# WRV 1.2

Model Calibration Update
Wood River Valley MTAC
11 December 2025
Presented by Alex Moody

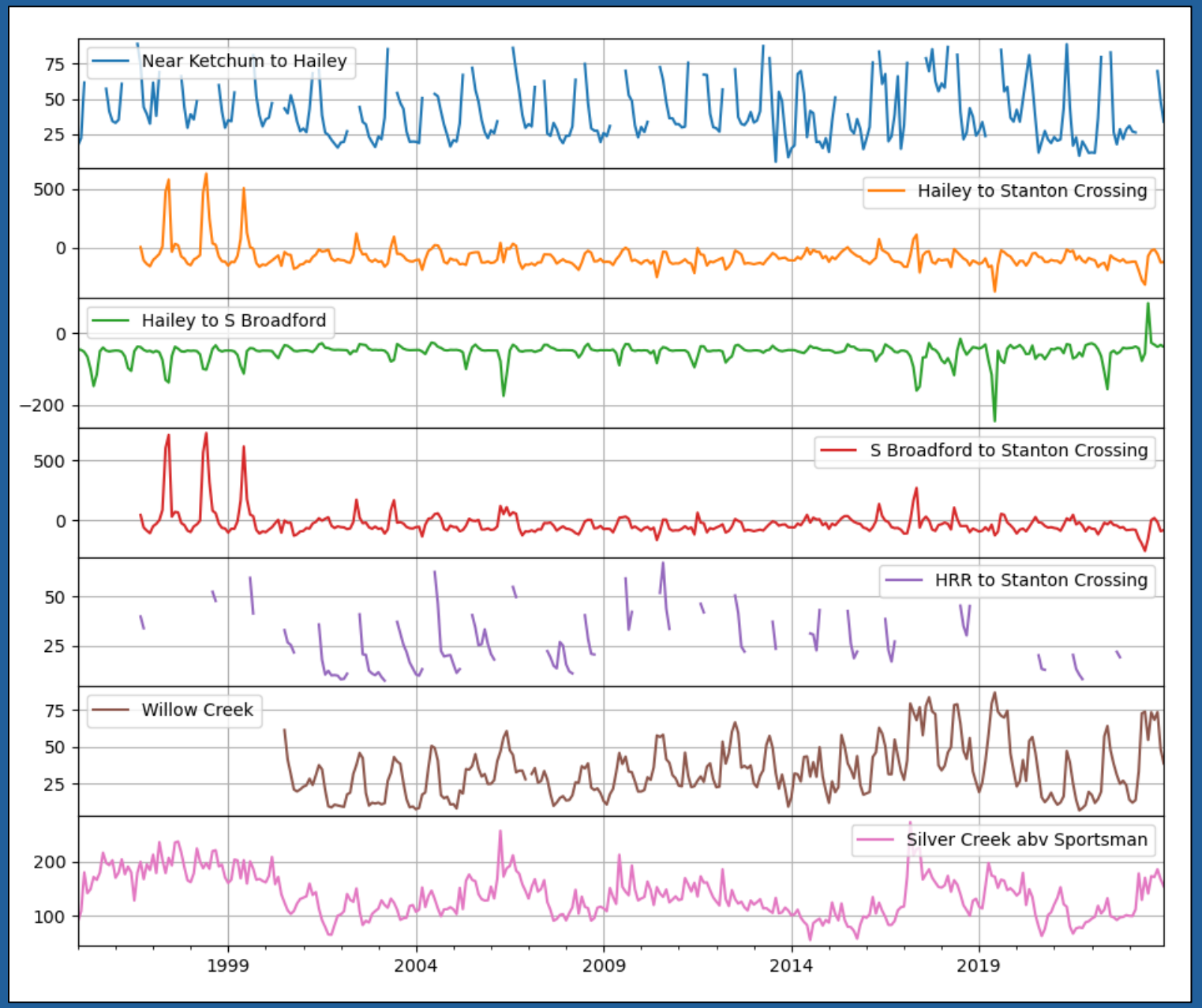
IDAHO DEPARTMENT OF
WATER RESOURCES

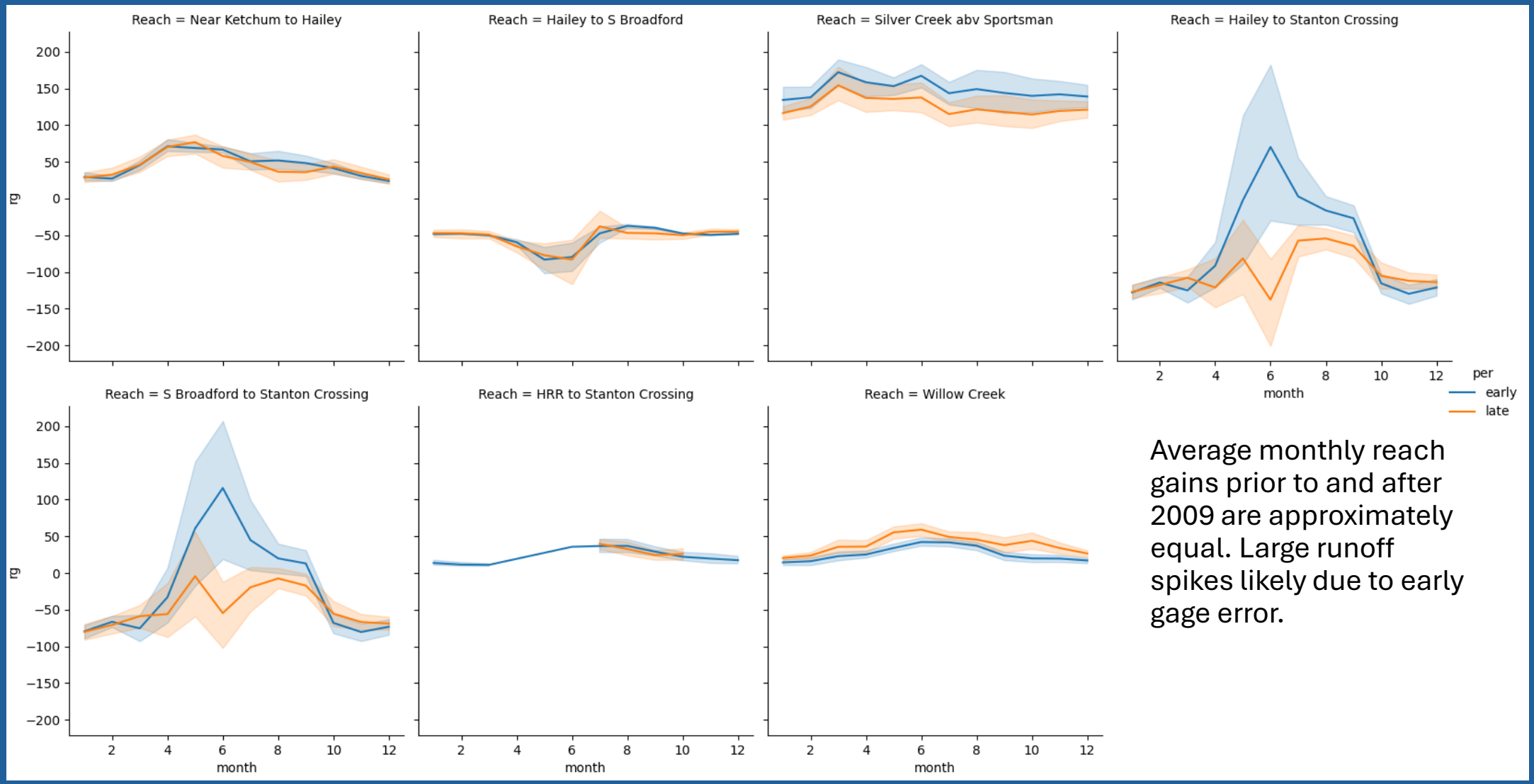
# Outline

1. Parameterization changes and model behavior
    1. Calibration period change (2009 to 2023)
    2. Tributary underflow baseflow method
    3. Pilot Points
        1. More Points
        2. No zonation for tribs and basalt
    4. Range of possible estimated pumping
    5. Silver Creek Drain
2. Results from latest PEST++ run

# Shorten Model Period

- Speeds up run-time
- 2009-10 to 2023-12, 172 stress periods (vs 347 from Jan 1995 to Dec 2023)
- Steady State Period = October 2016 to September 2017
- Warmup period of 12 months



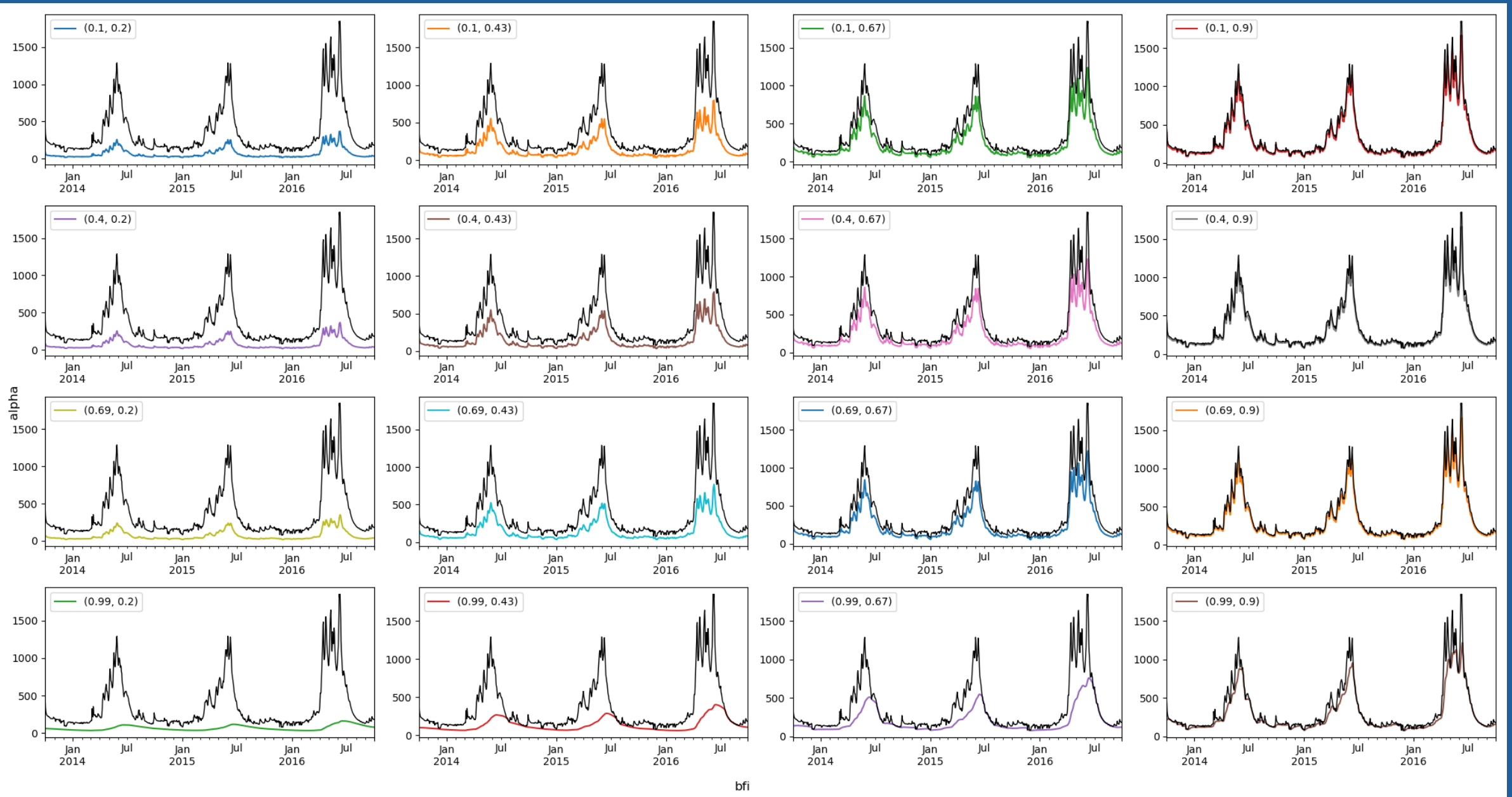



Average monthly reach gains prior to and after 2009 are approximately equal. Large runoff spikes likely due to early gage error.

# Tributary Underflow Parameterization

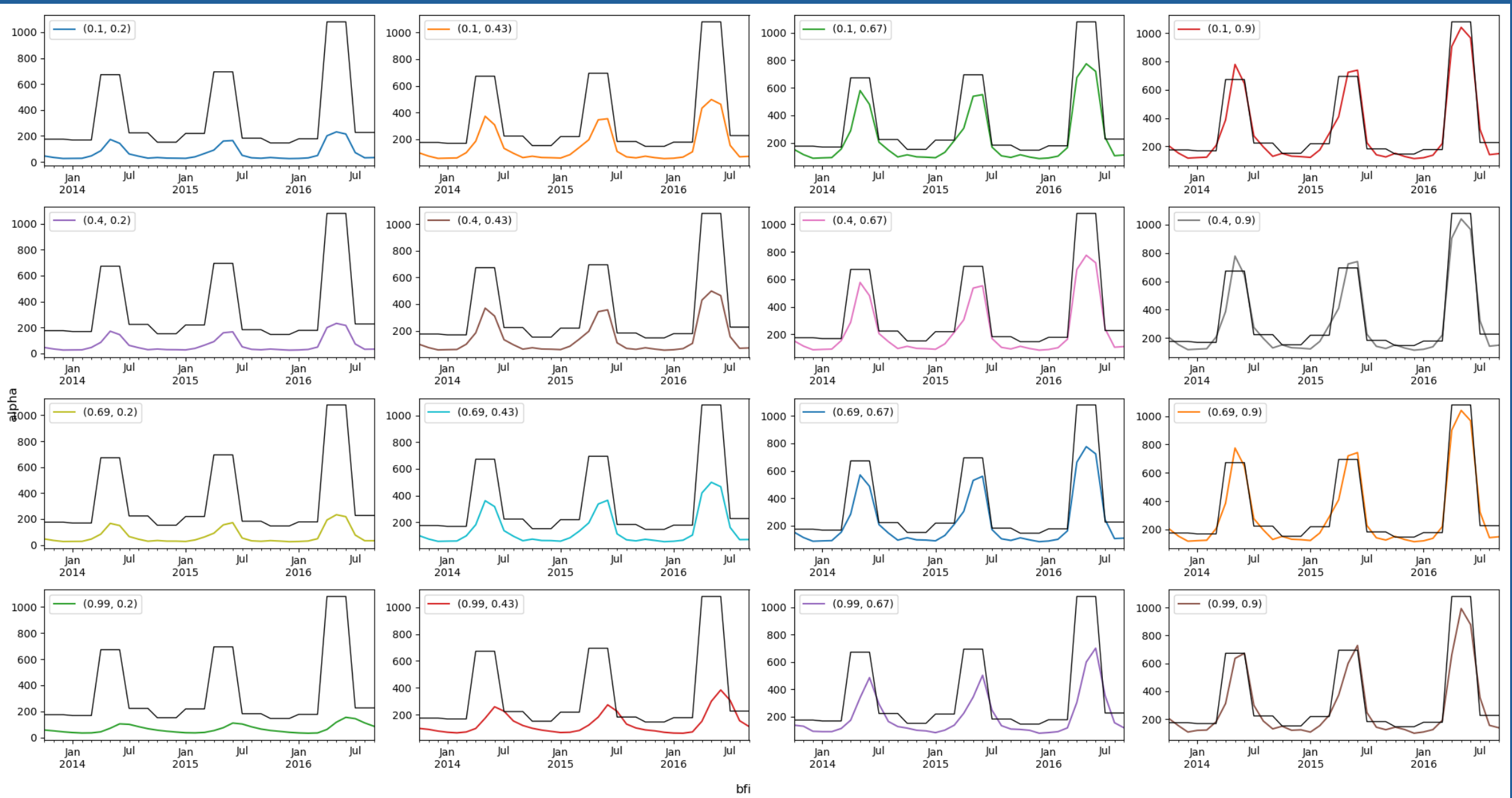
- Hailey gage baseflow separation scheme with 4 parameters per trib ( alpha, baseflow index, time shift, reduction factor). Going from 26 to 96 parameters (currently implemented)
- Considering assigning CHD/GHB in tribs with good transducer record
  - East Fork, Deer Creek, Upper BWR
  - Use recharge model to extend datasets

# Variation of baseflow separation with parameter values



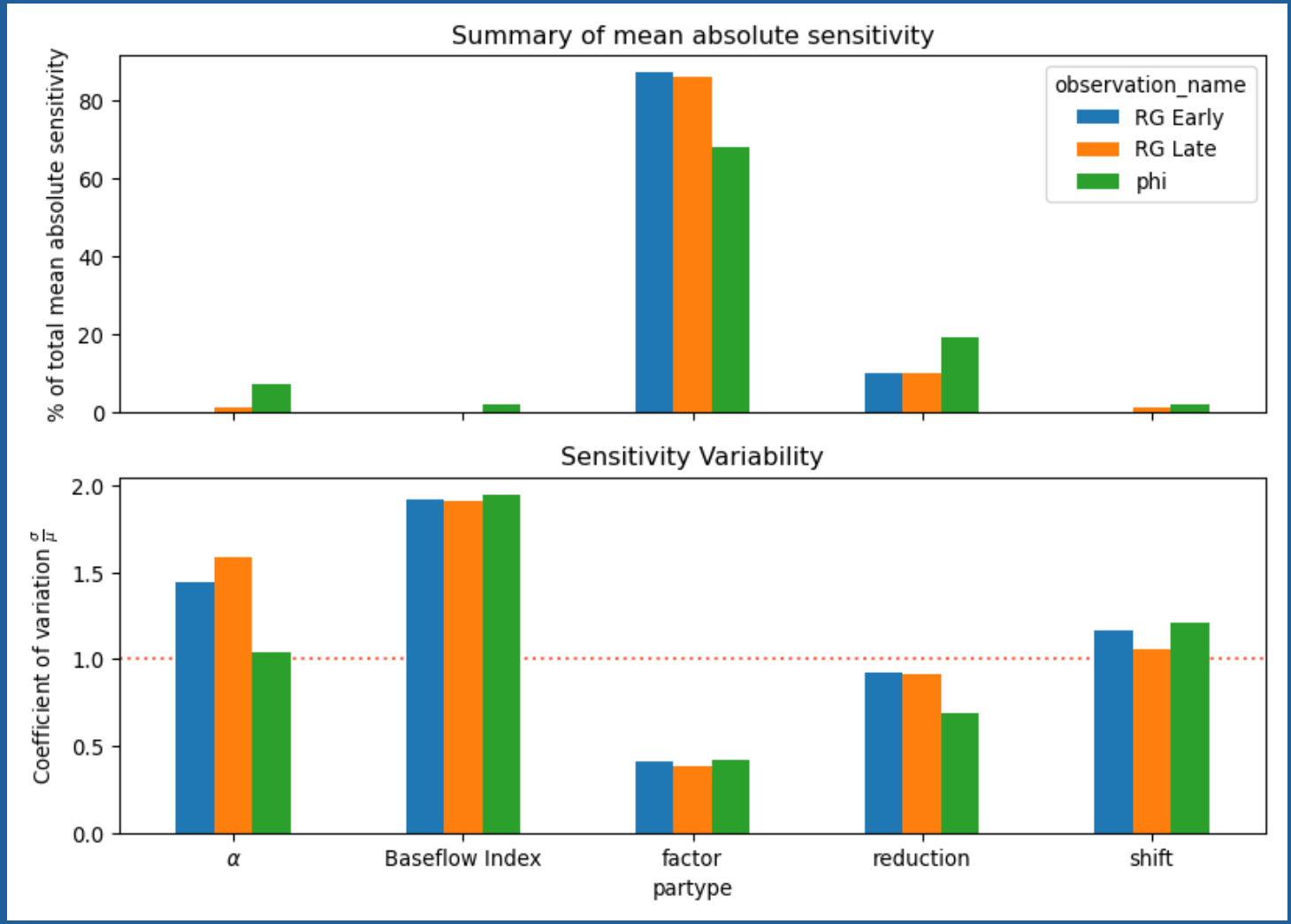

Alpha = Groundwater recession constant | BFI = Max baseflow index (long term ratio of baseflow to total streamflow

# Variation of monthly with parameter values



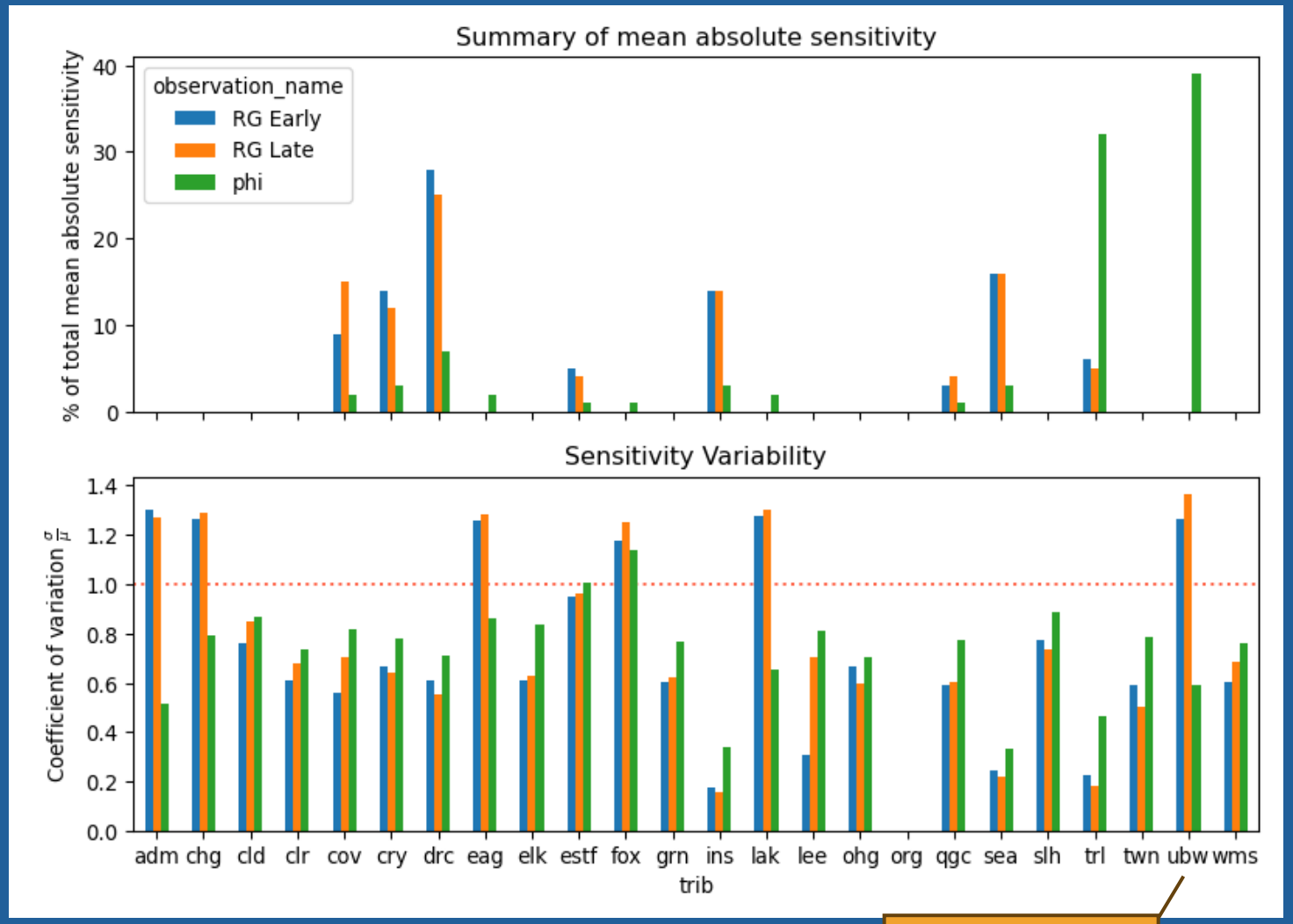
# *Tributary Parameter Sensitivity*

- Examines impact to objective function (phi) and impacts of interest
  - RG Early (Apr-Jun reach gains)
  - RG Late (Jul-Sep reach gains)
- Volume factor has the most effect on both the objective function and forecasts of interests (reach gains)
- Baseflow separation parameters have more non-linear relationship with objective function and forecasts across parameter space (CV > 1) than factor, reduction, and shifts.
- Though factor and reduction influence phi and forecasts the most, the relationship across parameters is more linear.



# *Tributary Parameter Sensitivity*

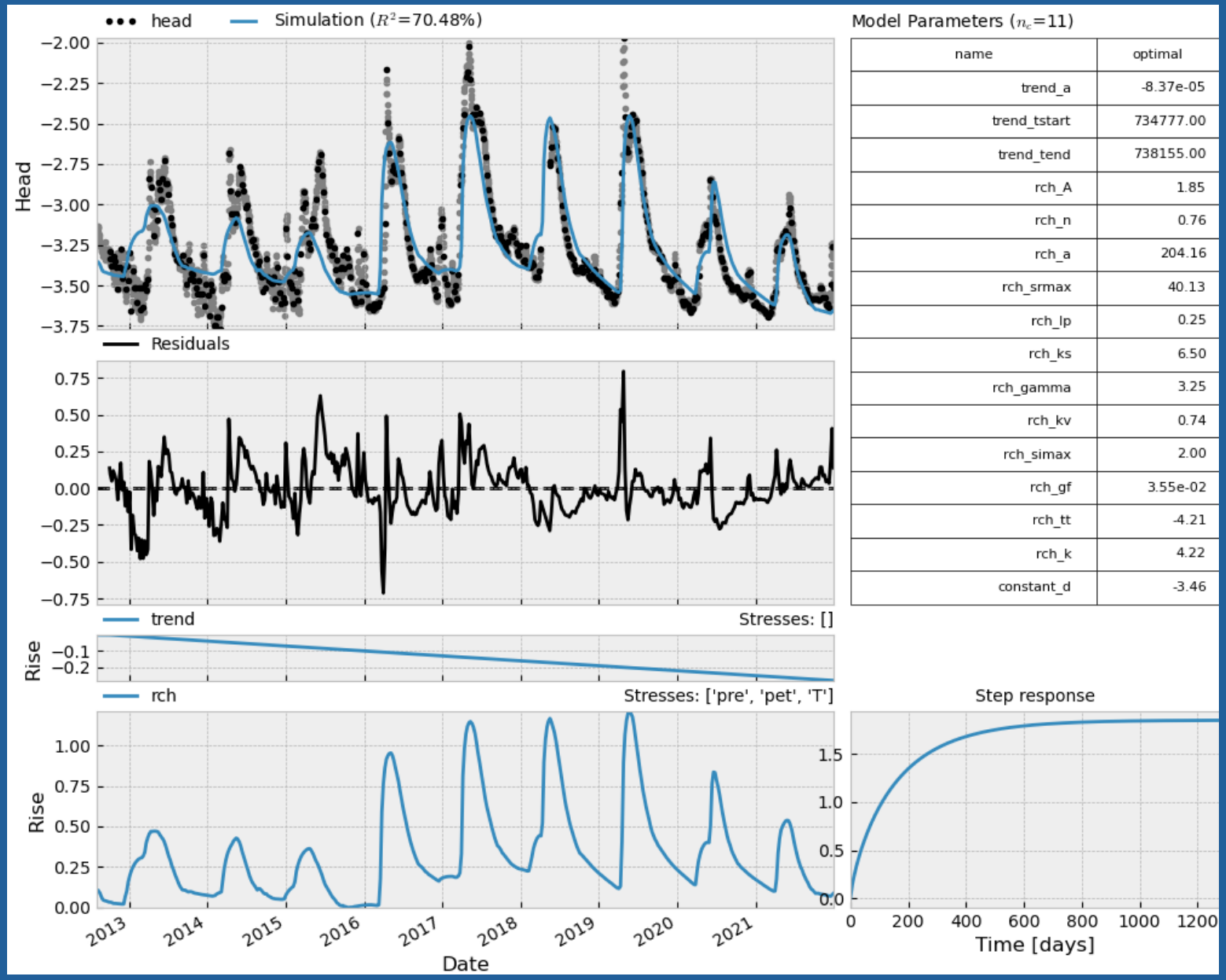
- Upper Big Wood and Trail Creek have greatest influence on objective function.
  - Largest trib inputs
- Forecasts are more sensitive to Cove, Croy, Deer Creek, Indian Creek, and Seaman's Gulch
  - Closer to dry bed
- Upper Big Wood parameters have a non-linear (more sensitive) relationship with reach gain forecasts and a linear relationship with the objective function.
- Trail Creek shows less variability




Upper Big Wood

# Constant head Tribs

- Use transducer data to calibrate recharge model
  - LUMPREM, Pastas (python package)
  - Target larger tribs with data
- Apply modeled heads to CHD cells, replacing WEL cells for tribs
- Requires positive flow target to ensure gradients don't reverse

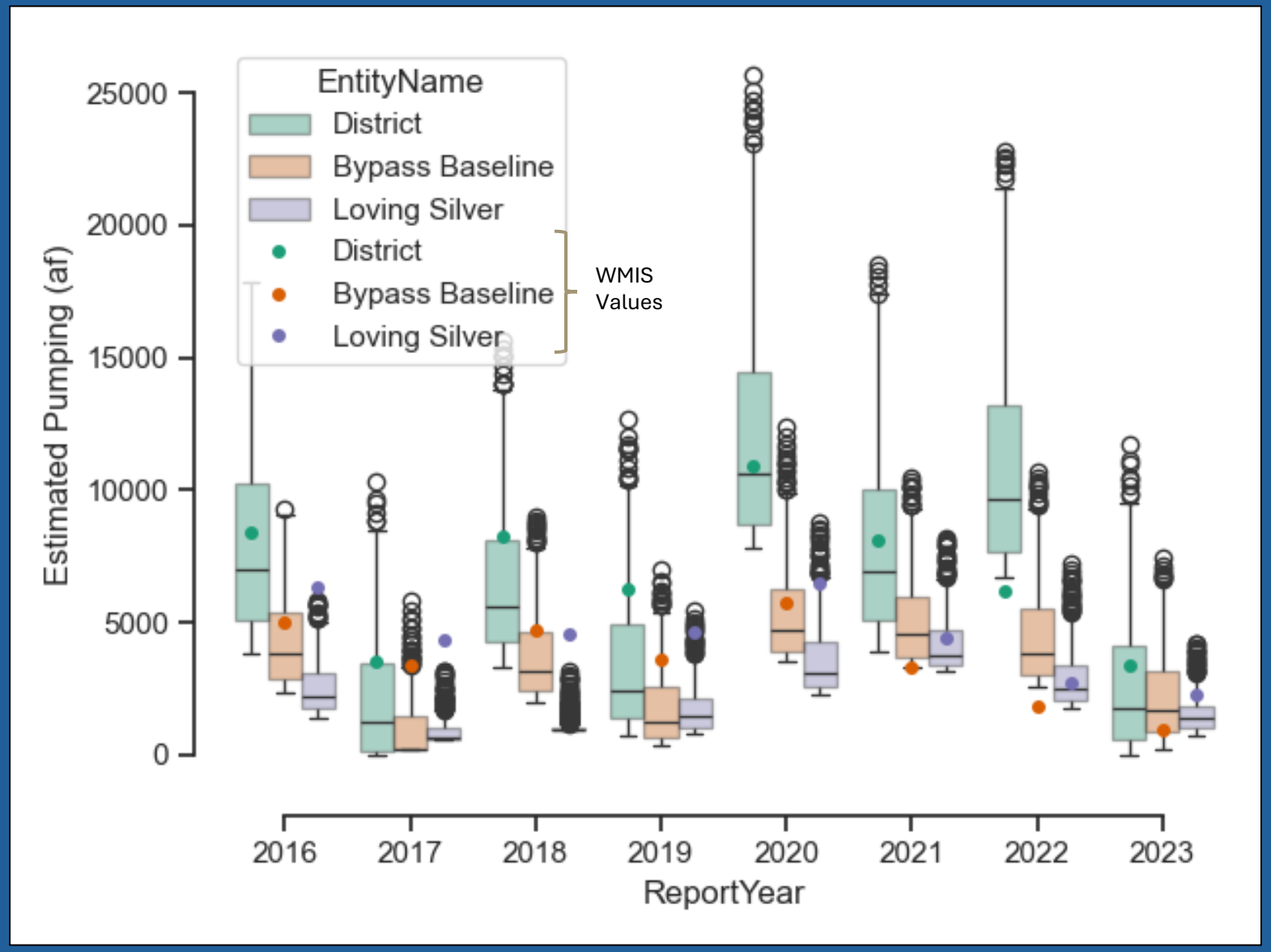



| name | optimal |
|---|---|
| trend_a | -8.37e-05 |
| trend_tstart | 734777.00 |
| trend_tend | 738155.00 |
| rch_A | 1.85 |
| rch_n | 0.76 |
| rch_a | 204.16 |
| rch_srmax | 40.13 |
| rch_lp | 0.25 |
| rch_ks | 6.50 |
| rch_gamma | 3.25 |
| rch_kv | 0.74 |
| rch_simax | 2.00 |
| rch_gf | 3.55e-02 |
| rch_tt | -4.21 |
| rch_k | 4.22 |
| constant_d | -3.46 |

SNRA Visitor Center well recharge model

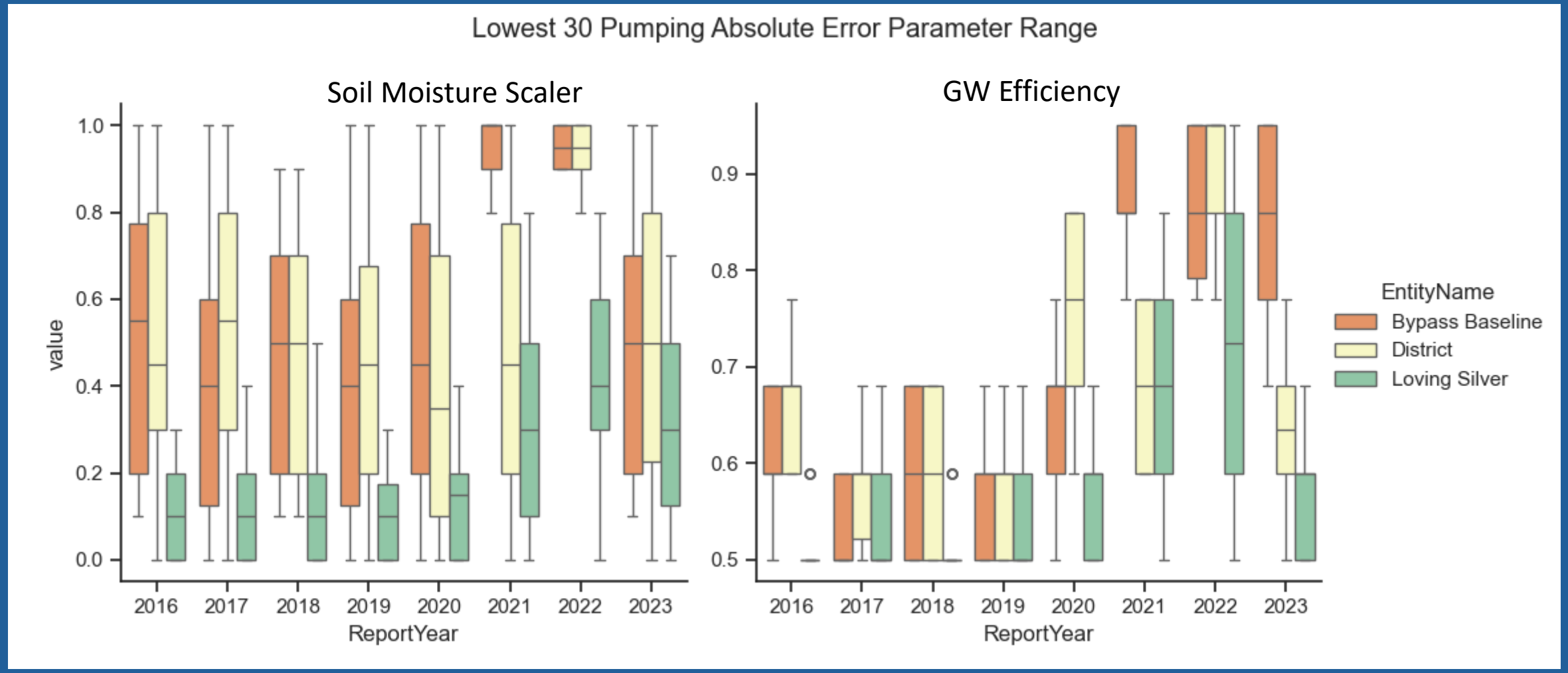
# Can the water balance calculator match WMIS?

- Explored 396 combinations of soil moisture storage scalar (0-1), and efficiencies (gw and sw, 0.5-.95)
  - Uses water budget calculator (no MODFLOW or PEST)
- Most years shows range of estimated pumping covering WMIS values.

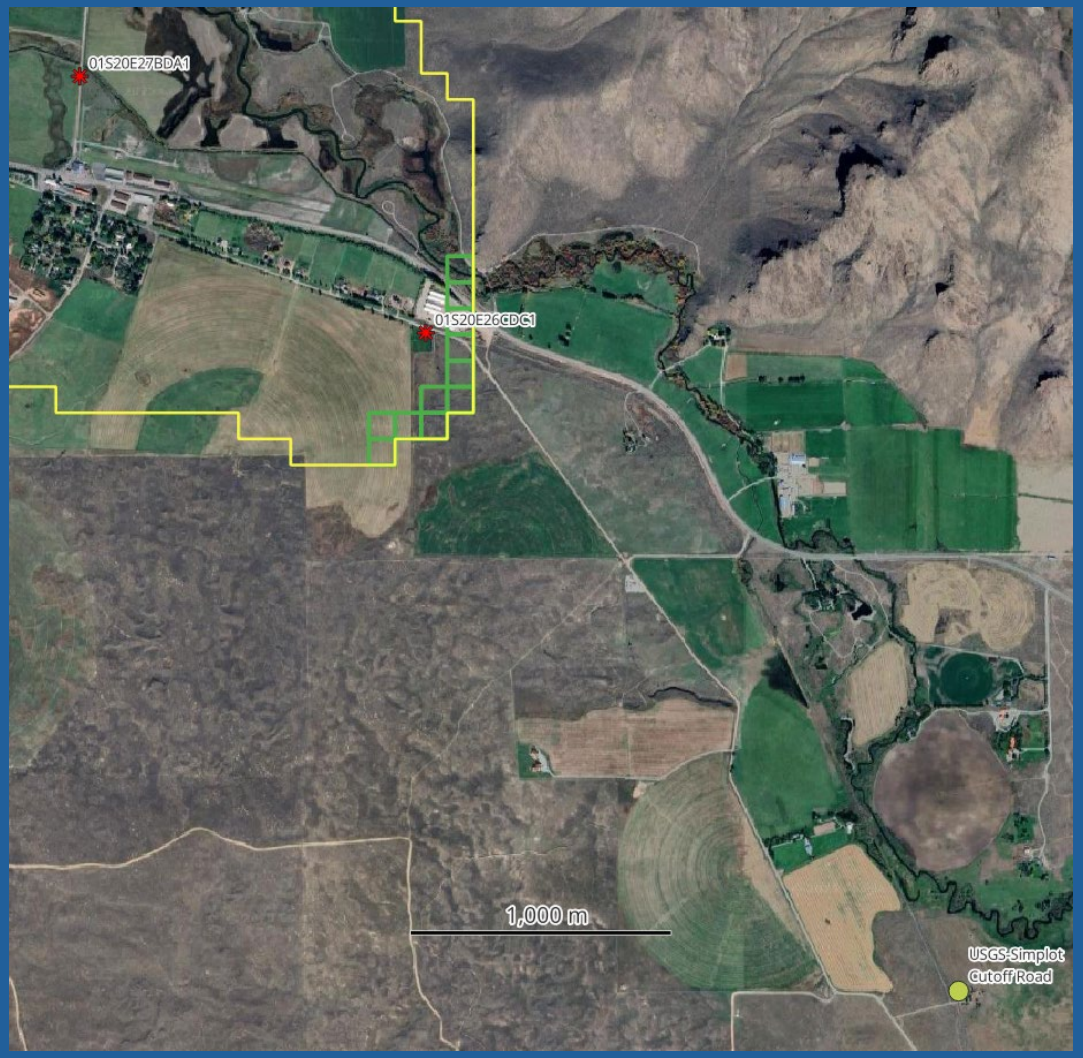


# Can the water balance calculator match WMIS?

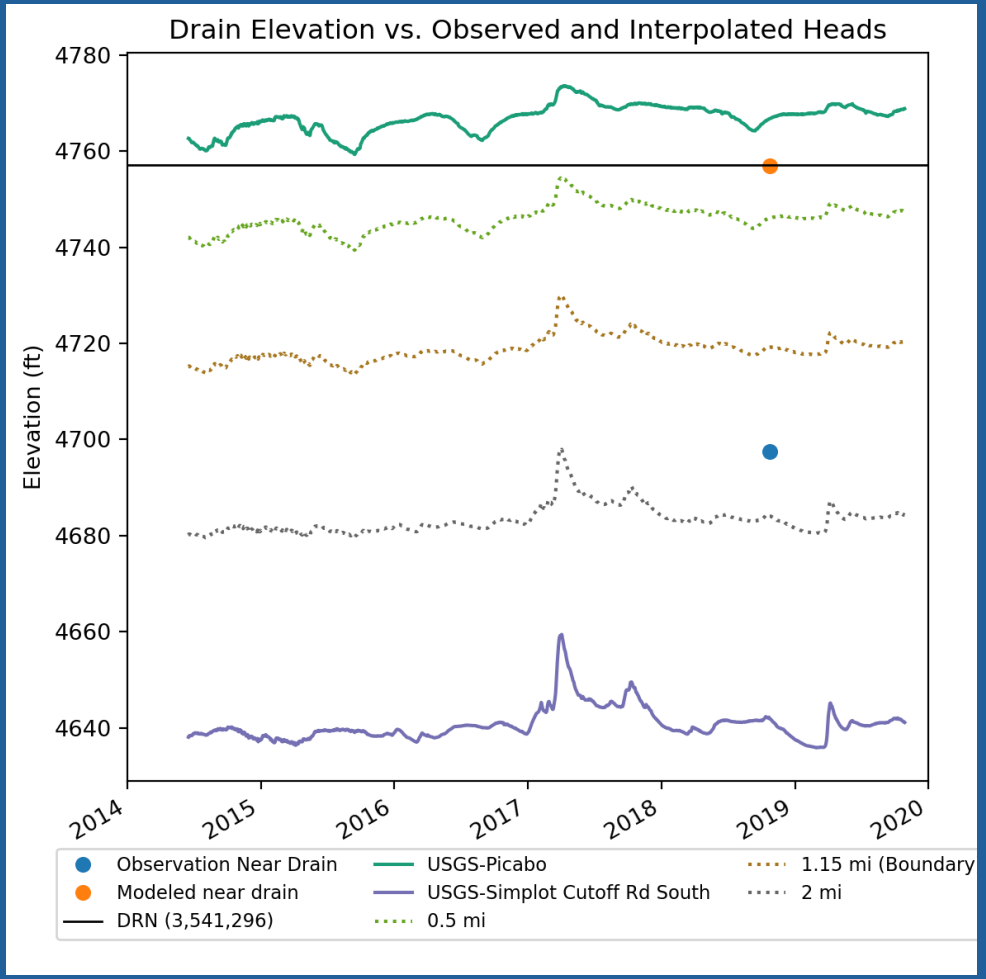
The ranges of parameter values with the best (minimum) absolute error can be wide and are not constant year to year



# Silver Creek Drain




- Average drain target = 33 cfs
- Heads near drain are high by 50-60 feet, matching drain elevation
- Linear gradient between Picabo and Simplot wells overpredicts observation near drain
- Lower drain elevation to match observation well



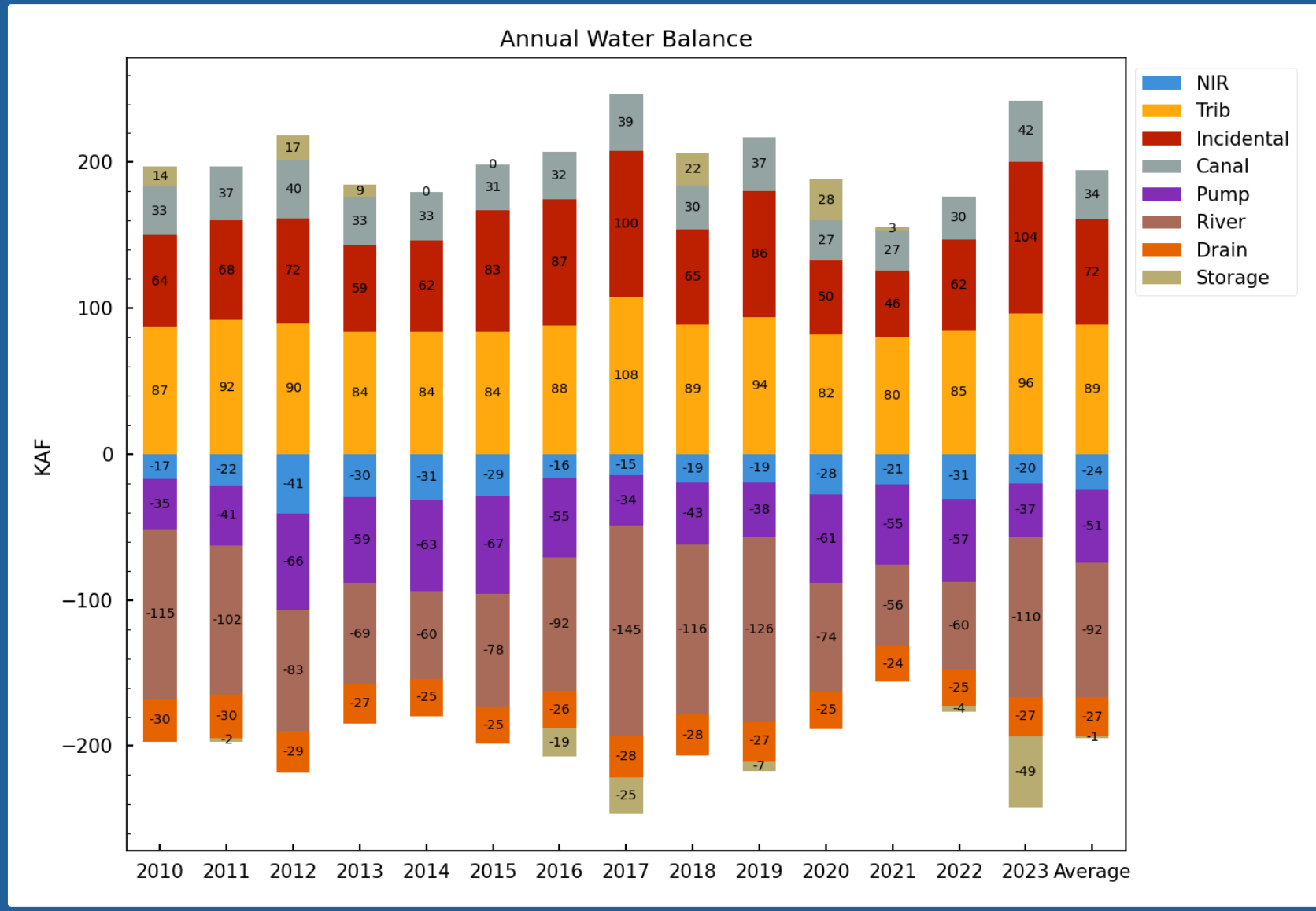
# Calibration Status

## Water Budget, Targets, and Aquifer Properties

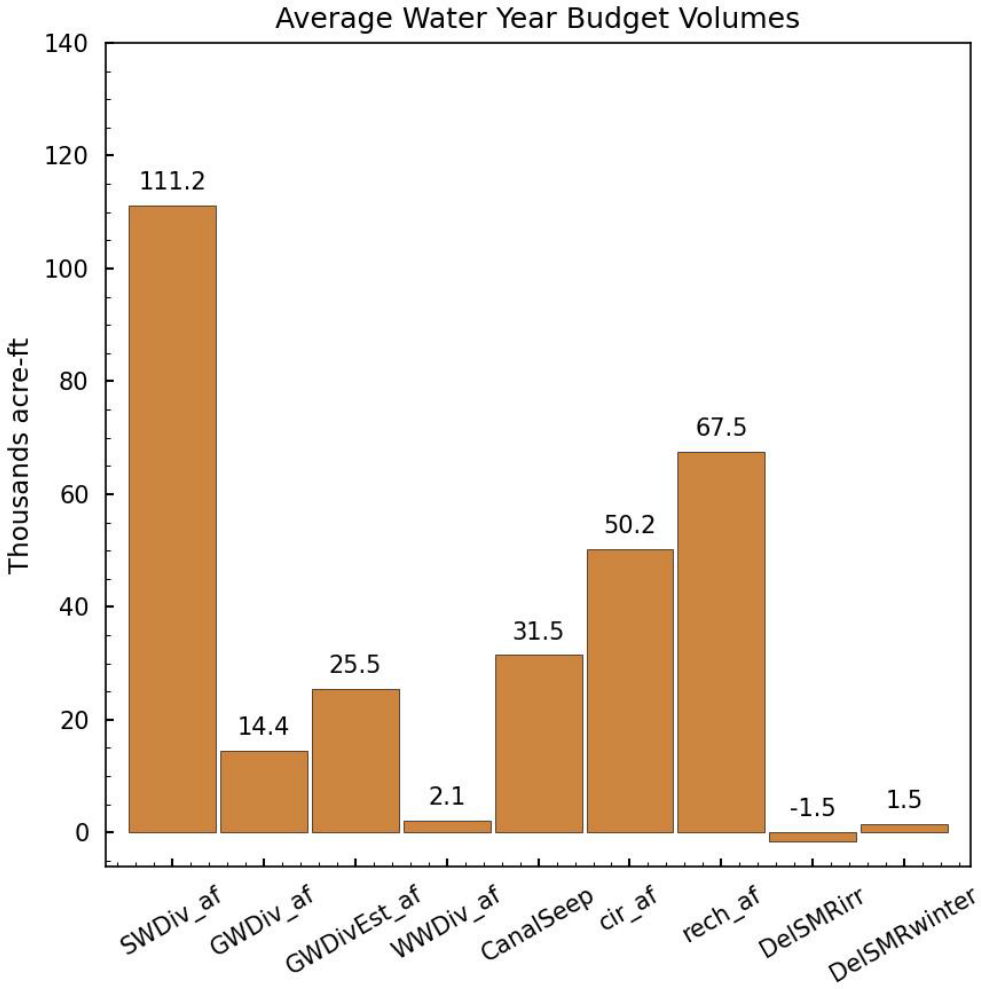
```
0
* parameter groups
dcon                relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
effgw               relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
effsw               relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
hk1pp               relative          2.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
hk2pp               relative          2.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
hk3pp               relative          2.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
rbcon               relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
s1pp                relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
s2pp                relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
s3pp                relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
seep                relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
smrmult             absolute          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
trib_alph           relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
trib_bfi            relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
trib_fac            relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
trib_red            relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
trib_shift          relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
vc                  relative          1.0000000000E-02     0.0 switch          2.0000000000E+00     parabolic          1.0000000
* parameter data
hk1003003           log               factor              1.3433201100E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1013007           log               factor              8.3781876976E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1015025           log               factor              4.4748154262E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1020[illegible]   log               factor              4.5180184471E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1026015           log               factor              7.51[illegible]043E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1036020           log               factor              1.28[illegible]206E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1046026           log               factor              4.3404[illegible]355E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1053028           log               factor              6.3534779180E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1054051           log               factor              2.7488723580E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1058[illegible]   log               factor              [illegible]     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1062030           log               factor              3.1562905915E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1062038           log               factor              1.9596953682E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1066032           log               factor              1.4325858447E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1071030           log               factor              2.7572658336E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1080030           log               factor              2.0361495360E+01     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1088063           log               factor              5.6554085997E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1092040           log               factor              4.1677694128E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1103042           log               factor              8.4880523355E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1103056           log               factor              3.4829578395E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1105022           log               factor              5.6600769431E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1106028           log               factor              3.6820916714E+02     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1107038           log               factor              4.4780037643E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
hk1108053           log               factor              1.1008601301E+03     1.0000000000E-05     3.0000000000E+05     hk1pp
```

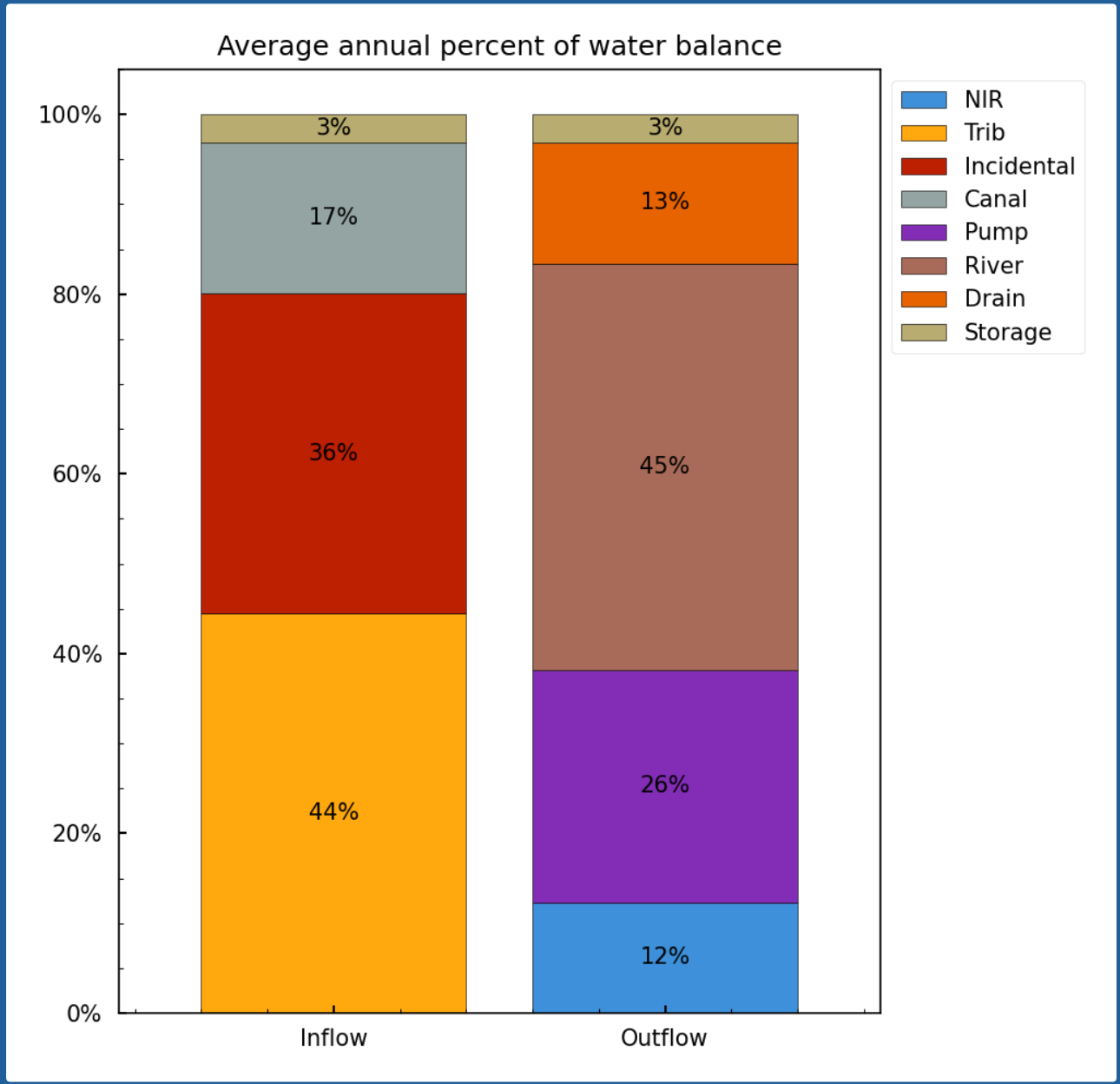
# Annual Budget

- Positive storage is release from aquifer storage to the groundwater flow model
- Negative storage is groundwater flow losing water to storage



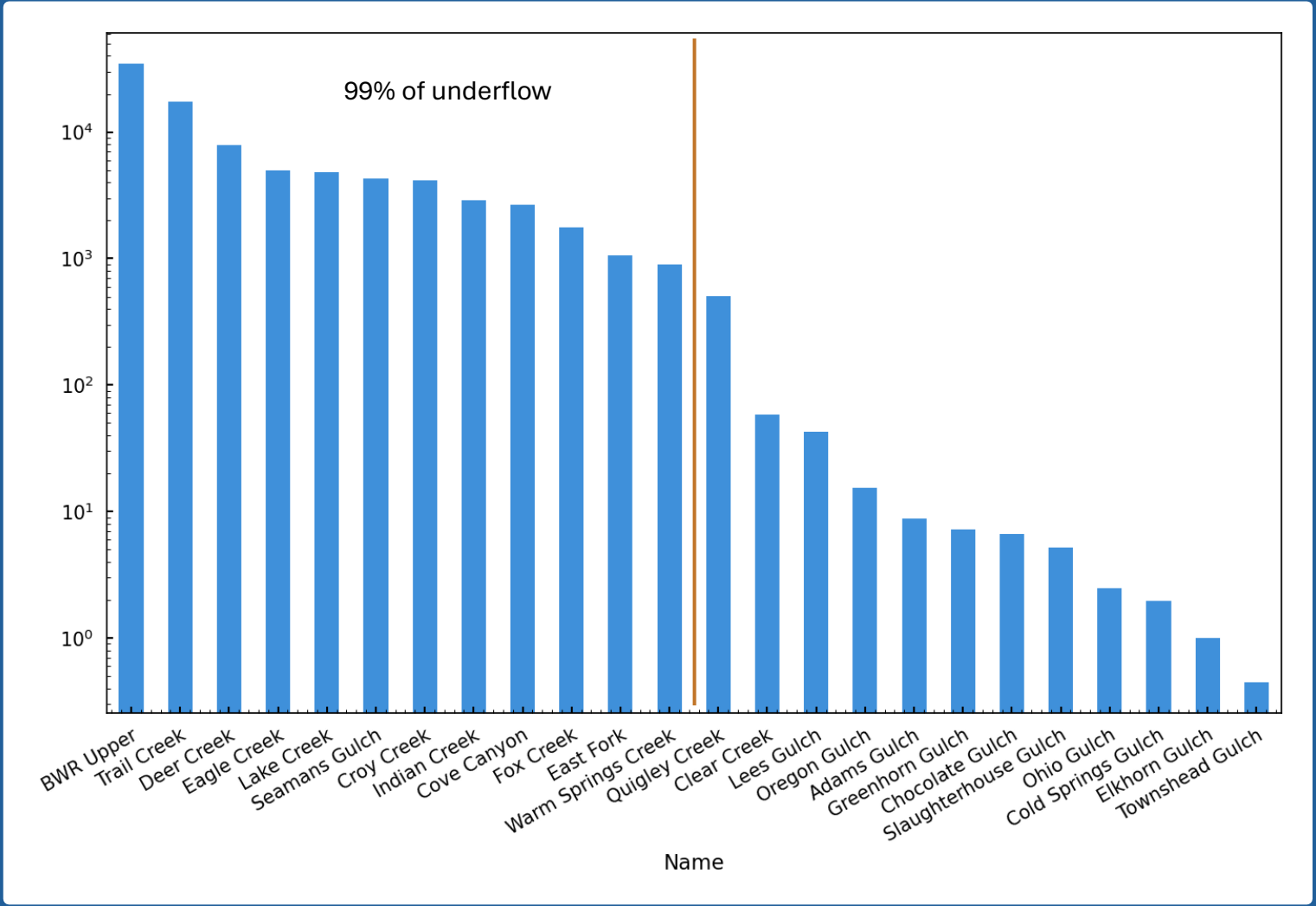
# Annual Budget



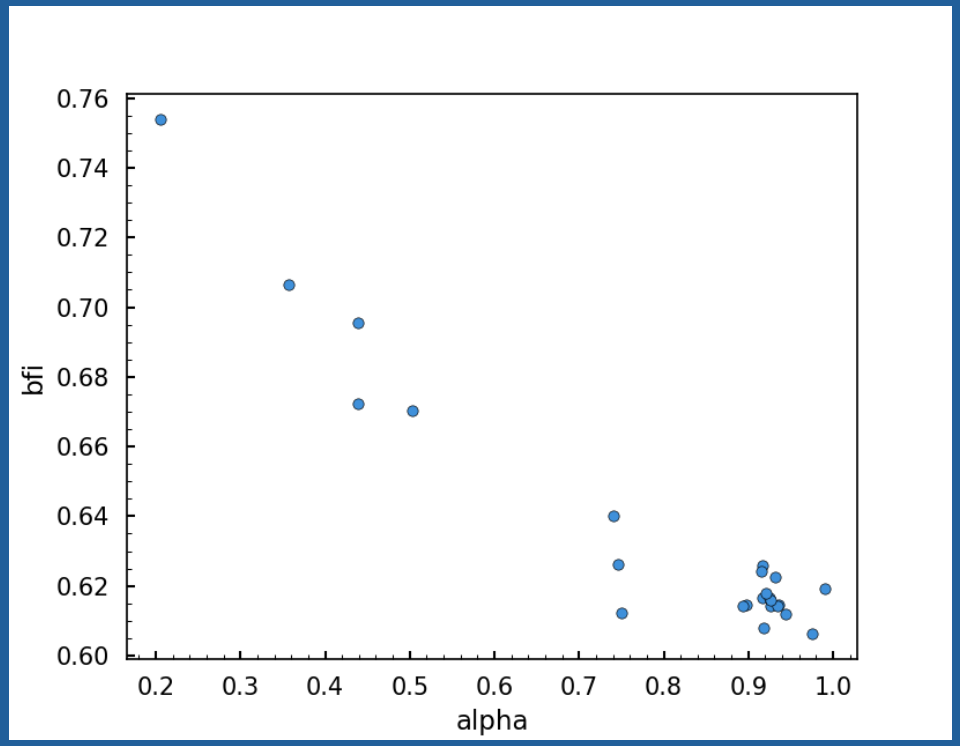
# Tributary Underflow Volumes

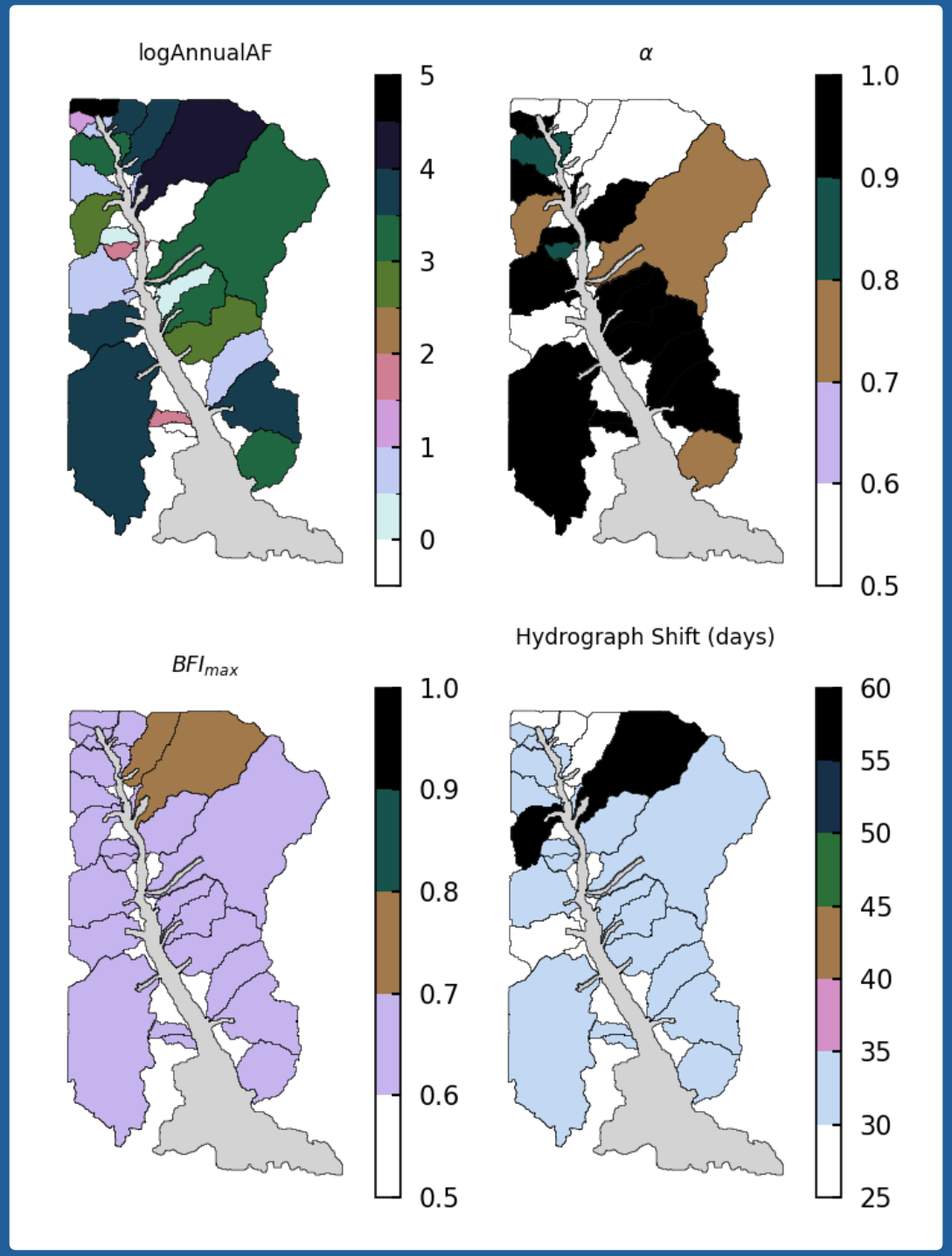
- Upper Big Wood and Trail Creek provide 59% of underflow
- Quigley Creek probably too low (largest under-estimated head targets)



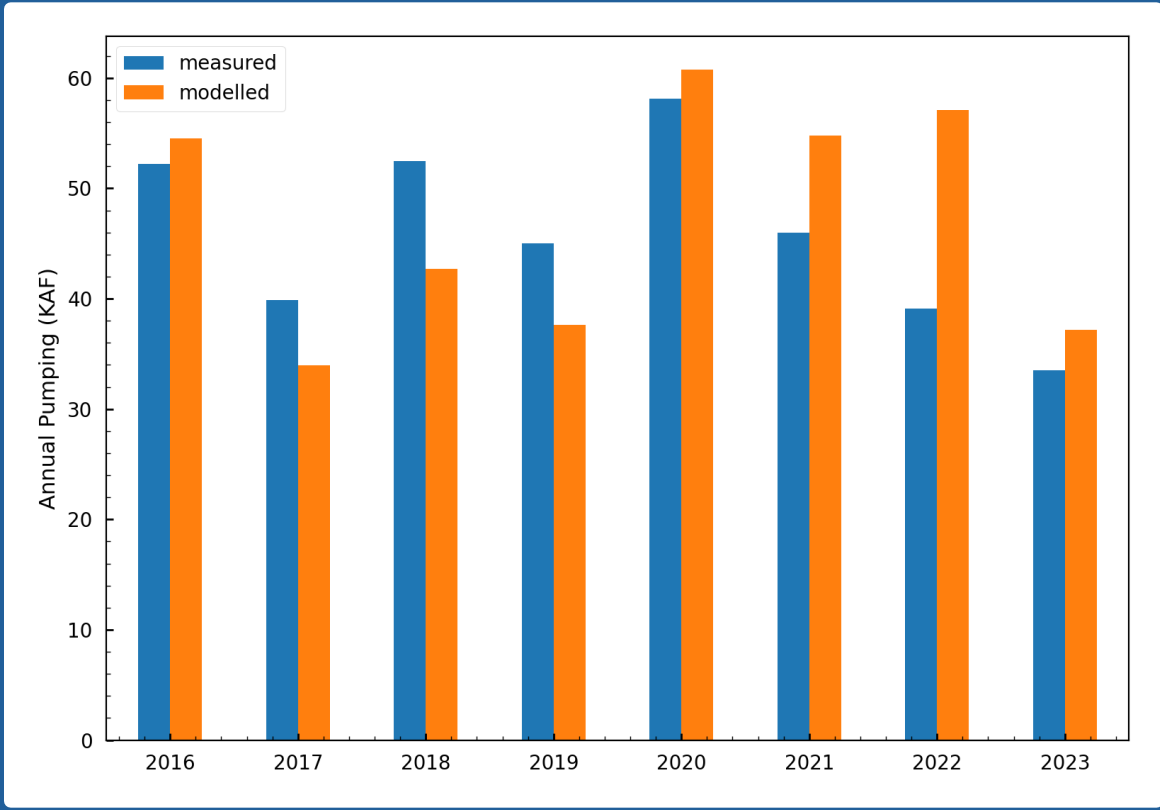
# Tributary Parameters

- Alpha (recession parameter) and Baseflow Index Inversely correlated
- All tribs have a shift of at least a month (lagged groundwater response)

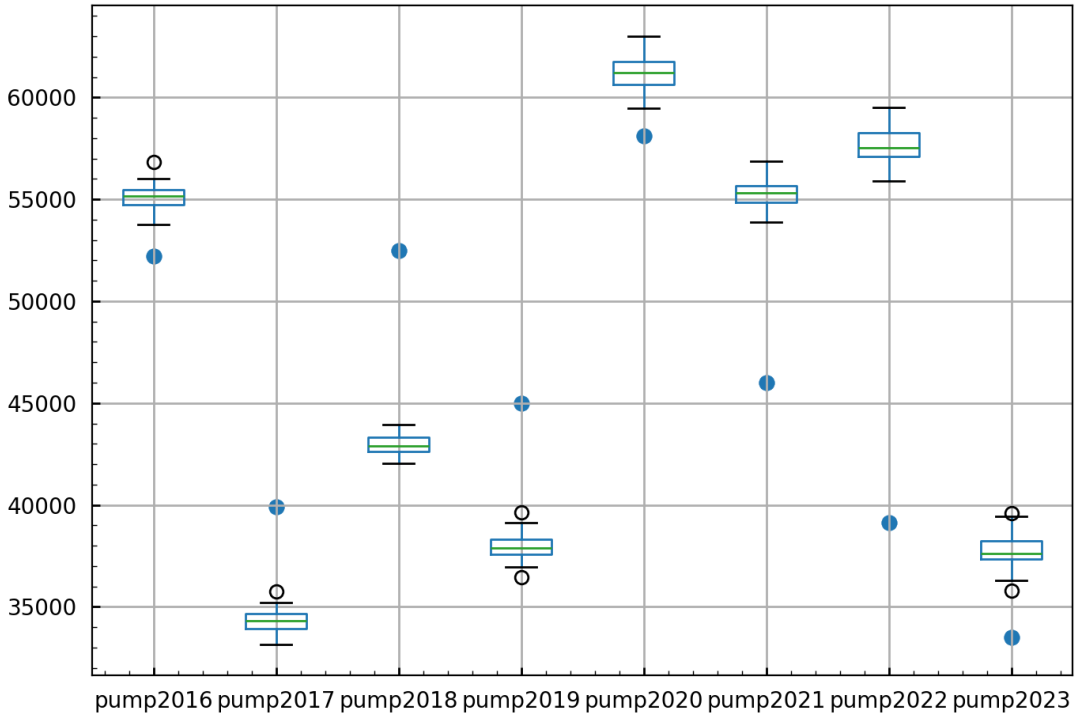


# Estimated pumping

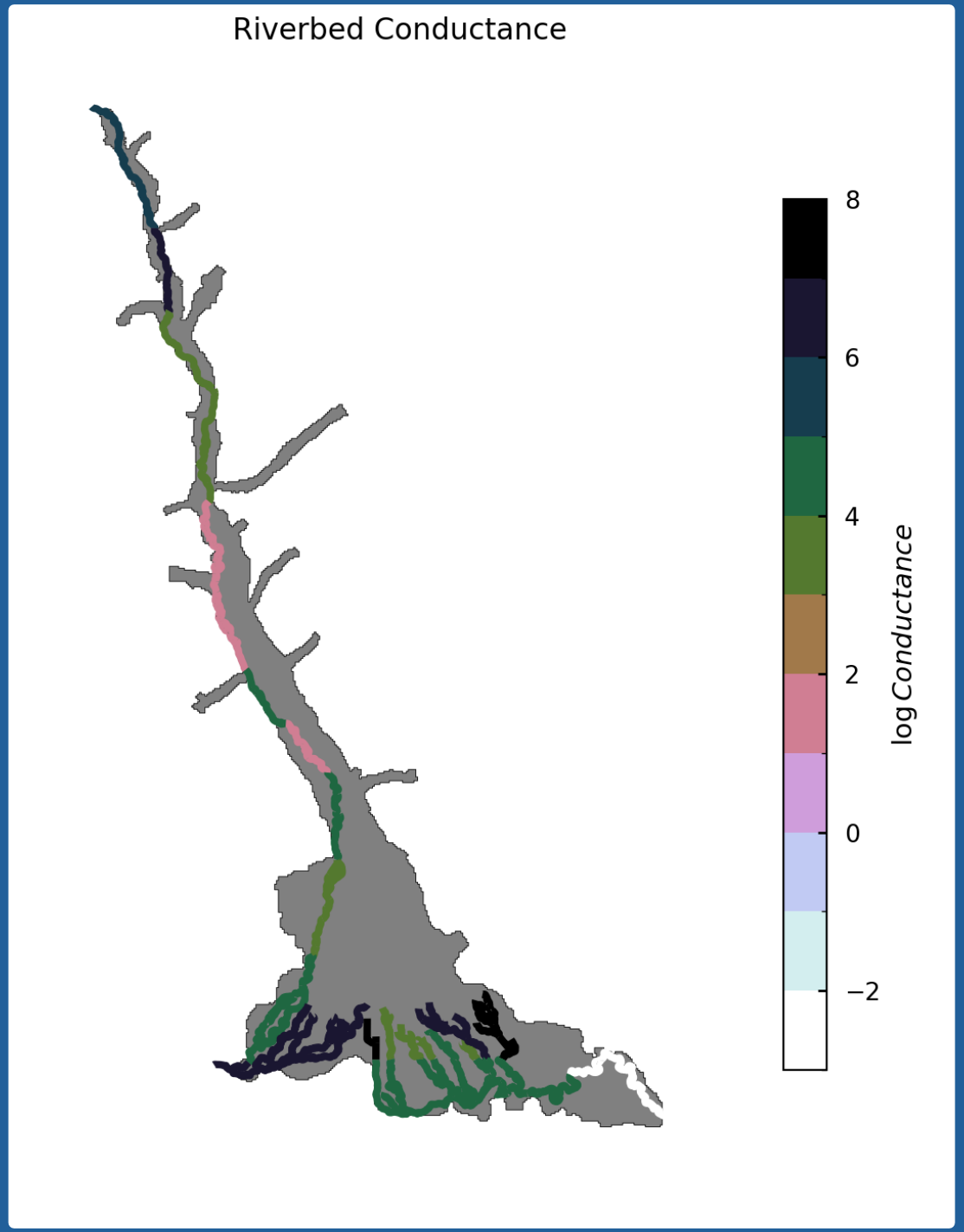



Current calibration pumping volumes don’t align with record WMIS



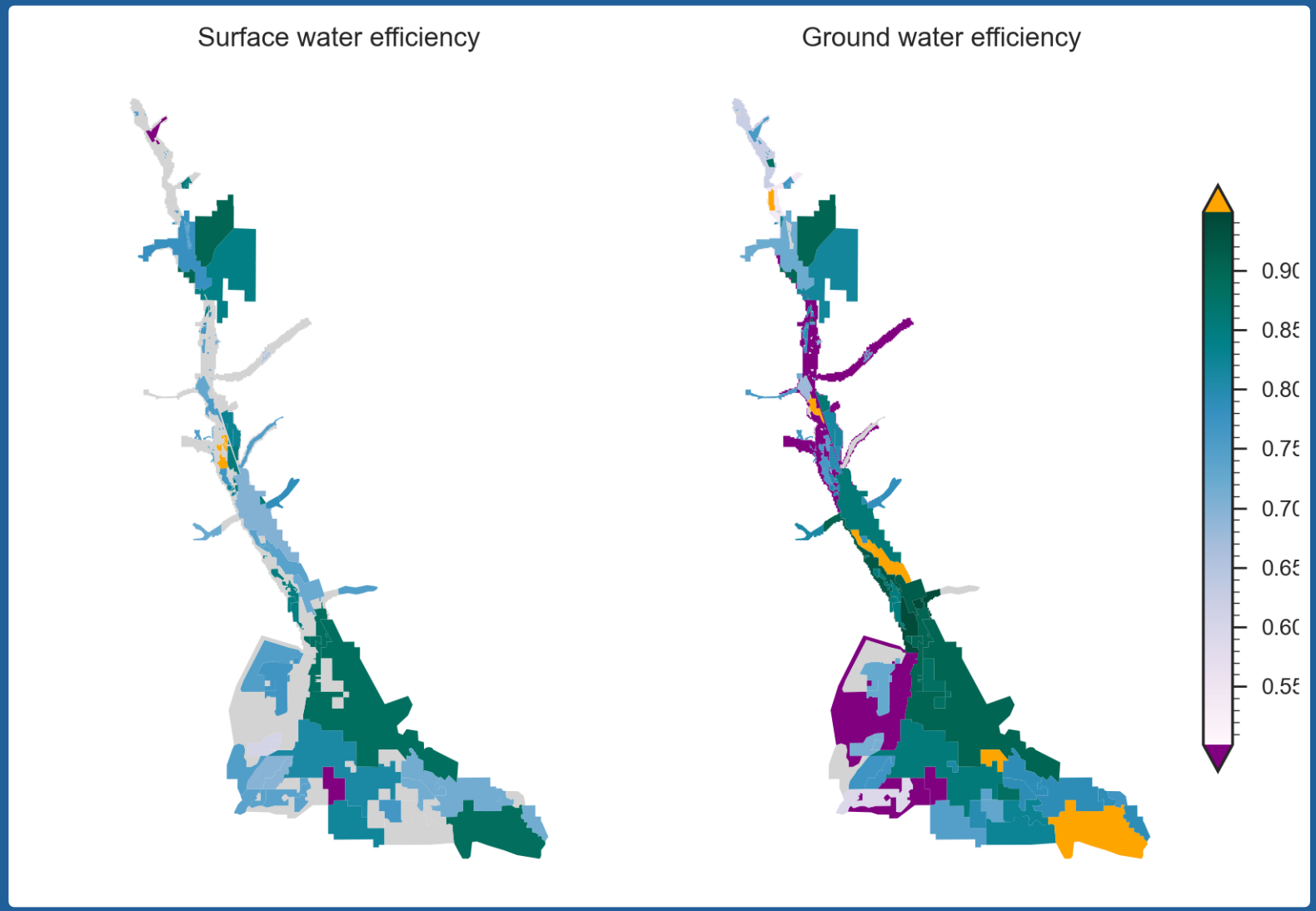

Ranges of pumping from 50 random parameter realizations during calibration

# Riverbed Conductance

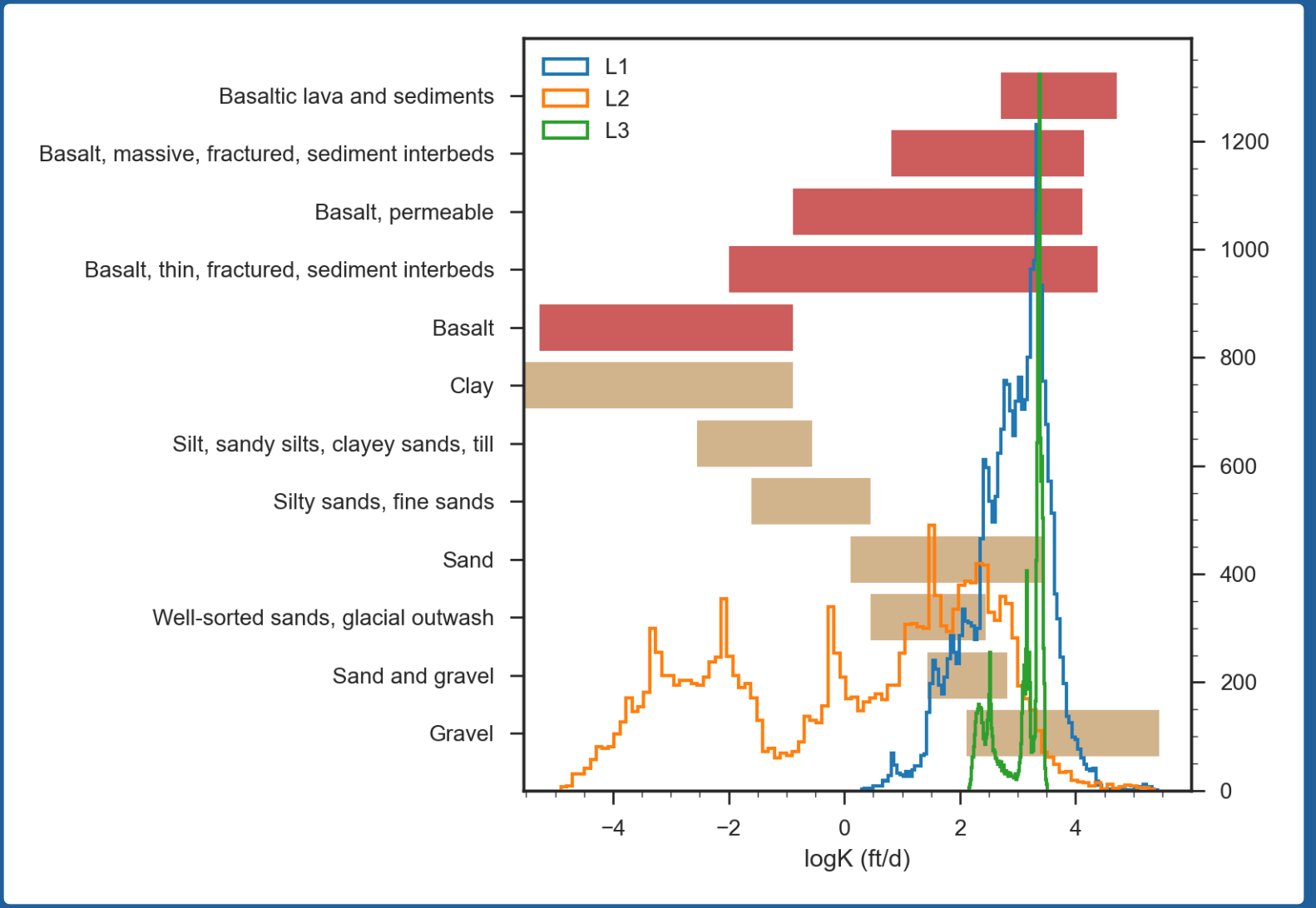


# Irrigation Efficiency

- More groundwater efficiencies pegged at upper bound than surface water efficiencies.

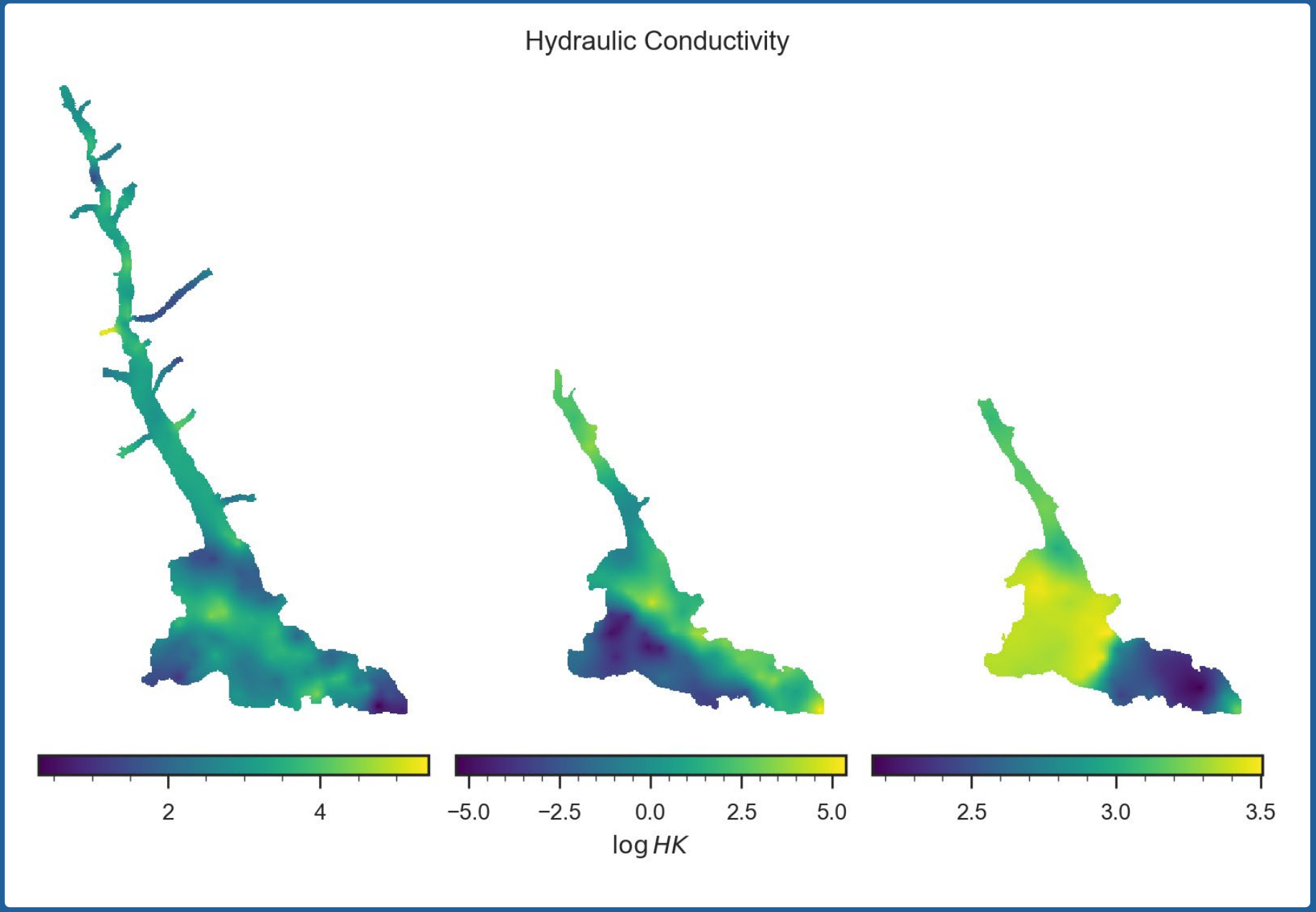


# HK distribution



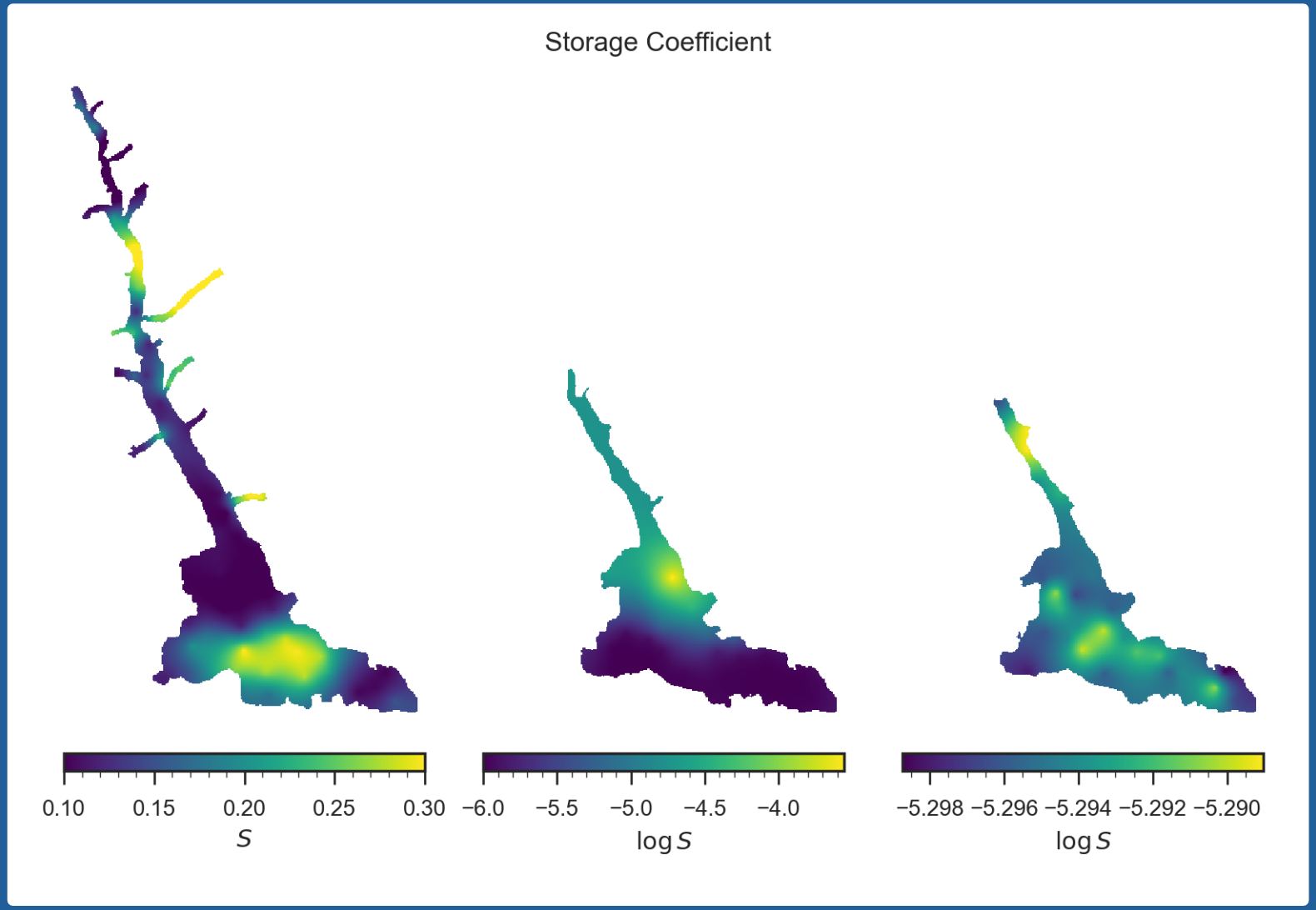
# HK

- Basalt and confining layer still defined despite no zonation
- Greenhorn Gulch has highest conductivity.
  - Parameter near upper bound

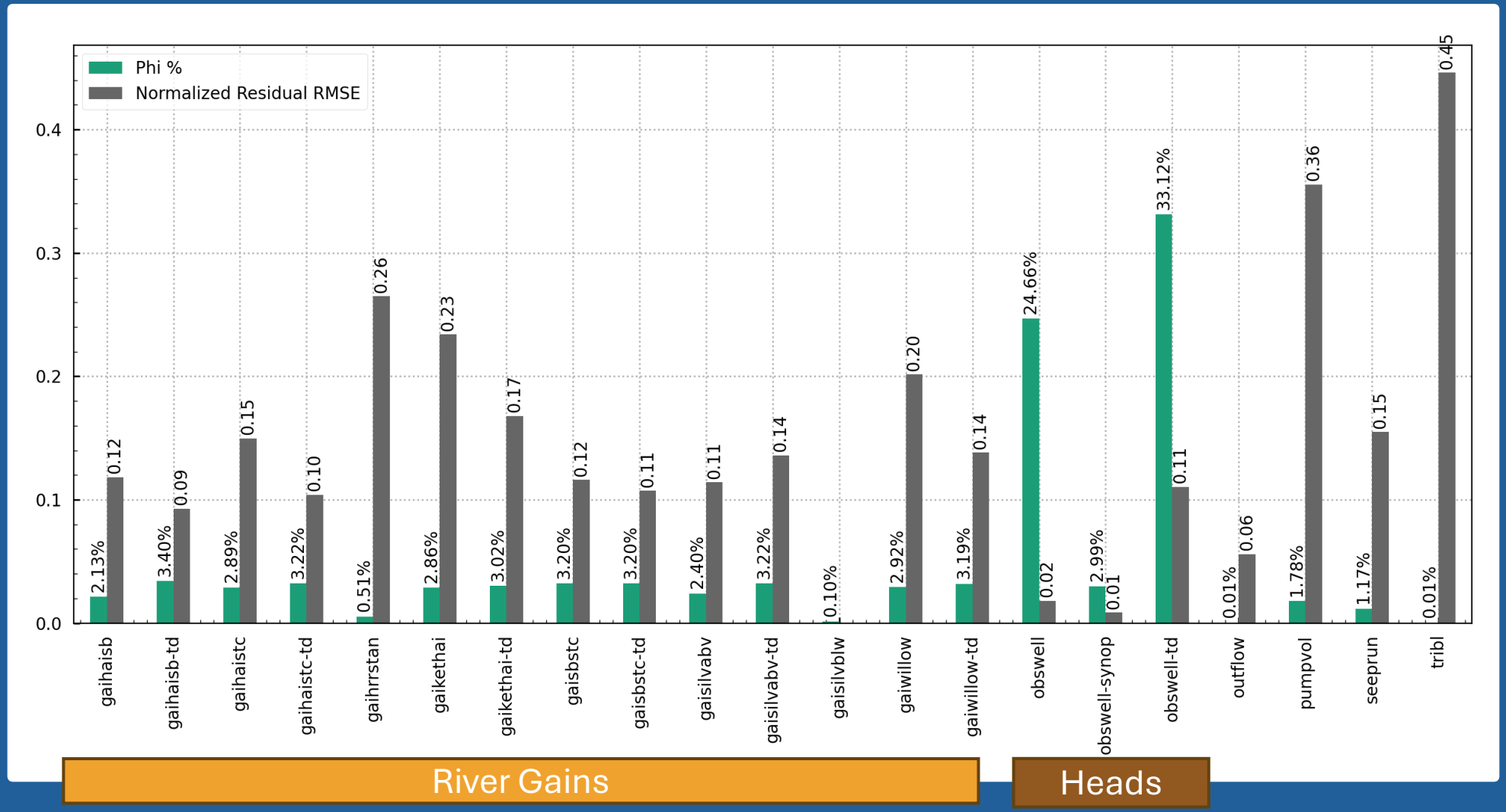


# Storage

- Layer 1: 0.14
- Layer 2:  0.000002
- Layer 3: 0.000005



# Objective Function Summary



# Parameter Summary

Adjustable Parameters: 908

Weighted Observations: 8,658

Phi: 9,569

| Parameter | Transform | Count | Min Value | Max Value | Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| hk1pp | log | 223 | 1.69 | 272,861 | 1.00E-05 | 300,000 |
| hk2pp | log | 134 | 1.05E-05 | 289,506 | 1.00E-05 | 300,000 |
| hk3pp | log | 119 | 140 | 3,281 | 1.00E-05 | 300,000 |
| Vertical Conductivity Ratio | log | 1 | 0.02 | - | 0.001 | 0.3 |
| s1pp | log | 78 | 0.05 | 0.35 | 0.05 | 0.35 |
| s2pp | log | 40 | 9.81E-07 | 5.0E-04 | 1.00E-07 | 0.001 |
| s3pp | log | 36 | 5.01E-06 | 5.15E-06 | 1.00E-07 | 0.001 |
| River Conductance | log | 25 | 1.94E-03 | 1.73E+07 | 1.10E-10 | 1.10E+10 |
| Drain Conductance | log | 4 | 1.39E-03 | 1.20E+07 | 1.10E-10 | 1.10E+10 |
| Canal Seepage | fixed | 19 | 0.1 | 0.6 | 0.05 to 0.4 | 0.3 to 0.7 |
| Irrigation Efficiency GW | log | 74 | 0.5 | 0.99 | 0.5 | 0.95 to 0.99 |
| Irrigation Efficiency SW | log | 53 | 0.5 | 0.95 | 0.5 | 0.95 |
| Soil Moisture Factor | none | 1 | 0.58 | | 0 | 1 |
| Tributary Alpha | log | 24 | 0.21 | 0.99 | 0.1 | 0.99 |
| Tributary Baseflow Index Max | log | 24 | 0.61 | 0.75 | 0.1 | 0.99 |
| Tribtuary Annual Volume Factor | log | 24 | 0.79 | 2 | 0.1 | 2 |
| Tributary Hailey Gage Reduction | log | 24 | 3.5 | 10 | 1 | 10 |
| Tributary Hailey Gage Shift | log | 24 | 11 | 46.6 | 1 | 76 |

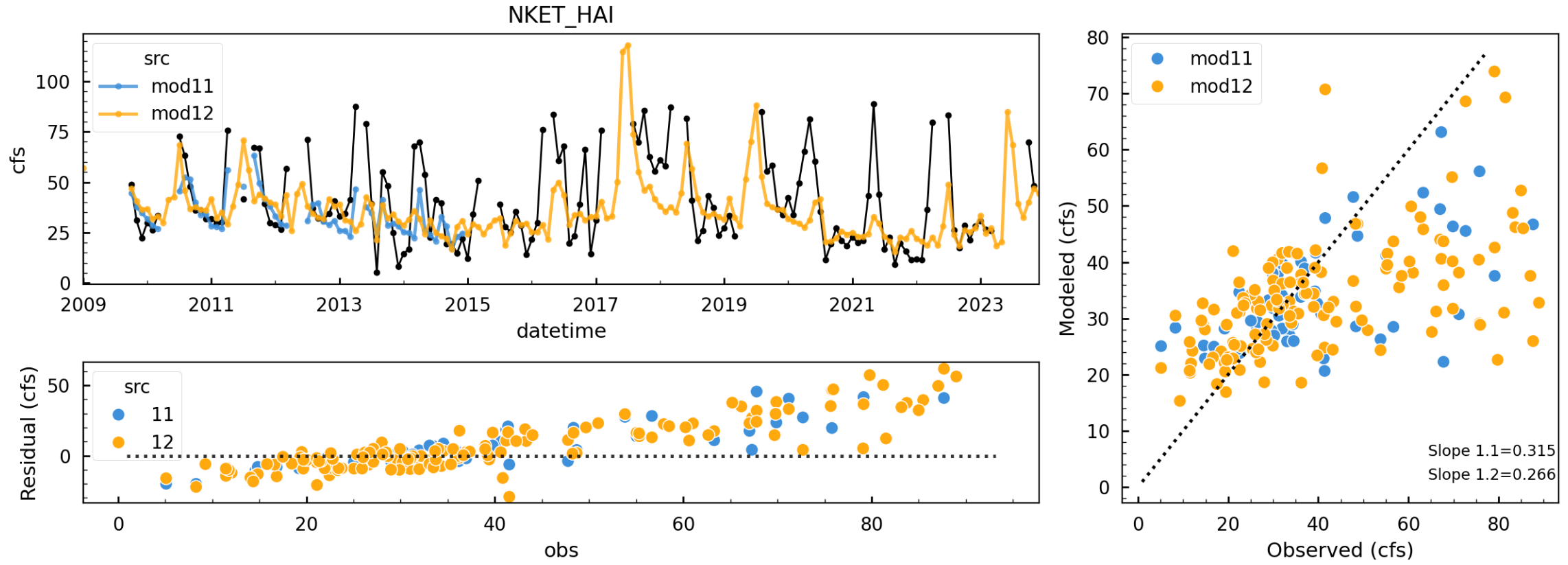
# Parameters Near Bounds

Parameters within 5% of bounds

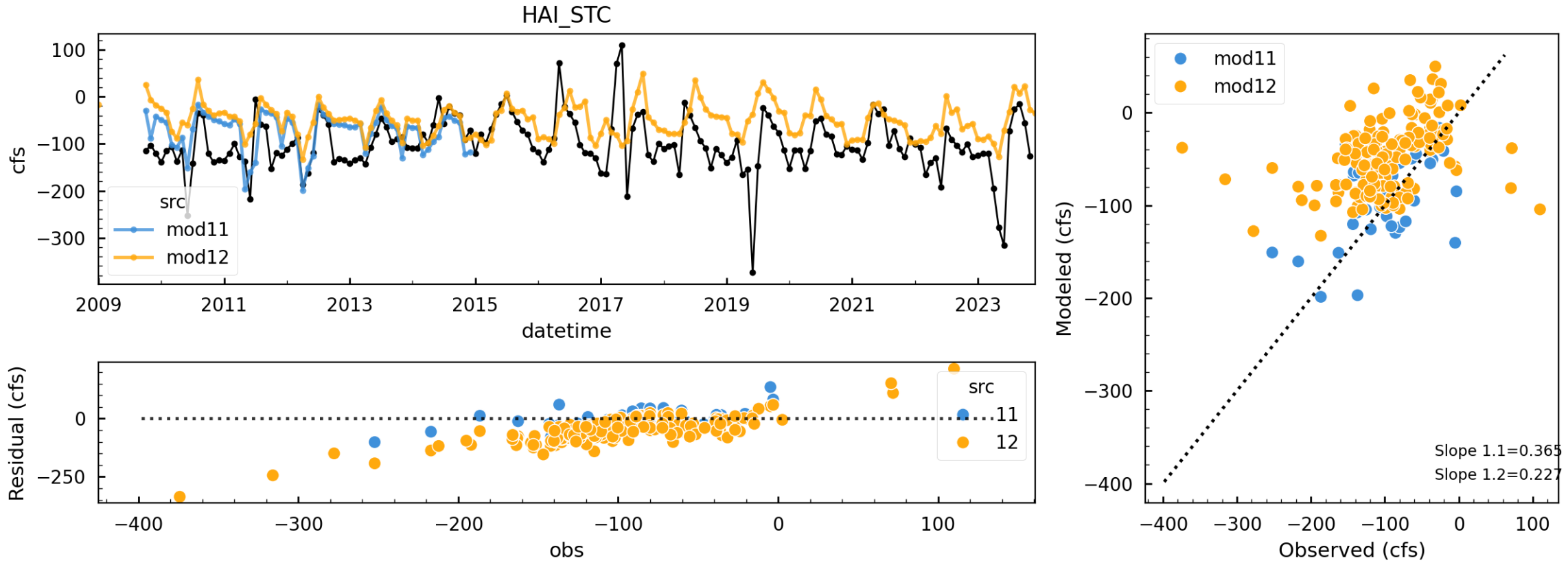
| High/Low | Parameter | Value | Bound |
|---|---|---|---|
| high | hk2537296 | 289,506 | 300,000 |
| | s1142055 | 0.35 | 0.35 |
| | s1164124 | 0.35 | 0.35 |
| | s1186096 | 0.35 | 0.35 |
| | s1303077 | 0.34 | 0.35 |
| | s1354154 | 0.33 | 0.35 |
| | s1487149 | 0.34 | 0.35 |
| | effpurdumsw | 0.95 | 0.95 |
| | effbellevugw | 0.92 | 0.95 |
| | effcovegw | 0.95 | 0.95 |
| | effdistricgw | 0.90 | 0.95 |
| | effgwcroygw | 0.91 | 0.95 |
| | effgwgannegw | 0.95 | 0.95 |
| | effgwhasbrgw | 0.92 | 0.95 |
| | effgwsbrglgw | 0.94 | 0.95 |
| | effhulenmdgw | 0.99 | 0.99 |
| | effkilidengw | 0.95 | 0.95 |
| | effsocomfgw | 0.93 | 0.95 |
| | effstarwxrgw | 0.95 | 0.95 |
| | cry_f | 2 | 2 |
| | estf_r | 10 | 10 |
| | lak_r | 10 | 10 |
| | trl_r | 10 | 10 |
| | ins_a | 0.99 | 0.99 |
| | qgc_a | 0.98 | 0.99 |
| | sea_a | 0.94 | 0.99 |

| High/Low | Parameter | Value | Bound |
|---|---|---|---|
| low | hk2471117 | 1.05E-05 | 1.00E-05 |
| | s1055049 | 0.05 | 0.05 |
| | s1064028 | 0.05 | 0.05 |
| | effbuhler1sw | 0.5 | 0.5 |
| | effeaglecrsw | 0.5 | 0.5 |
| | effbuhler1gw | 0.5 | 0.5 |
| | effgweforkgw | 0.5 | 0.5 |
| | effgwgimhagw | 0.5 | 0.5 |
| | effgwglwrrgw | 0.5 | 0.5 |
| | effgwkegimgw | 0.5 | 0.5 |
| | effgwwillogw | 0.5 | 0.5 |

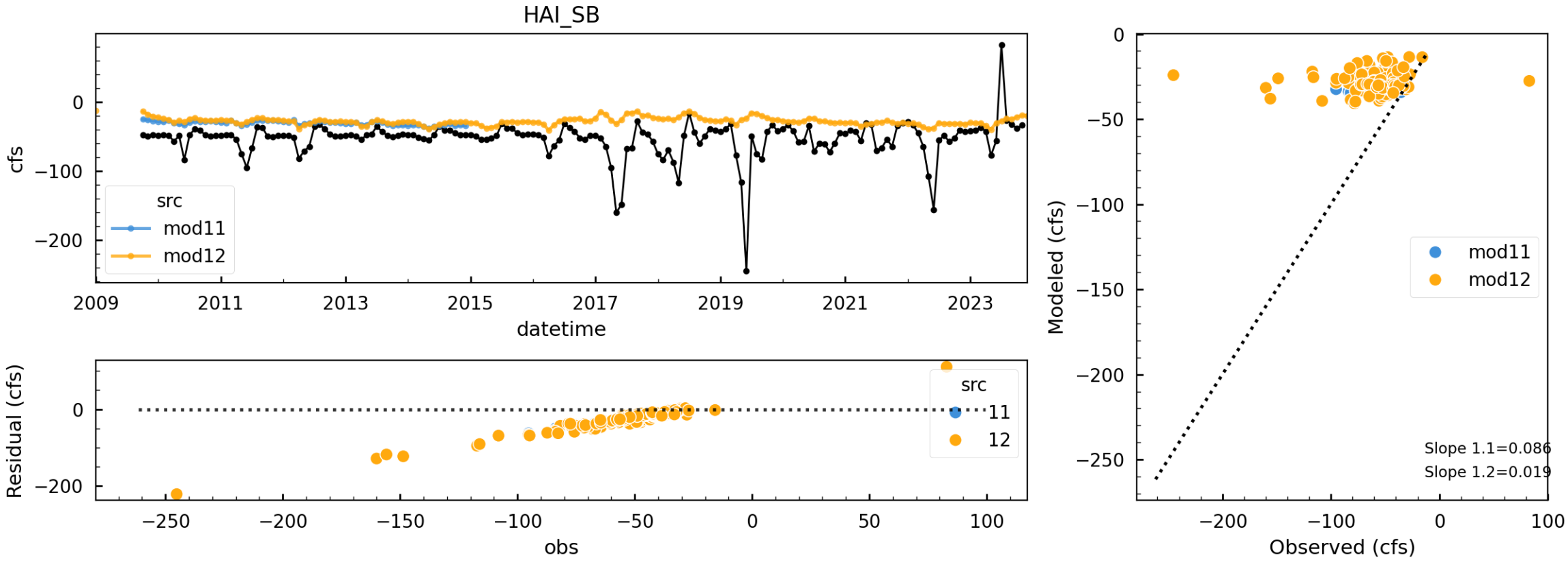
# Reach Gain Target: Near Ketchum to Hailey



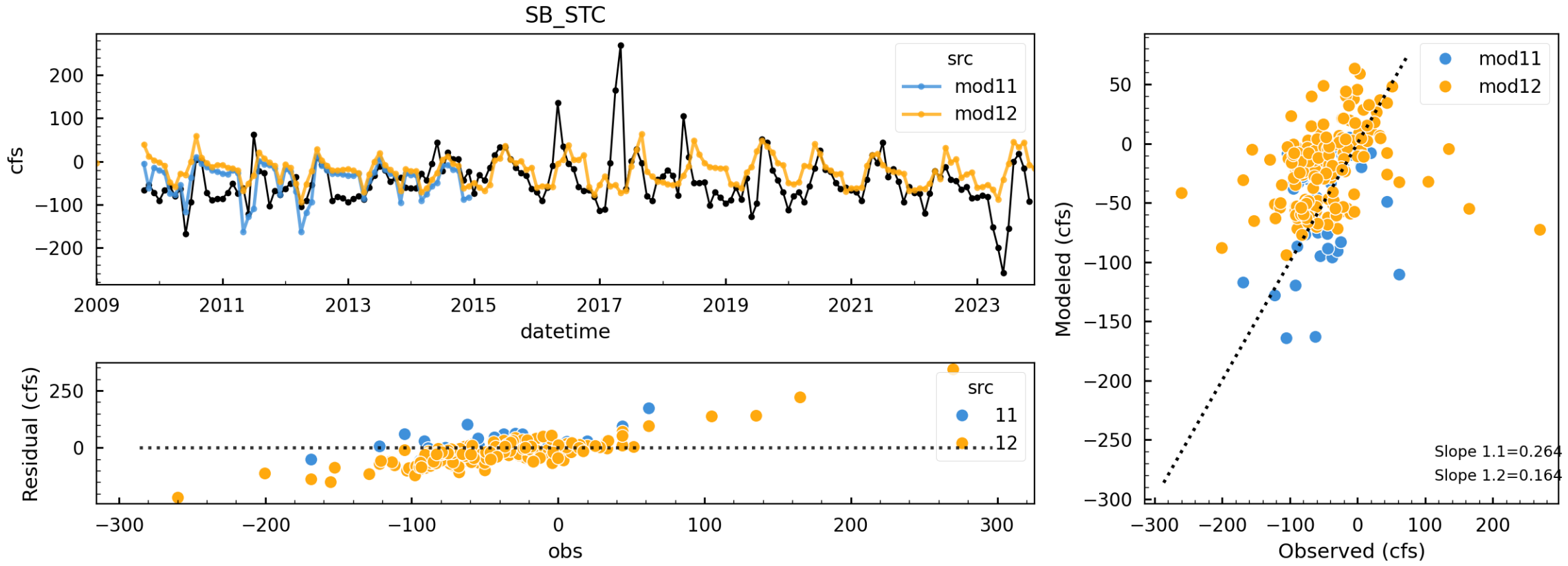
# *Reach Gain Target: Hailey to Stanton Crossing*



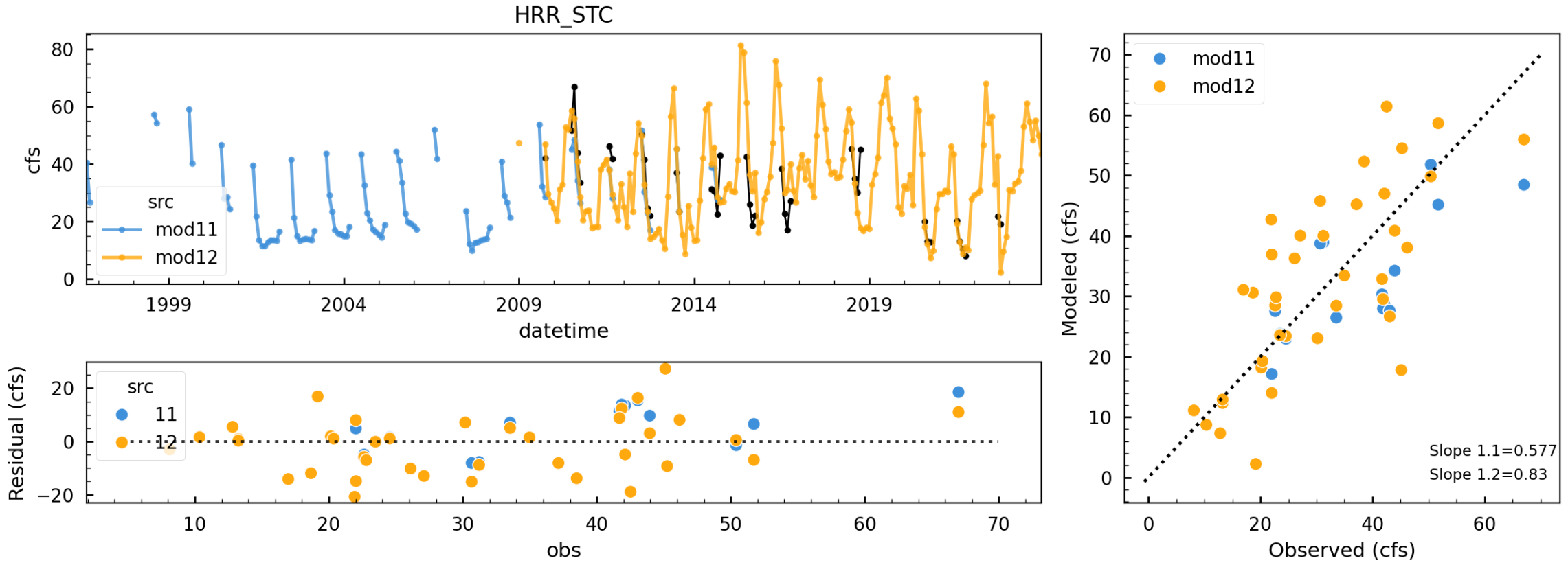
# *Reach Gain Target: Hailey to South Broadford*



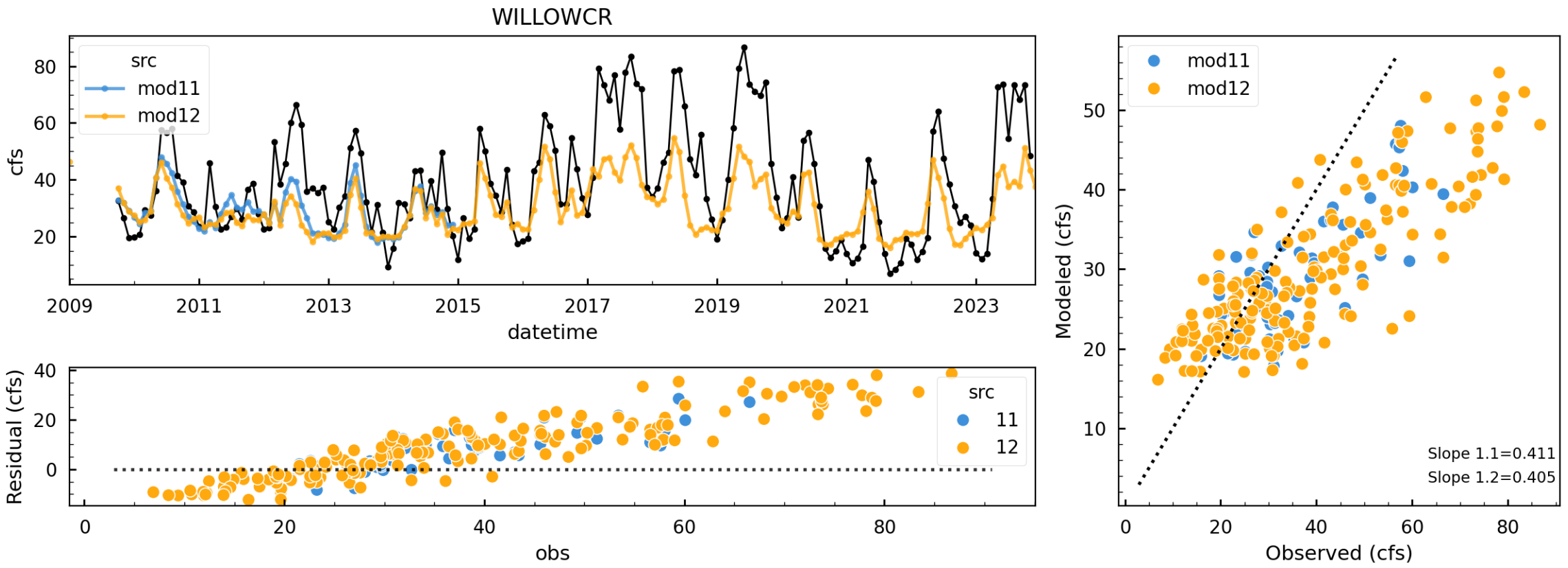
# *Reach Gain Target: South Broadford to Stanton*



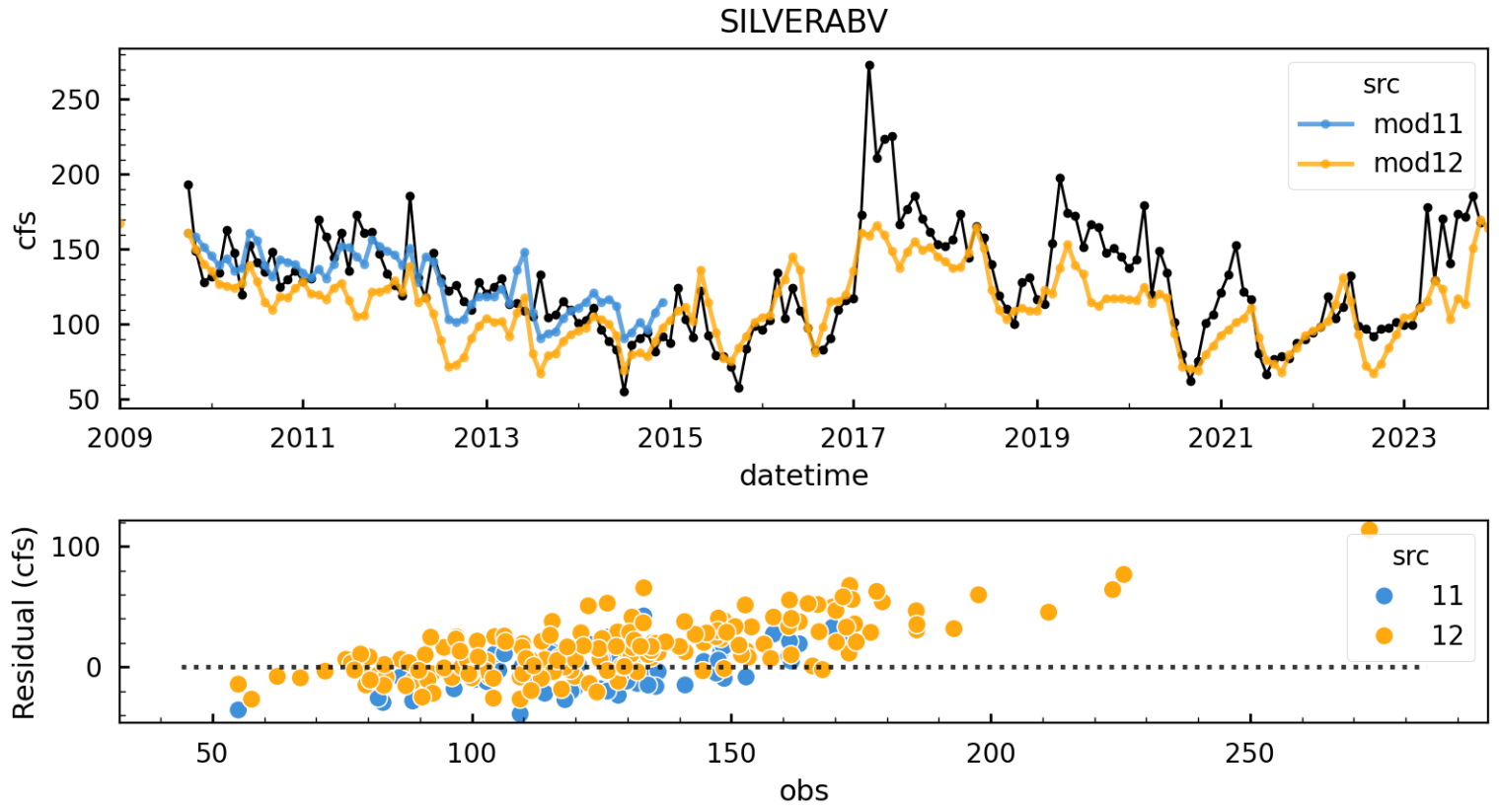
# *Reach Gain Target: Heart Rock Ranch to Stanton*

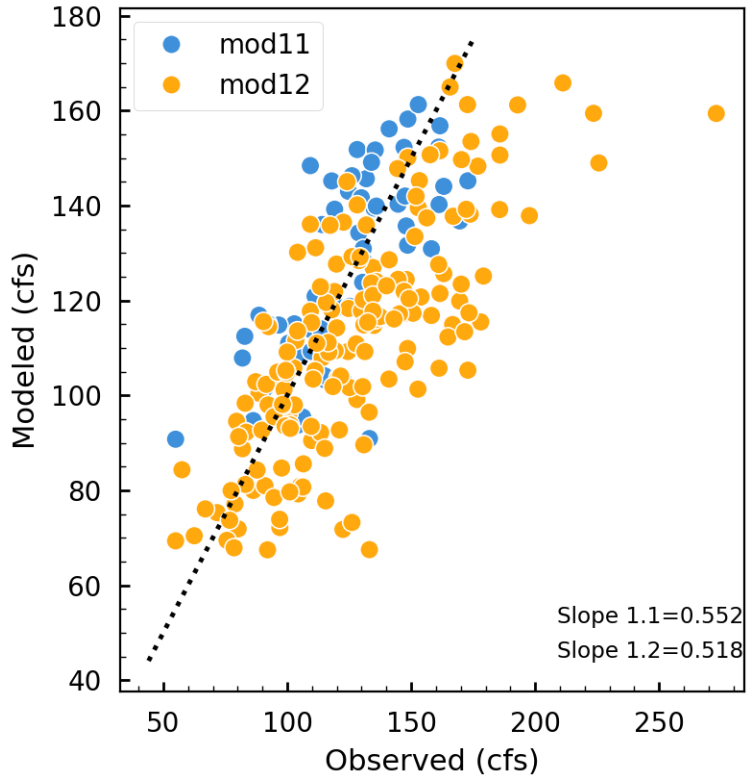


# Reach Gain Target: Willow Creek



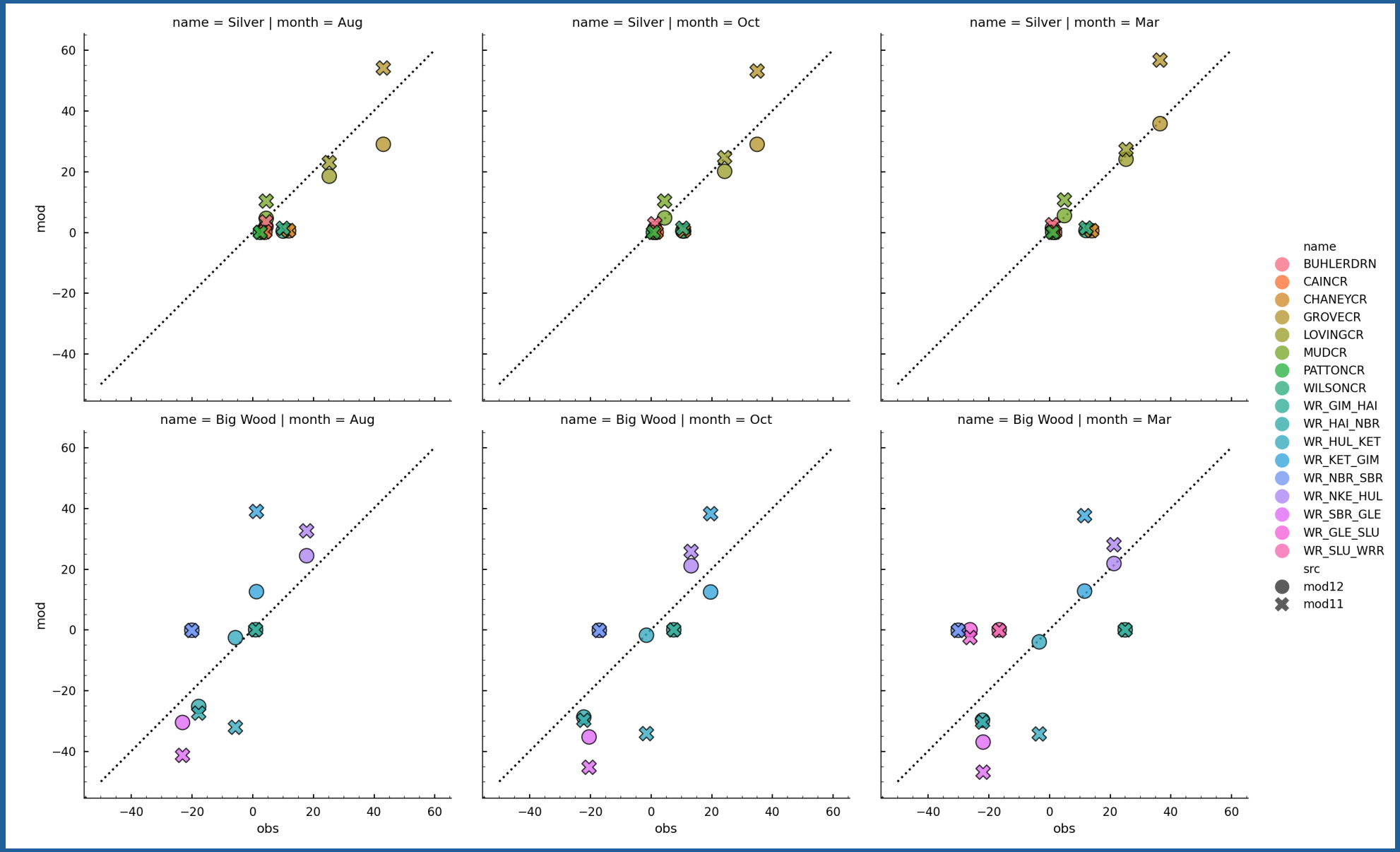
# *Reach Gain Target: Silver Creek*



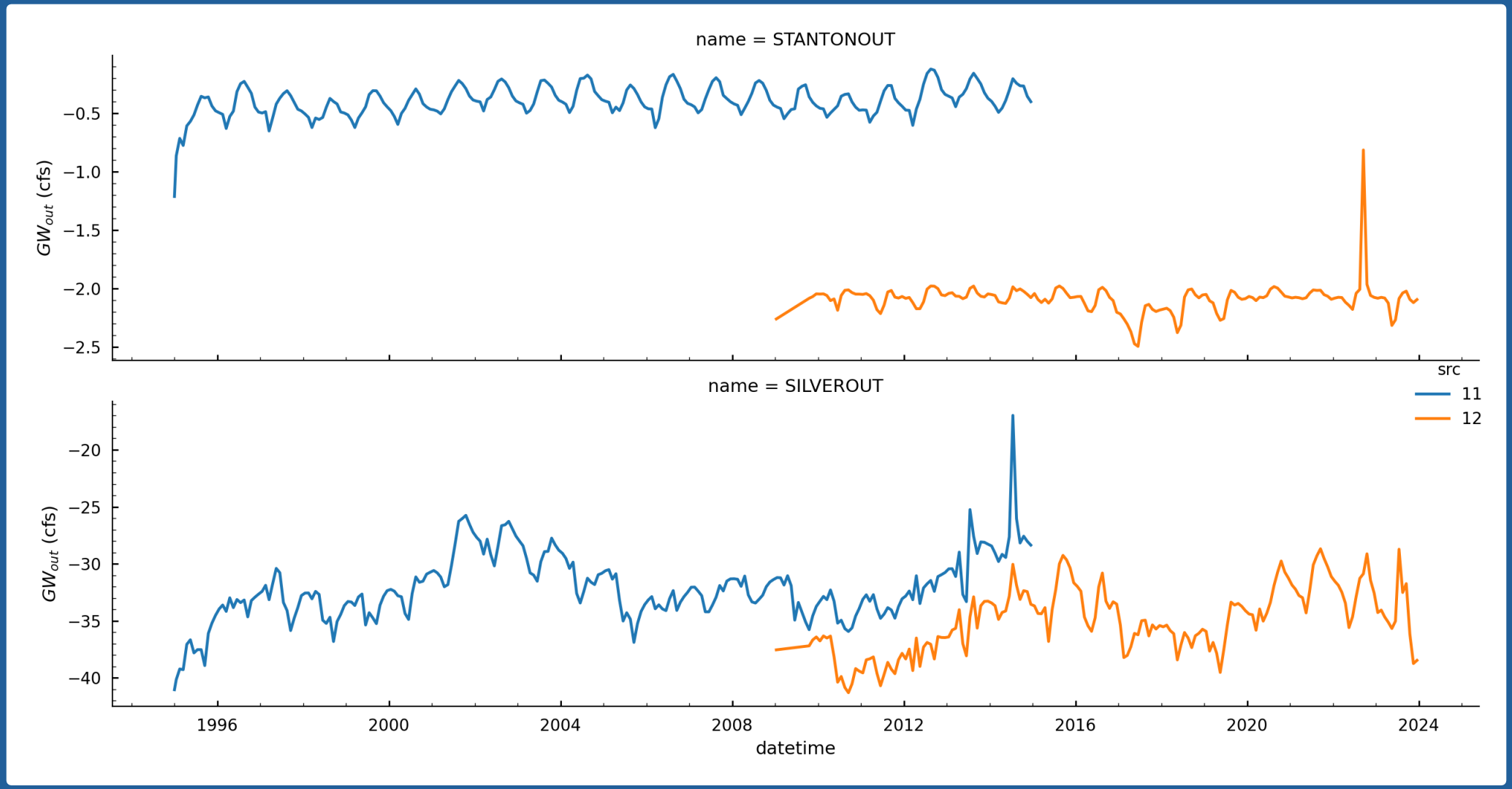



# Reach Gain Target: Seepage Runs

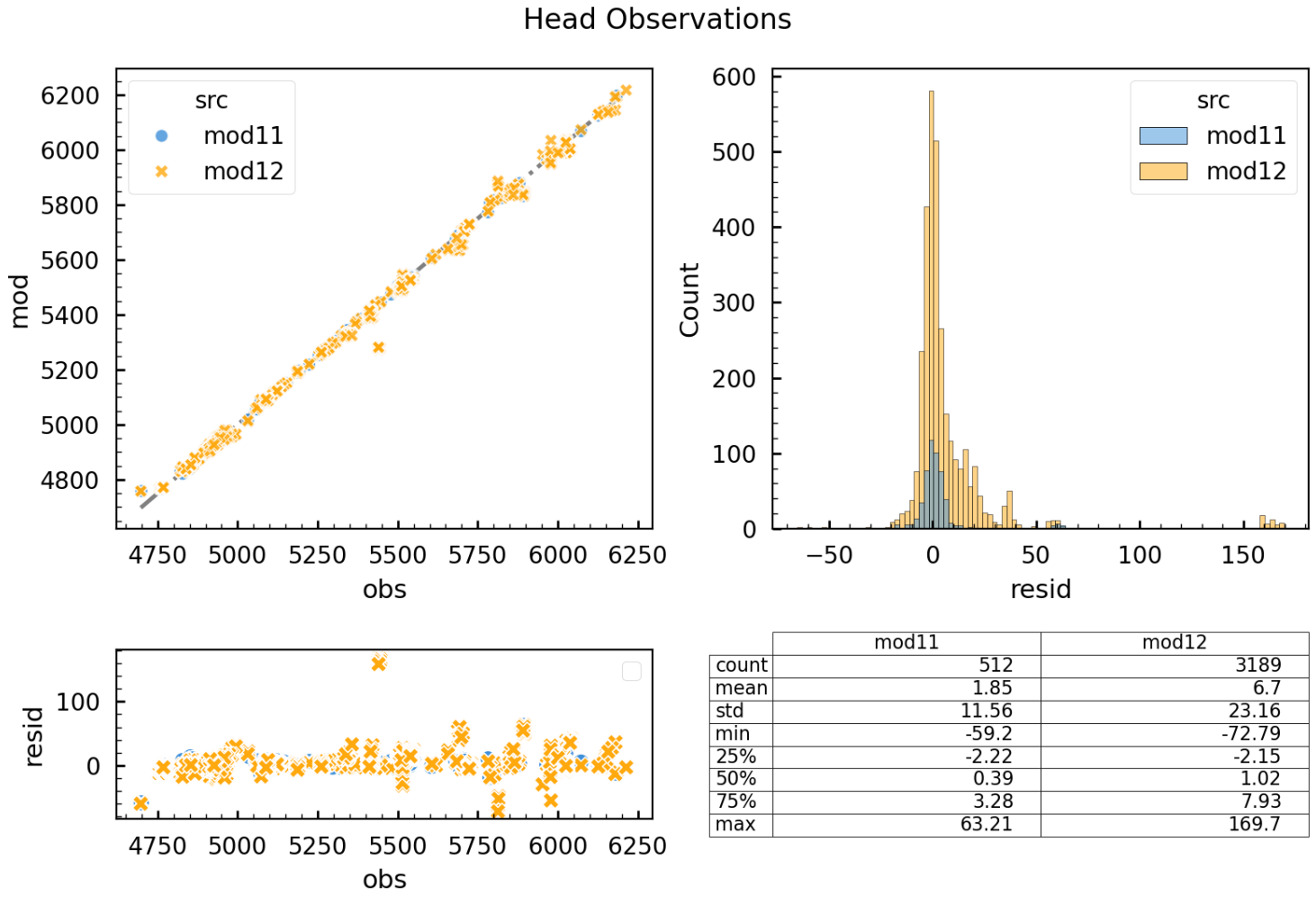
Most seepage run targets saw improvements from WRV 1.1



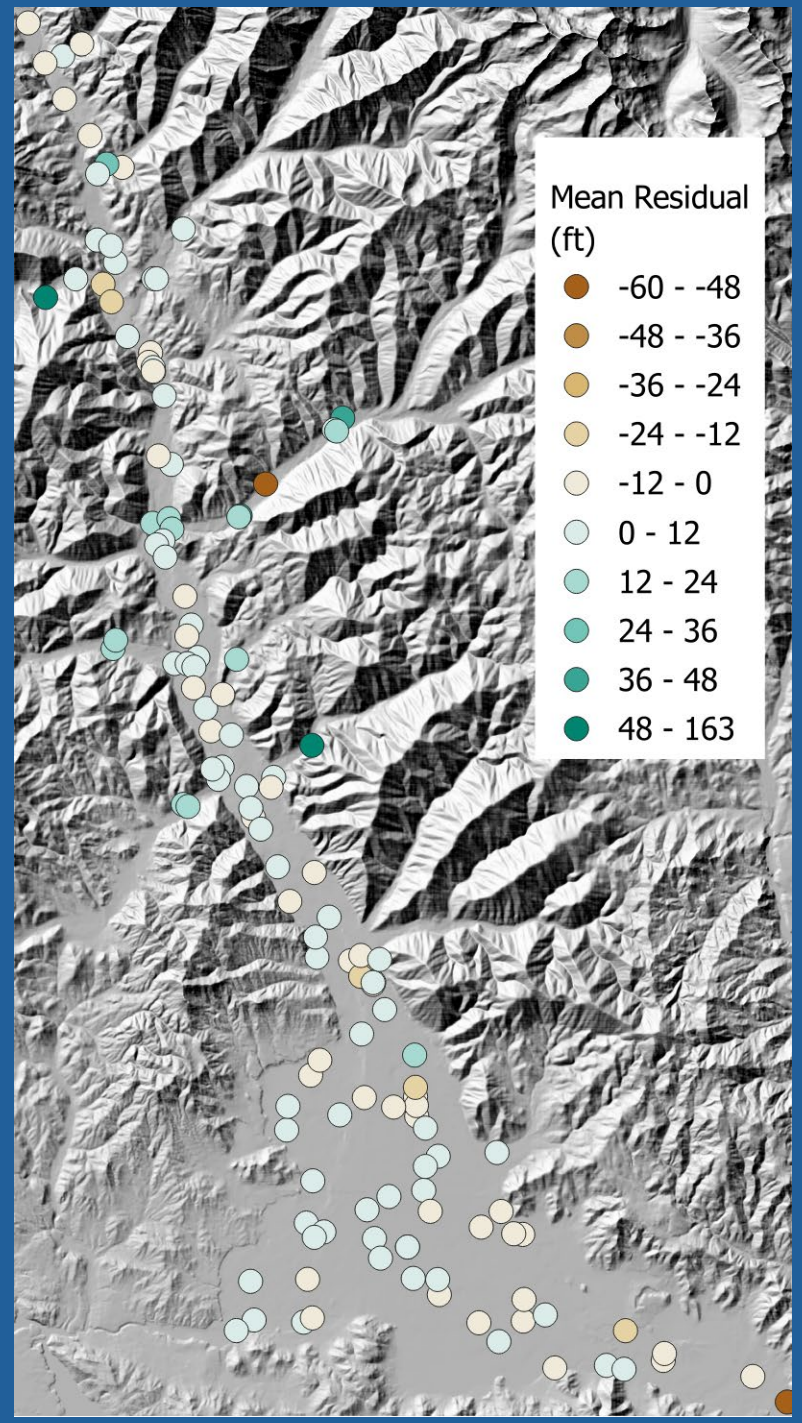
# Drains

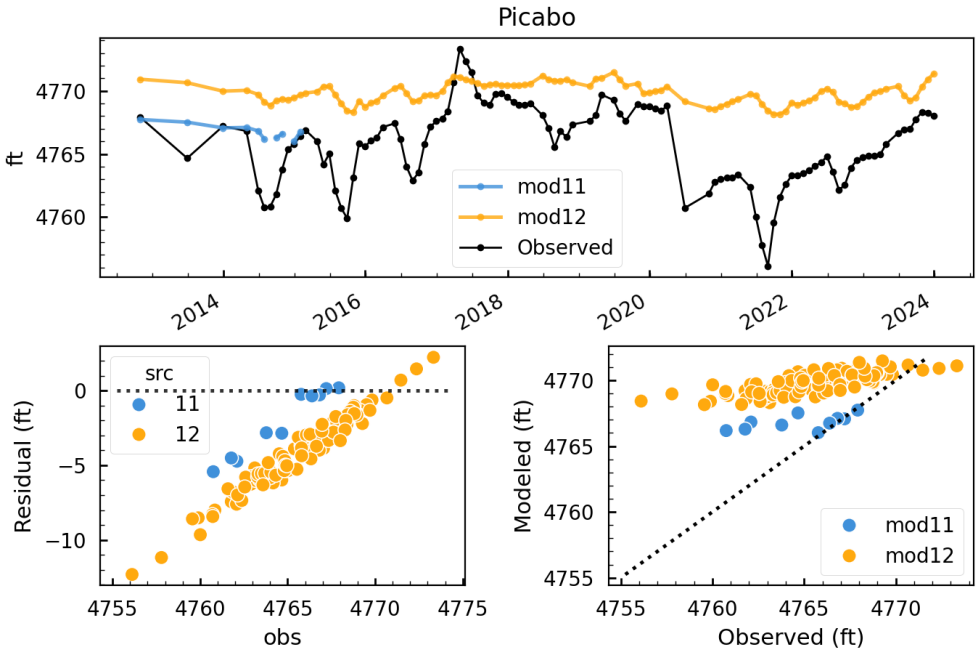

name = STANTONOUT
−0.5
−1.0
−1.5
−2.0
−2.5
$GW_{out}$ (cfs)
name = SILVEROUT
−20
−25
−30
−35
−40
$GW_{out}$ (cfs)
1996
2000
2004
2008
2012
2016
2020
2024
datetime
src
11
12

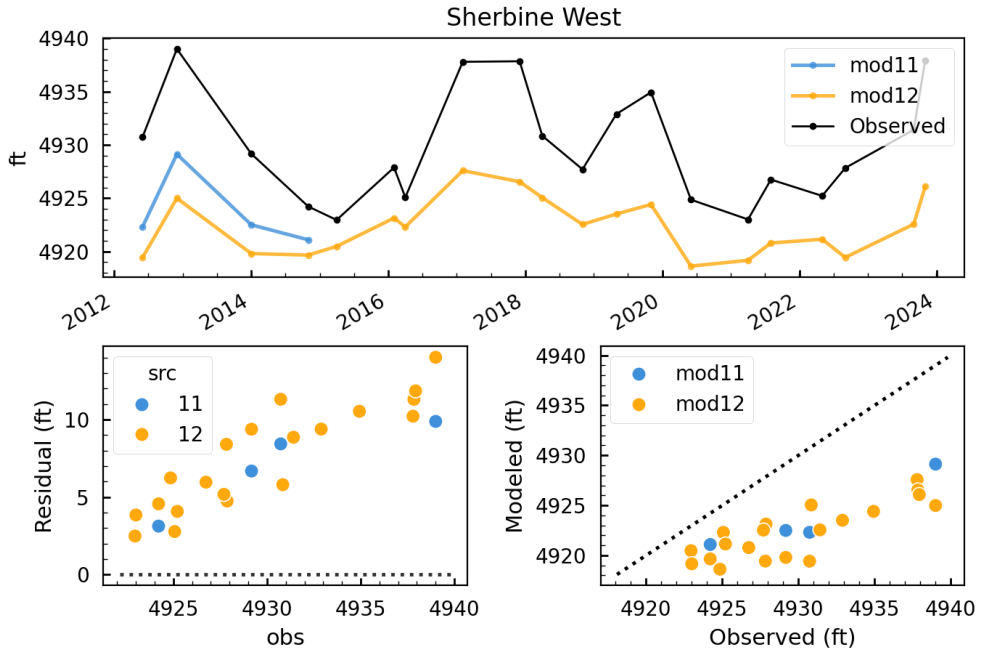
# Head Targets

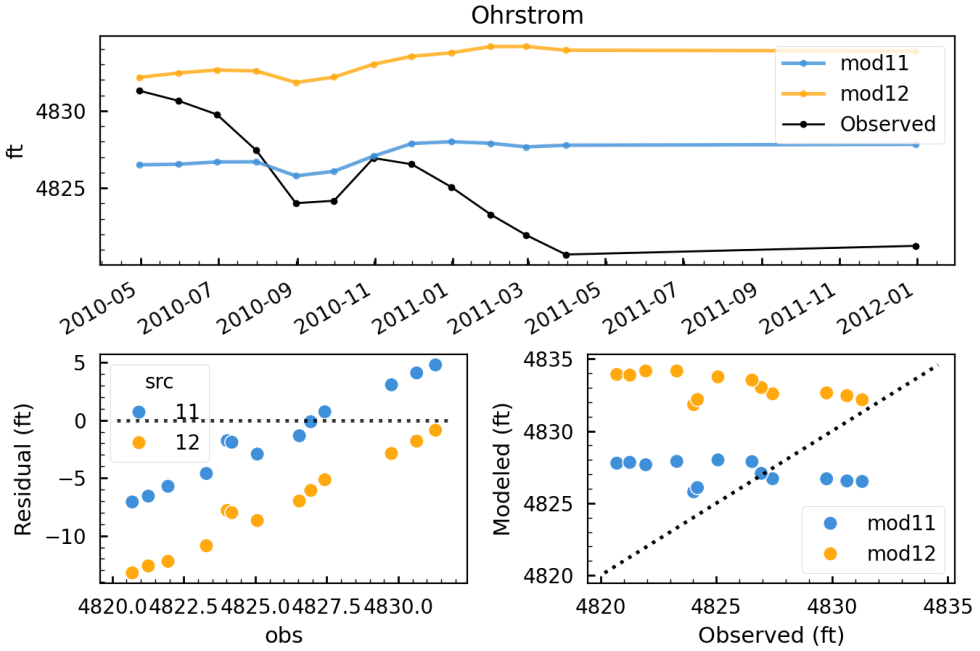


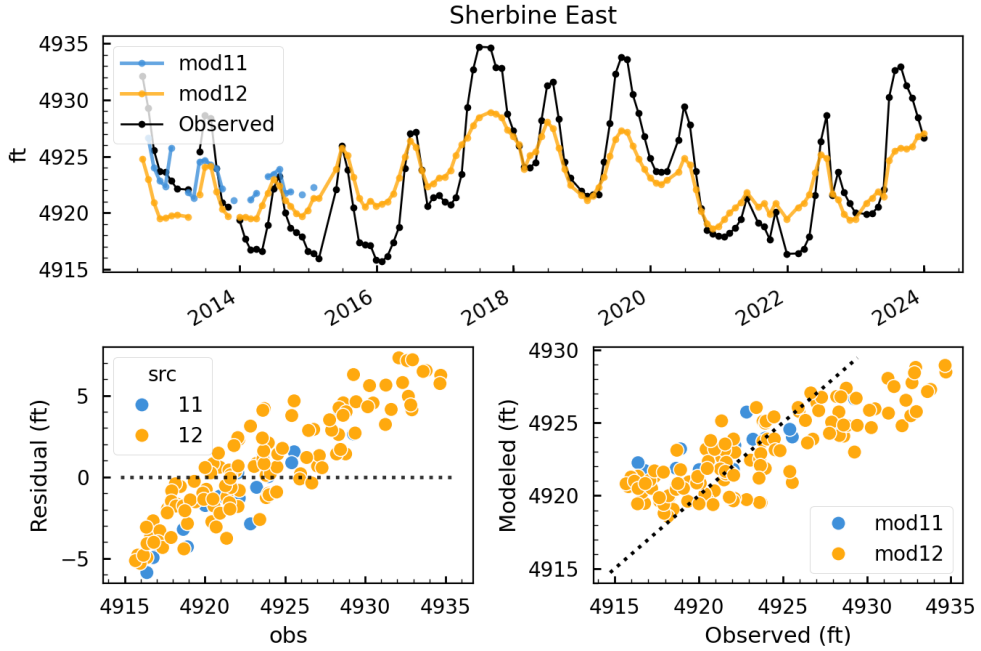

| | mod11 | mod12 |
|---|---|---|
| count | 512 | 3189 |
| mean | 1.85 | 6.7 |
| std | 11.56 | 23.16 |
| min | -59.2 | -72.79 |
| 25% | -2.22 | -2.15 |
| 50% | 0.39 | 1.02 |
| 75% | 3.28 | 7.93 |
| max | 63.21 | 169.7 |

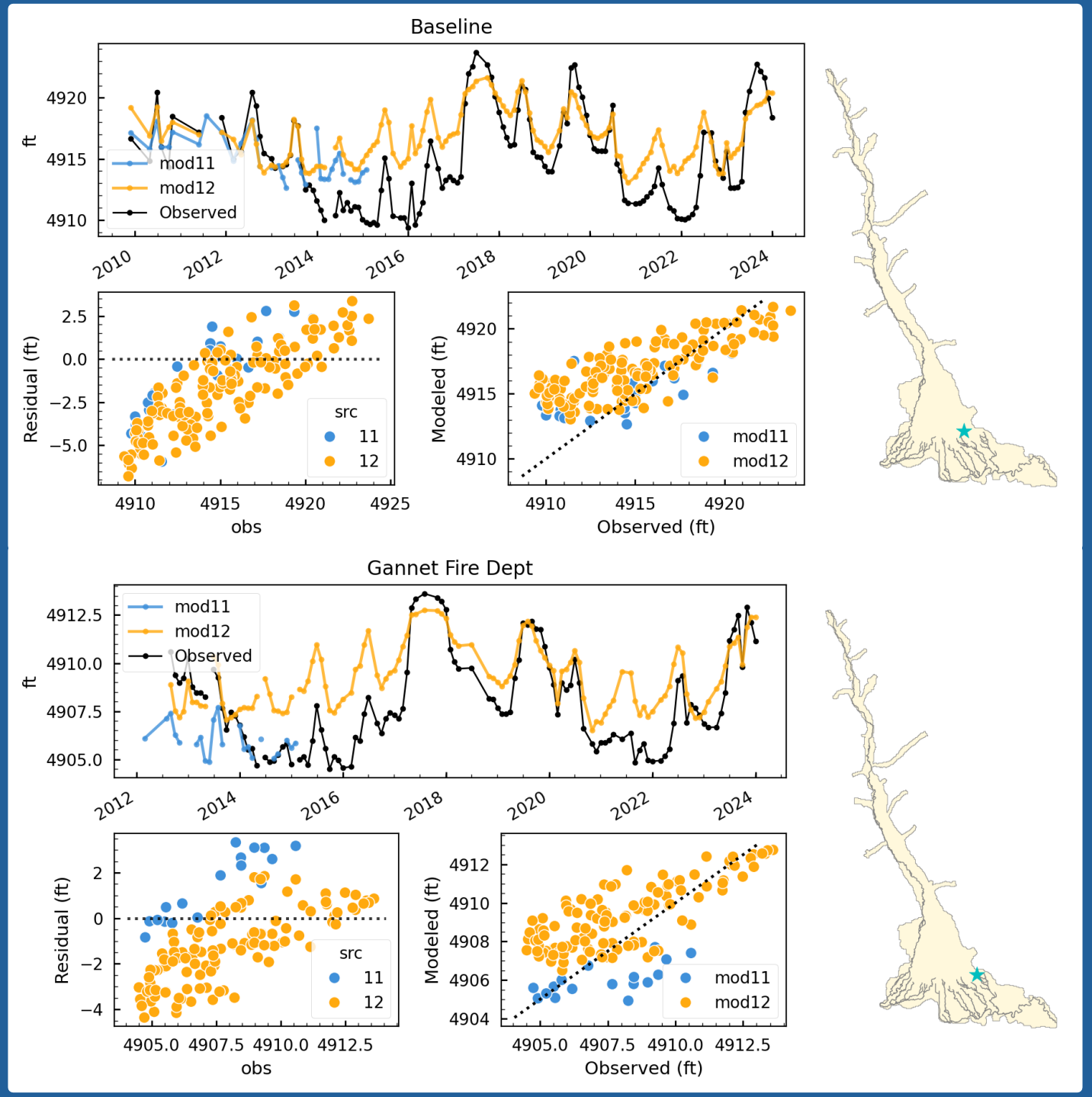


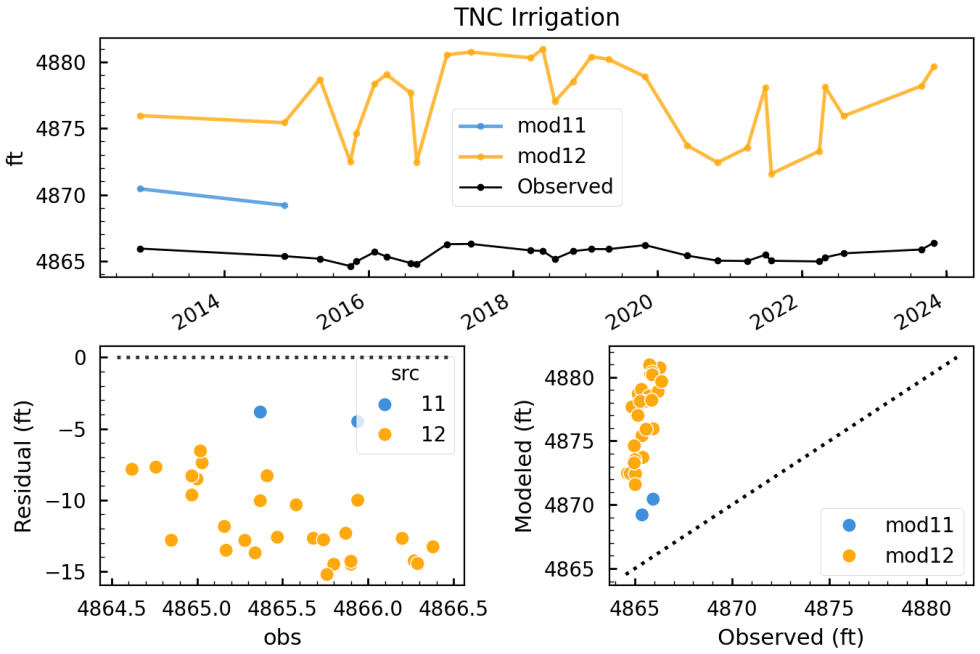

Picabo
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

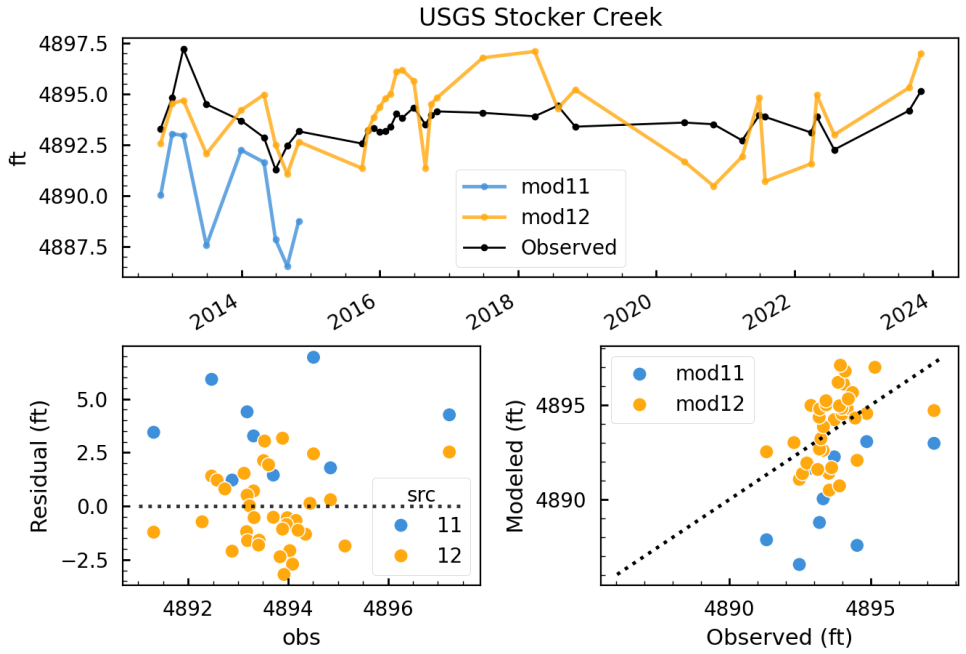

Sherbine West
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

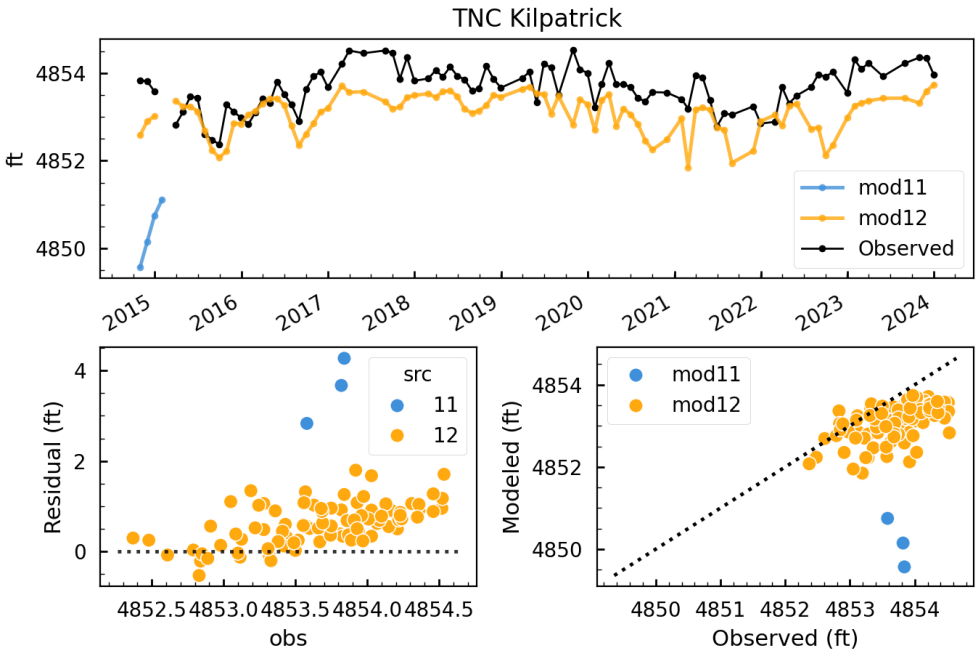

Ohrstrom
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

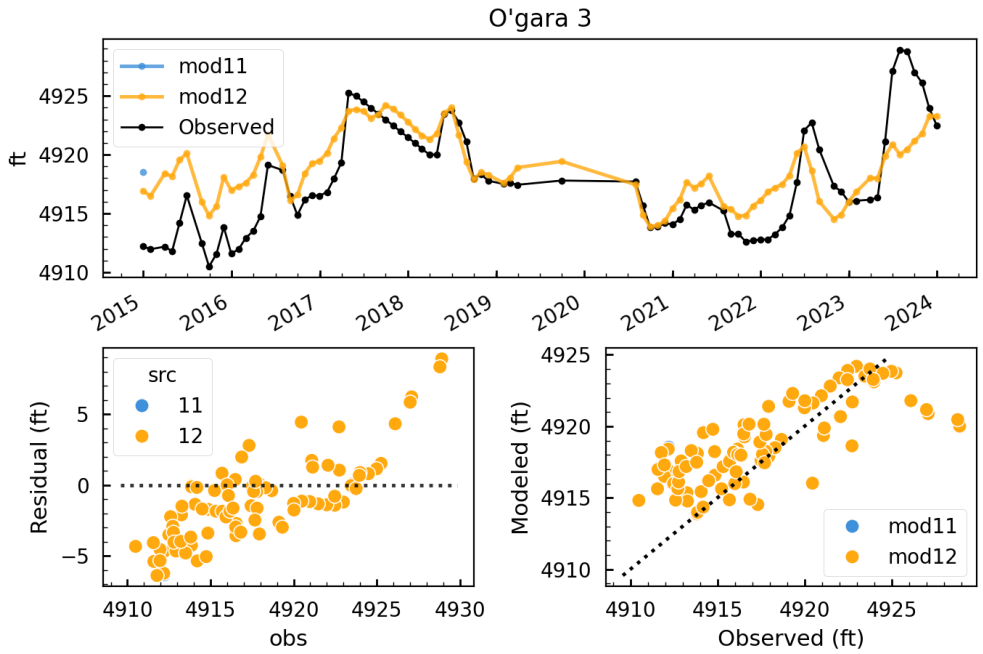

Sherbine East
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

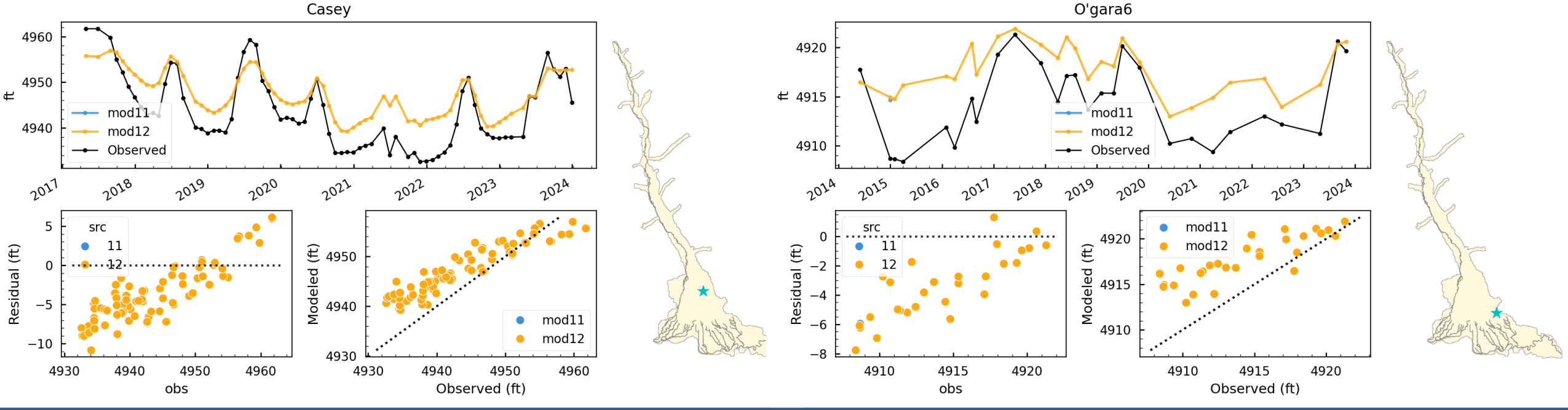

Baseline
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)
Gannet Fire Dept

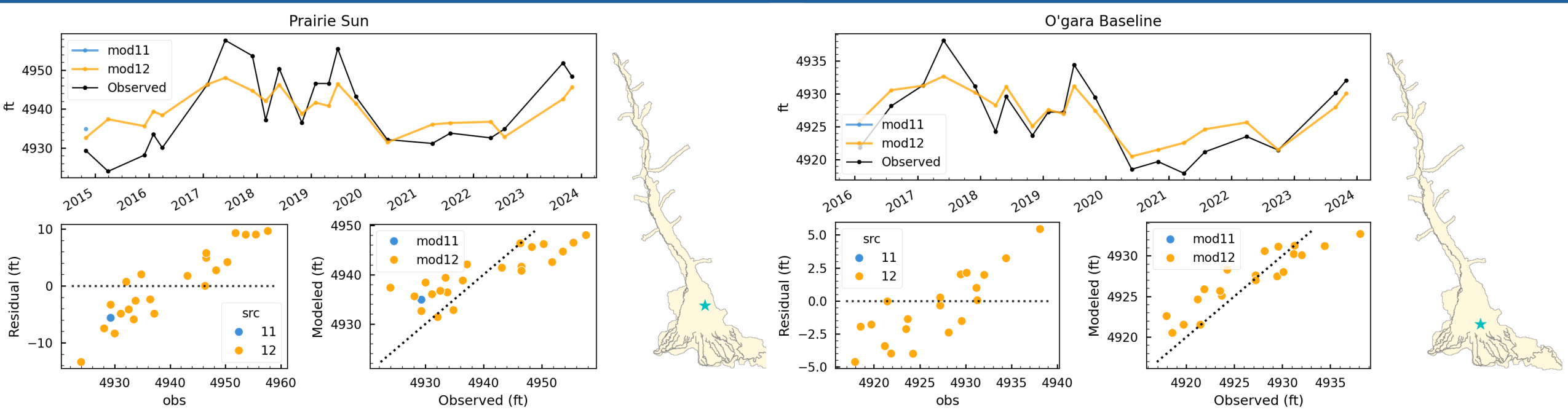

TNC Irrigation
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)


USGS Stocker Creek
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)


TNC Kilpatrick
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

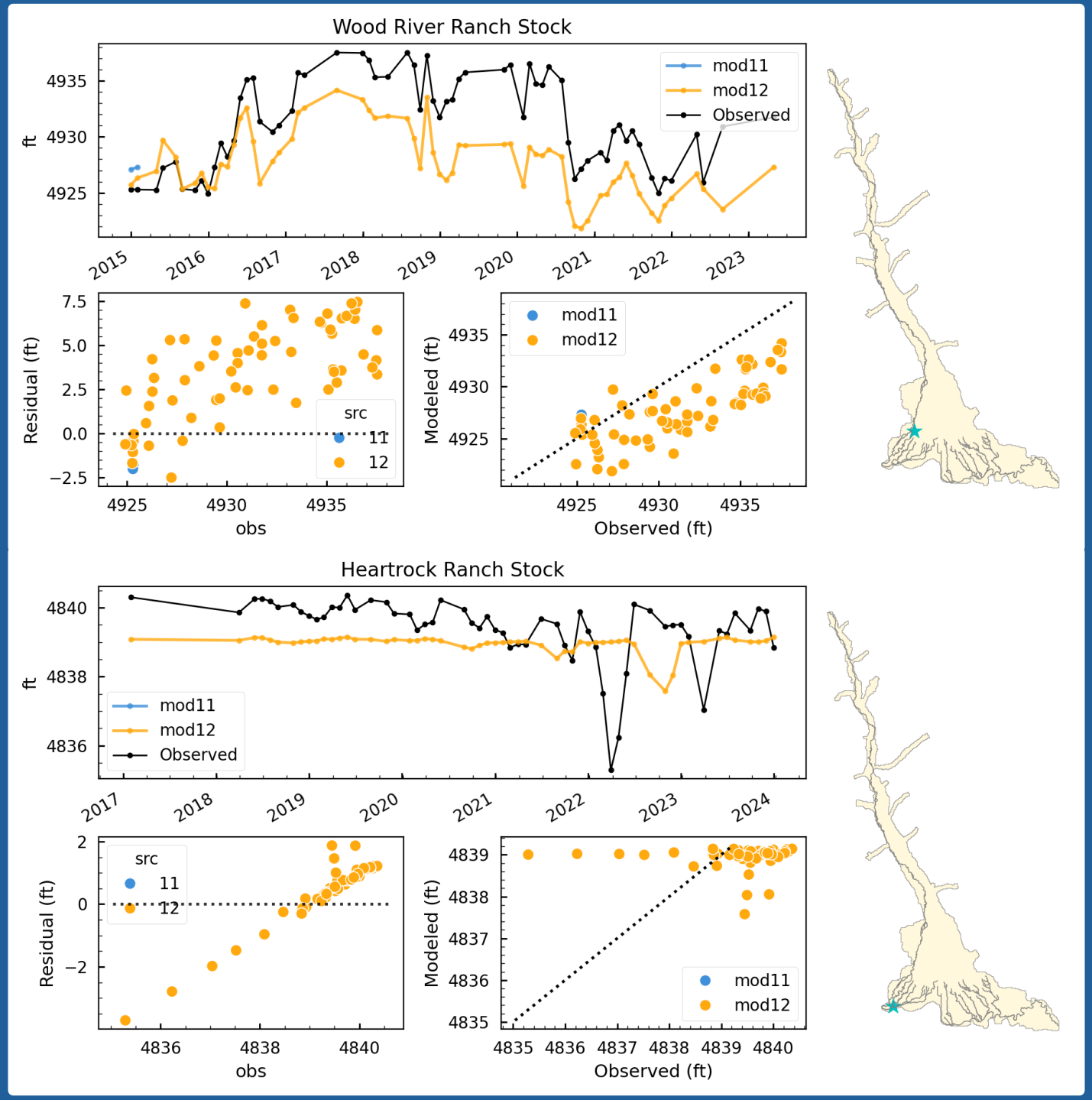

O'gara 3
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

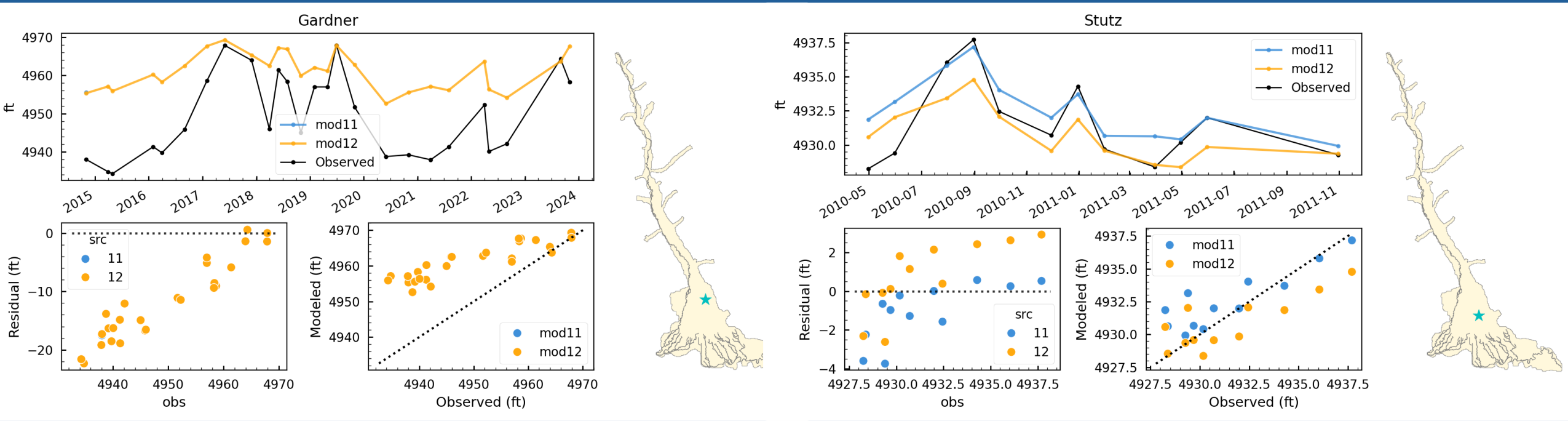

Casey
ft
mod11
mod12
Observed
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)

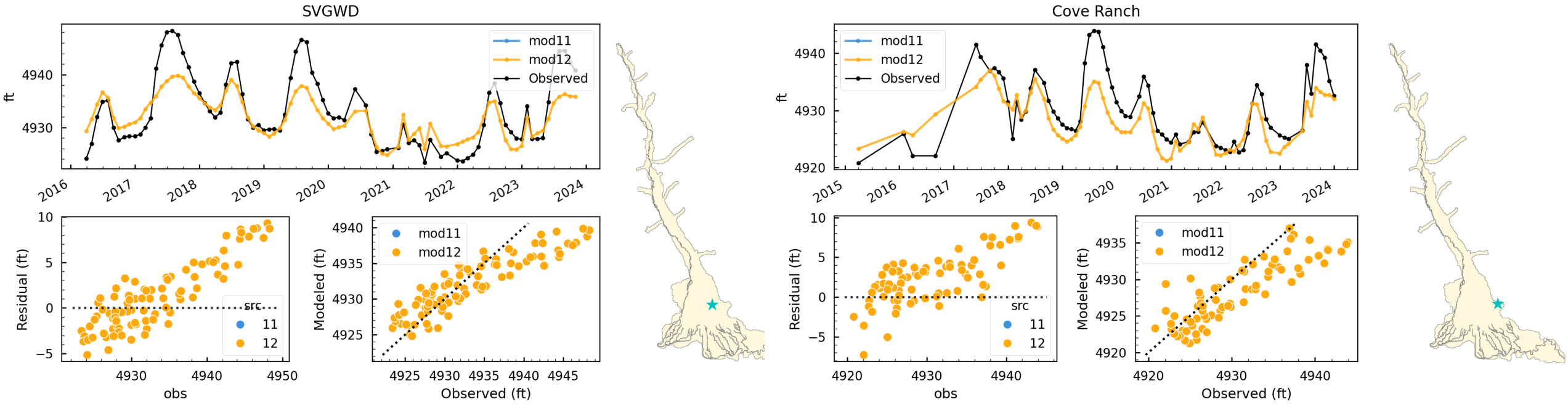

Prairie Sun
ft
mod11
mod12
Observed
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)

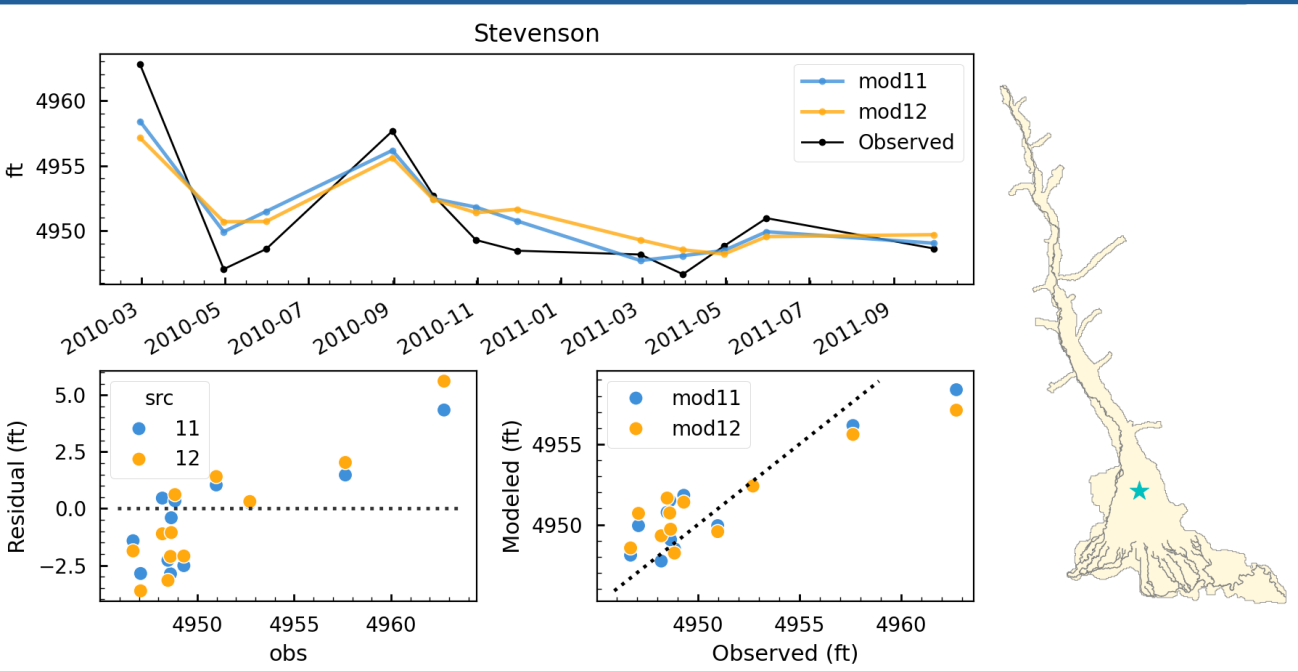

O'gara6
ft
mod11
mod12
Observed
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)


O'gara Baseline
ft
mod11
mod12
Observed
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)

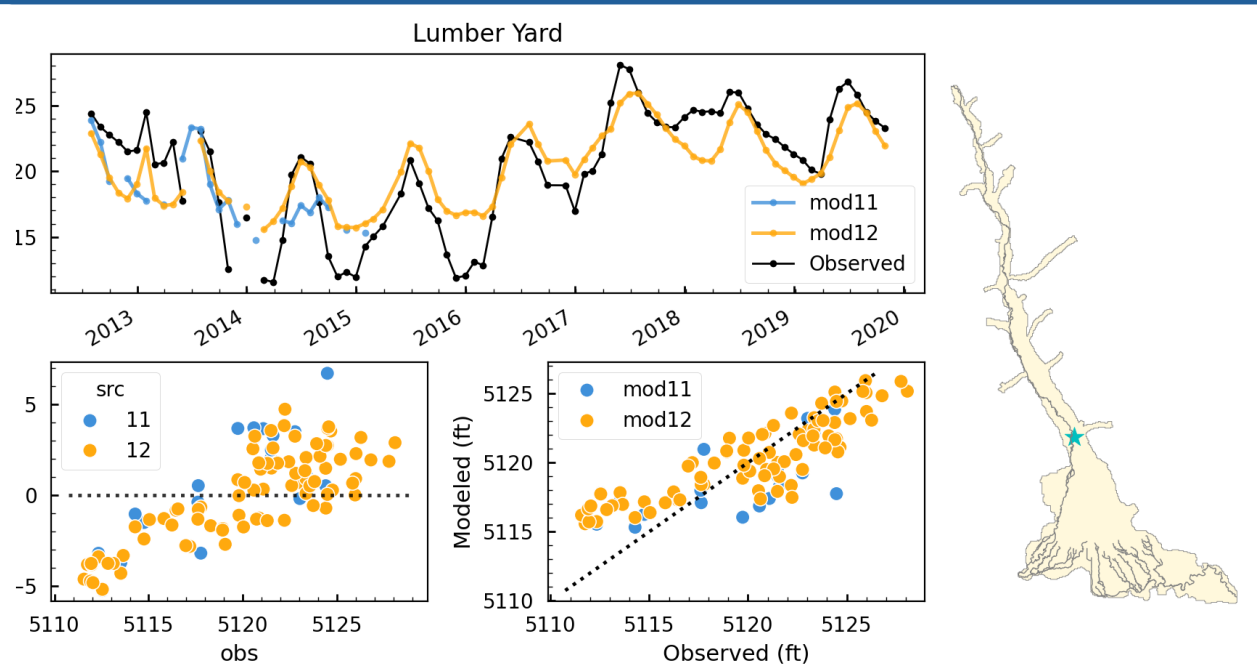

Wood River Ranch Stock
mod11
mod12
Observed
ft
4935
4930
4925
2015
2016
2017
2018
2019
2020
2021
2022
2023
Residual (ft)
7.5
5.0
2.5
0.0
−2.5
src
11
12
obs
Modeled (ft)
Observed (ft)
Heartrock Ranch Stock
4840
4838
4836
2017
2018
2019
2020
2021
2022
2023
2024
2
0
−2
4839
4838
4837
4836
4835
4836
4838
4840


Gardner
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)
Stutz
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

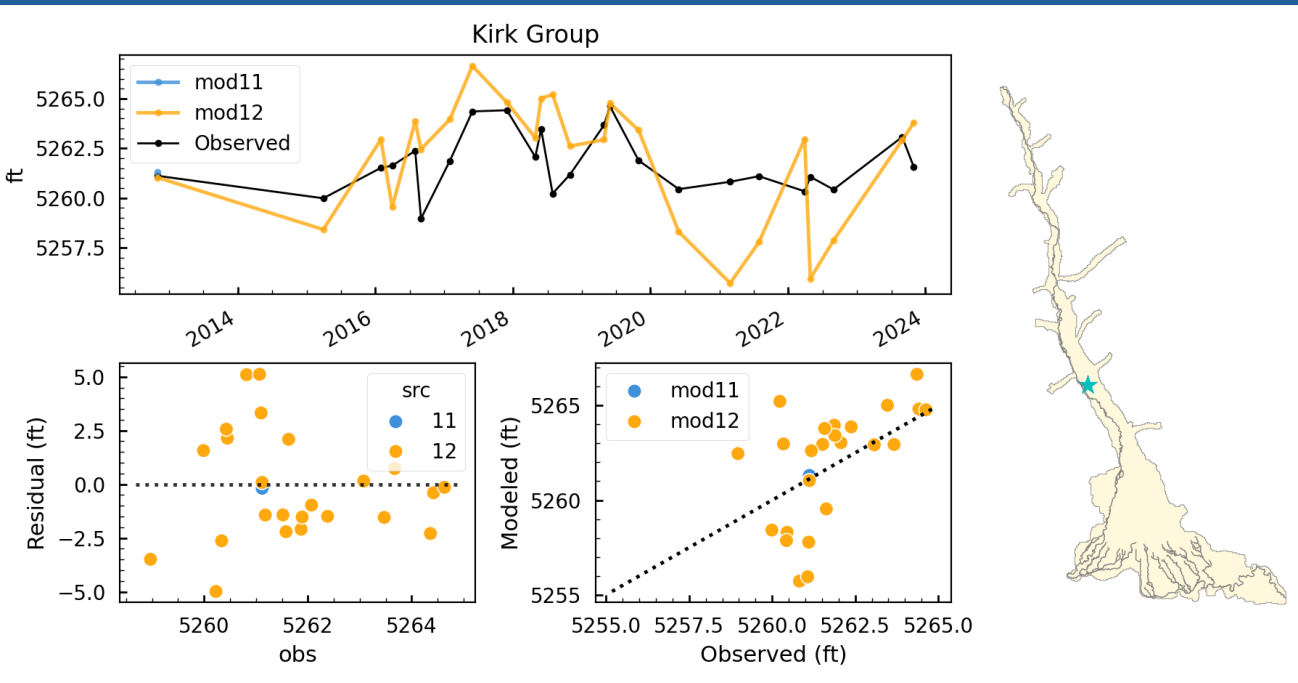

SVGWD
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)
Cove Ranch
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)


Stevenson
mod11
mod12
Observed
ft
4960
4955
4950
2010-03
2010-05
2010-07
2010-09
2010-11
2011-01
2011-03
2011-05
2011-07
2011-09
src
11
12
Residual (ft)
5.0
2.5
0.0
−2.5
4950
4955
4960
obs
mod11
mod12
Modeled (ft)
4955
4950
4950
4955
4960
Observed (ft)

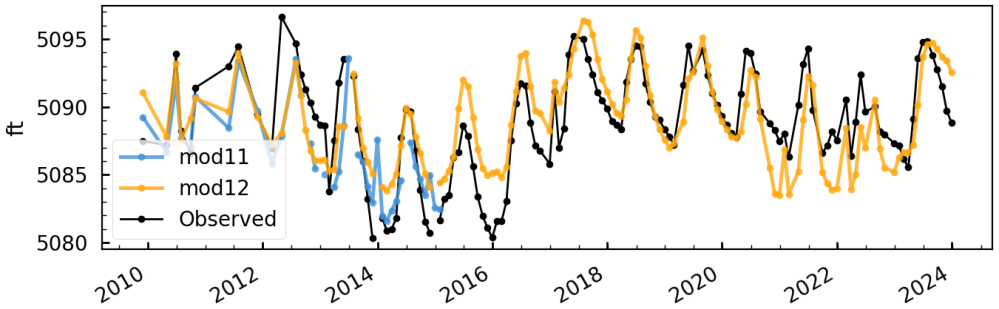


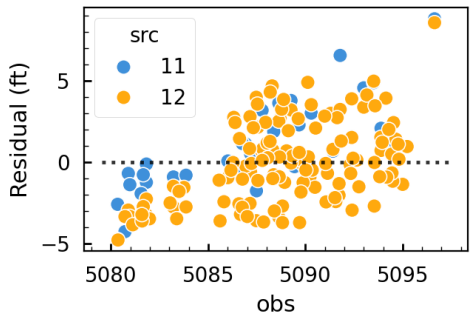

Lumber Yard
mod11
mod12
Observed
25
20
15
2013
2014
2015
2016
2017
2018
2019
2020
src
11
12
5
0
−5
5110
5115
5120
5125
obs
mod11
mod12
Modeled (ft)
5125
5120
5115
5110
5110
5115
5120
5125
Observed (ft)

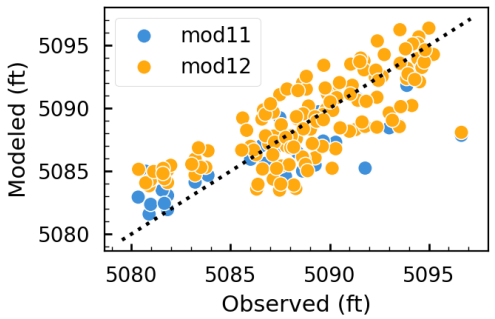



Kirk Group
mod11
mod12
Observed
ft
5265.0
5262.5
5260.0
5257.5
2014
2016
2018
2020
2022
2024
src
11
12
Residual (ft)
5.0
2.5
0.0
−2.5
−5.0
5260
5262
5264
obs
mod11
mod12
Modeled (ft)
5265
5260
5255
5255.0
5257.5
5260.0
5262.5
5265.0
Observed (ft)

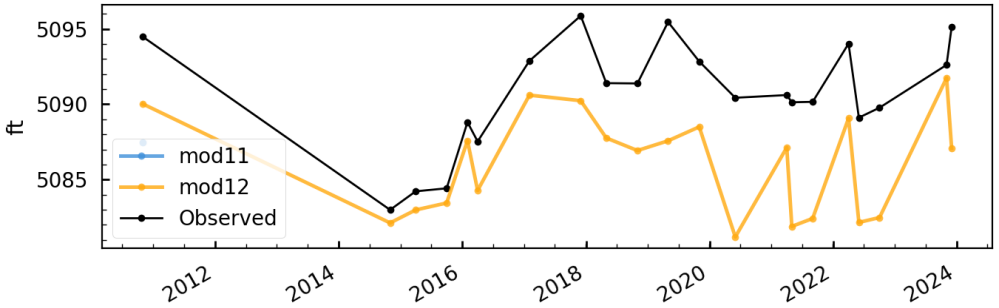
## Labrador South

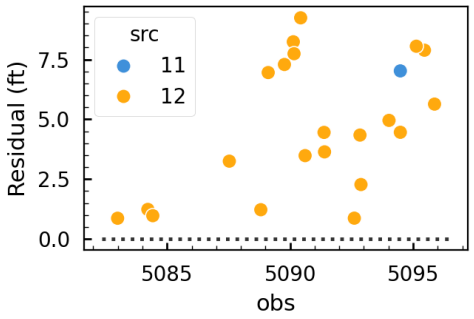


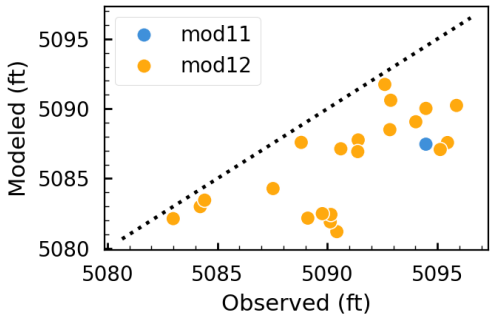



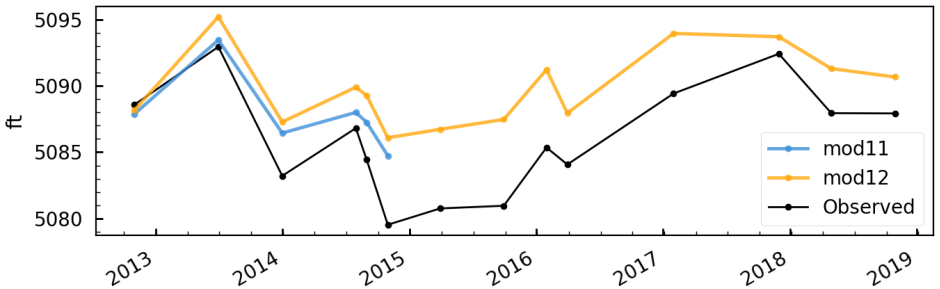
## Labrador Irrigation

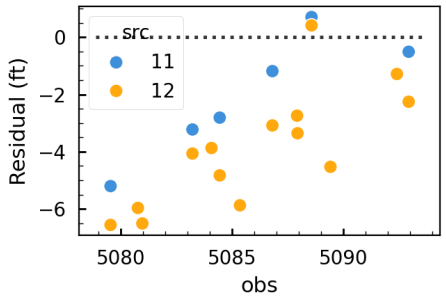


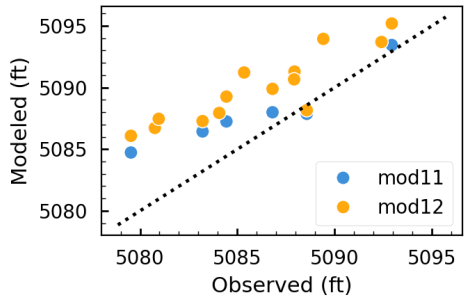



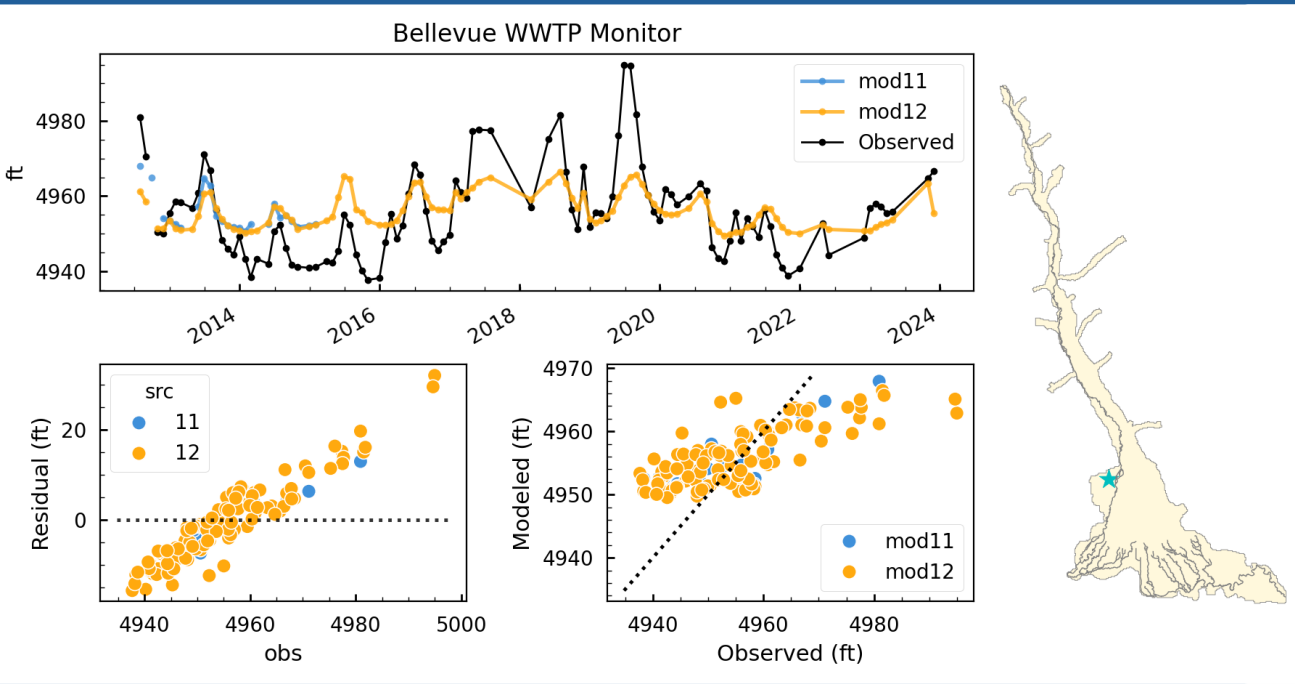



## USGS Labrador North

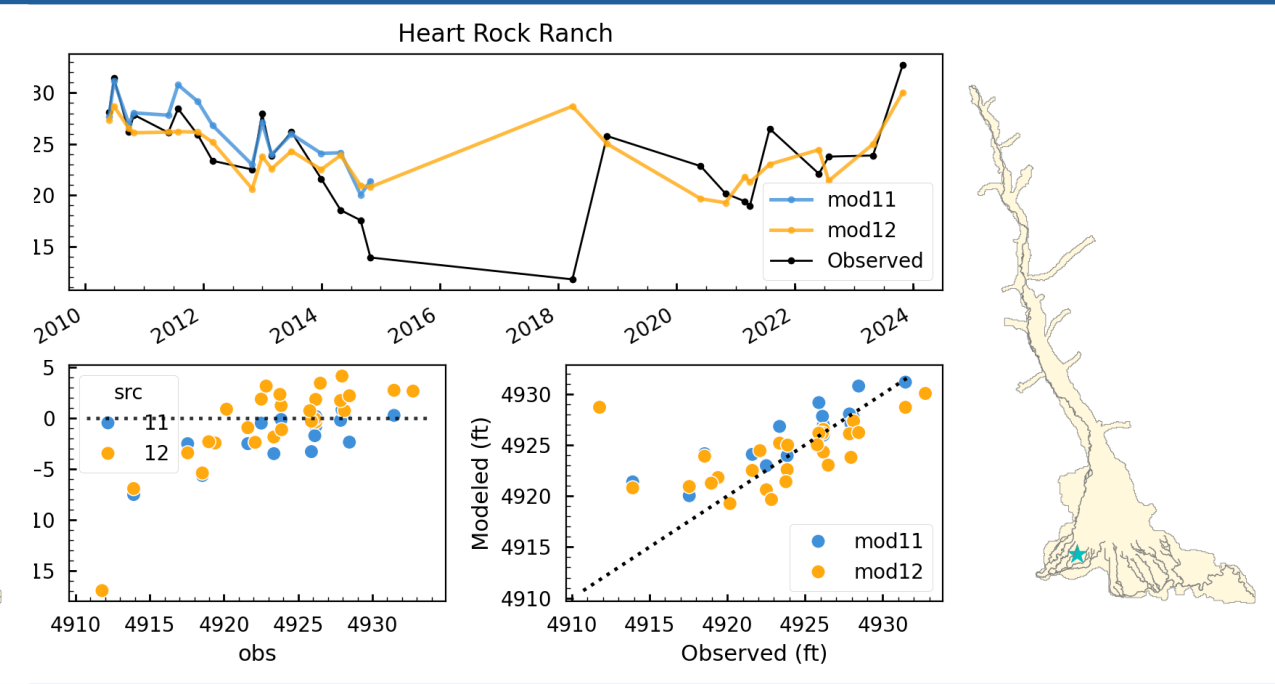


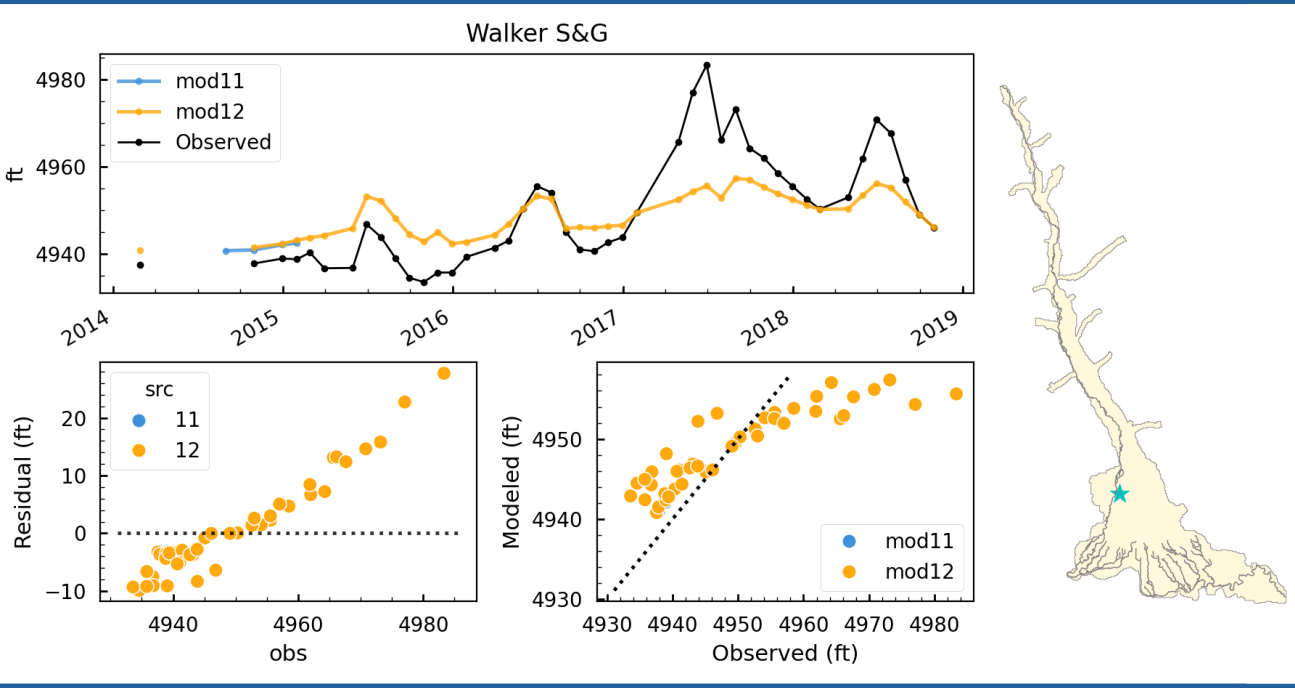




Bellevue WWTP Monitor
mod11
mod12
Observed
ft
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

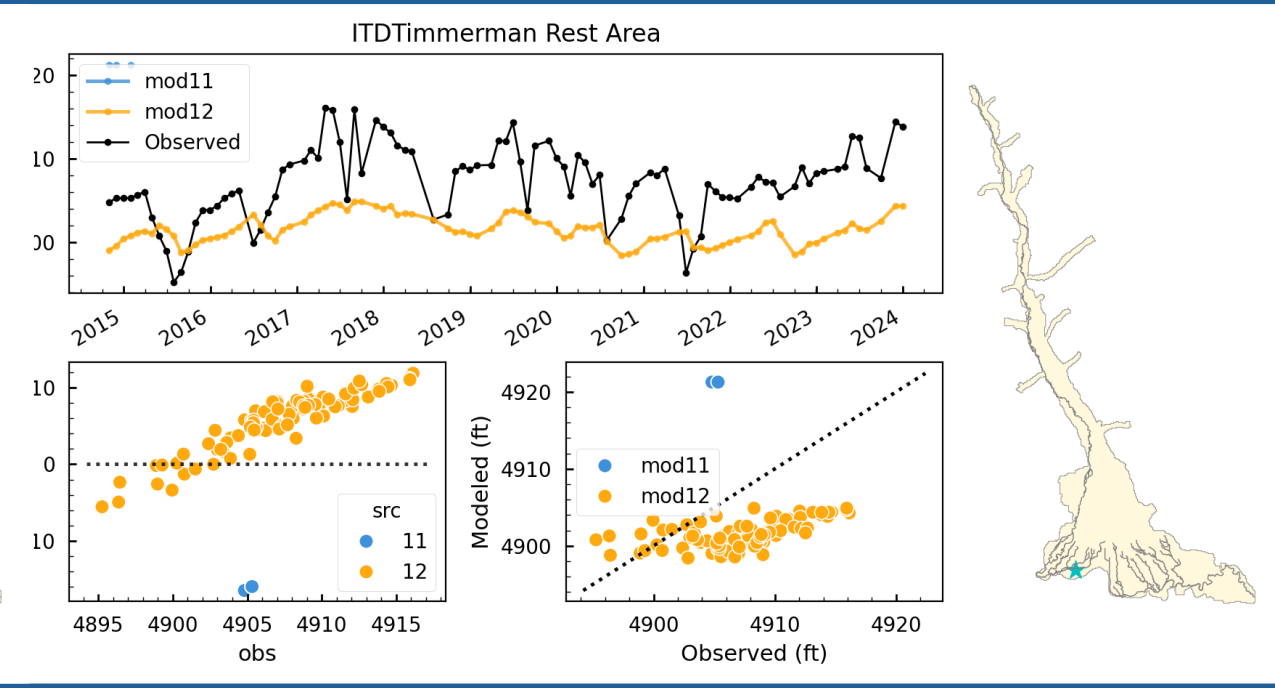


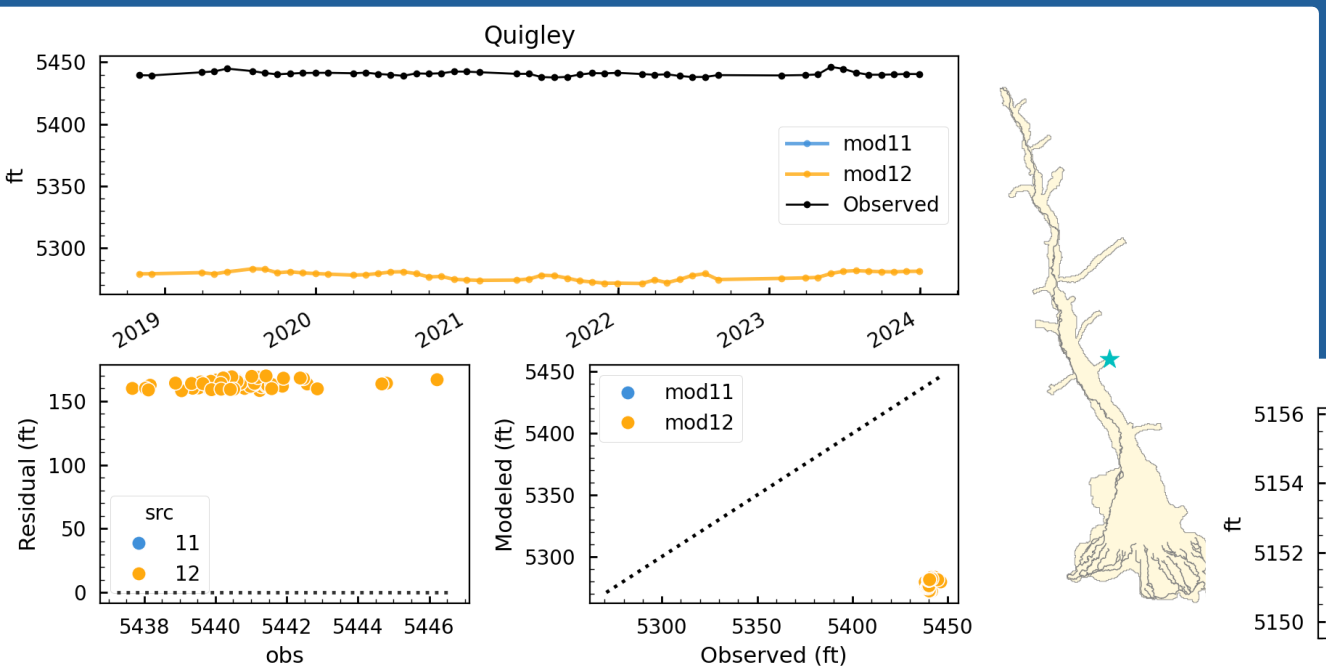

Heart Rock Ranch
mod11
mod12
Observed
src
11
12
obs
Modeled (ft)
Observed (ft)



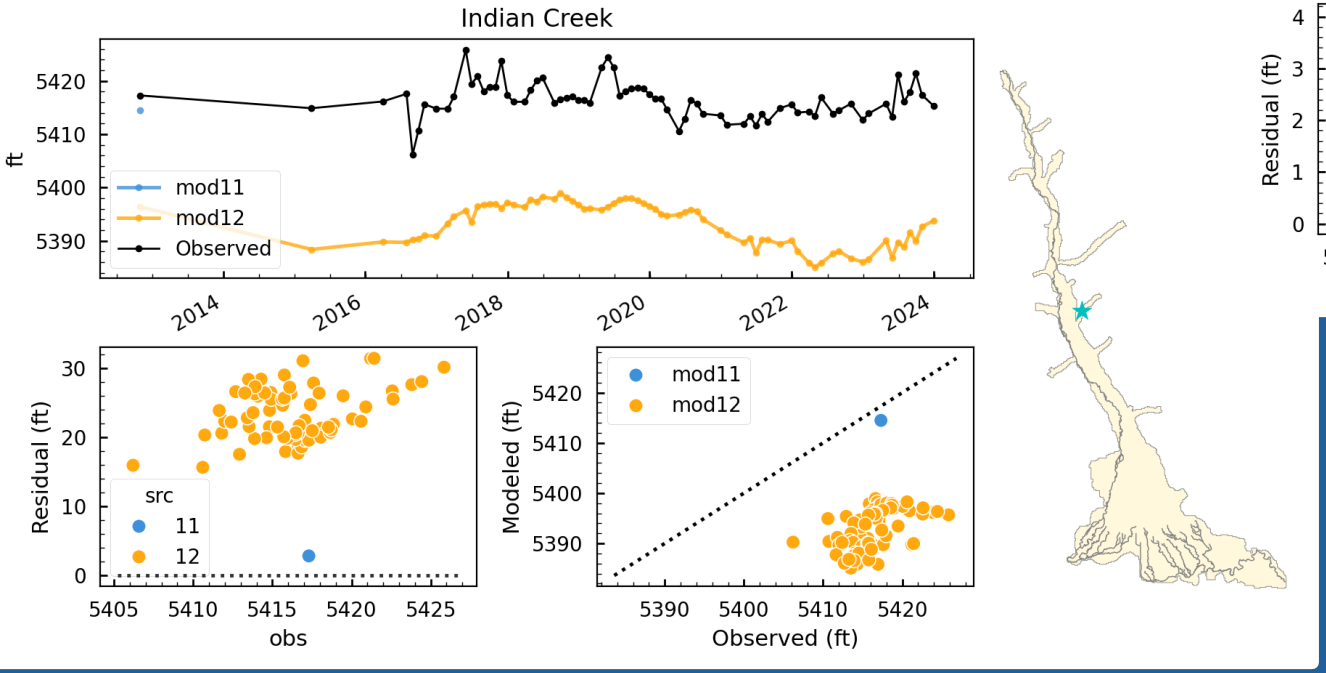

Walker S&G
mod11
mod12
Observed
ft
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)



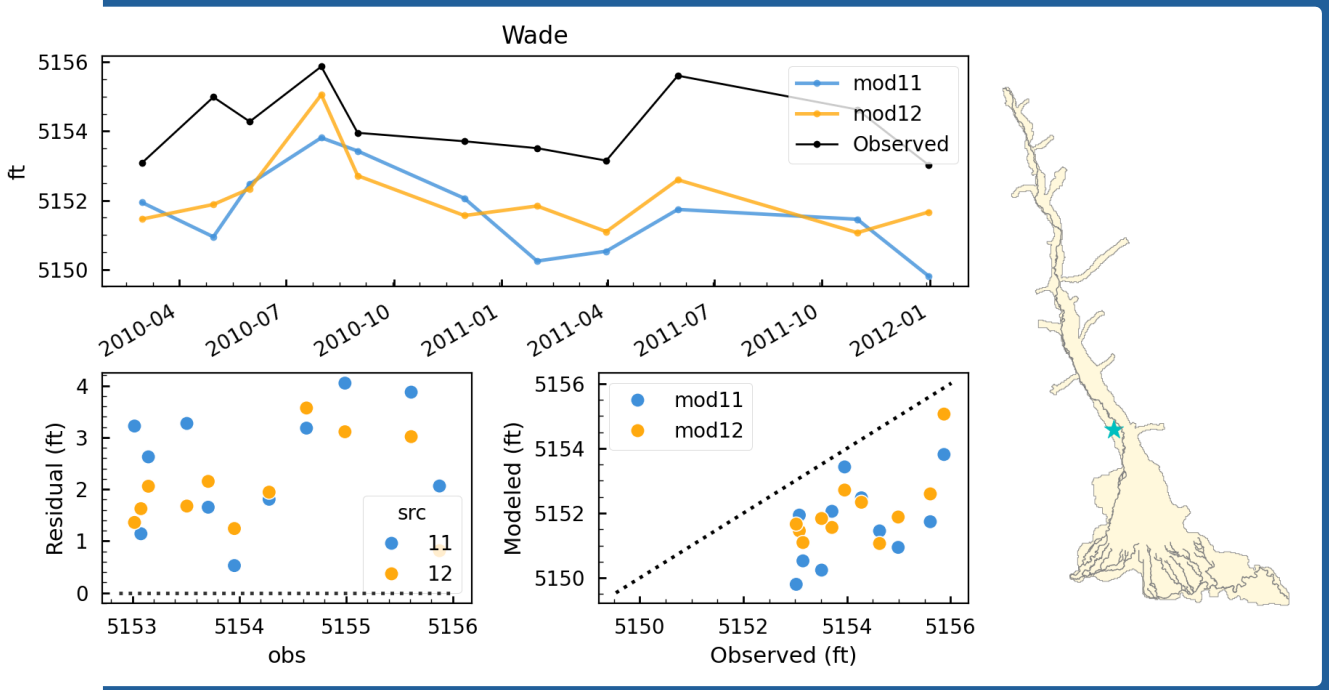

ITDTimmerman Rest Area
mod11
mod12
Observed
src
11
12
obs
Modeled (ft)
Observed (ft)

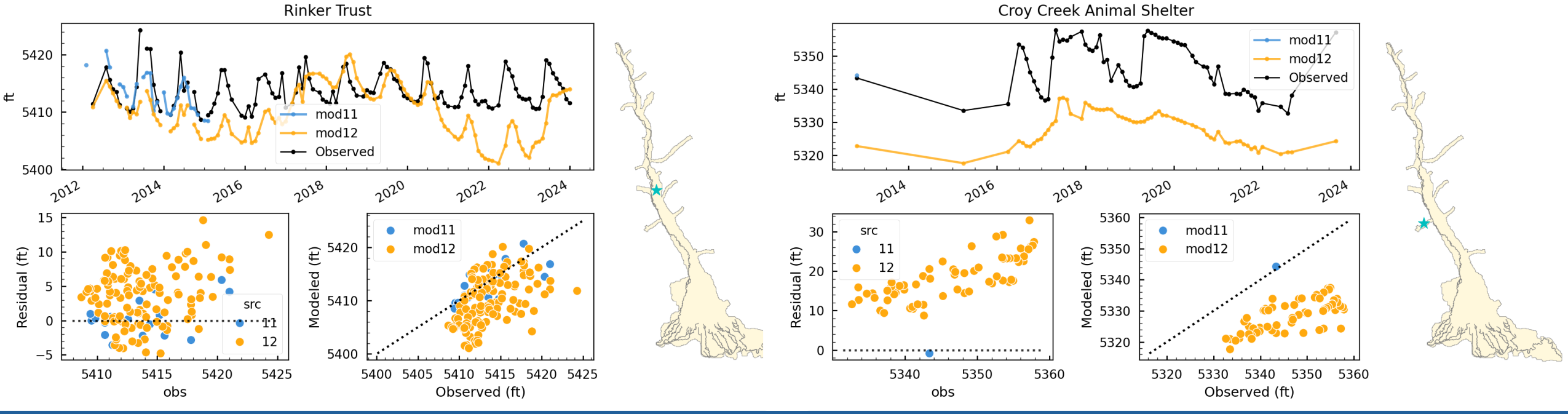

Quigley
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)




Indian Creek
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

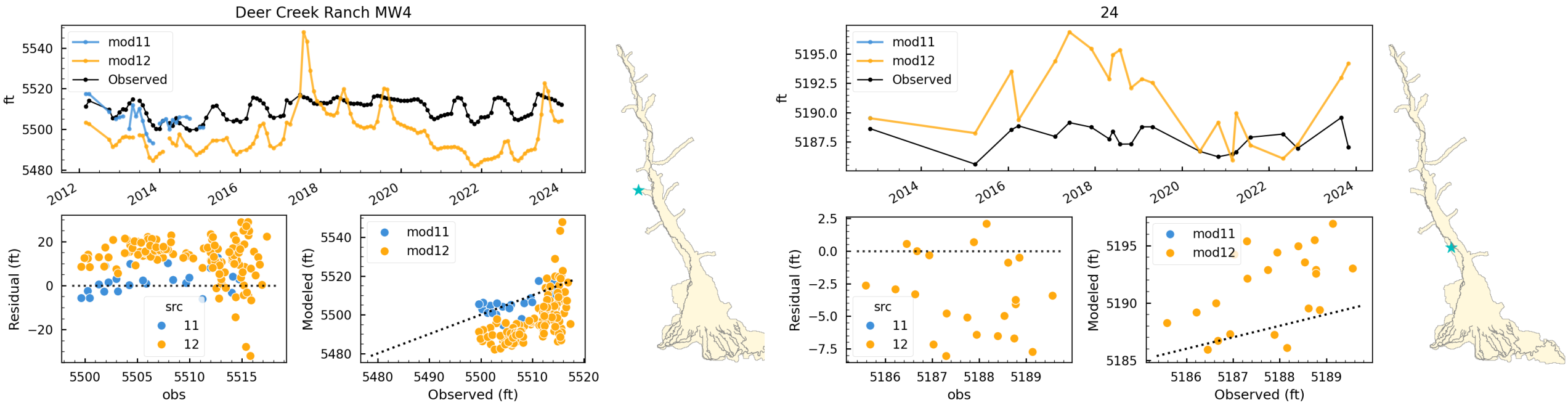



Wade
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)


Rinker Trust
ft
mod11
mod12
Observed
Residual (ft)
obs
src
11
12
Modeled (ft)
Observed (ft)

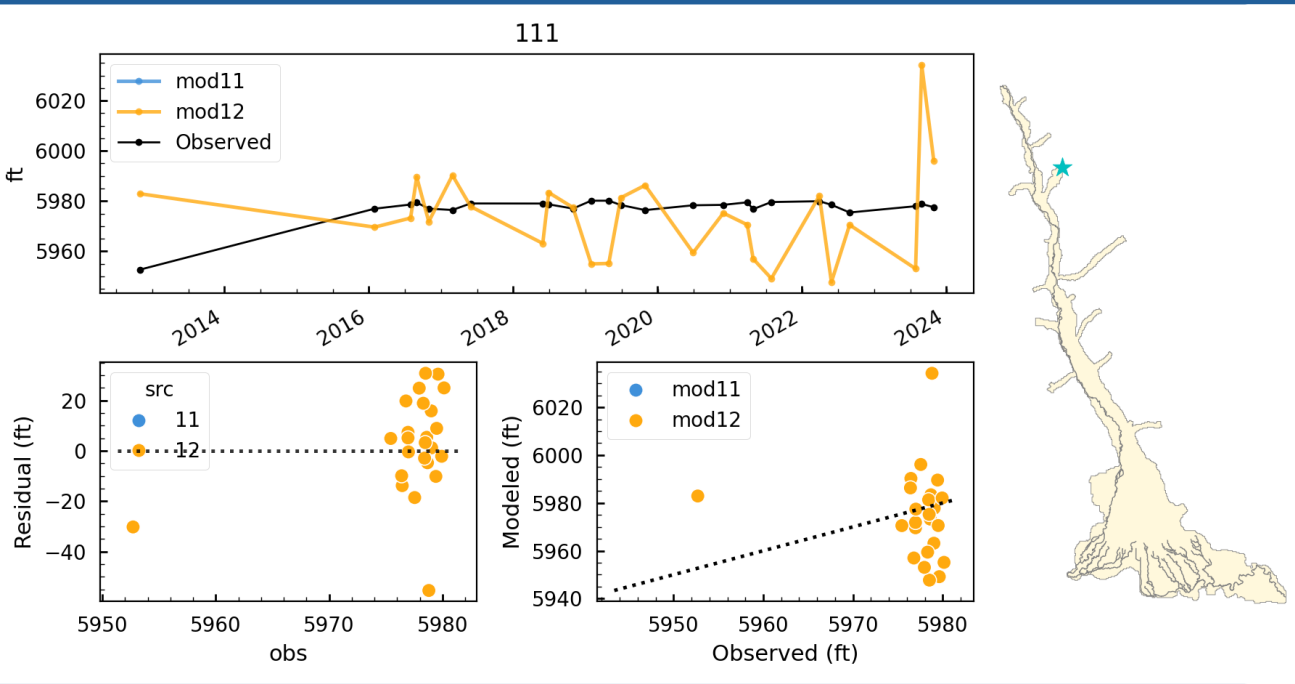



Croy Creek Animal Shelter
ft
mod11
mod12
Observed
Residual (ft)
obs
src
11
12
Modeled (ft)
Observed (ft)

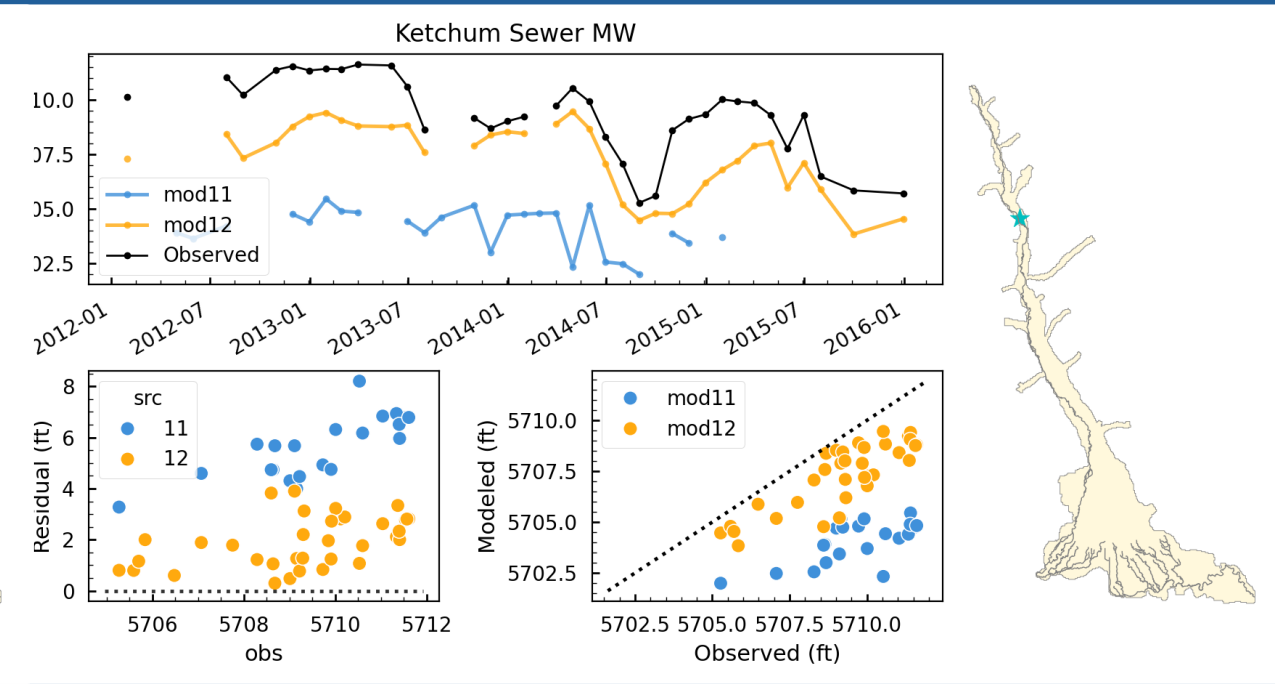

Deer Creek Ranch MW4
ft
mod11
mod12
Observed
Residual (ft)
obs
src
11
12
Modeled (ft)
Observed (ft)



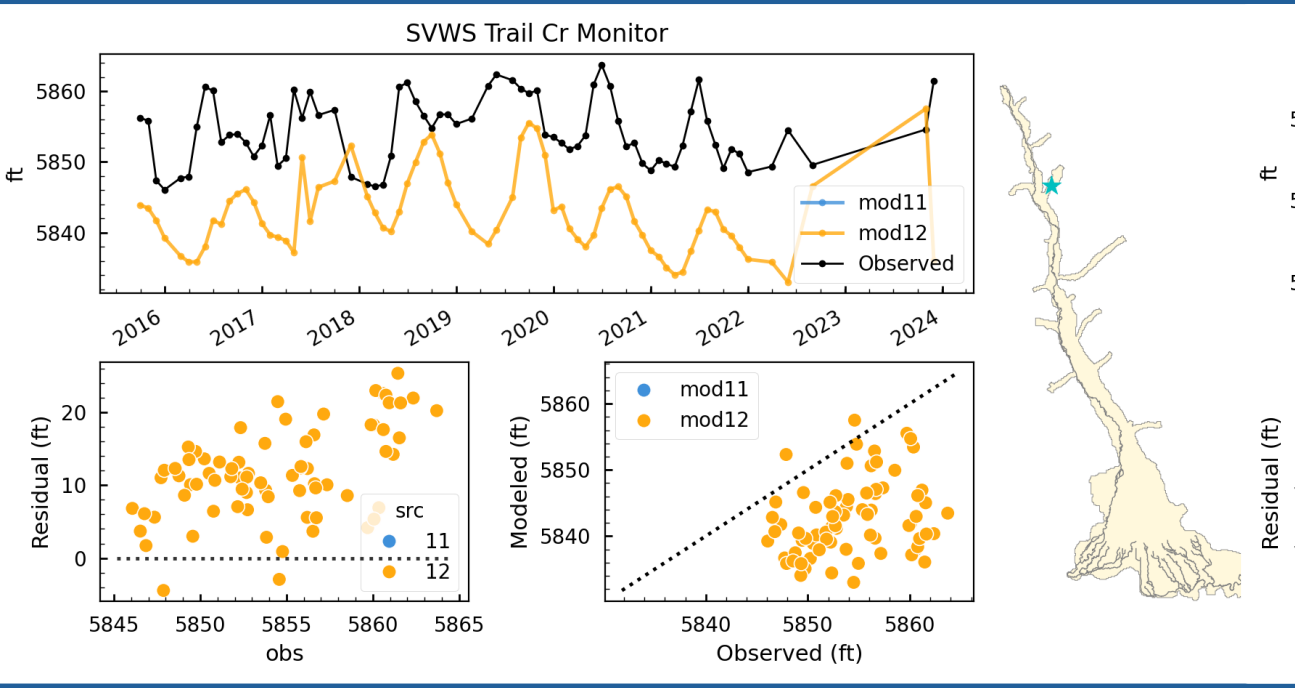

24
ft
mod11
mod12
Observed
Residual (ft)
obs
src
11
12
Modeled (ft)
Observed (ft)


111
mod11
mod12
Observed
ft
6020
6000
5980
5960
2014
2016
2018
2020
2022
2024
src
11
12
Residual (ft)
20
0
−20
−40
5950
5960
5970
5980
obs
mod11
mod12
Modeled (ft)
6020
6000
5980
5960
5940
5950
5960
5970
5980
Observed (ft)

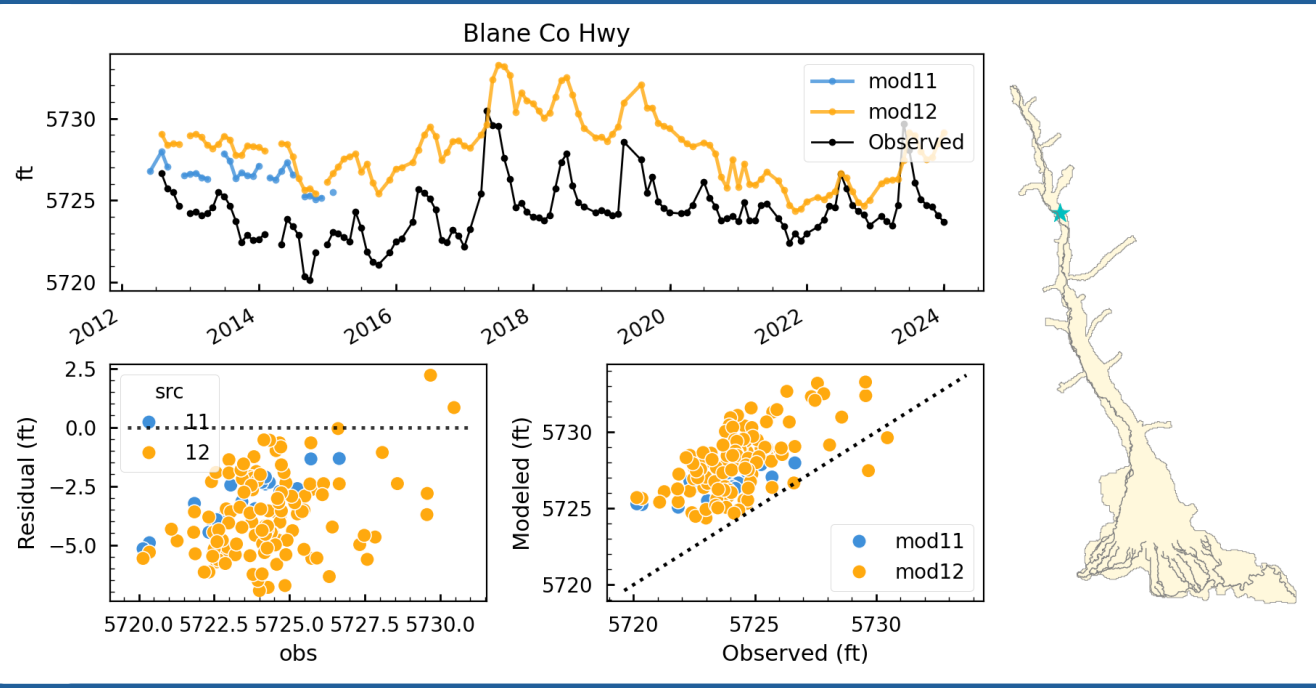


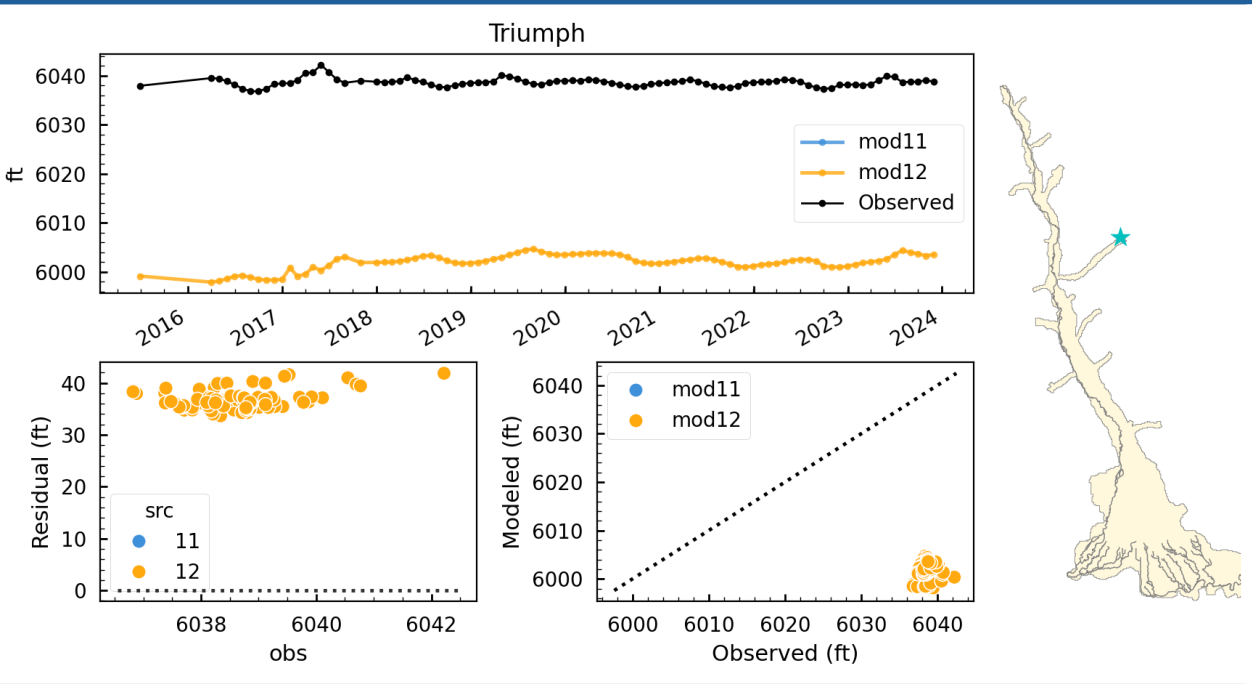

Ketchum Sewer MW
10.0
07.5
05.0
02.5
mod11
mod12
Observed
2012-01
2012-07
2013-01
2013-07
2014-01
2014-07
2015-01
2015-07
2016-01
src
11
12
Residual (ft)
8
6
4
2
0
5706
5708
5710
5712
obs
mod11
mod12
Modeled (ft)
5710.0
5707.5
5705.0
5702.5
5702.5 5705.0 5707.5 5710.0
Observed (ft)



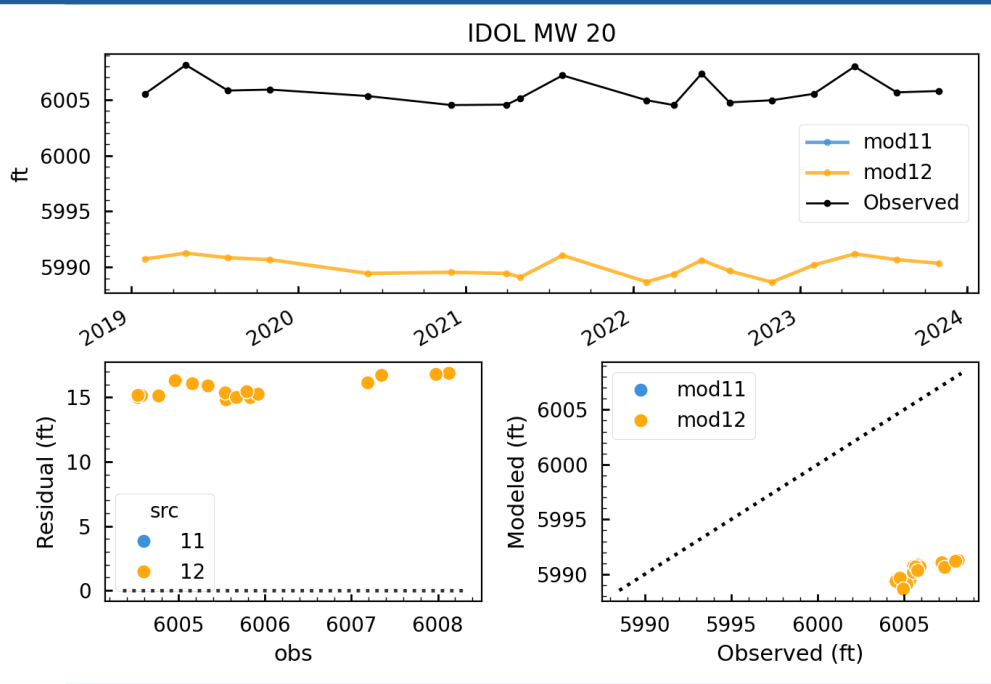

SVWS Trail Cr Monitor
ft
5860
5850
5840
mod11
mod12
Observed
2016
2017
2018
2019
2020
2021
2022
2023
2024
src
11
12
Residual (ft)
20
10
0
5845
5850
5855
5860
5865
obs
mod11
mod12
Modeled (ft)
5860
5850
5840
5840
5850
5860
Observed (ft)

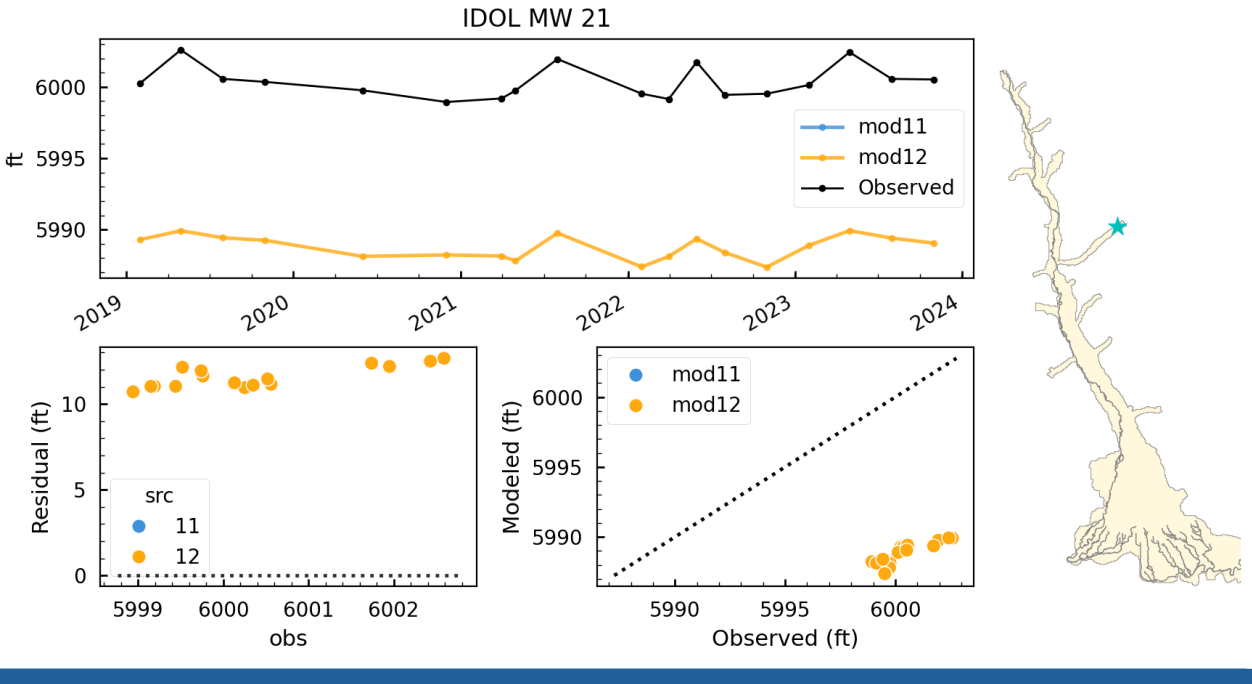



Blane Co Hwy
ft
5730
5725
5720
mod11
mod12
Observed
2012
2014
2016
2018
2020
2022
2024
src
11
12
Residual (ft)
2.5
0.0
−2.5
−5.0
5720.0 5722.5 5725.0 5727.5 5730.0
obs
mod11
mod12
Modeled (ft)
5730
5725
5720
5720
5725
5730
Observed (ft)

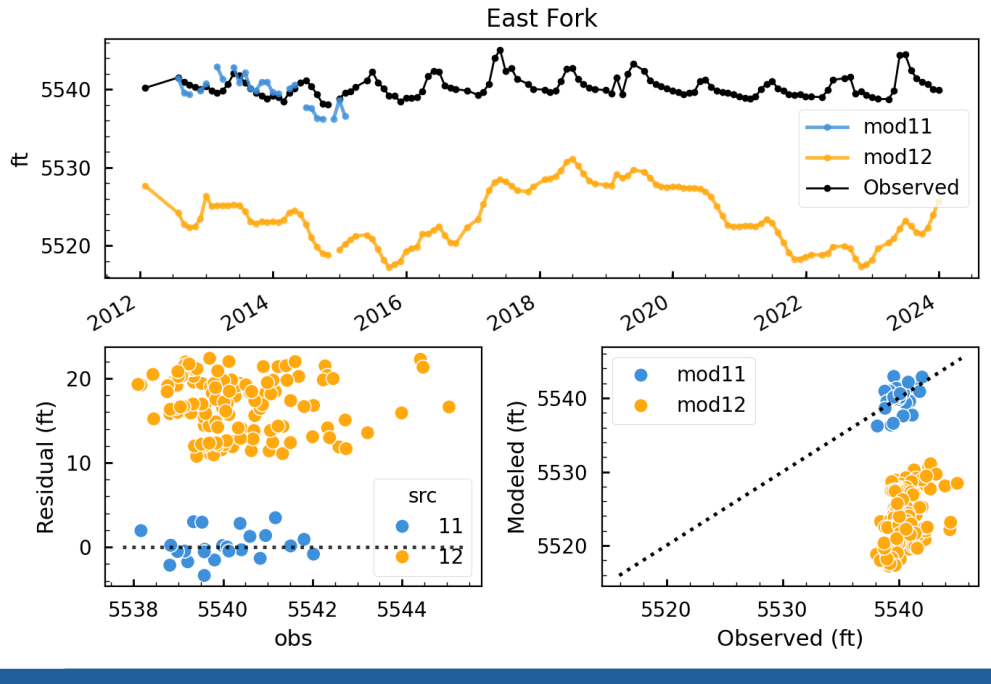

Triumph
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

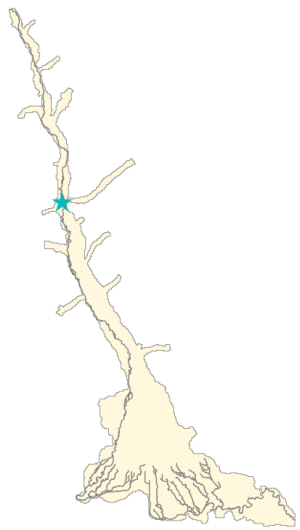


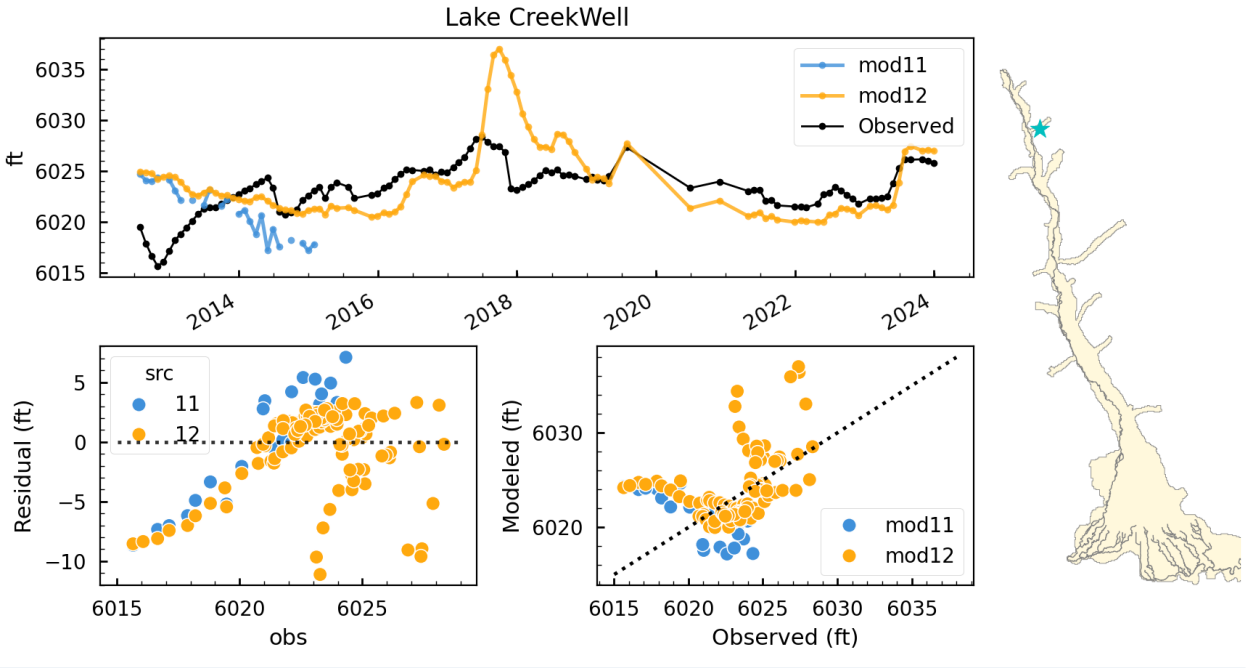

IDOL MW 20
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)


IDOL MW 21
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)

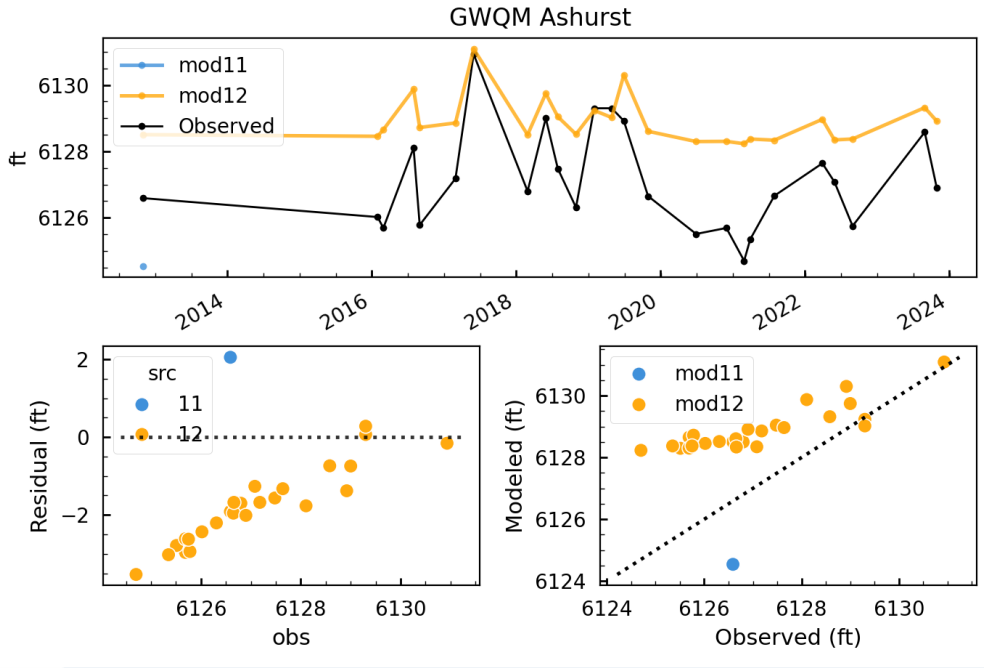


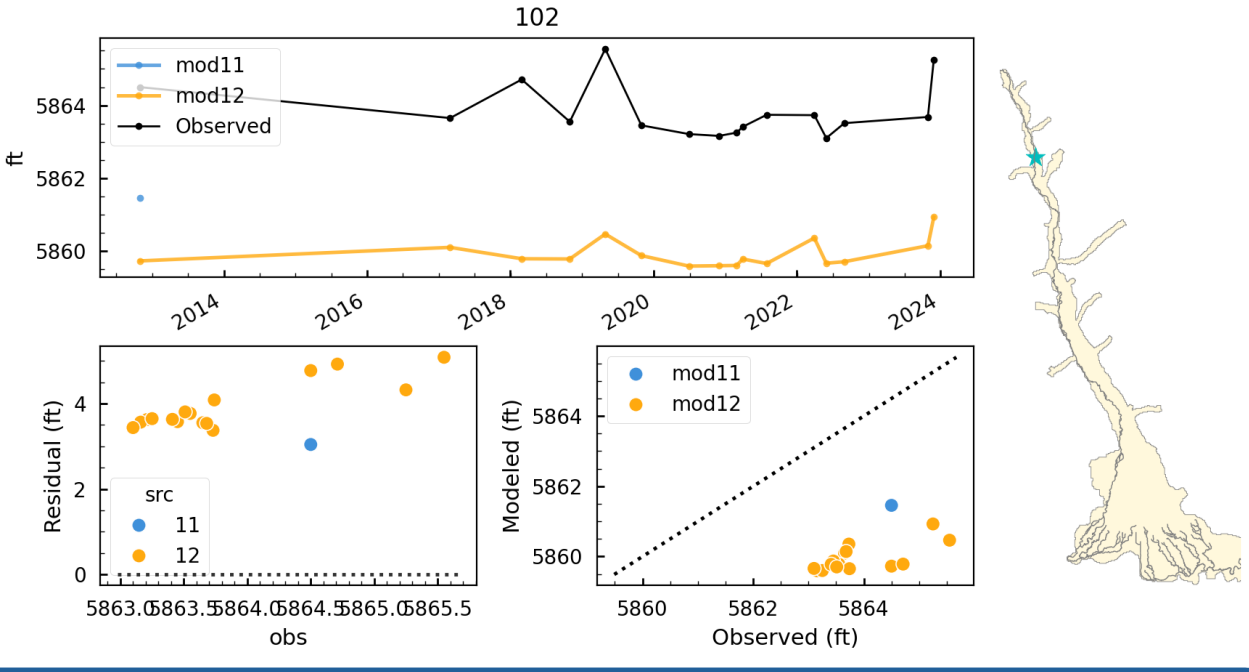

East Fork
ft
mod11
mod12
Observed
Residual (ft)
src
11
12
obs
Modeled (ft)
Observed (ft)



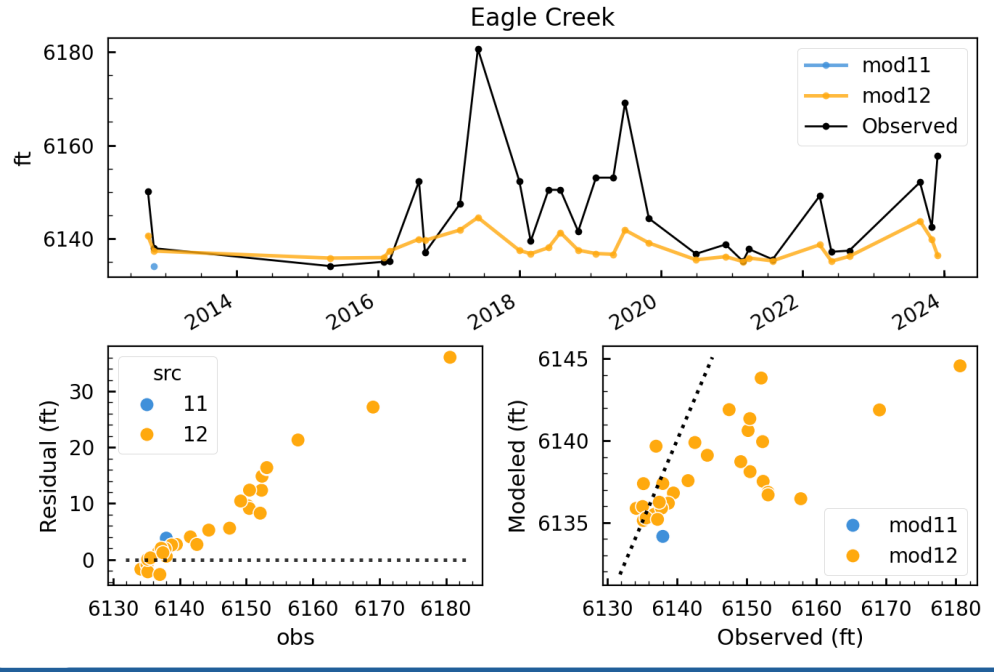

Lake CreekWell
mod11
mod12
Observed
ft
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)




GWQM Ashurst
mod11
mod12
Observed
ft
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)


102
mod11
mod12
Observed
ft
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)




Eagle Creek
mod11
mod12
Observed
ft
src
11
12
Residual (ft)
obs
Modeled (ft)
Observed (ft)

# Next Steps

- Implement CHB for large tributaries (Upper Big Wood, Trail Creek)
- Lower Silver Creek Drain