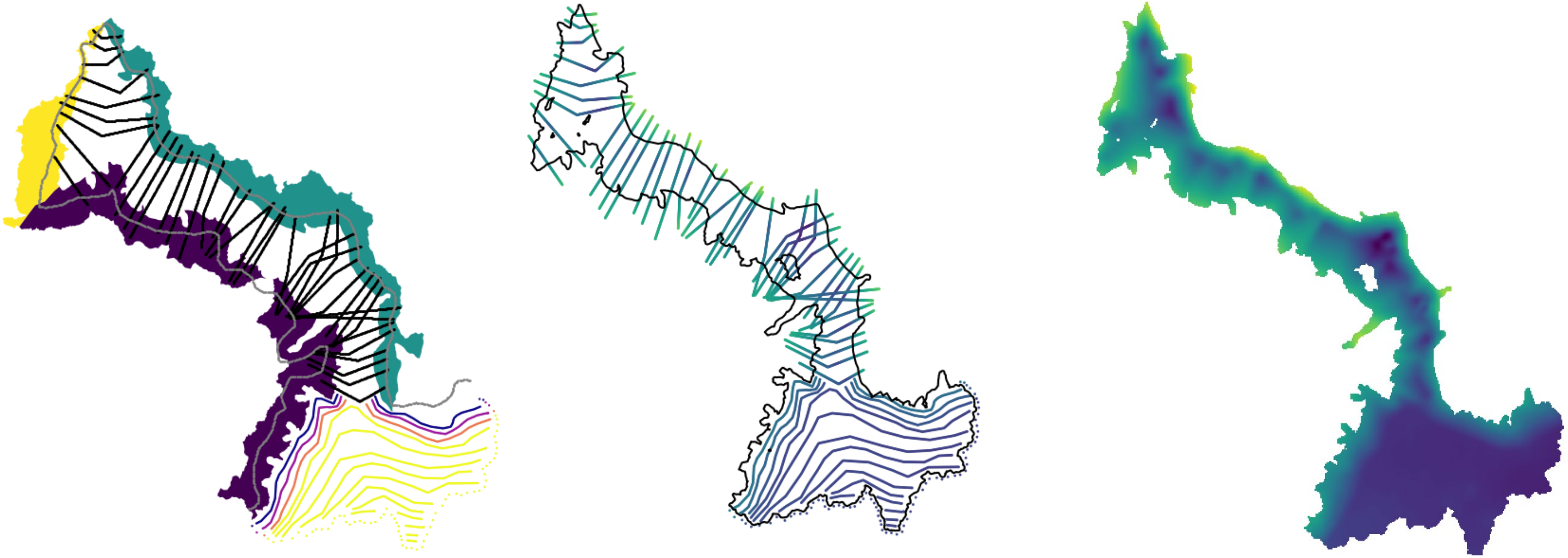
Land surface elevation and estimated depth contours for additional control on interpolation



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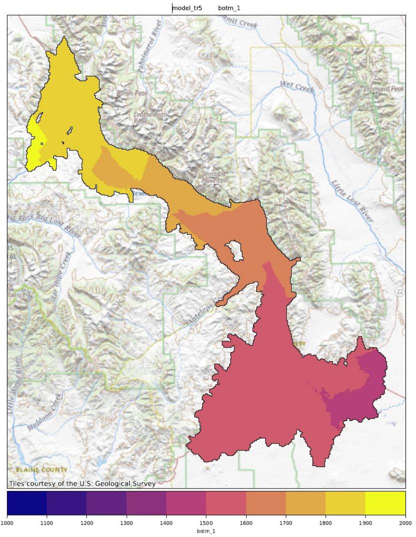
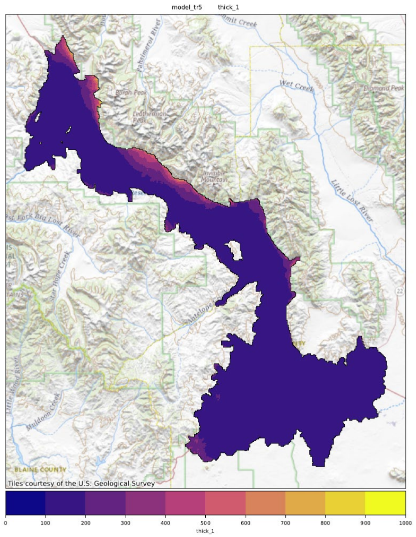
Current layering scheme

Layer 1

Bottom elevation

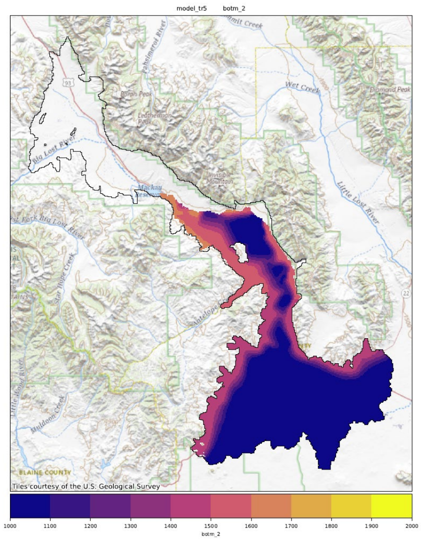


Thickness

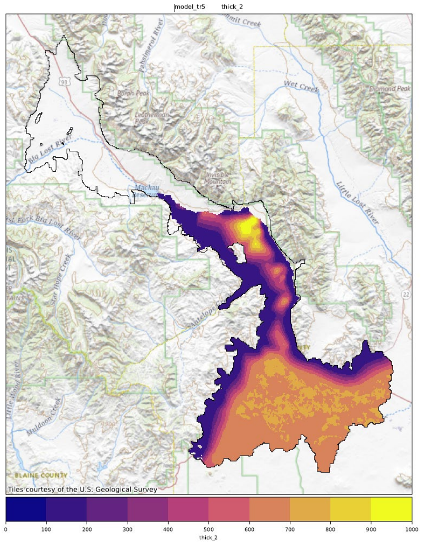


Layer 2

Bottom elevation



Thickness



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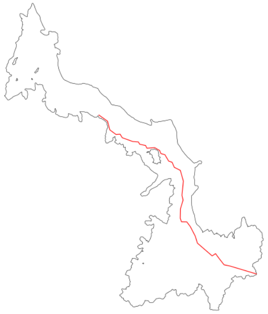
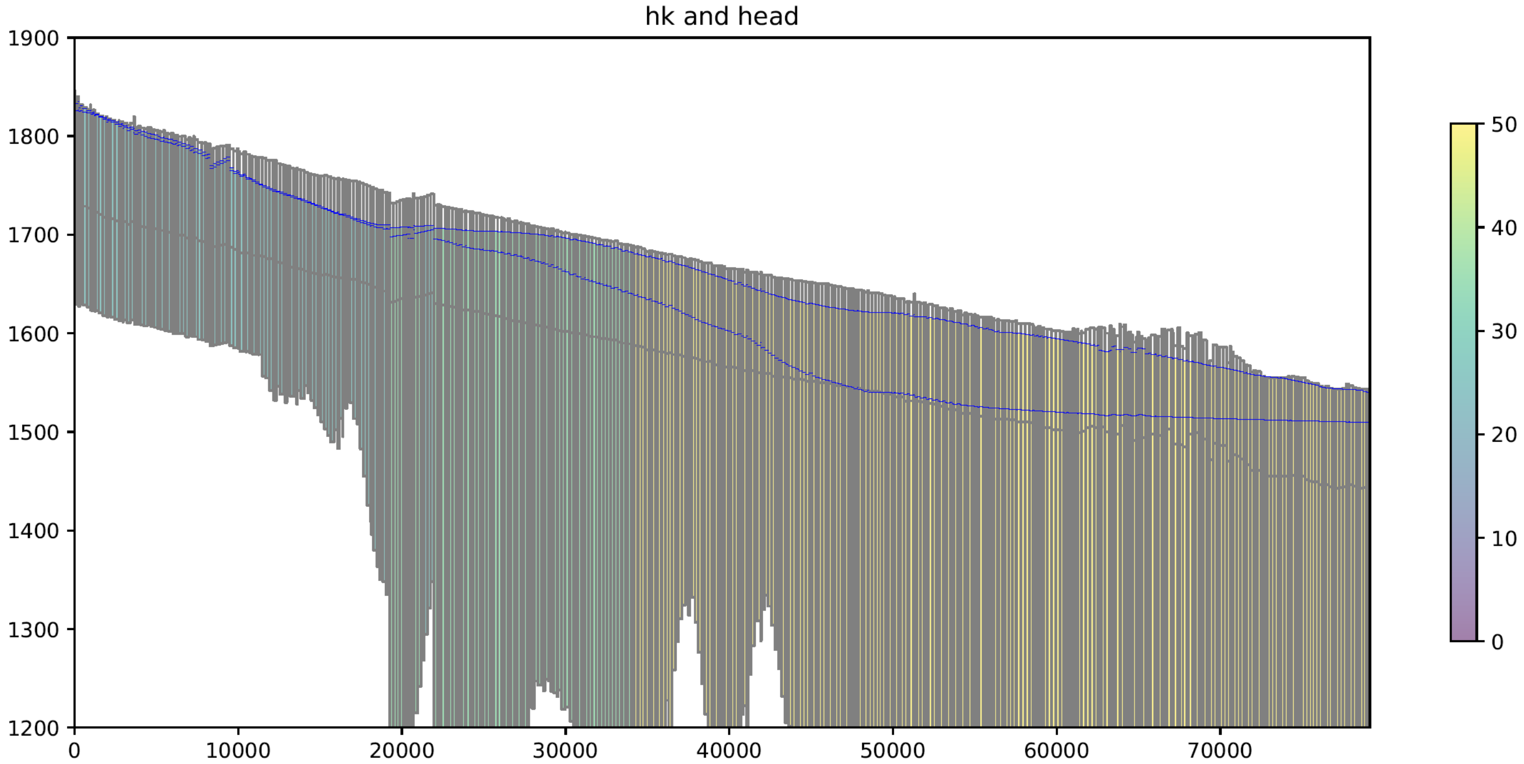
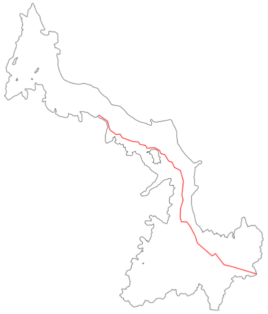
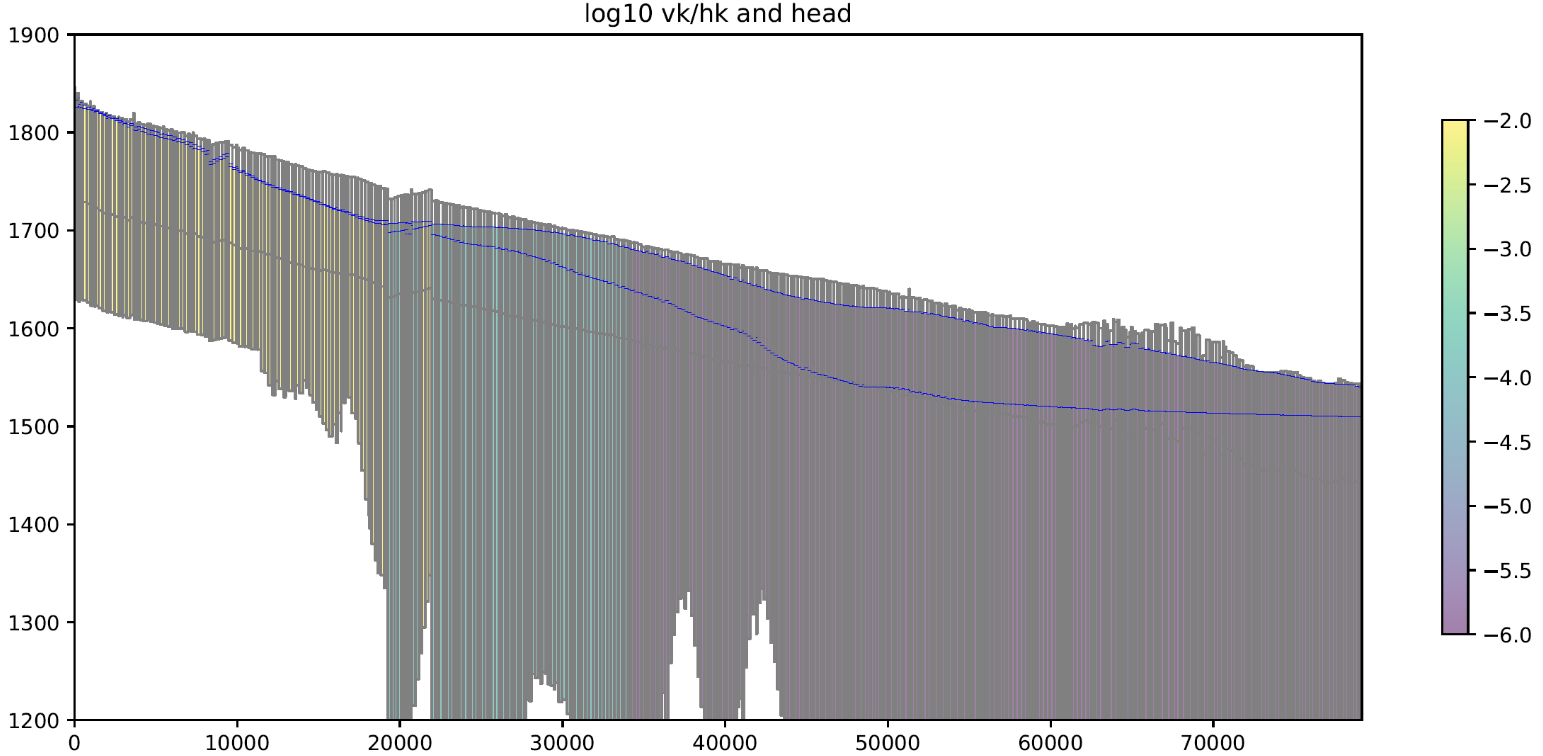
Current layering scheme





Current layering scheme





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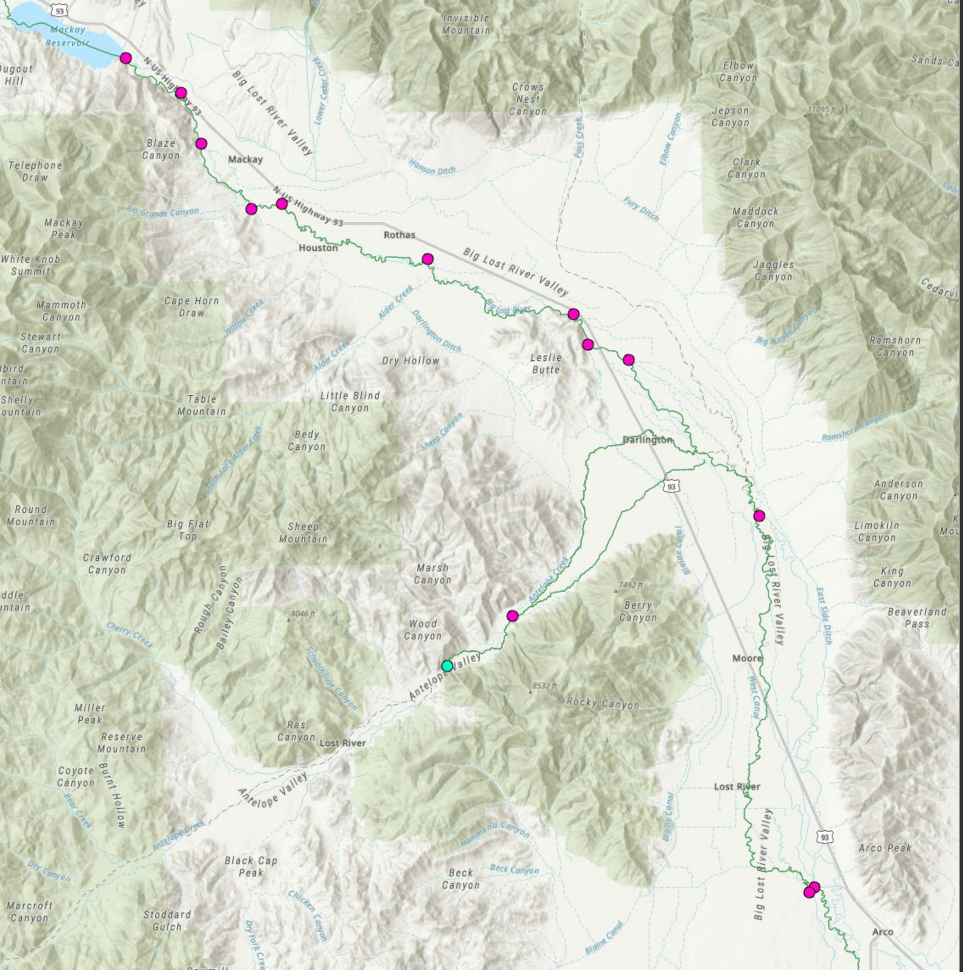

Streamflow Routing

Inflows, Outflows, and Storage

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Model status - streamflow routing

Inflows

Howell gage measured flows, Antelope gage measured and estimated flows

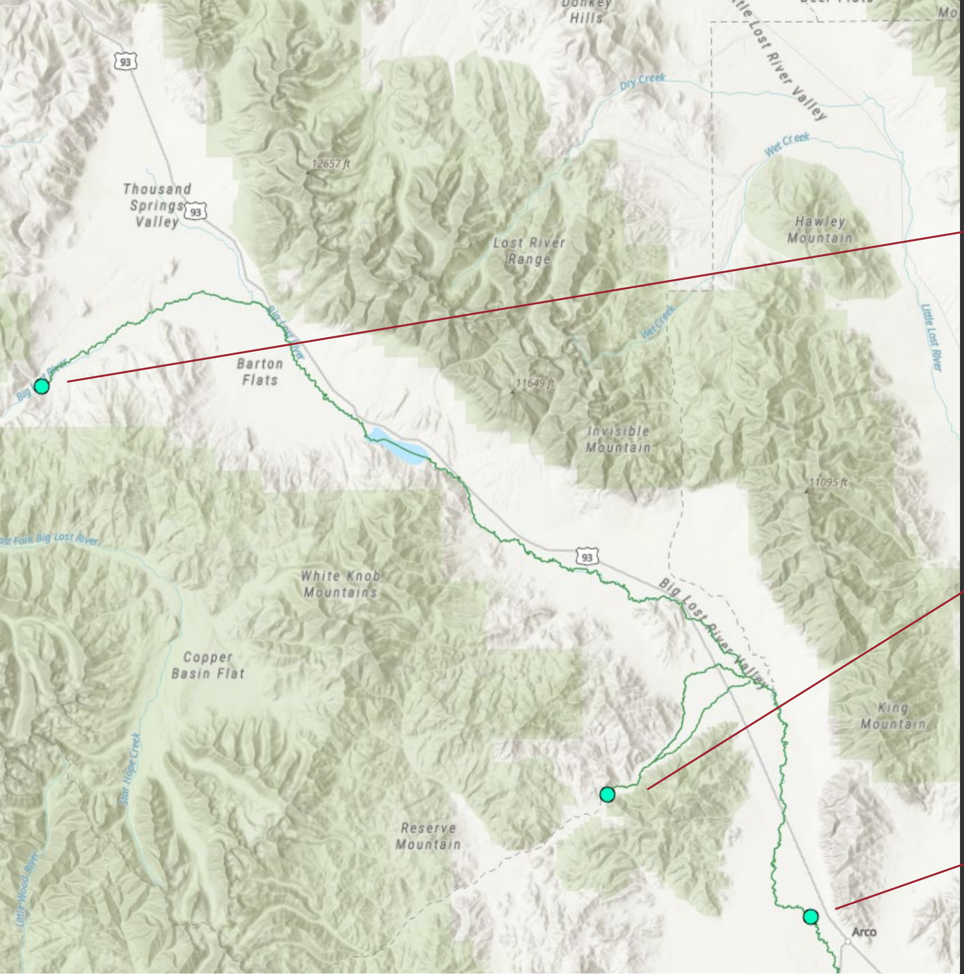
Outflows

Non-routed diversions. Surface water removed from stream at POD locations, up to a priori defined-volumes used in farm service area calculator

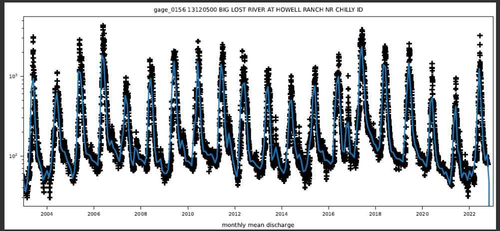
Storage

To Do – simulate storage and release of Mackay reservoir with LAK package and connect to SFR package with MVR package

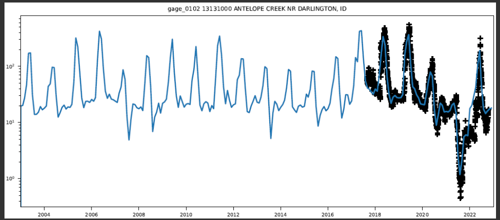
BLRM surface water inflows



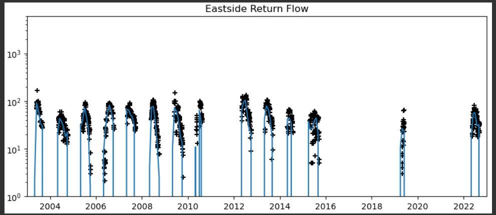
Howell gage



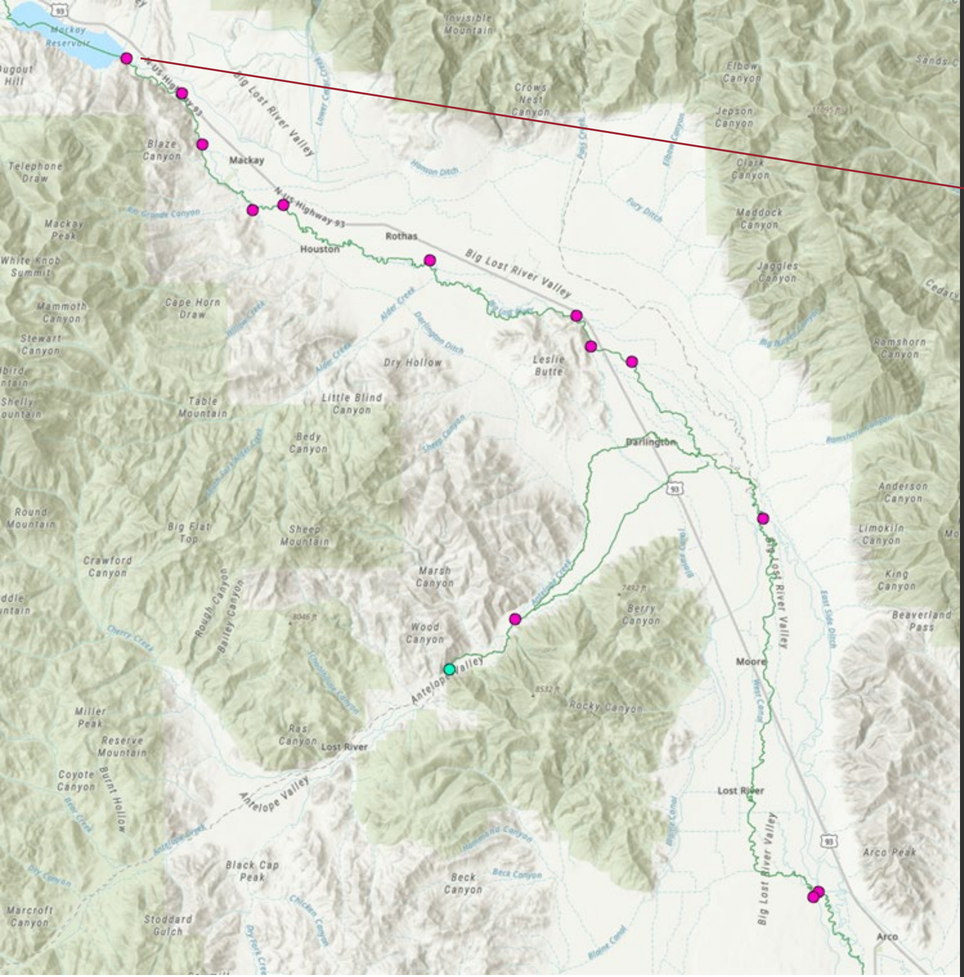
Antelope gage



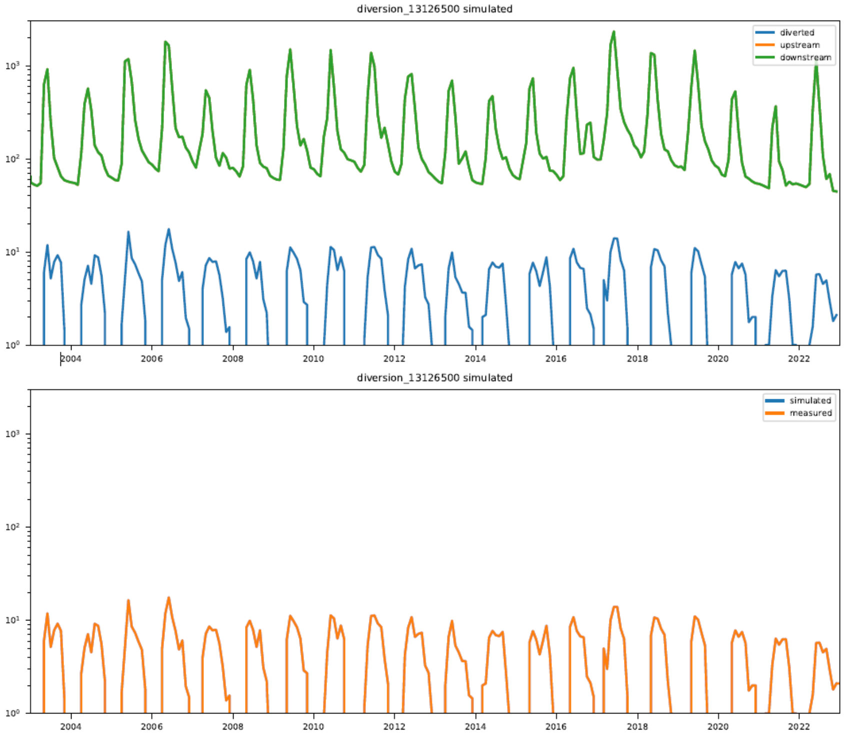
Eastside return



BLRM surface water diversions



Sharp Diversion



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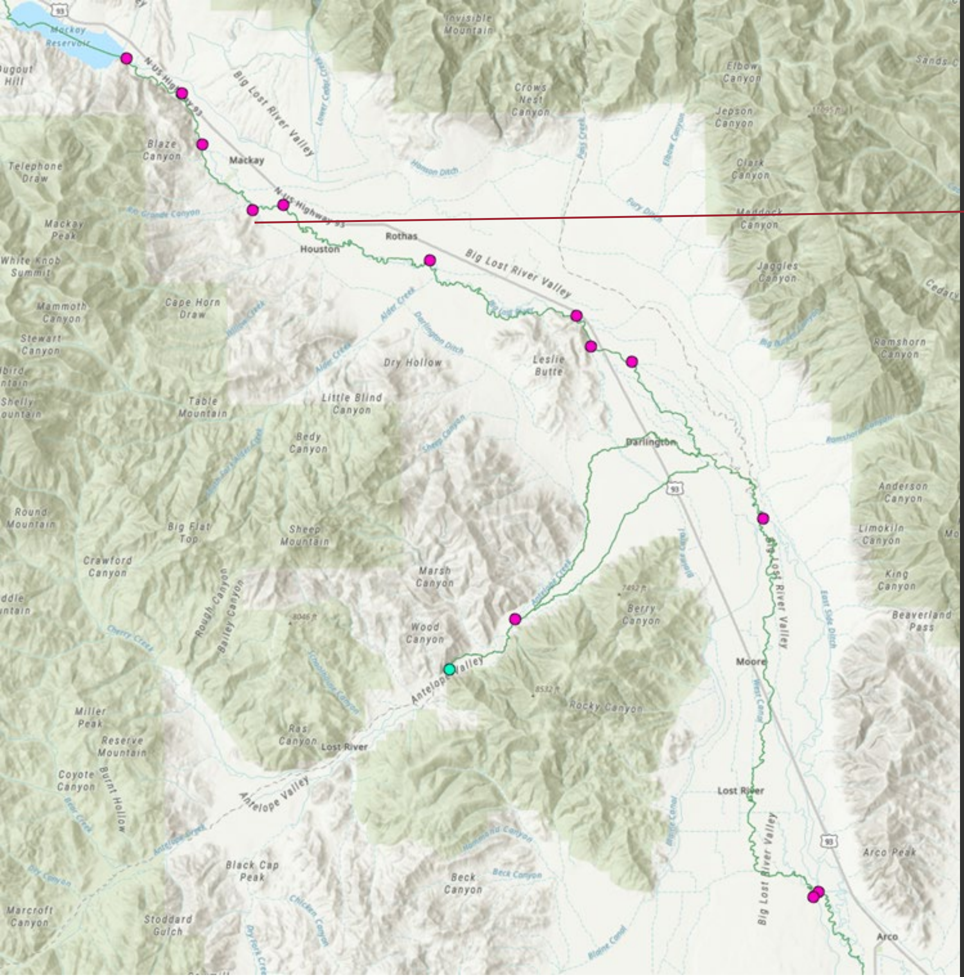
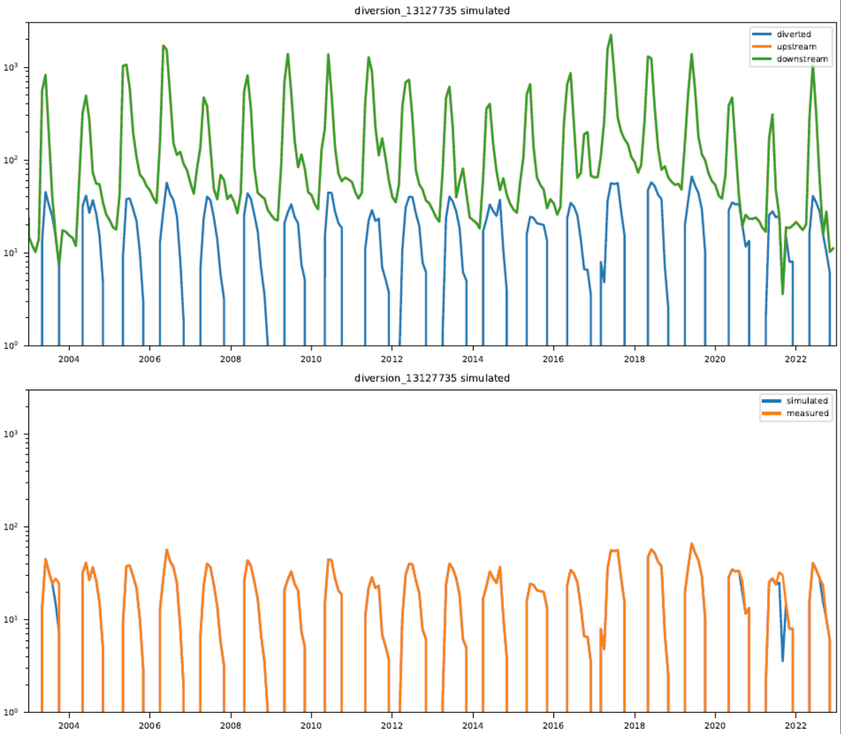


BLRM surface water diversions

Darlington Diversion



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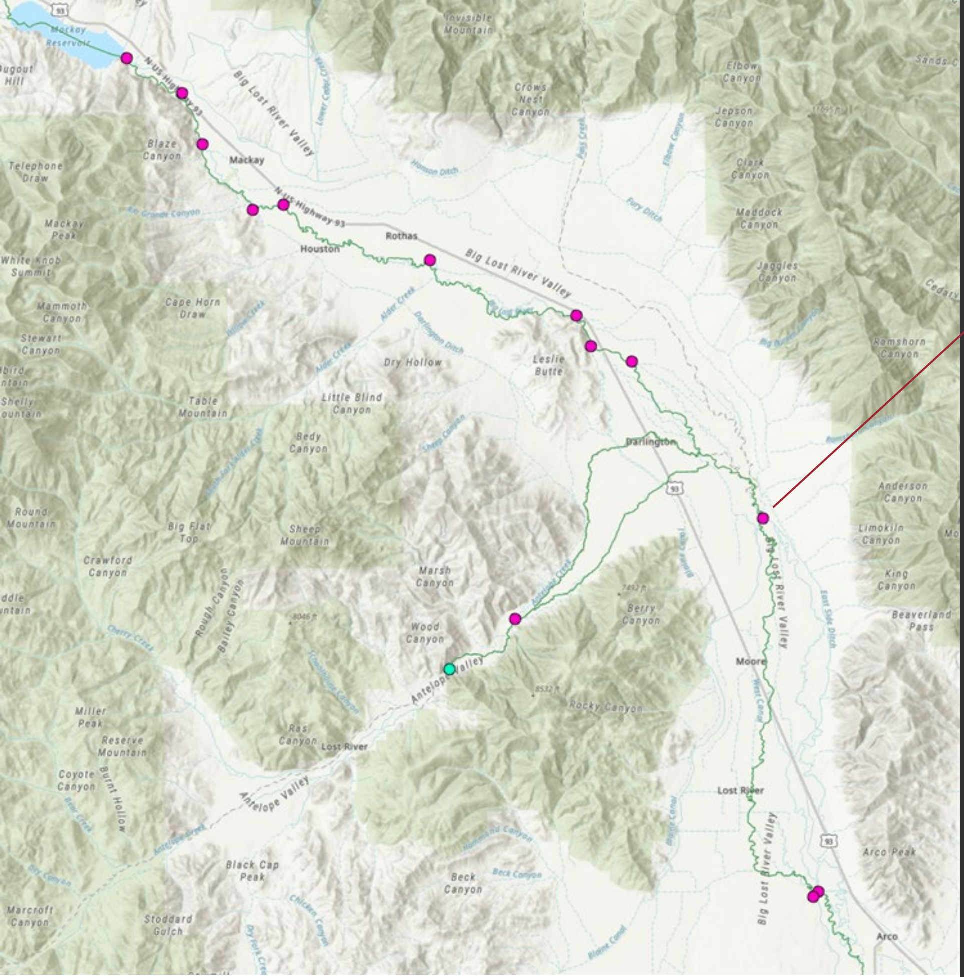
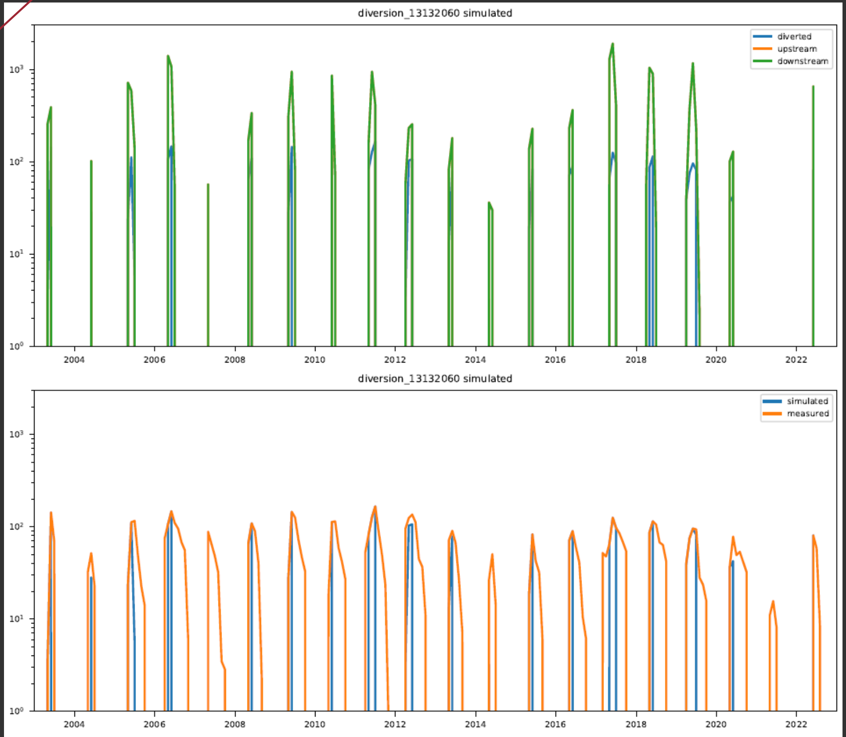
BLRM surface water diversions



Eastside Diversion



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Model status – streamflow routing

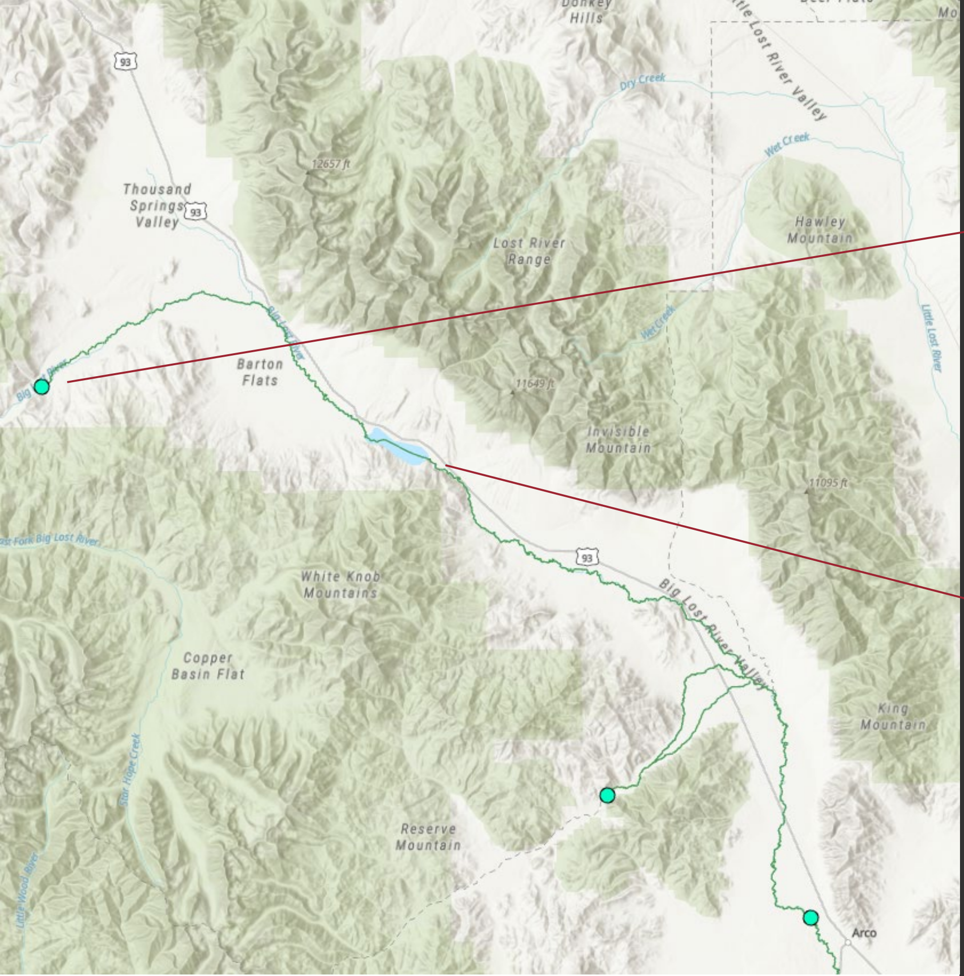
Stream-Aquifer Exchange

Gains and losses are simulated via head-dependent boundary condition between stream stage and aquifer head. Overall volumes are reasonable but not yet matching to reach-scale observations (e.g. seepage study findings)

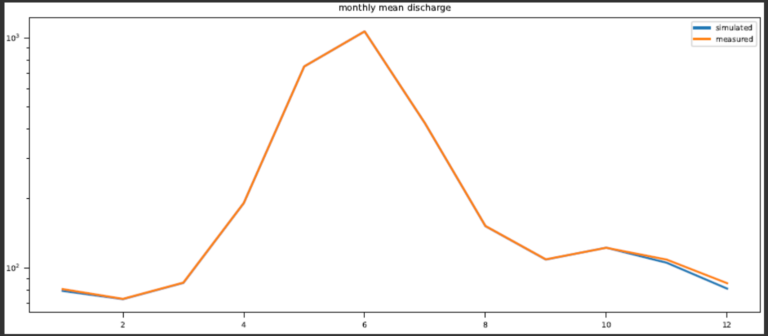
Monthly Flows

Early season flows over-simulated, late-season under-simulated (will resolve when Mackay storage and release is added to model).

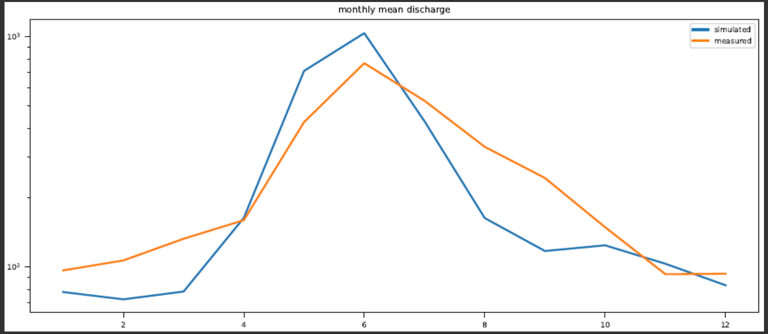
Importance of simulating storage and release



Howell gage



Below Mackay gage



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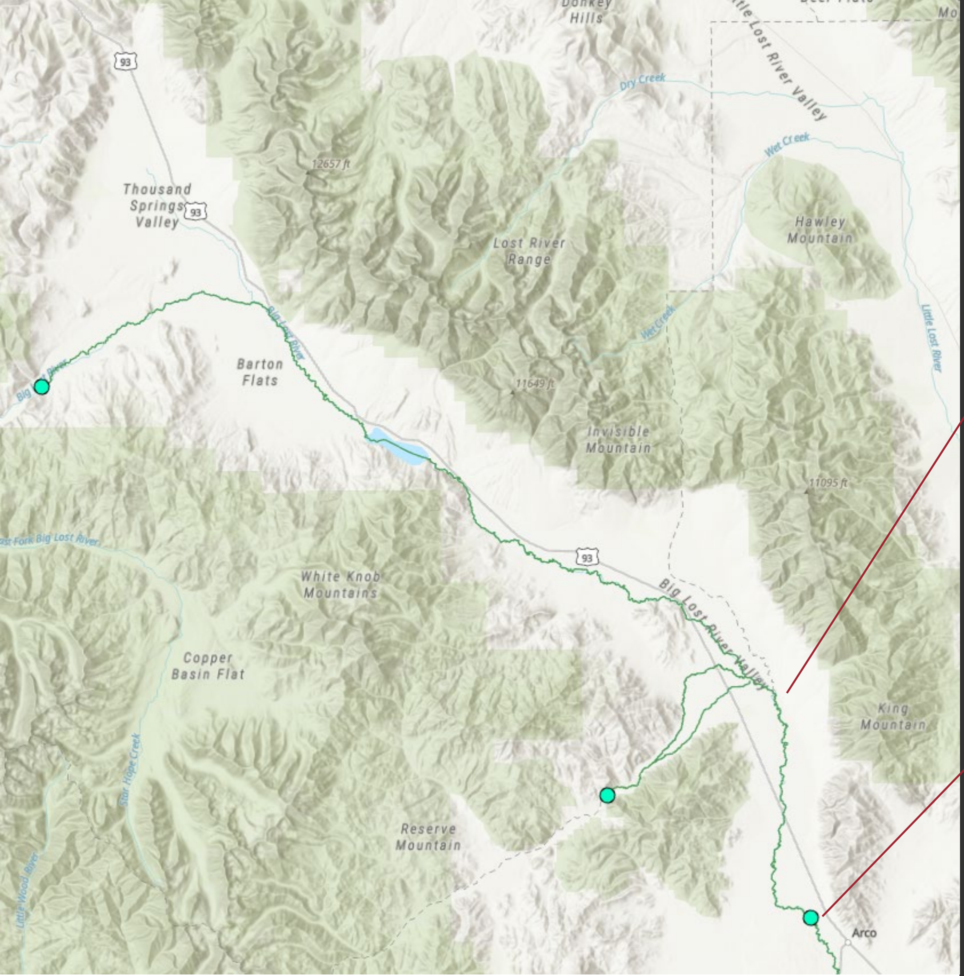
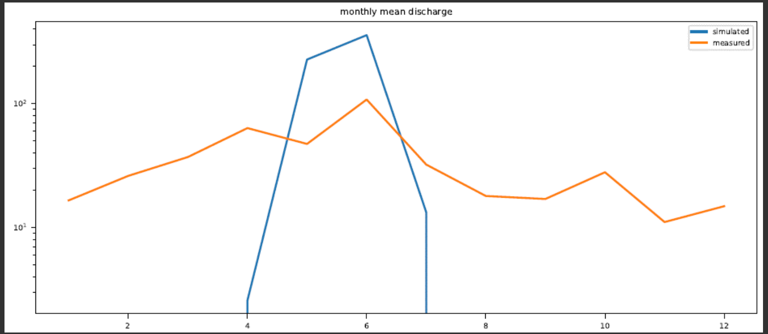
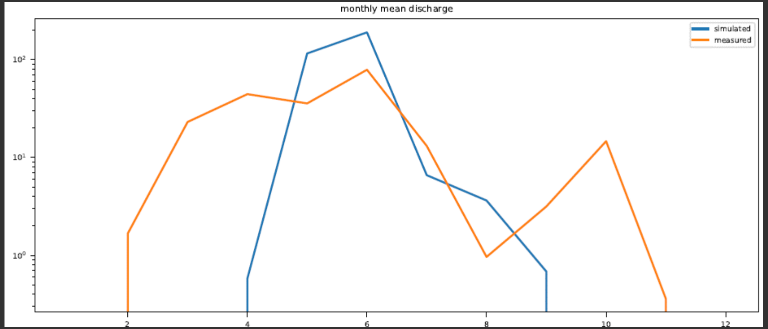


Importance of simulating storage and release

Below Moore gage



Arco gage



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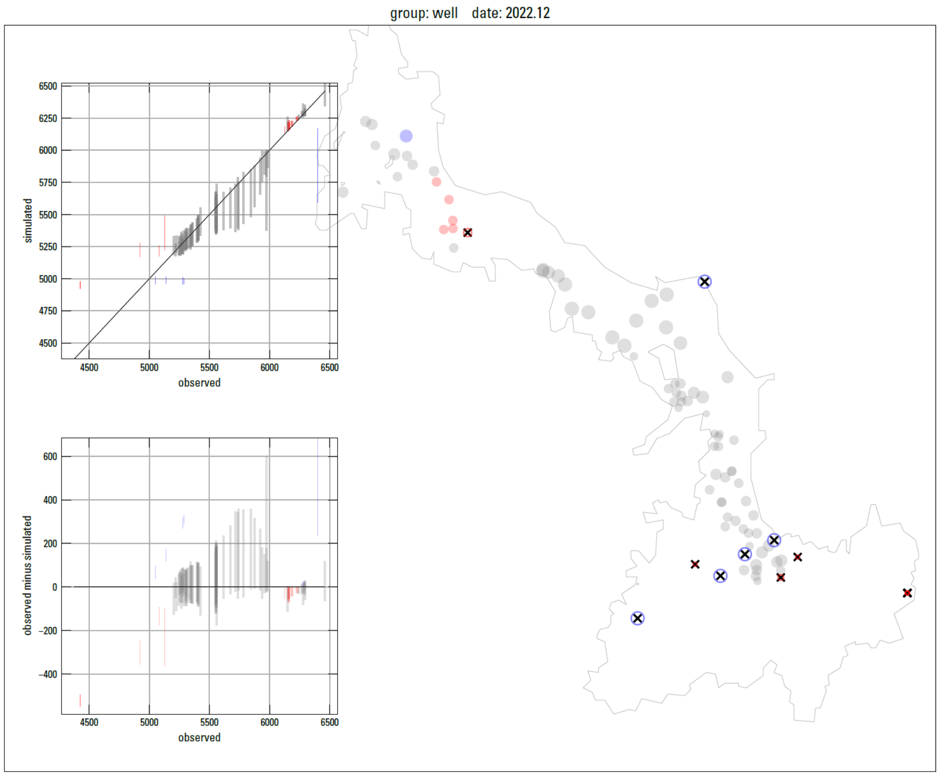
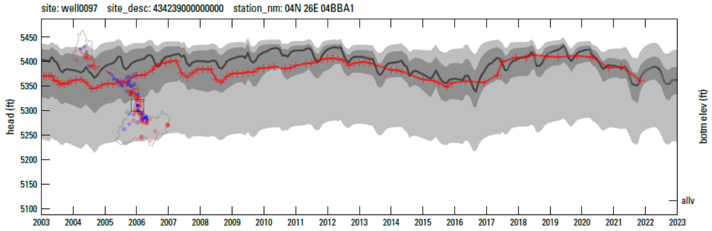




Parameter Estimation

Initial investigation with the Prior Parameter Ensemble

Two necessary conditions for decision-support modeling

(Knowling and others, 2019)

High-dimensional

Avoid erroneous decision based on model forecast bias

Stochastic

Express reliability in simulated outcomes

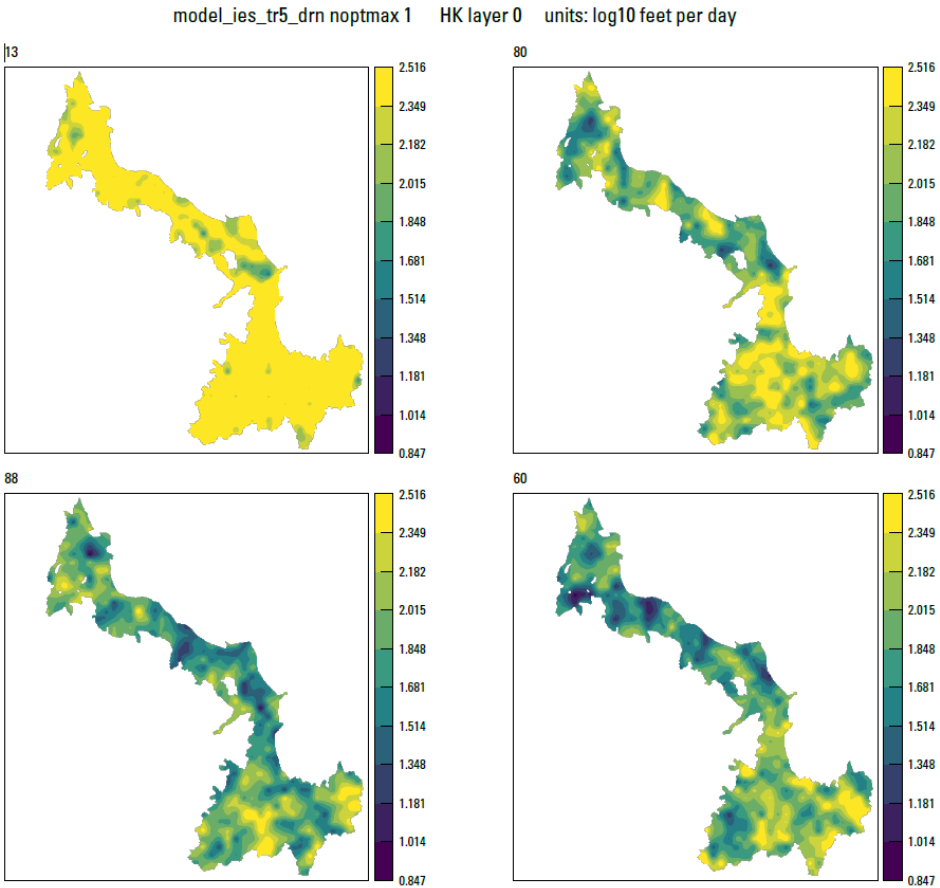
Ensemble modeling with PESTPP-IES

High-dimensional

Make use of many thousands of parameters (or even millions) to better simulate natural variability on multiple spatio-temporal scales **(with fewer total model runs, less CPU time)**

Stochastic

Upgraded parameter ensemble provides multiple model realizations that fit historical observations equally well, retaining a level of uncertainty in parameter values that will give a range of equally likely forecast results.



In general, for BLRM we aim to OVER-parameterize and UNDER-fit

Define parameters as overlapping multipliers at Coarse, Intermediate, and Fine scales

Providing many “receptacles” (pars) to assimilate information from observation data prevents bias incurred from parameter compensation

Some parameters are assigned a fixed range of values and not allowed to adjust to match observations. This formalizes our ignorance of certain inputs and retains appropriate unceraintanty

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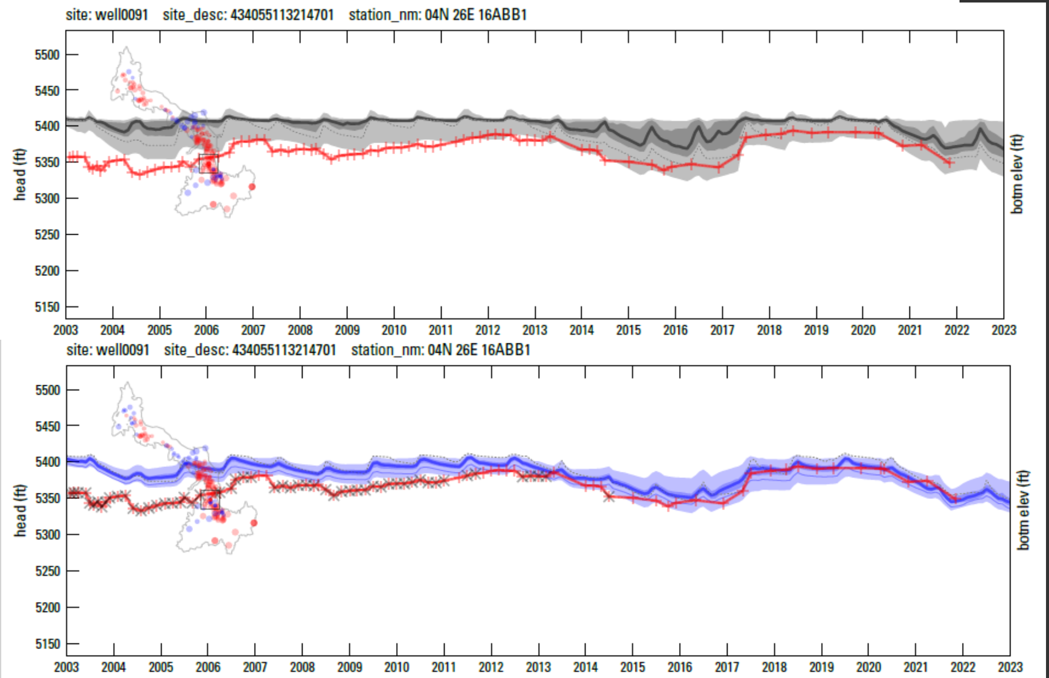
In general, for BLRM we aim to OVER-parameterize and UNDER-fit



Overfitting parameters to historical observations leads to bias in forecast, and too-low variance (false certainty) that ignores the importance of what we don't know or can't simulate

Some outlier measurements are far outside the range of the prior ensemble results (prior data conflict) and automatically removed from the objective function to avoid parameter compensation

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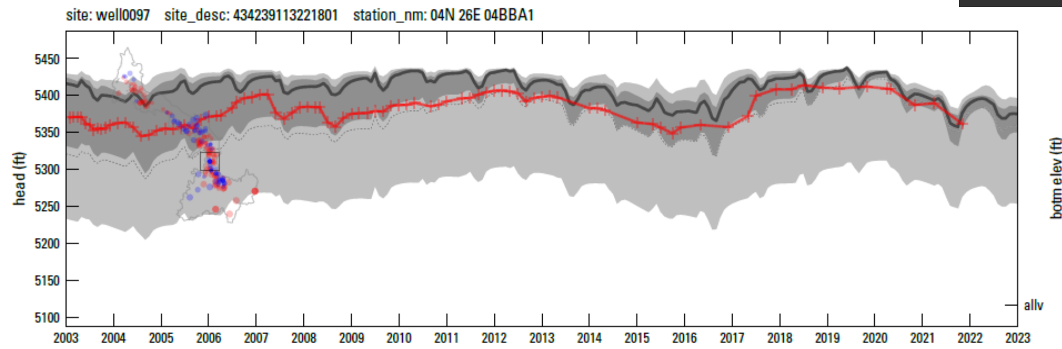
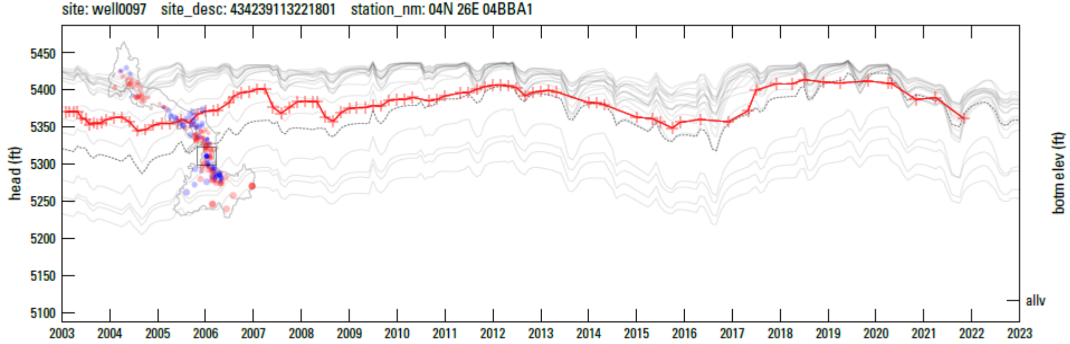
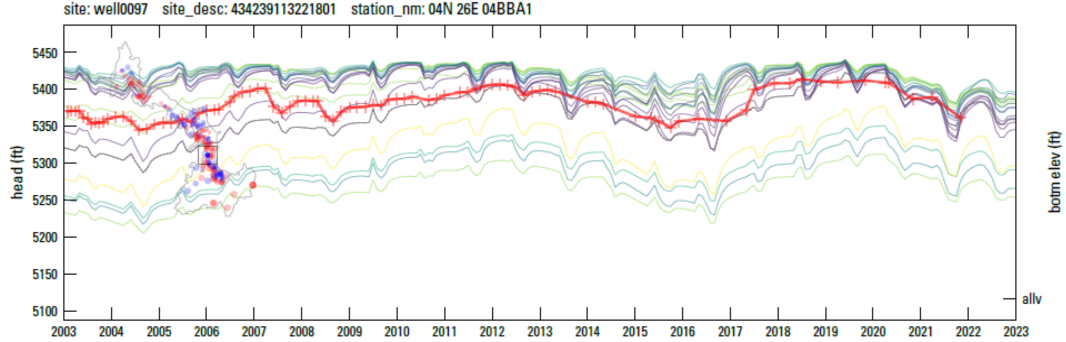




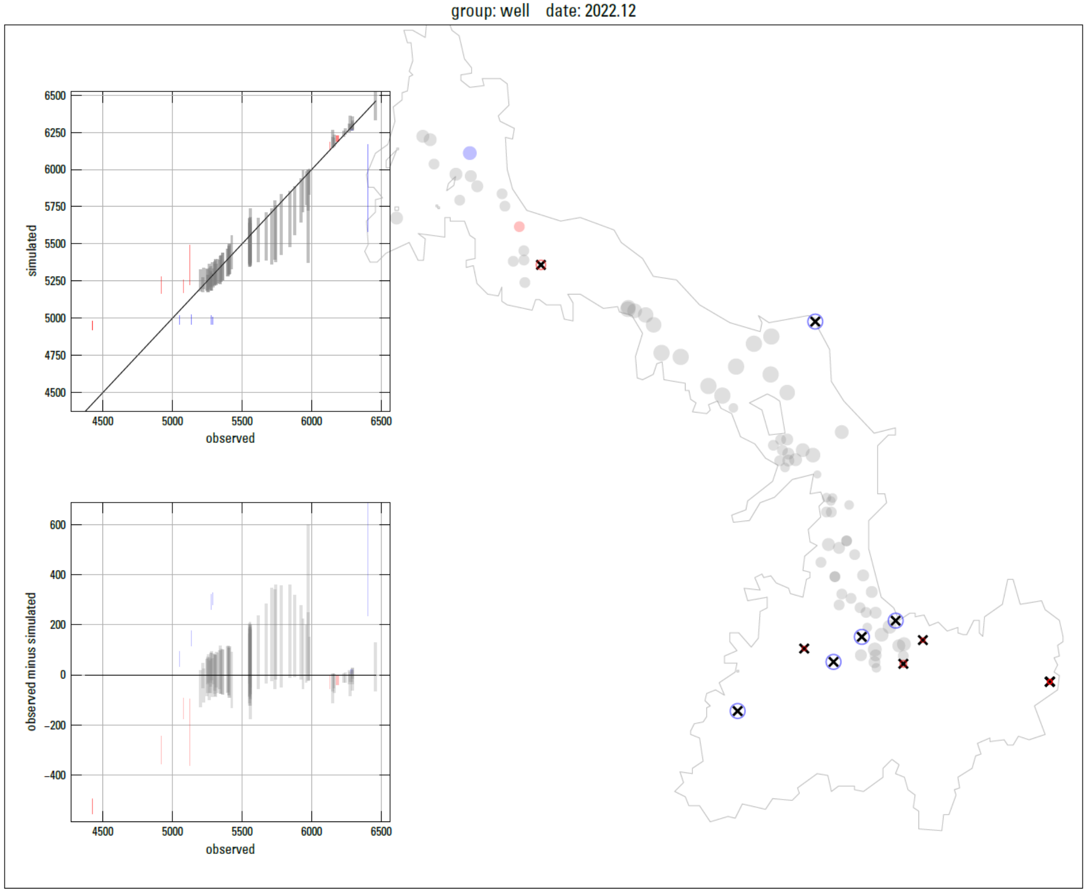


Example to get familiar with ensemble results

Filled plots show max/min range, interquartile range, and median simulated value at each time step

Time series of individual model realizations can look more chaotic

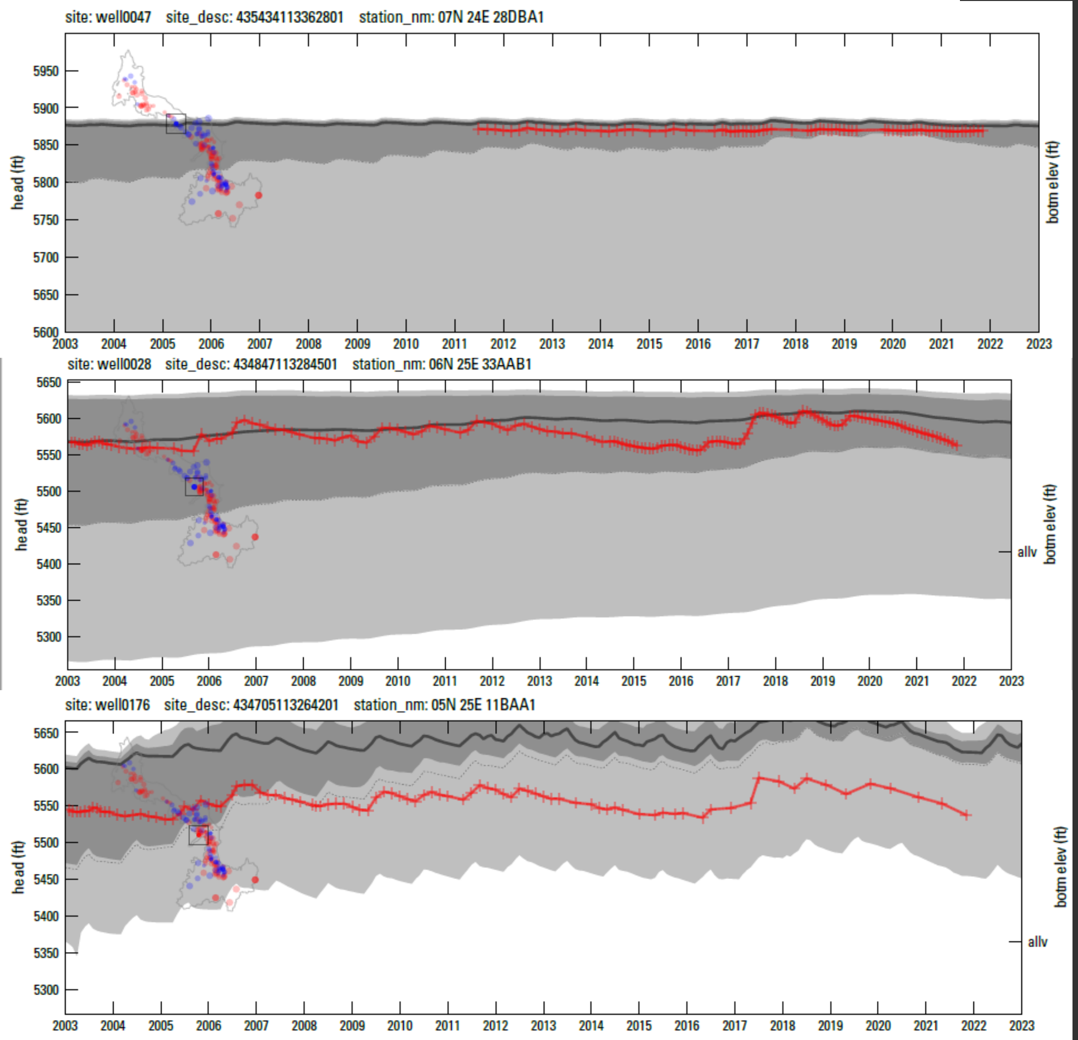
Each realization has different parameter values, randomly drawn from the defined prior distribution



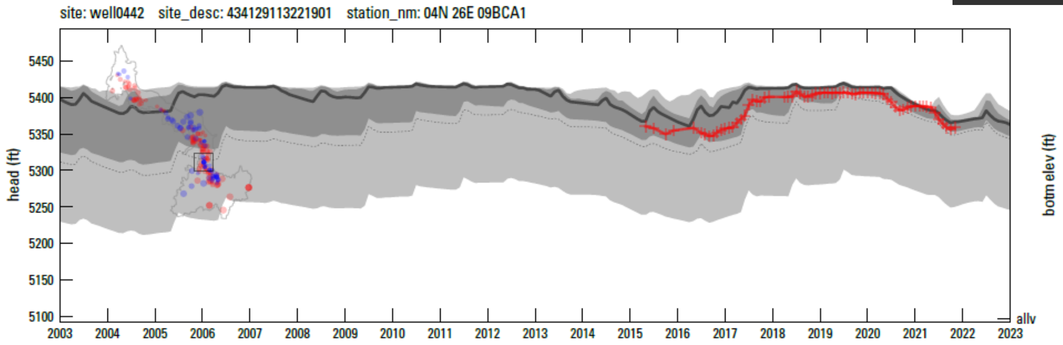
Example to get familiar with ensemble results

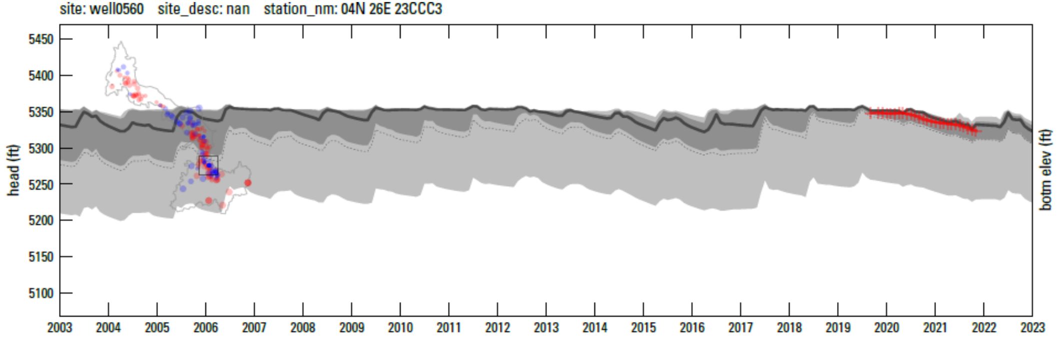
Residual maps show spatial variability of fit to observations and range of simulated values for a given time step

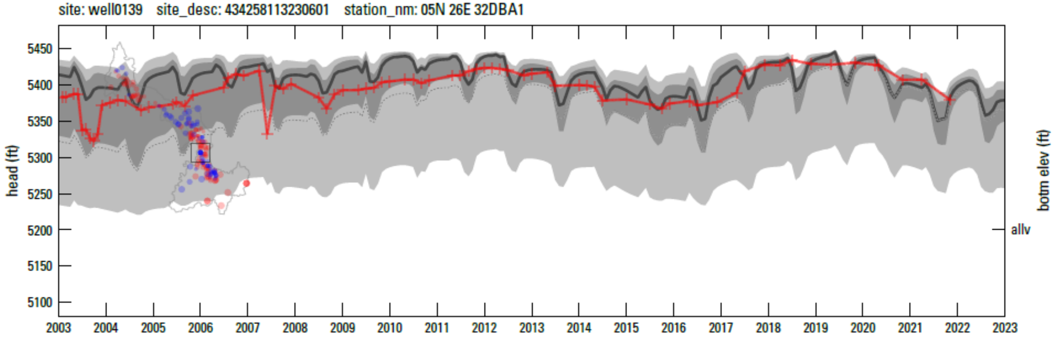
Decent coverage of GW level observations in most areas

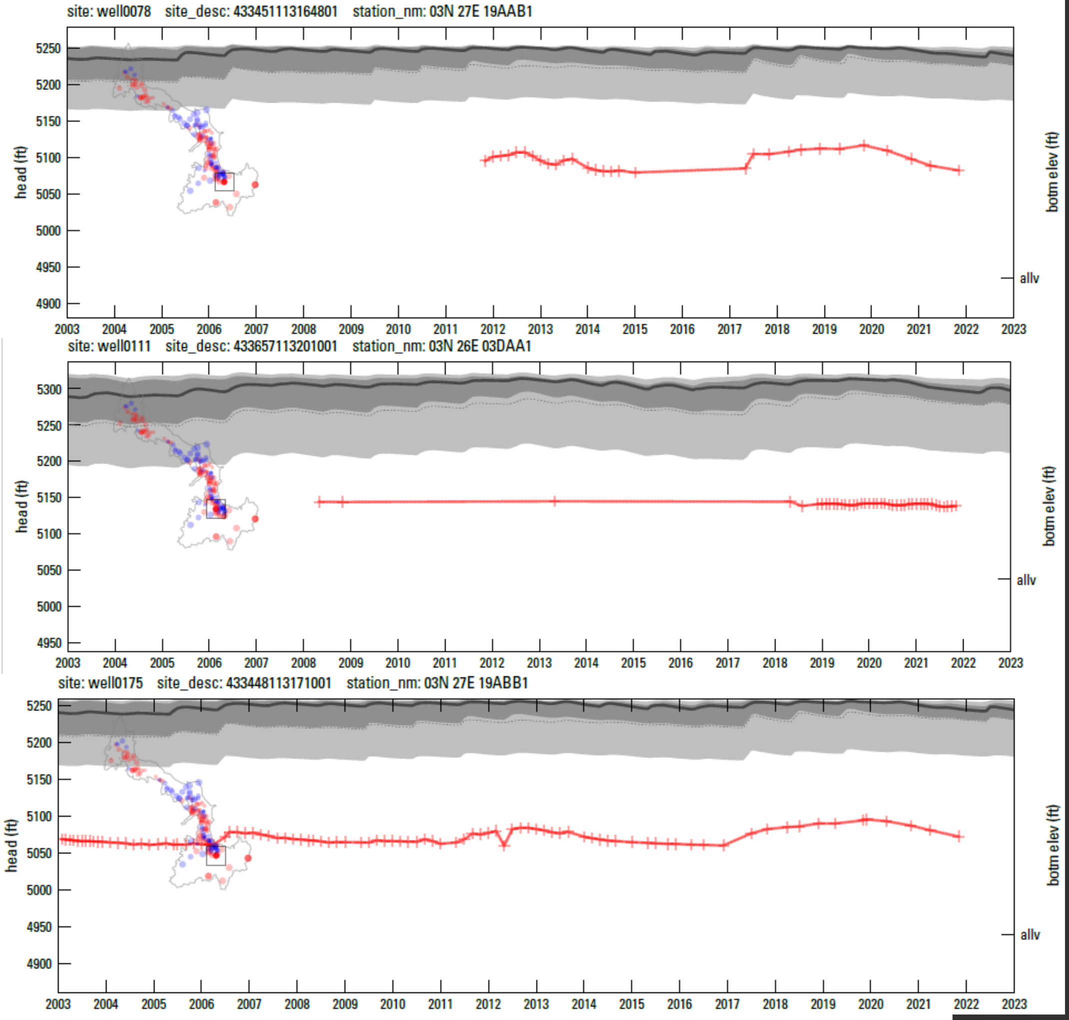


Best matches in lower valley between Moore and Arco

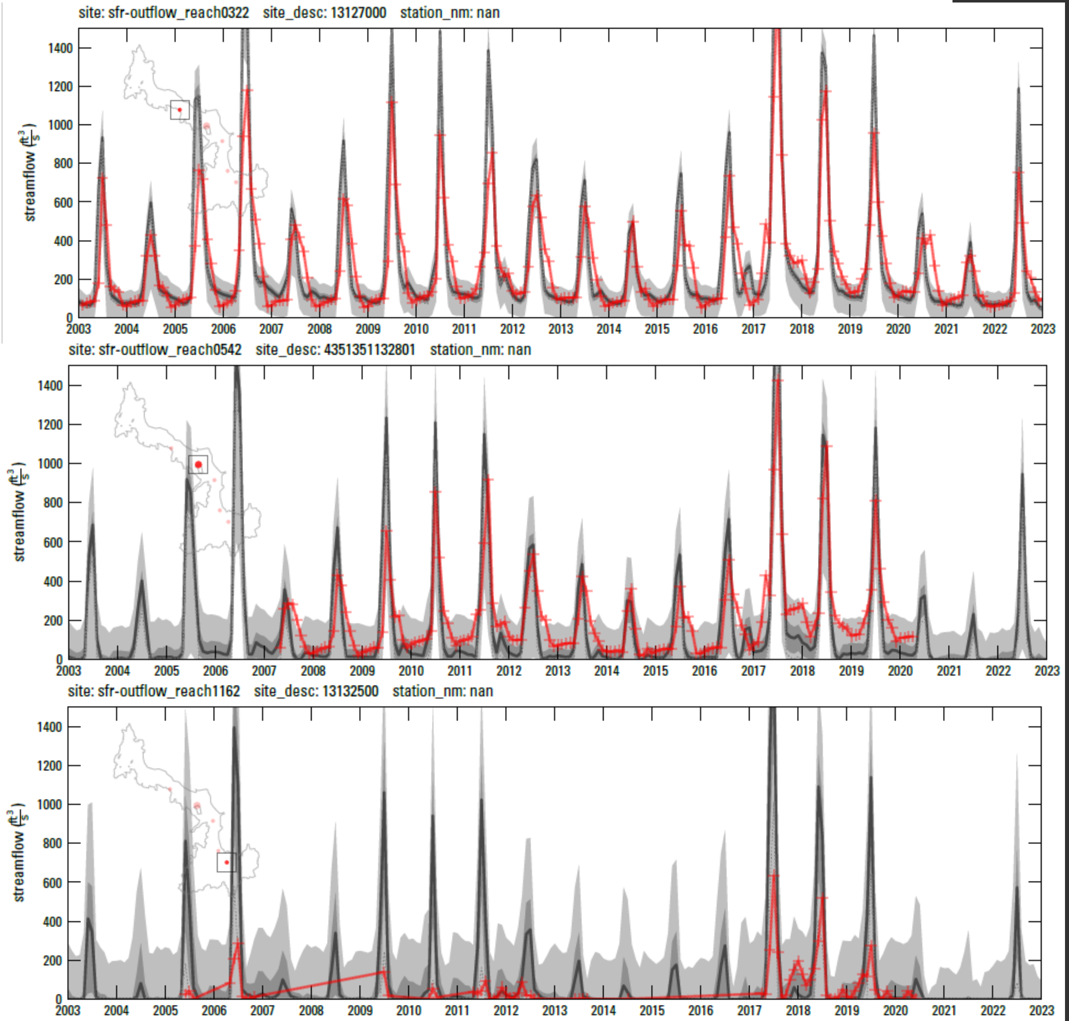






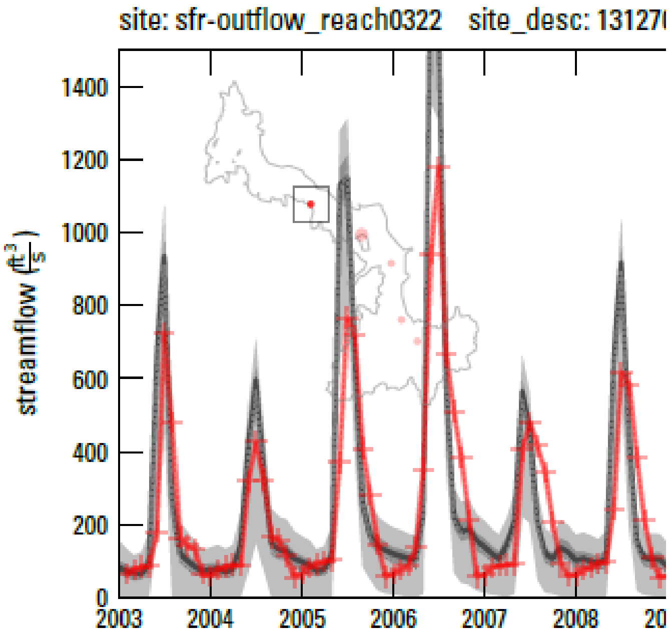


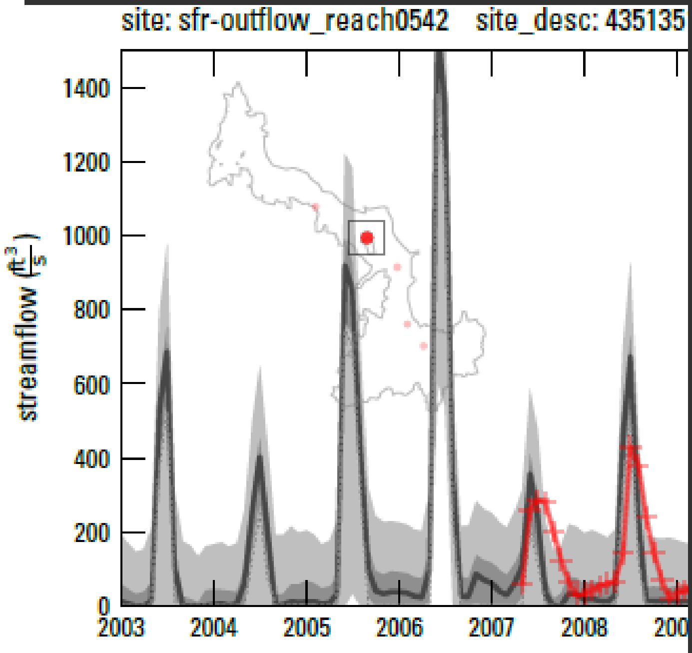
Poor performance south of Arco (more work to do on layering scheme)



Storage and release simulation needed to better match stream hydrographs.

Storage and release simulation needed to better match stream hydrographs.





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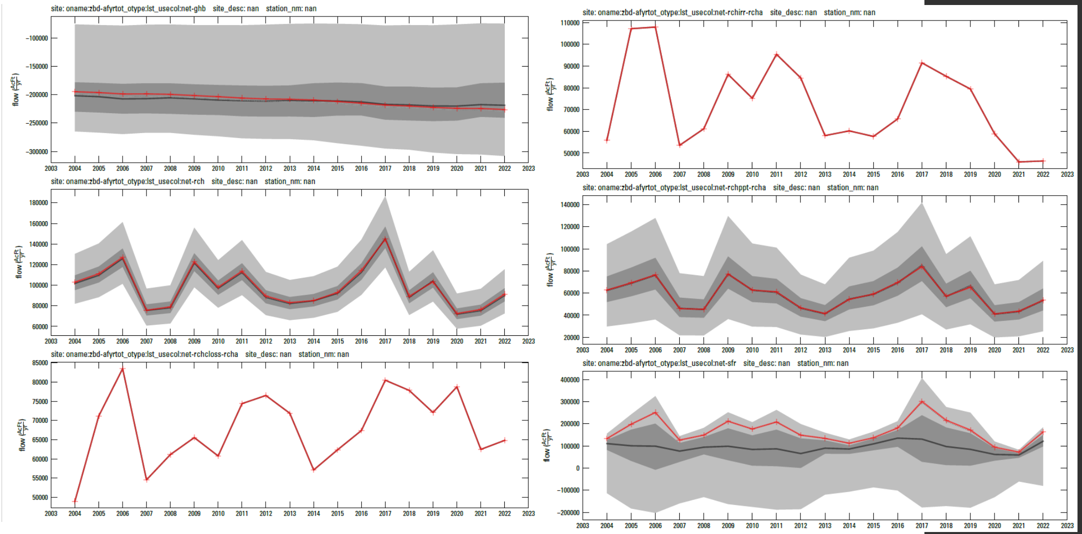
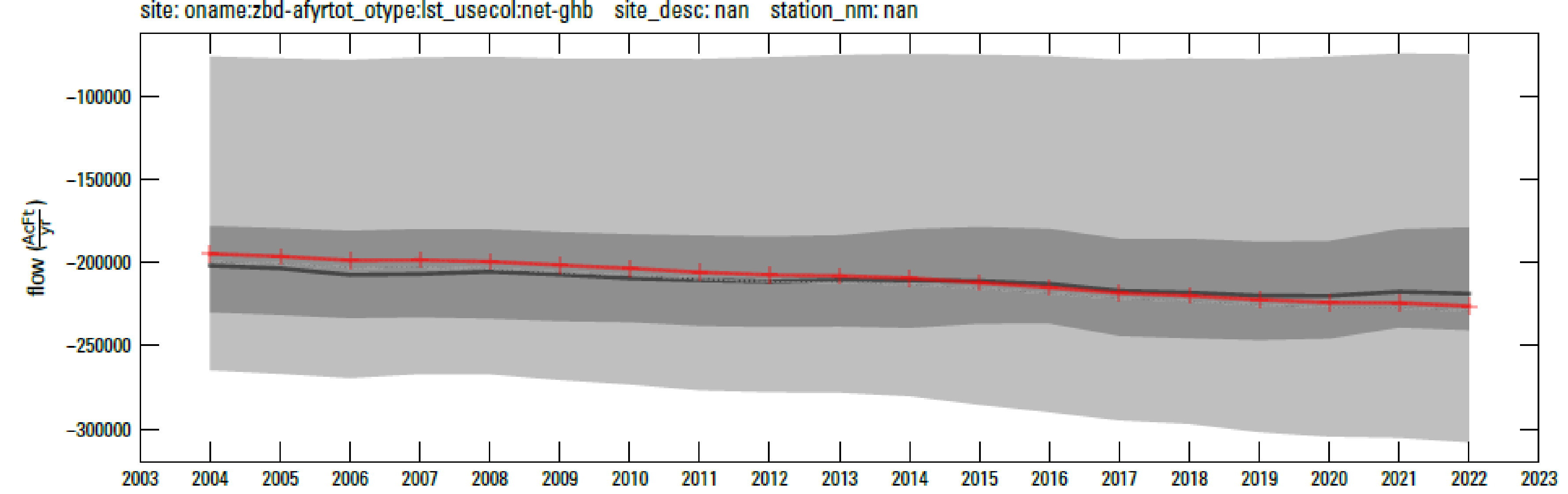
Simulated water budget is “In the ballpark” of Clark calculations





Underflow to SRP

BLRM: ~200k afyr

ACGB: ~300k afyr*

***total budget residual, includes storage change**

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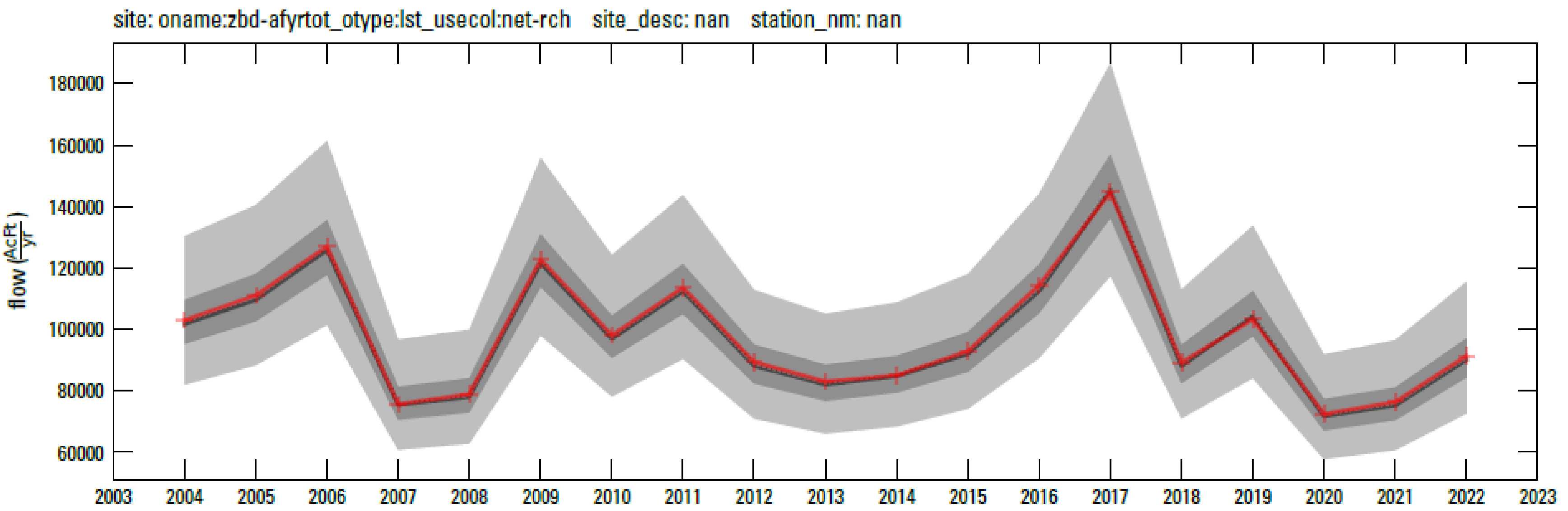

Tributary underflow
BLRM: ~100k afyr
ACGB: ~90k afyr

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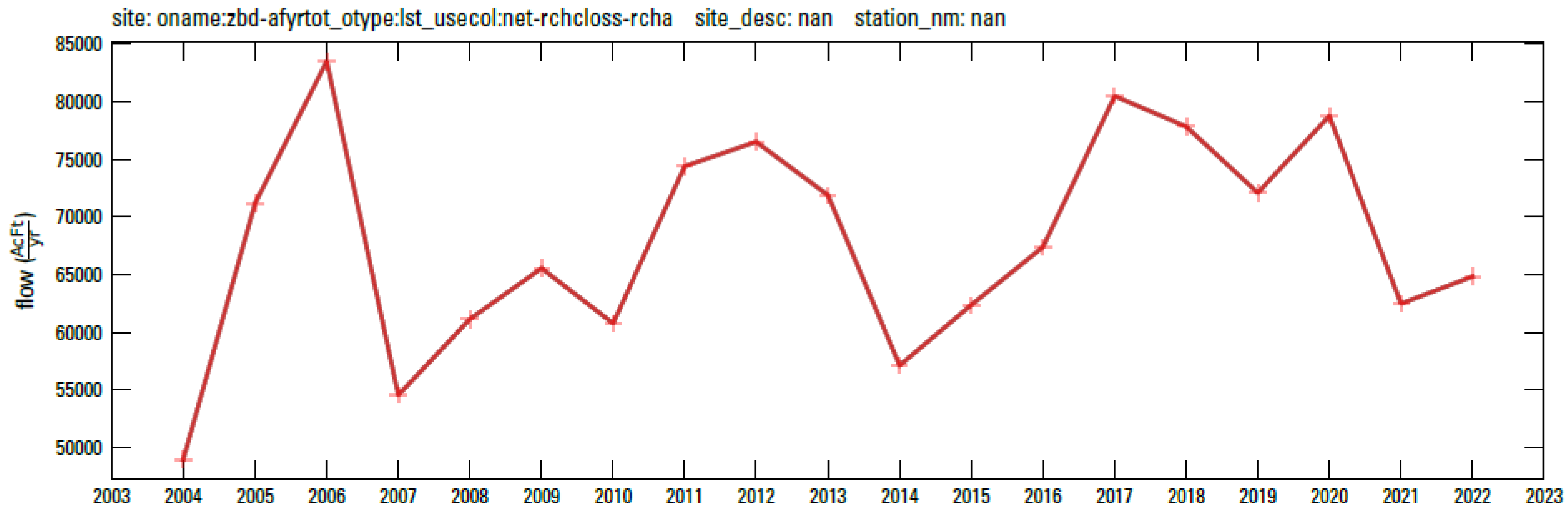

Canal seepage
BLRM: ~70k afyr
ACGB: ~60k afyr

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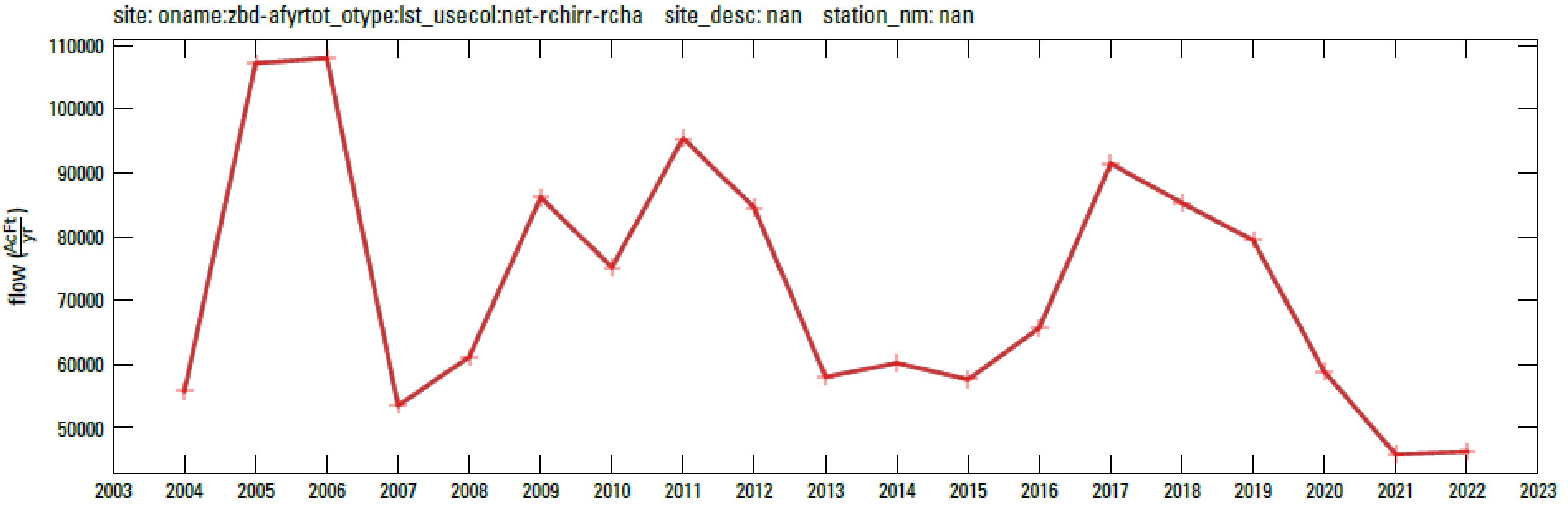

Applied irrigation recharge
BLRM: ~75k afyr
ACGB: ~50k afyr

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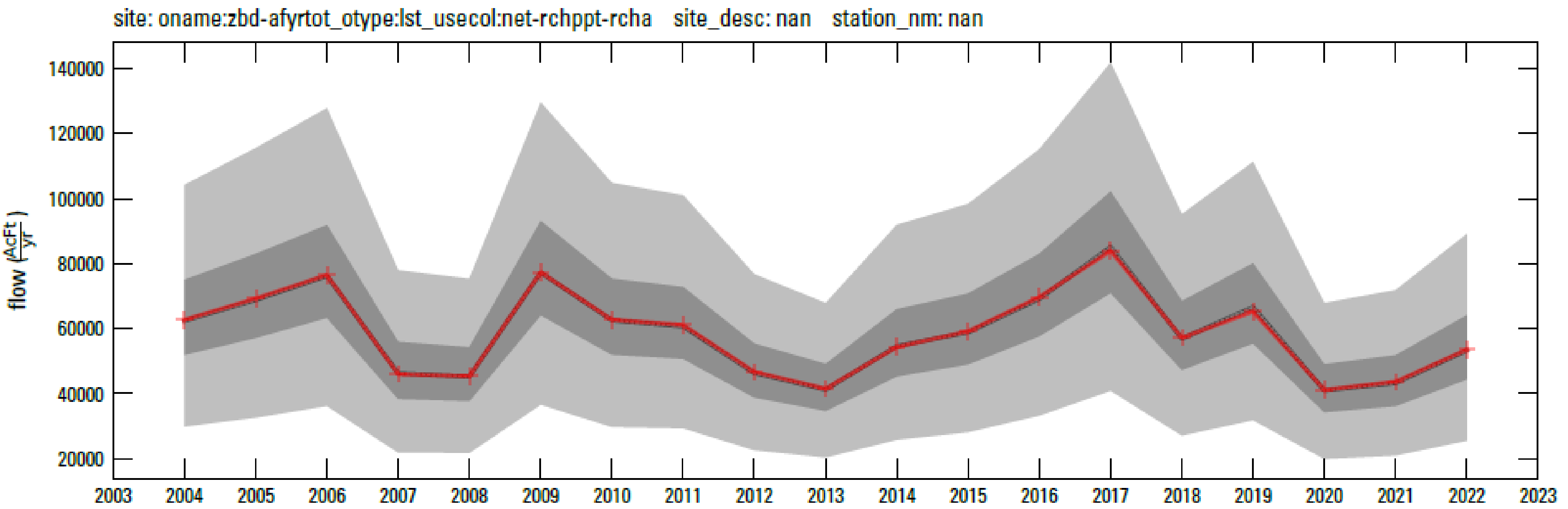

Areal recharge
BLRM: ~70k afyr
ACGB: ~100k afyr

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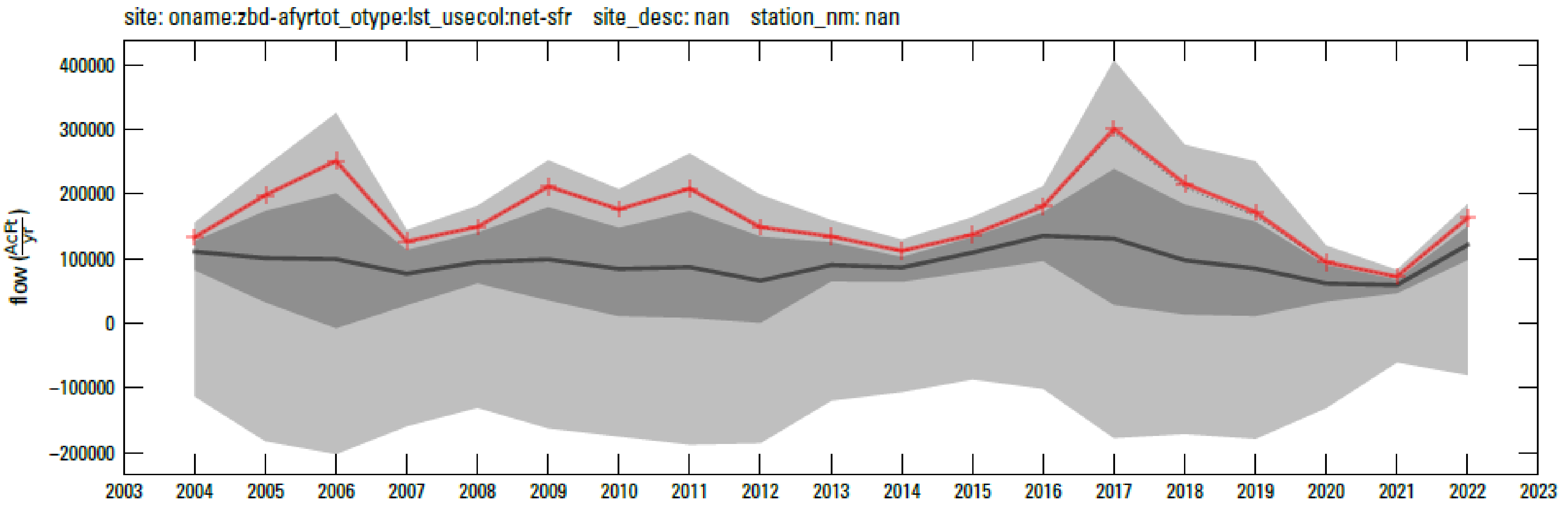

Net river losses to aquifer
BLRM: ~100k afyr
ACGB: ~120k afyr

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Thanks!

jknight@usgs.gov