IDAHO DEPARTMENT OF WATER RESOURCES

WRV MTAC

APRIL 8,2025 AT CSI COMMUNITY CAMPUS

ALEX MOODY

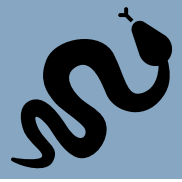
Outline

1. Demo of WRVpy python pre-processor and datasets
2. Calibration Check Up (warts and all)
3. Precipitation Distribution
4. Revisiting discretization and river boundary conditions

WRVGWFM
WRVpy
Preprocessor

Live Demo

Python help



USGS Python for Hydrologists Website: https://doi-usgs.github.io/python-for-hydrology/latest/index.html

- General python introduction, including installation, getting started, and up to using python to create and run MODFLOW models

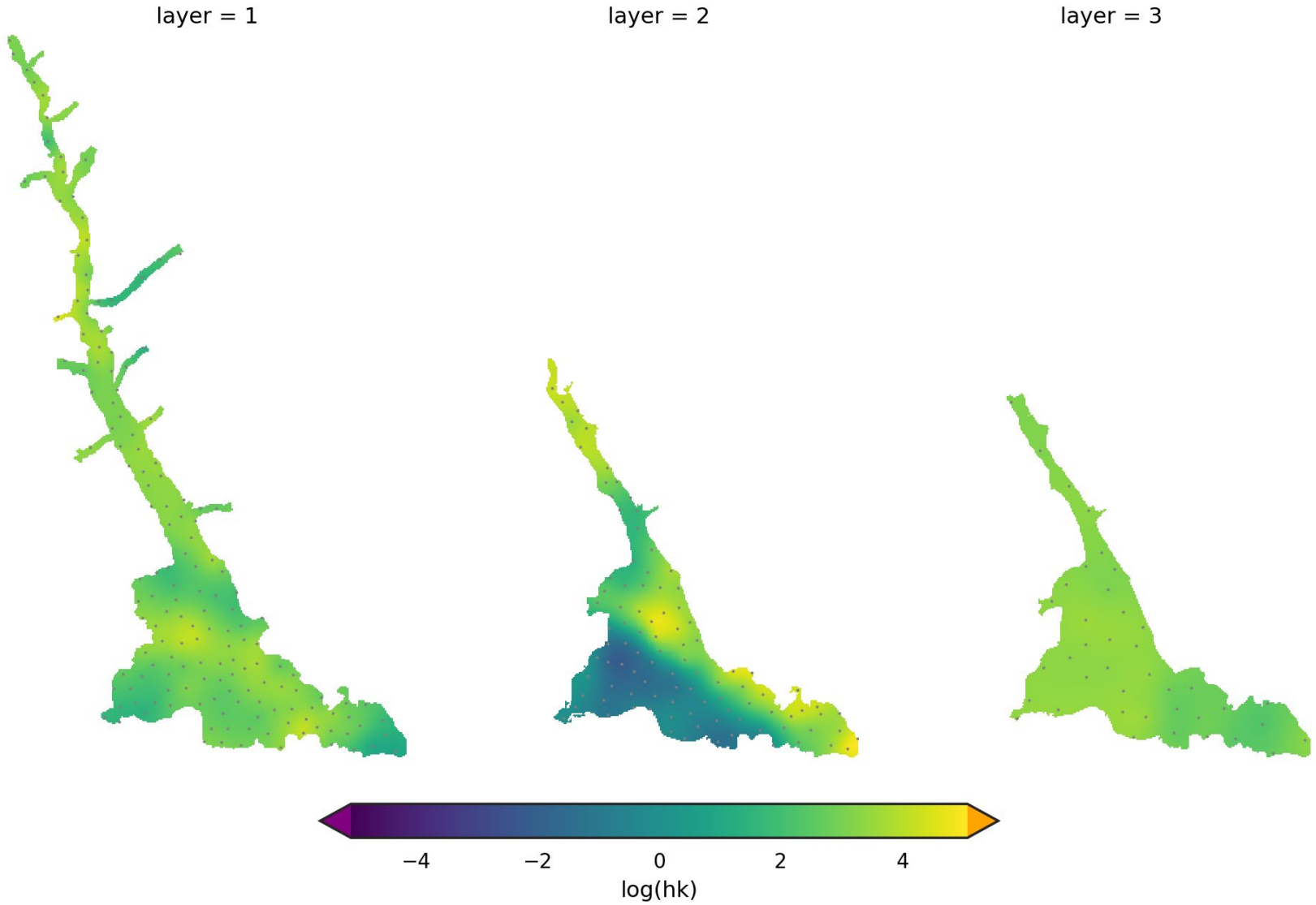
Calibration Update

PEST setup

- **PEST++ GLM**
- **Adjustable Parameters: 629**
- **Non-zero observations: 9,776**
- **Removed separate tributary and basalt pilot point zones**
- **Soil moisture scalar**

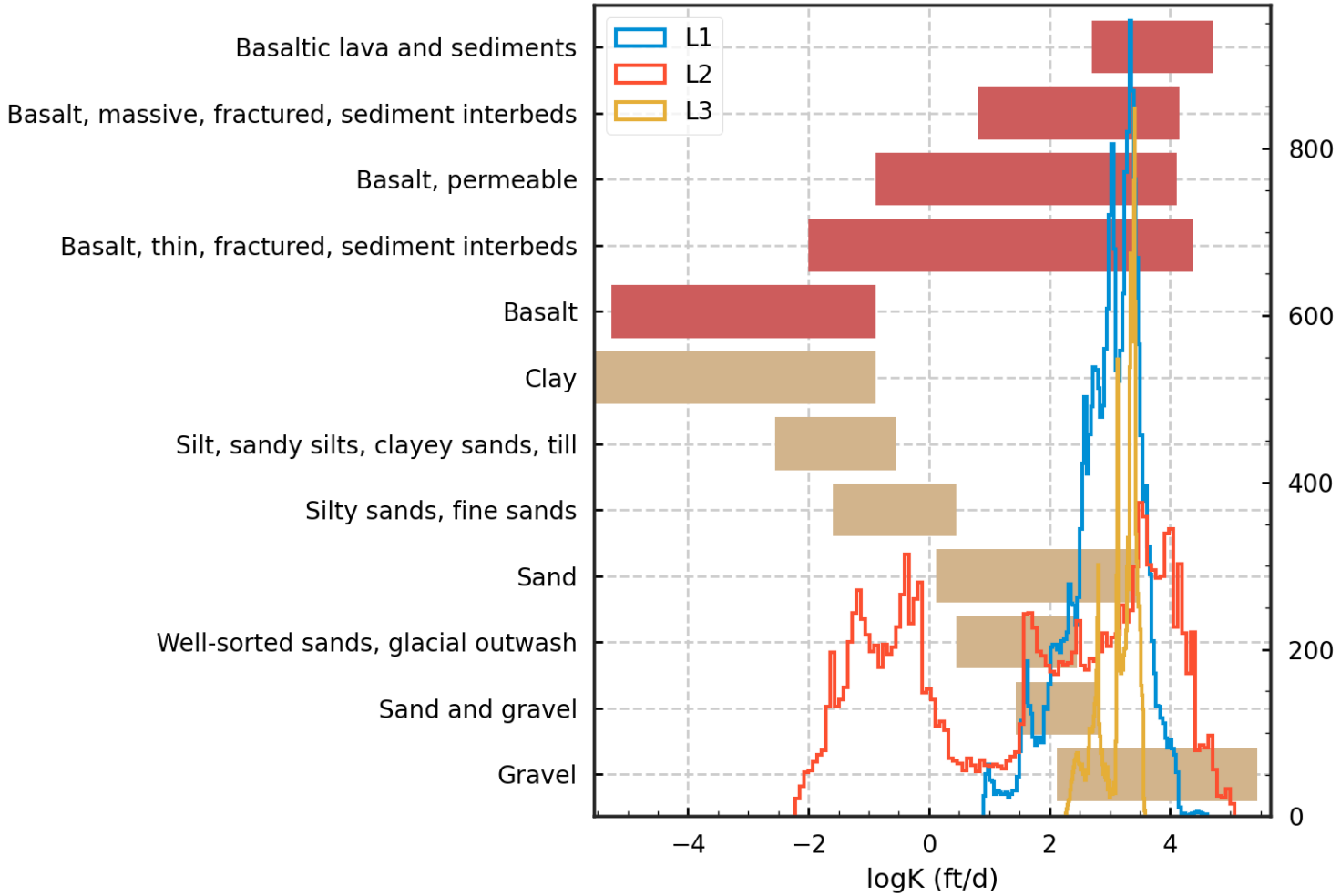
Parameter Category	Parameter Name	count
Aquifer Properties	Hk1 constant	1
	Hk1 pilot point	160
	Hk2 constant	1
	Hk2 pilot point	99
	Hk3 constant	1
	Hk3 pilot point	40
	Vertical HK	1
	S1 constant	1
	S1 pilot point	73
	S2 constant	1
	S2 pilot point	38
	S3 constant	1
	S3 pilot point	38
Conductance	Riverbed	25
	Drain	5
Water Balance	GW efficiency	74
	SW efficiency	53
	Canal Seepage	19
	West Tribs	13
	East Tribs	11
	SMR factor	1
	Underflow	2

Hydraulic Conductivity



Hydraulic Conductivity

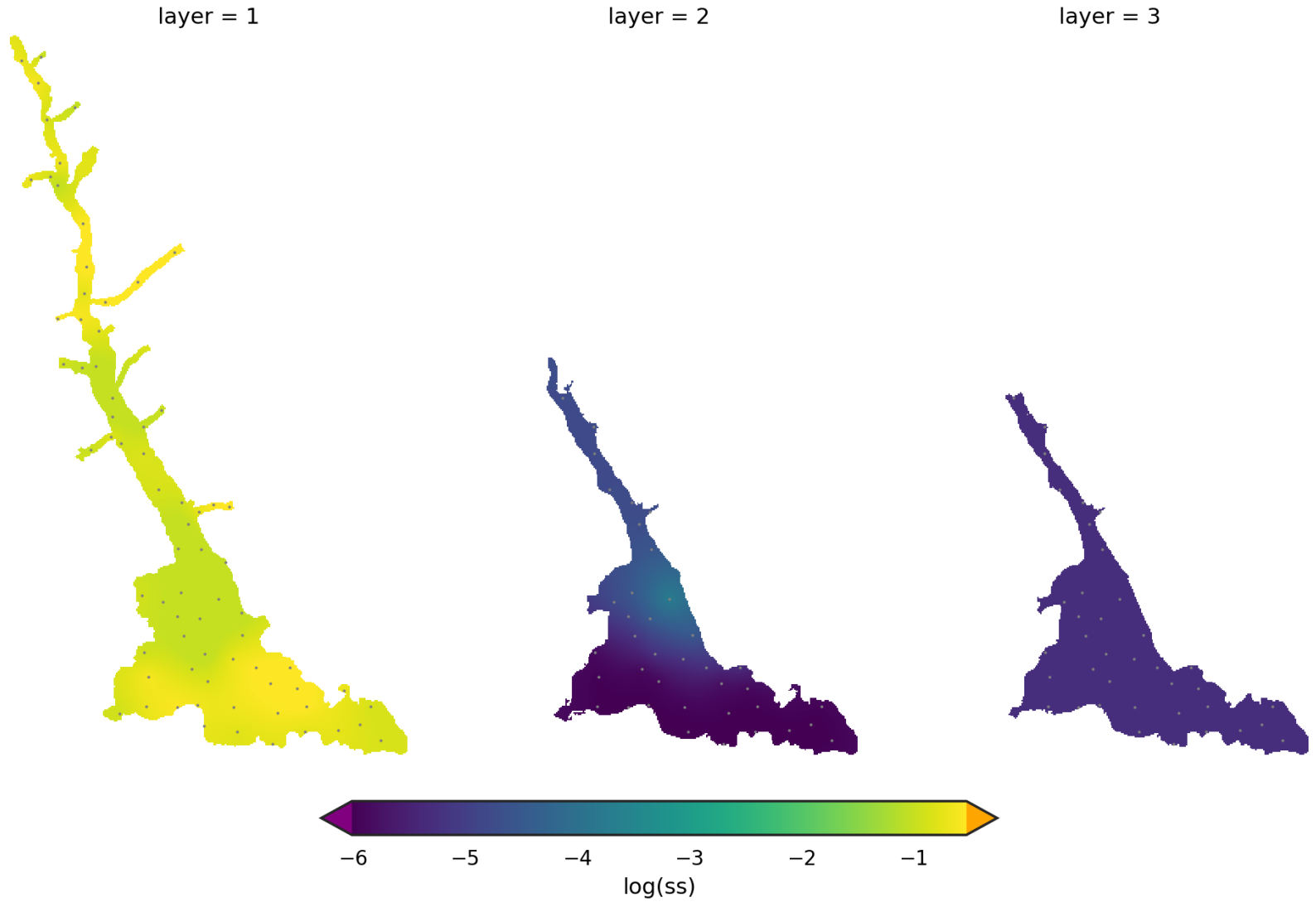
- **Upper bound on conductivity has clipped off the few extremely high conductivity cells**
- **Lower end of clay conductivity is higher than in 1.1**
- **Basalts (layer 3) within higher range of literature values**



Specific Storage

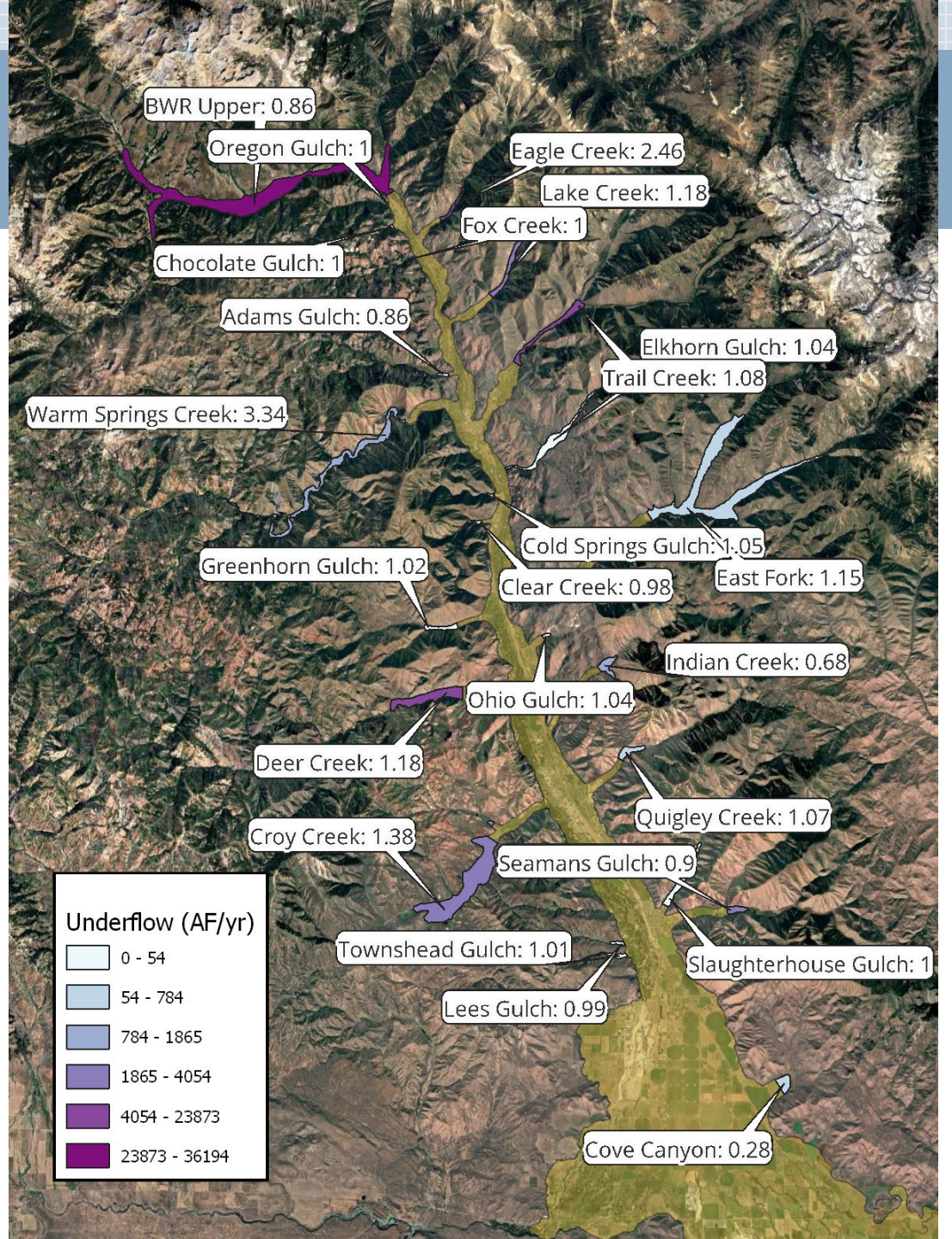
Average by layer

- 1: 0.16
- 2: 0.000013
- 3: 0.000005



Tributary Underflow

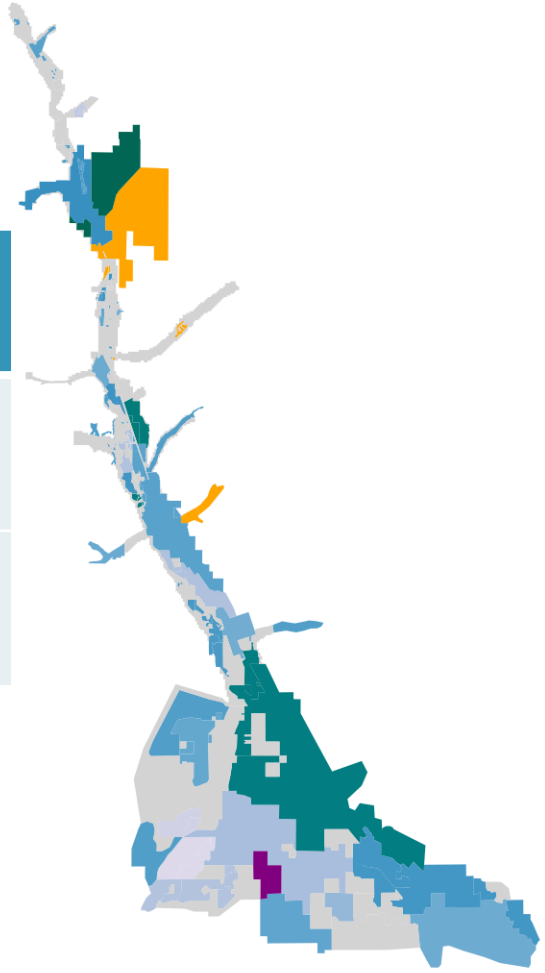
- **Reduction = 5.32**
- **Moving average window: 24 days**
- **Initial volumes set to WRV 1.1 values.**
  - PEST factor bounds= 0.01 to 10



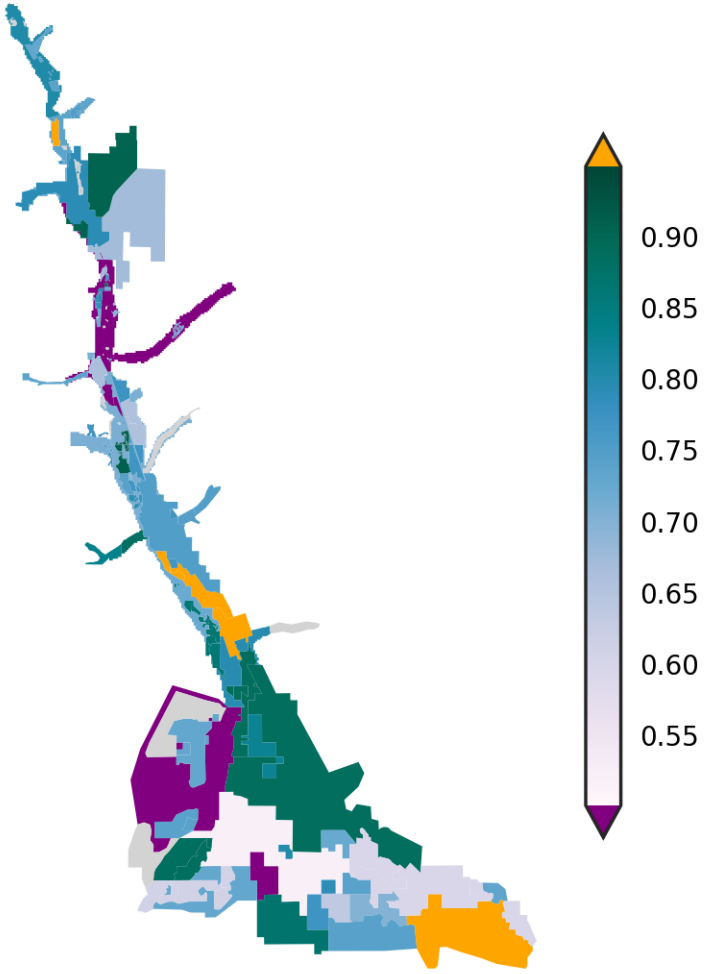
Efficiencies for pumping estimates

	mean	std	min	25%	50%	75%	max
Eff gw	0.750	0.1064	0.5	0.717	0.751	0.794	0.98
Eff sw	0.747	0.0810	0.5	0.722	0.75	0.766	0.95

Surface water efficiency



Ground water efficiency

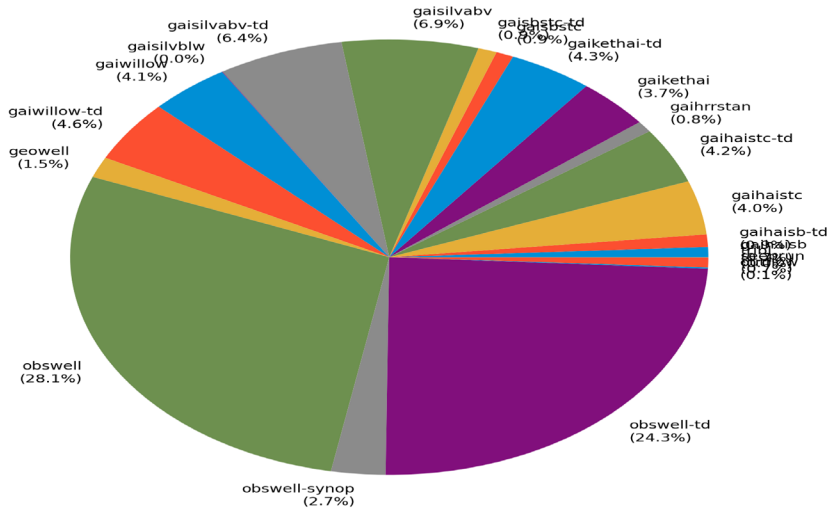


Observation Targets

Objective Function Phi

Beginning of Run: 35,163

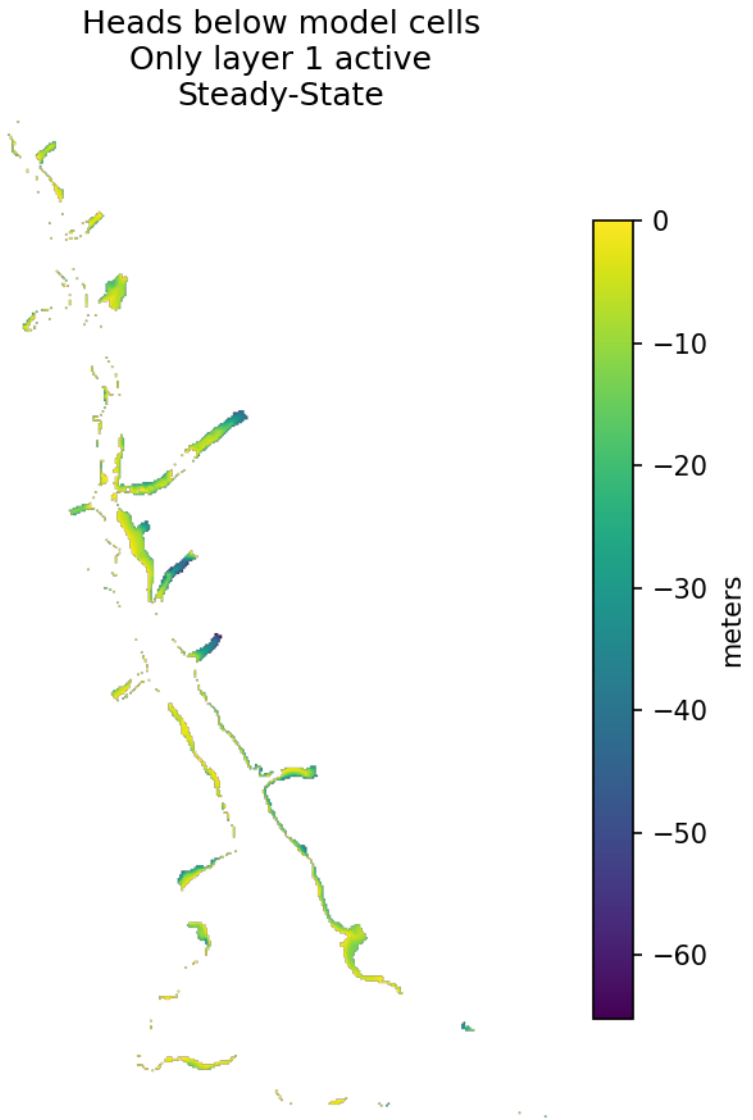
End of Run: 5,475

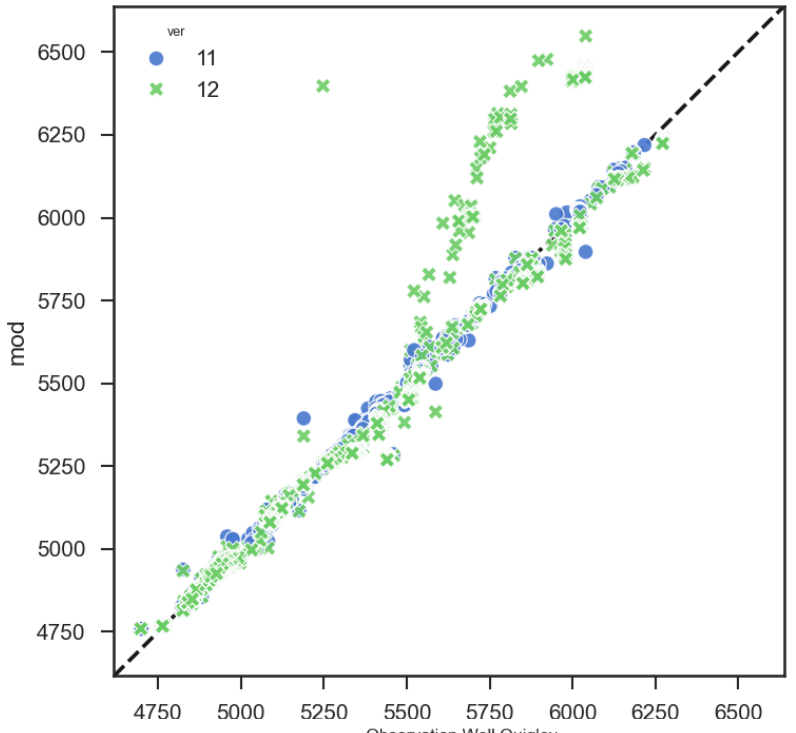


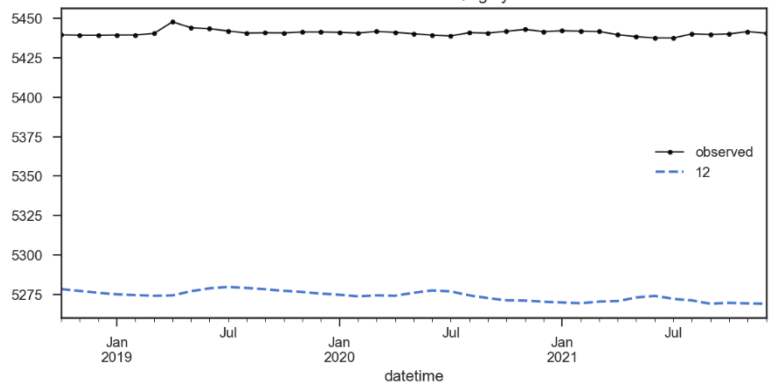
Objective Function Weights

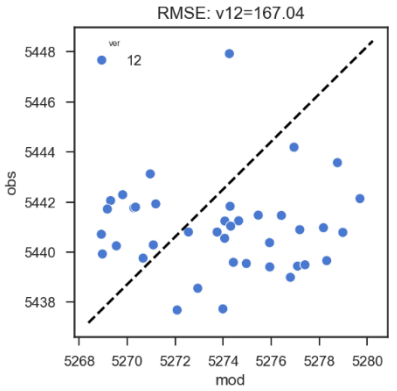
Group	Name	non-zero weight	zero weight
Gains	gaihaisb	53	0
	gaihaisb-td	52	0
	gaihaistc	250	0
	gaihaistc-td	249	0
	gaihrrstan	103	0
	gaikethai	254	0
	gaikethai-td	253	0
	gain-season	0	128
	gaisbstc	53	0
	gaisbstc-td	52	0
	gaisilvabv	327	0
	gaisilvabv-td	323	0
	gaisilvblw	324	0
	gaiwillow	257	0
	gaiwillow-td	256	0
	seeprun	50	0
Heads	geowell	254	0
	obswell	3443	0
	obswell-synop	198	0
	obswell-td	3018	0
Misc	outflow	2	0
	pumpvol	0	6
	tribl	5	0

Un(re)calibrated run





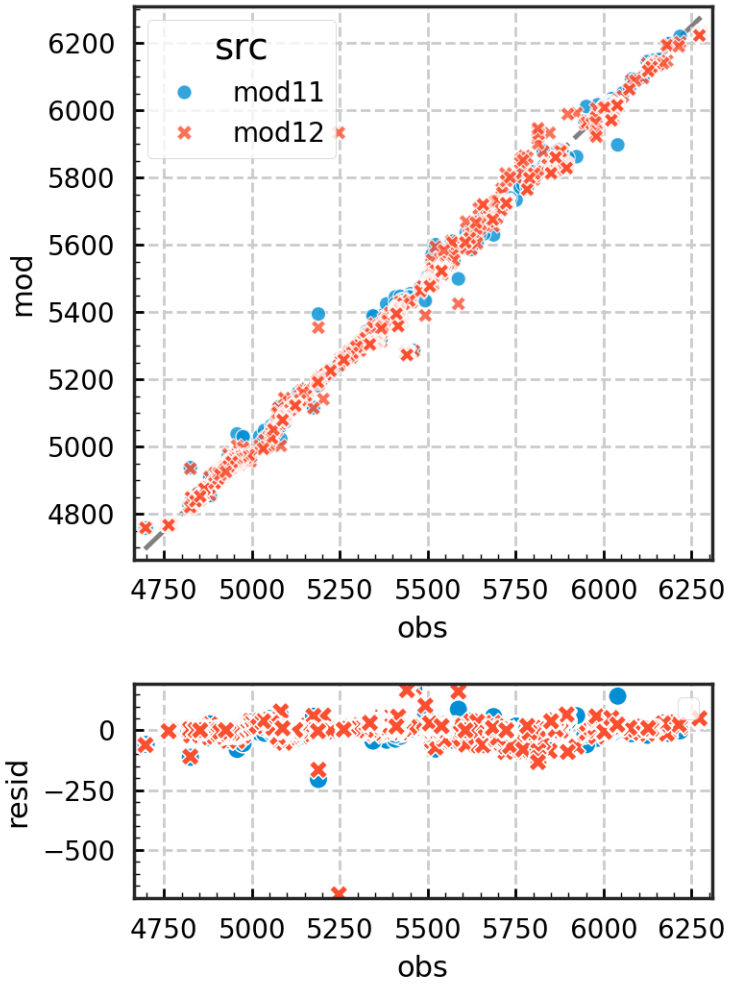


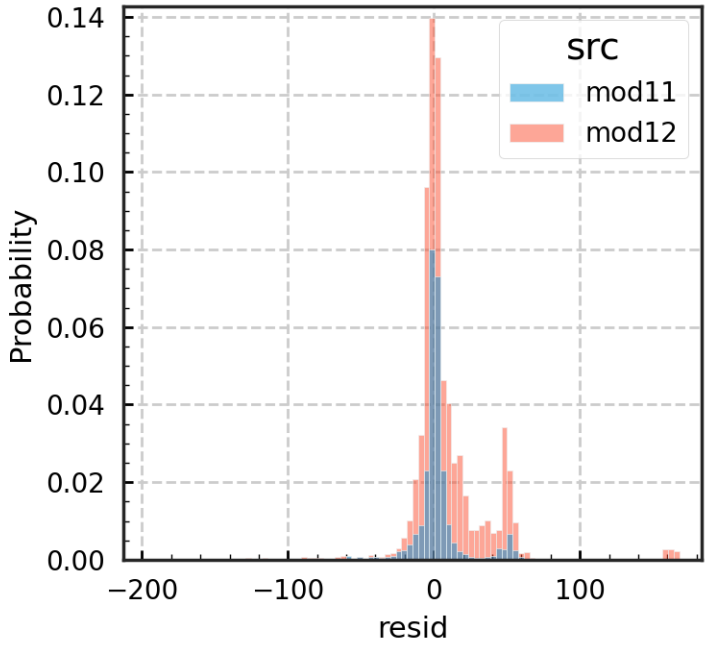


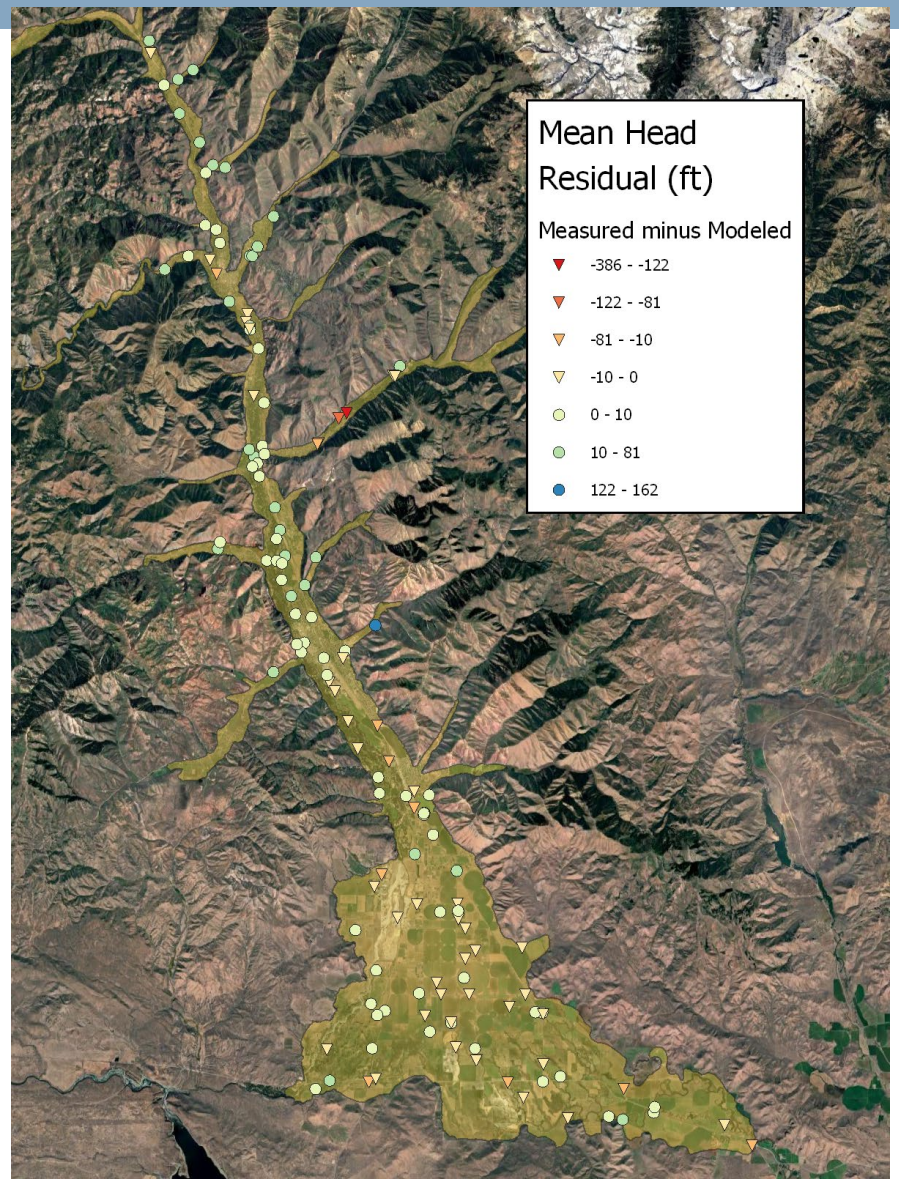
- First run with new recharge data and observation wells highlighted heads below aquifer in trib canyons
- Confined representation allows MODFLOW to solve flow equations
- Increase weights on tributary canyon synoptic wells

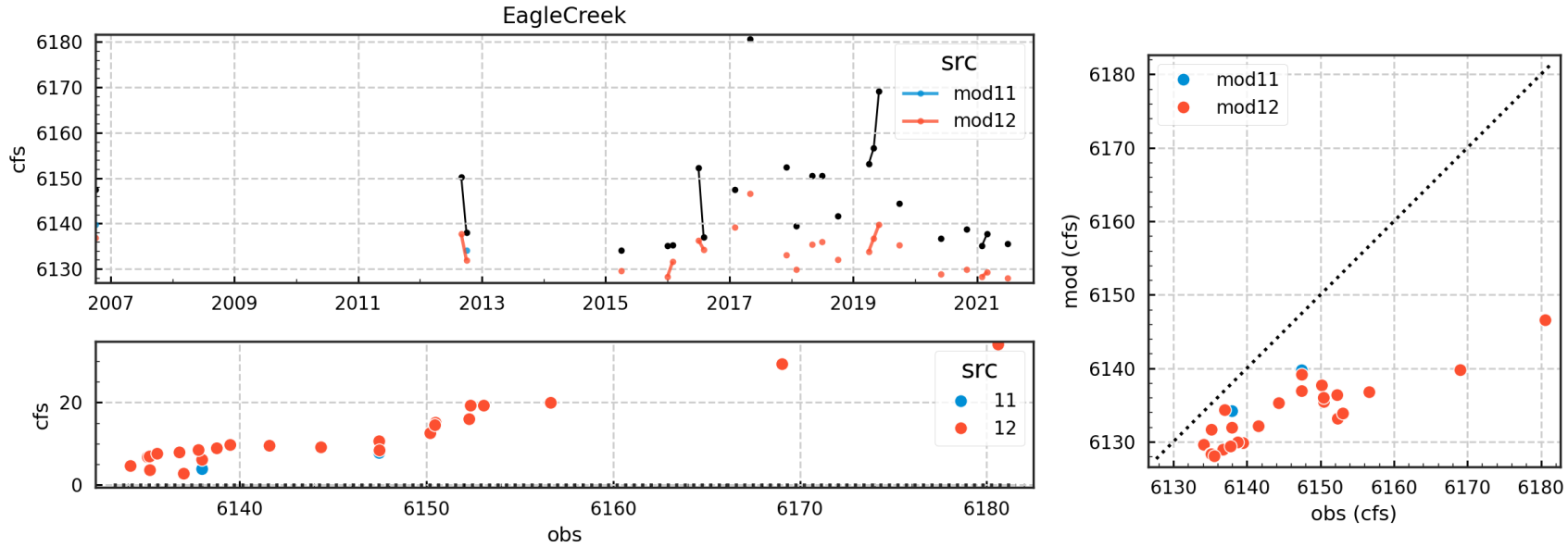
Head Targets

Residual Statistic (ft)	Well heads	Time-differenced heads	Synoptic Observation	Driller Logs
mean	9.76	1.54	4.15	-4.58
std	25.68	6.32	15.11	55.5
min	-132.62	-27.66	-61.21	-685.87
25%	-3.08	-1.39	-0.45	-11.63
50%	1.5	1.16	3.79	1.24
75%	14.15	4.08	9.89	13.4
max	169.17	34.69	57.27	175.78

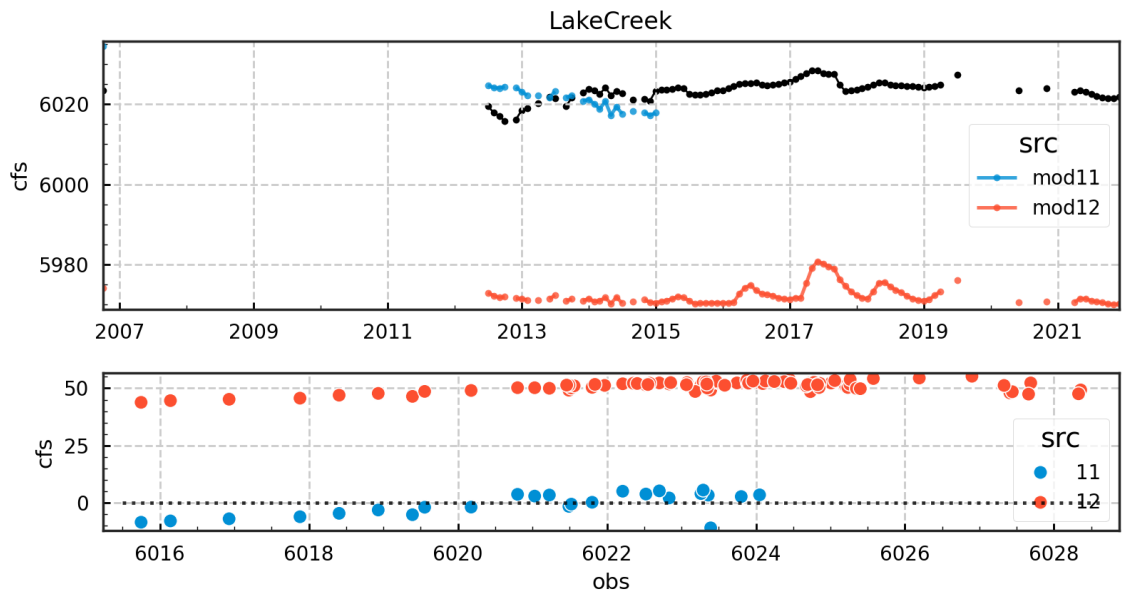





Mean Head Residual (ft)
Measured minus Modeled
-386 - -122
-122 - -81
-81 - -10
-10 - 0
0 - 10
10 - 81
122 - 162


EagleCreek
cfs
6180
6170
6160
6150
6140
6130
2007
2009
2011
2013
2015
2017
2019
2021
src
mod11
mod12
cfs
20
0
6140
6150
6160
6170
6180
obs
src
11
12

mod11
mod12
6180
6170
6160
6150
6140
6130
mod (cfs)
6130
6140
6150
6160
6170
6180
obs (cfs)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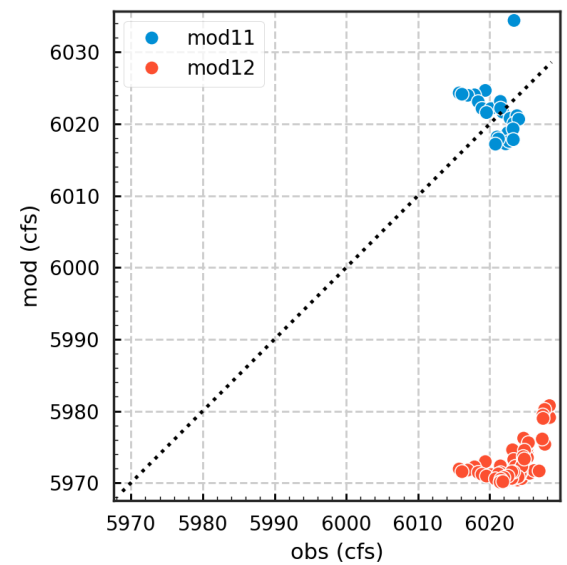
6020
6000
5980
2007
2009
2011
2013
2015
2017
2019
2021
src
mod11
mod12
cfs
50
25
0
6016
6018
6020
6022
6024
6026
6028
obs
src
11
12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mod12
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6020
6010
6000
5990
5980
5970
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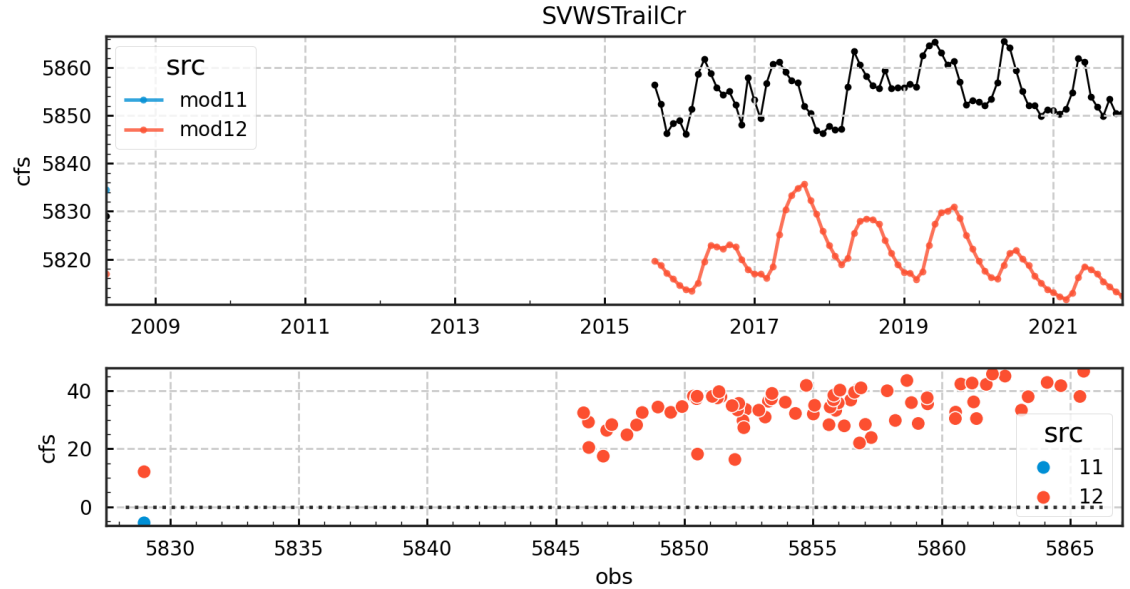
5980
5990
6000
6010
6020
obs (cfs)


SVWSTrailCr
src
mod11
mod12
cfs
5860
5850
5840
5830
5820
2009
2011
2013
2015
2017
2019
2021
40
20
0
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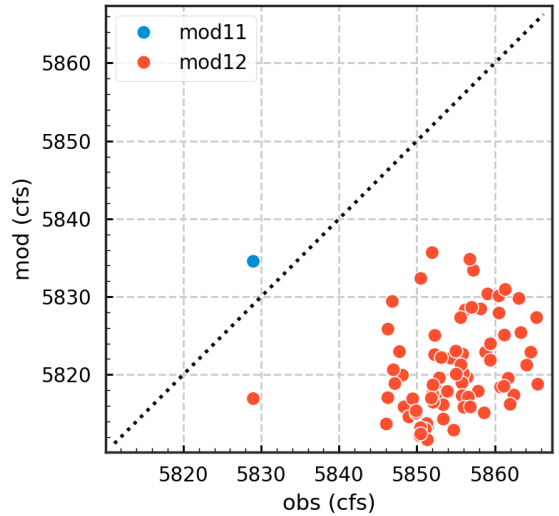
5835
5840
5845
5850
5855
5860
5865
obs
11
12


mod11
mod12
mod (cfs)
obs (cfs)
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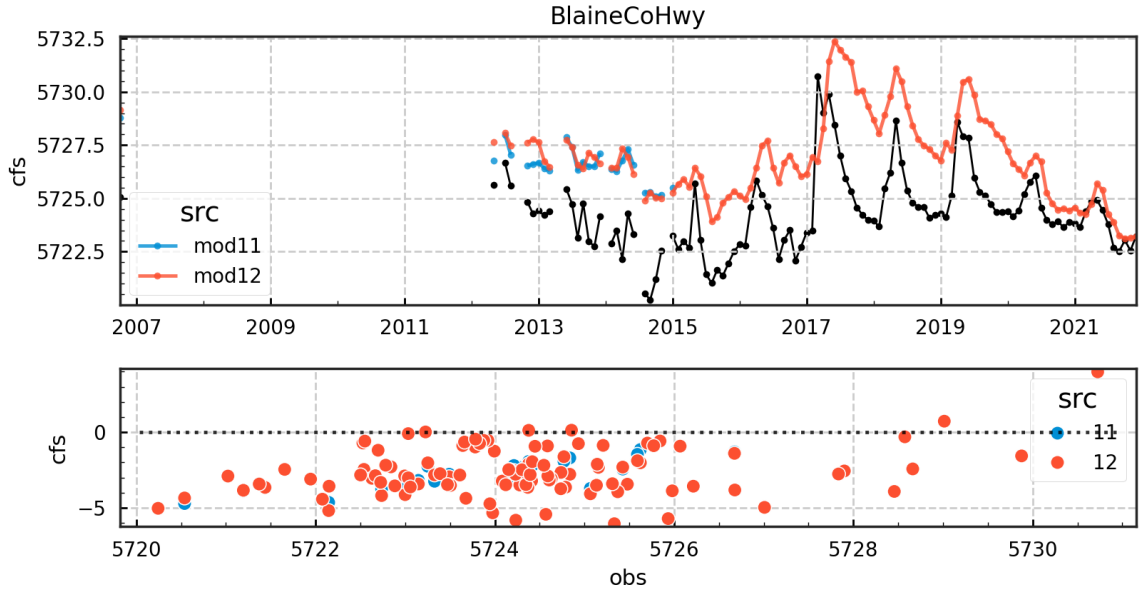
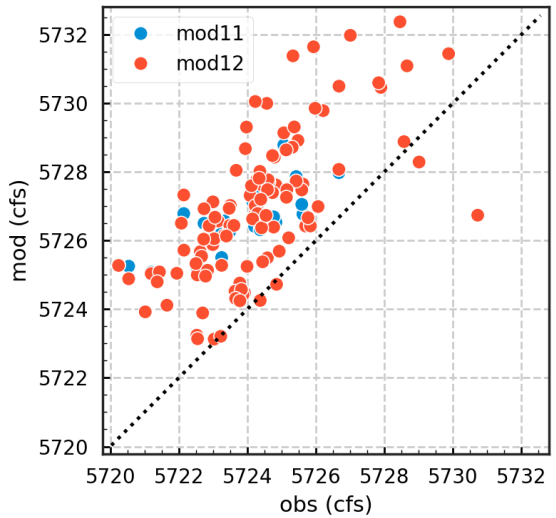
5830
5840
5850
5860


BlaineCoHwy
src
mod11
mod12
cfs
5732.5
5730.0
5727.5
5725.0
5722.5
2007
2009
2011
2013
2015
2017
2019
2021
0
−5
5720
5722
5724
5726
5728
5730
obs
11
12


mod11
mod12
mod (cfs)
obs (cfs)
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5722
5724
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5728
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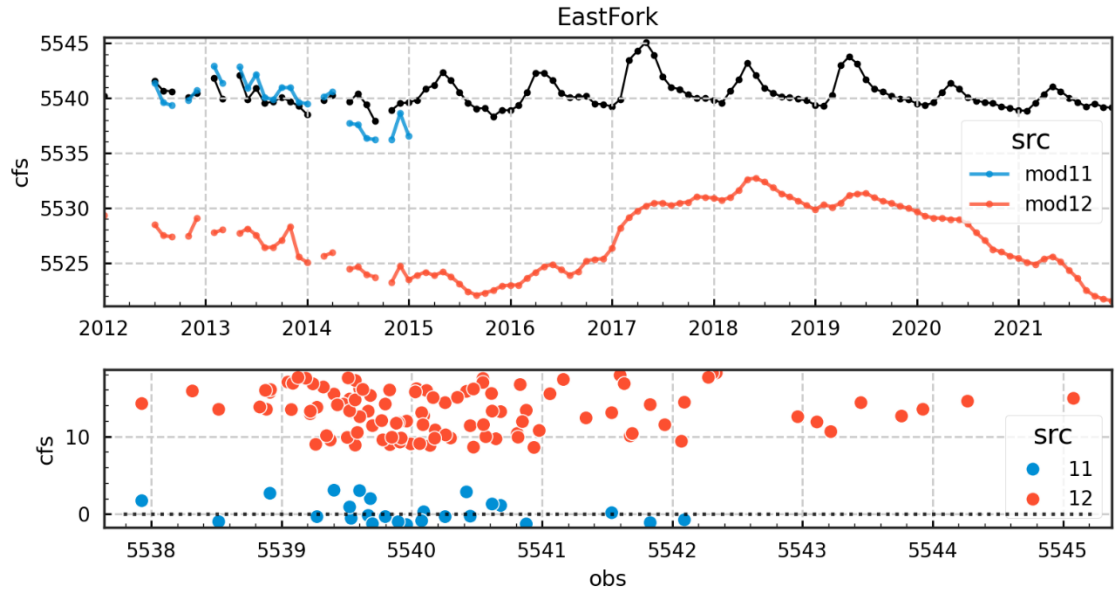
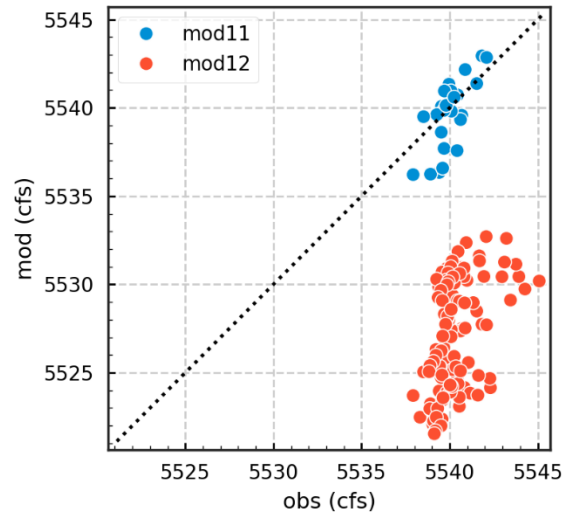
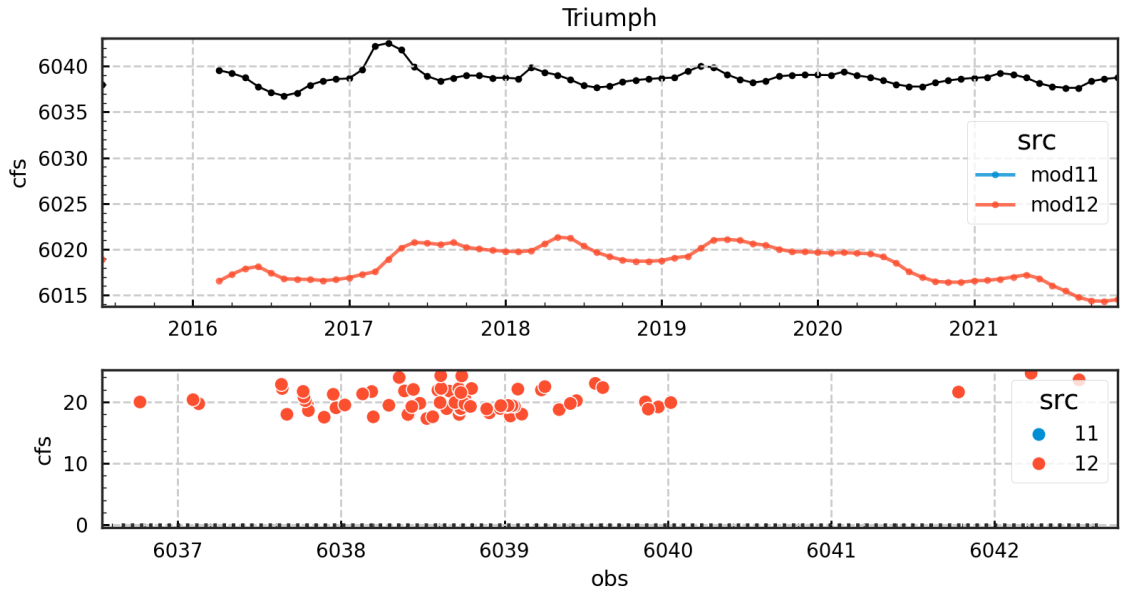
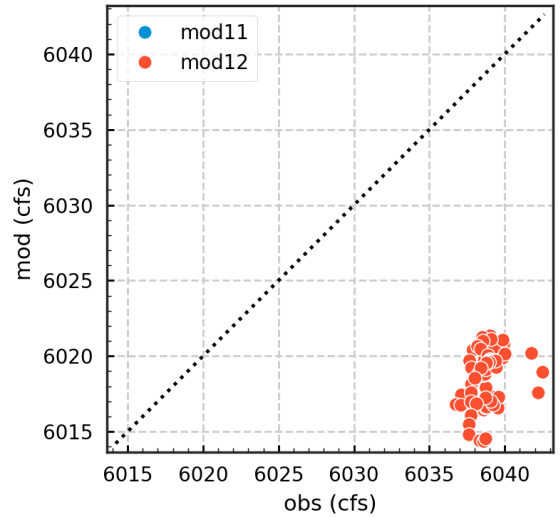
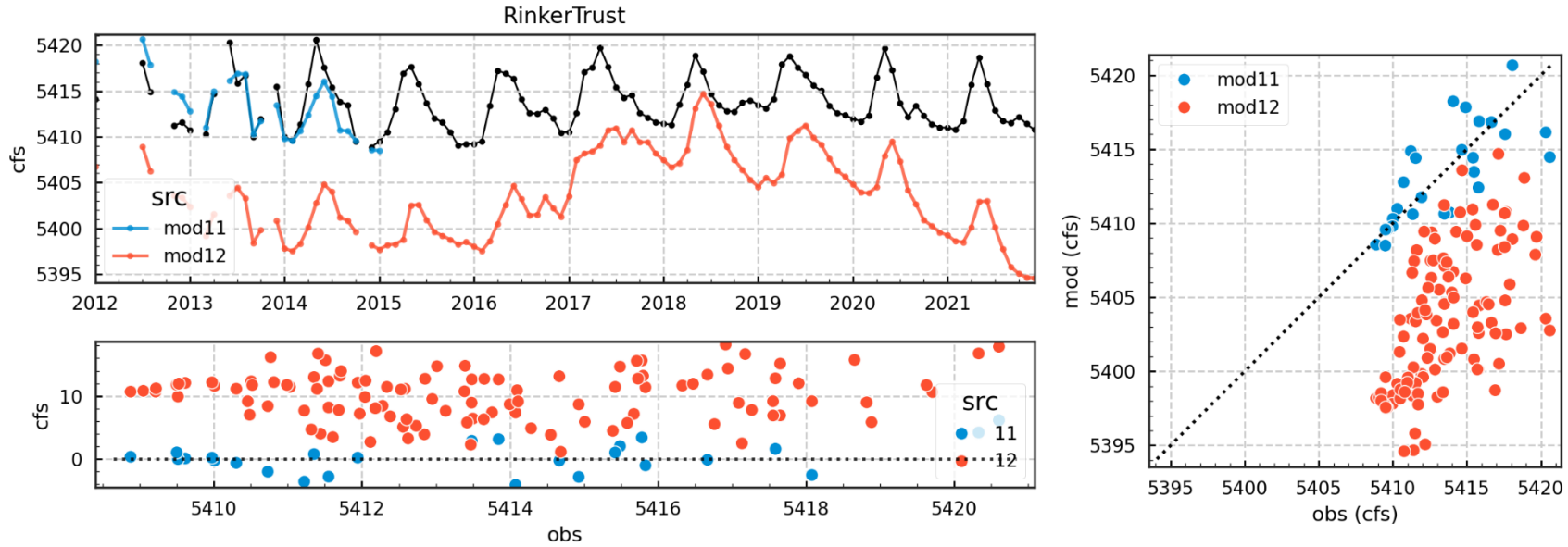
5732

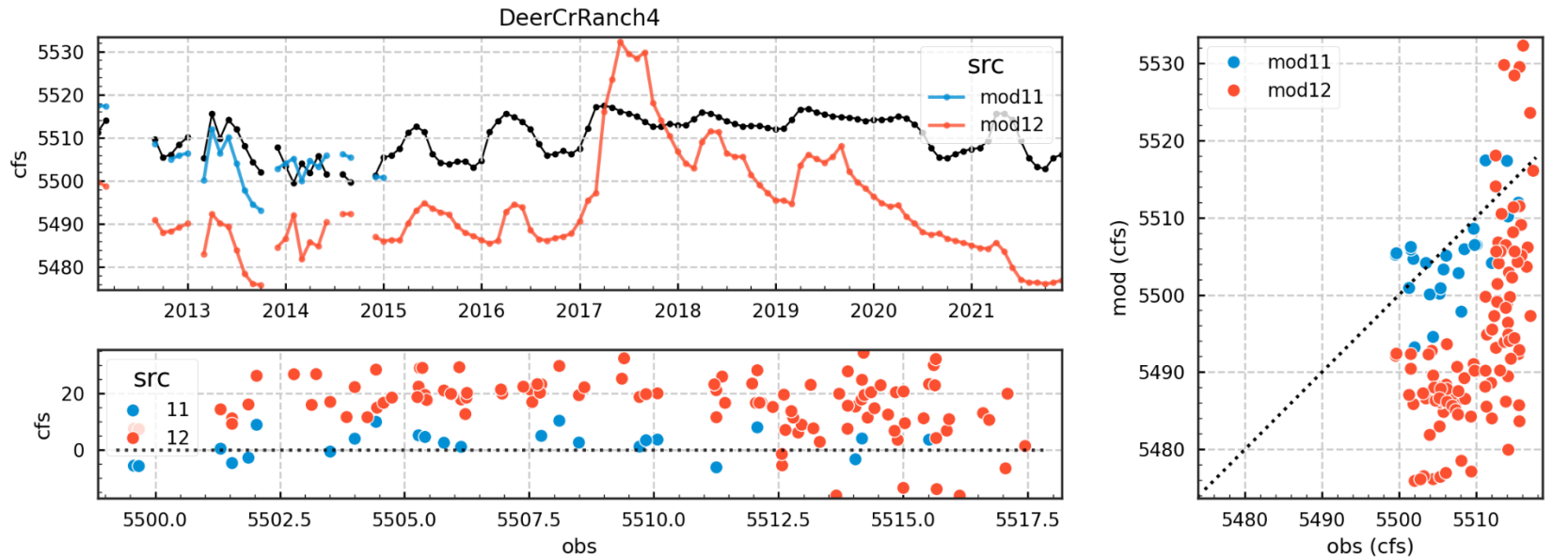

EastFork
cfs
src
mod11
mod12
obs
11
12

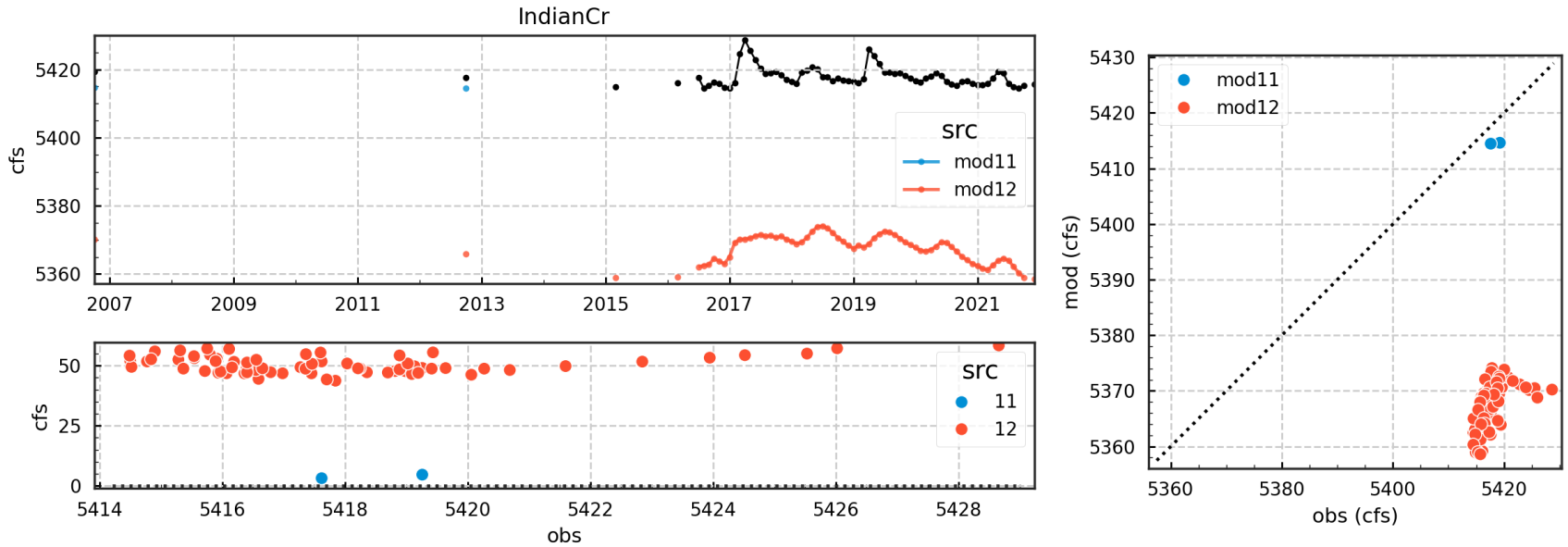

mod11
mod12
mod (cfs)
obs (cfs)

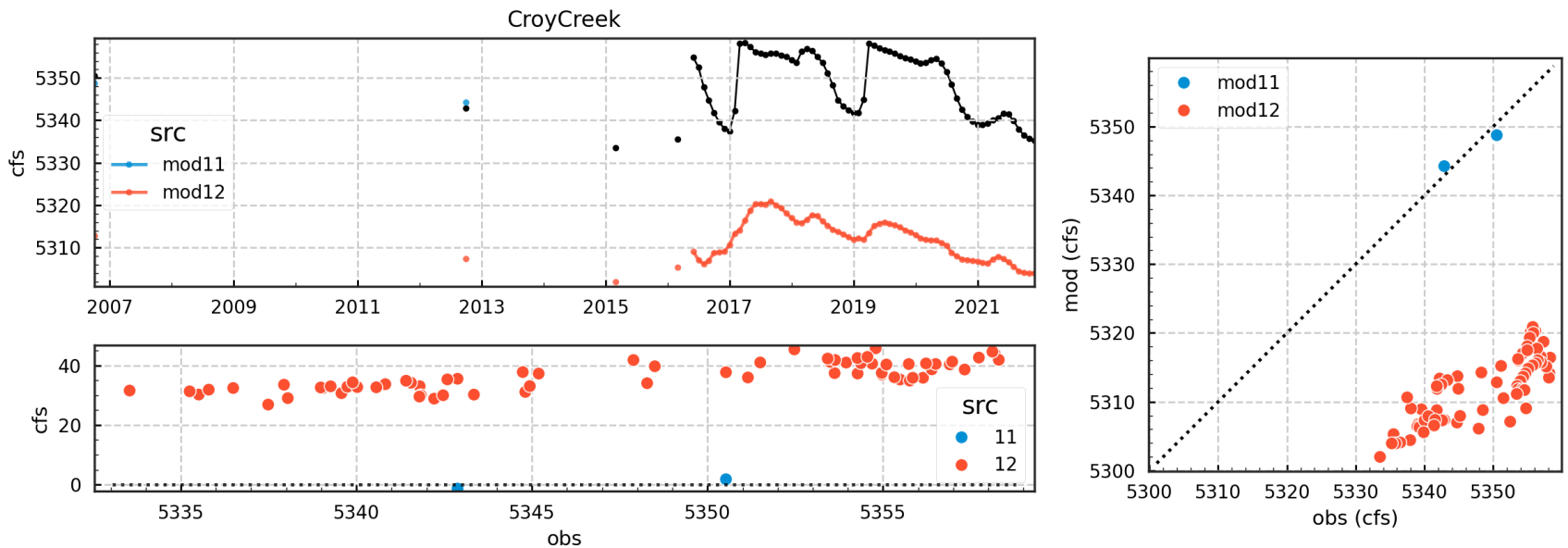

Triumph
cfs
src
mod11
mod12
obs
11
12

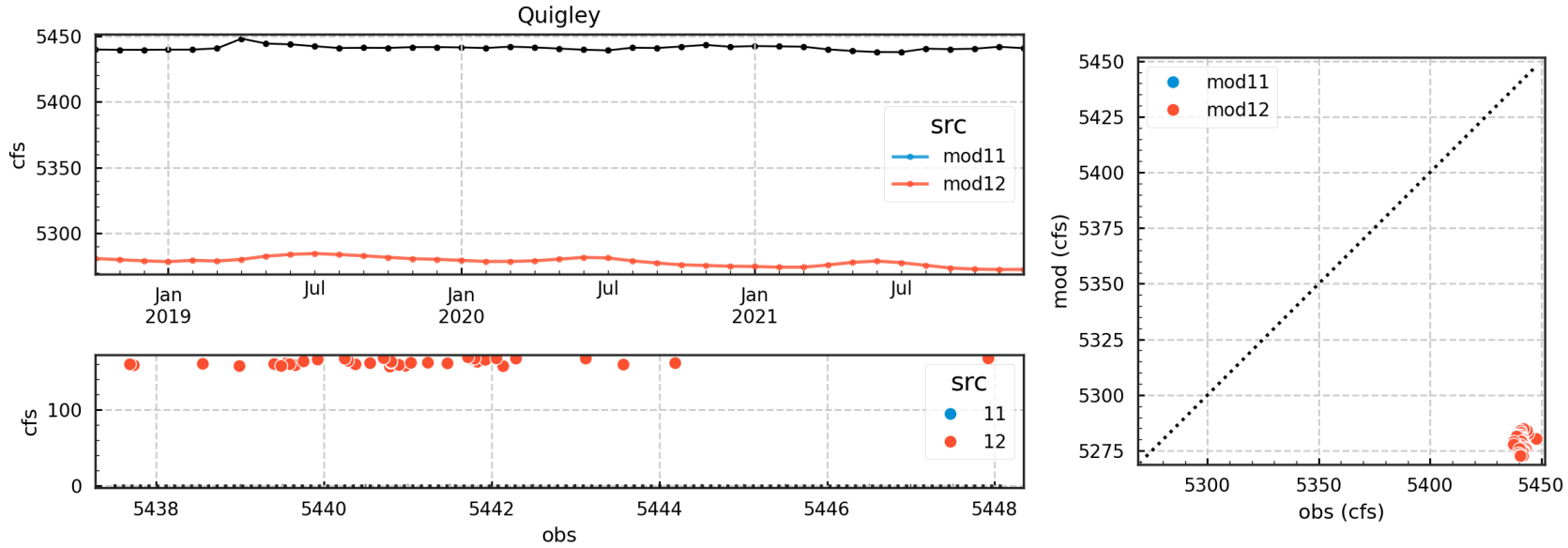

mod11
mod12
mod (cfs)
obs (cfs)

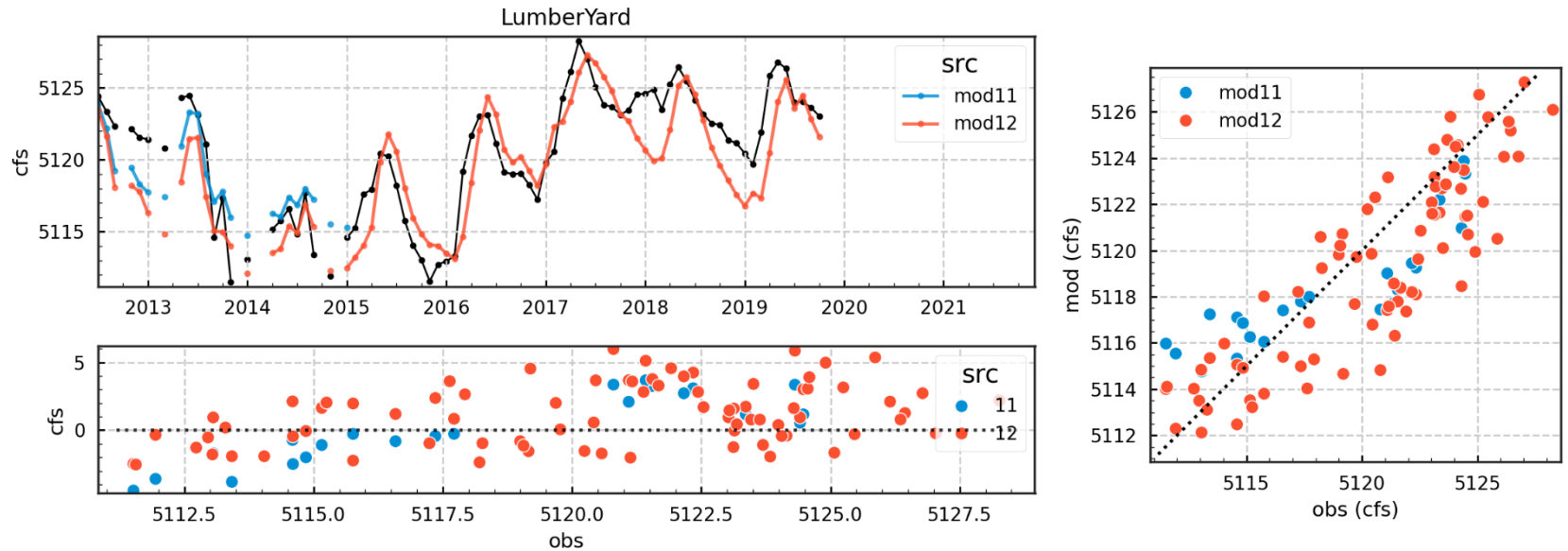

RinkerTrust
cfs
src
mod11
mod12
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
obs
mod (cfs)
obs (cfs)

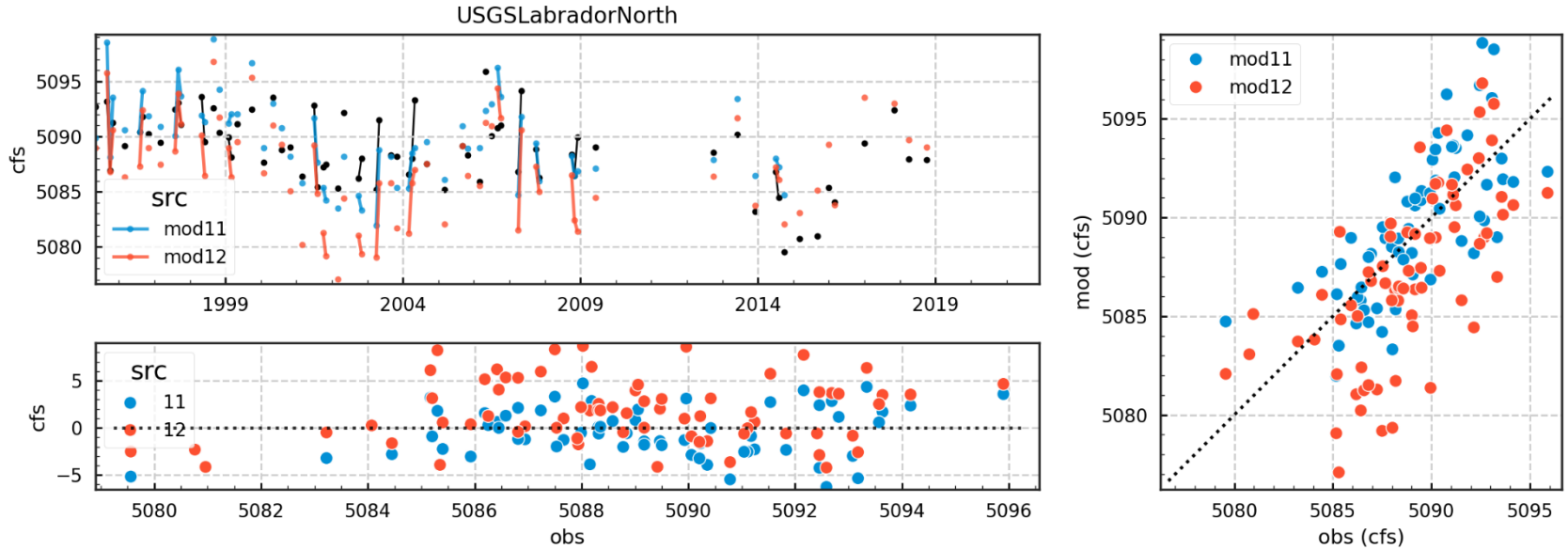

DeerCrRanch4
cfs
src
mod11
mod12
obs
mod (cfs)
obs (cfs)

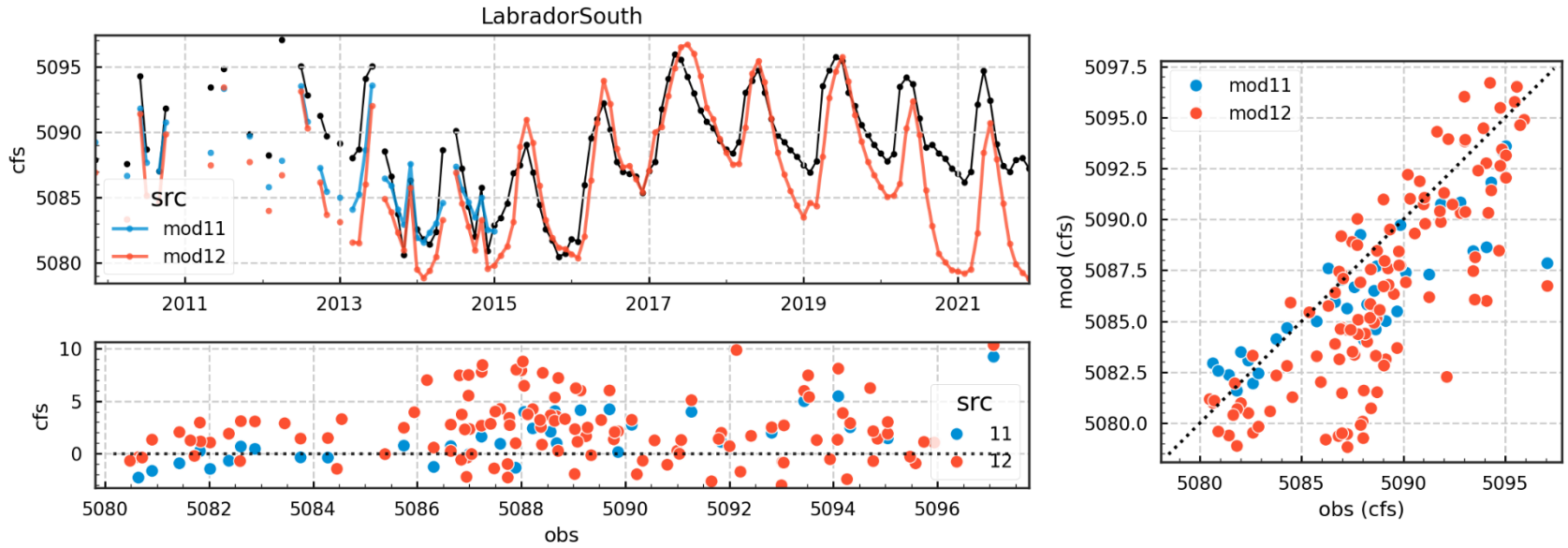

IndianCr
cfs
src
mod11
mod12
obs
11
12
mod (cfs)
obs (cfs)

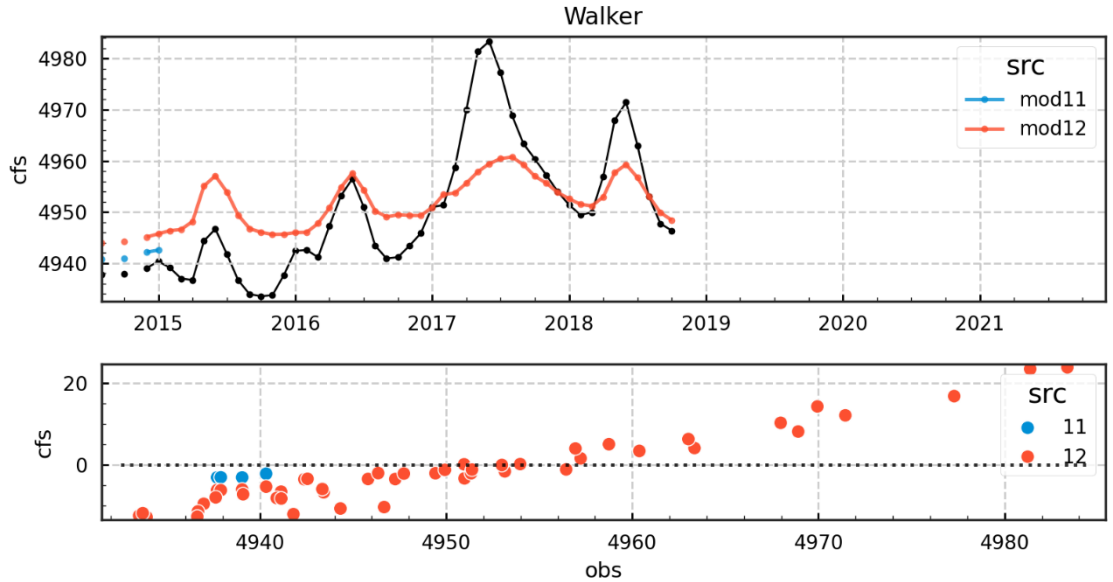

CroyCreek
cfs
src
mod11
mod12
obs
11
12
mod (cfs)
obs (cfs)

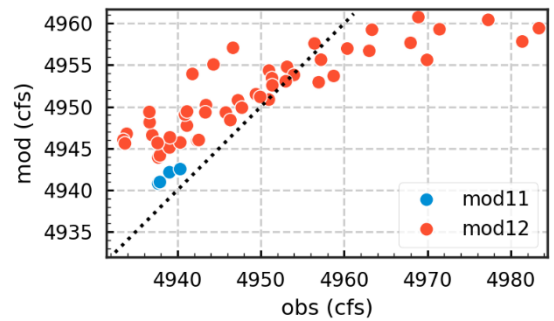

Quigley
cfs
5450
5400
5350
5300
Jan
2019
Jul
Jan
2020
Jul
Jan
2021
Jul
src
mod11
mod12
cfs
100
0
5438
5440
5442
5444
5446
5448
obs
src
11
12
mod (cfs)
5450
5425
5400
5375
5350
5325
5300
5275
5300
5350
5400
5450
obs (cfs)
mod11
mod12

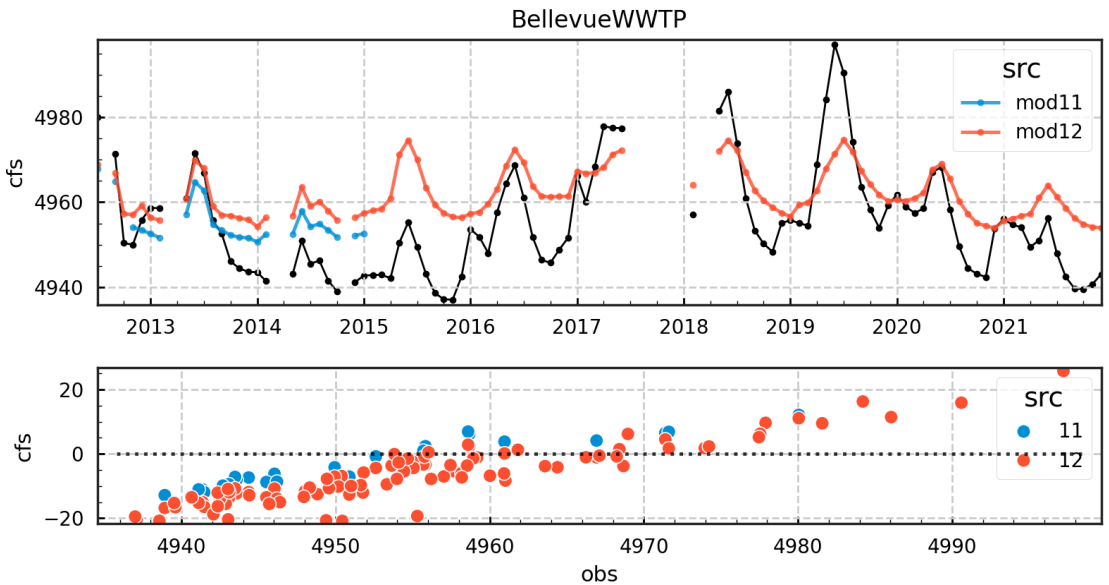

LumberYard
cfs
5125
5120
5115
2013
2014
2015
2016
2017
2018
2019
2020
2021
src
mod11
mod12
cfs
5
0
5112.5
5115.0
5117.5
5120.0
5122.5
5125.0
5127.5
obs
src
11
12
mod (cfs)
5126
5124
5122
5120
5118
5116
5114
5112
5115
5120
5125
obs (cfs)
mod11
mod12

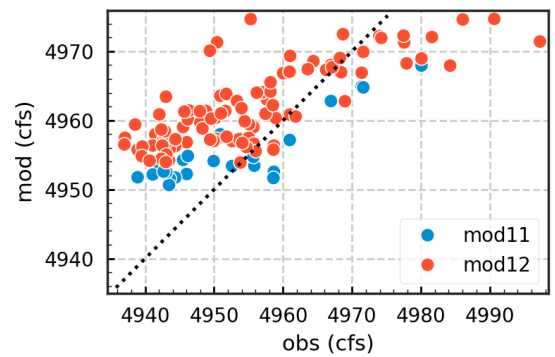

USGSLabradorNorth
cfs
src
mod11
mod12
1999
2004
2009
2014
2019
5095
5090
5085
5080
src
11
12
5
0
−5
5080
5082
5084
5086
5088
5090
5092
5094
5096
obs
mod11
mod12
mod (cfs)
obs (cfs)


LabradorSouth
cfs
src
mod11
mod12
2011
2013
2015
2017
2019
2021
5095
5090
5085
5080
src
11
12
10
5
0
5080
5082
5084
5086
5088
5090
5092
5094
5096
obs
mod11
mod12
mod (cfs)
obs (cfs)
5097.5
5095.0
5092.5
5090.0
5087.5
5085.0
5082.5
5080.0


Walker
src
mod11
mod12
cfs
4980
4970
4960
4950
4940
2015
2016
2017
2018
2019
2020
2021
20
0
cfs
src
11
12
4940
4950
4960
4970
4980
obs


mod (cfs)
4960
4955
4950
4945
4940
4935
mod11
mod12
4940
4950
4960
4970
4980
obs (cfs)


BellevueWWTP
src
mod11
mod12
cfs
4980
4960
4940
2013
2014
2015
2016
2017
2018
2019
2020
2021
20
0
−20
cfs
src
11
12
4940
4950
4960
4970
4980
4990
obs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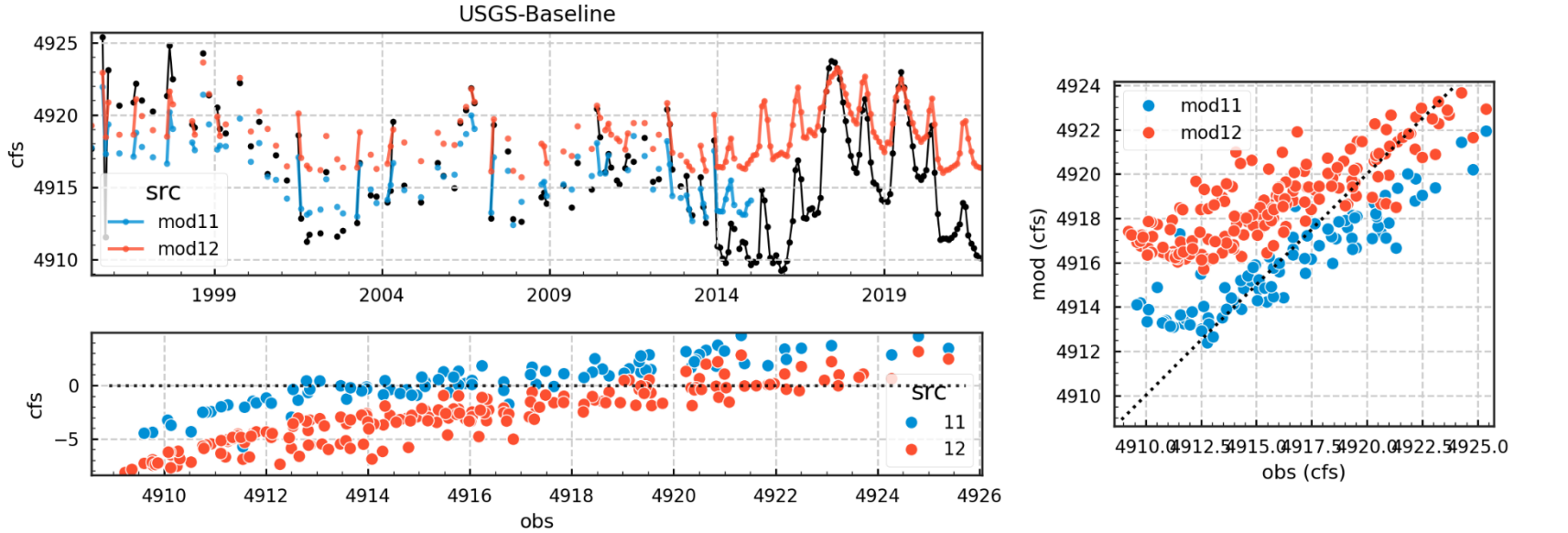
4980
4990
obs (cfs)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src
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4922
4924
4926
obs
mod (cfs)
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mod12
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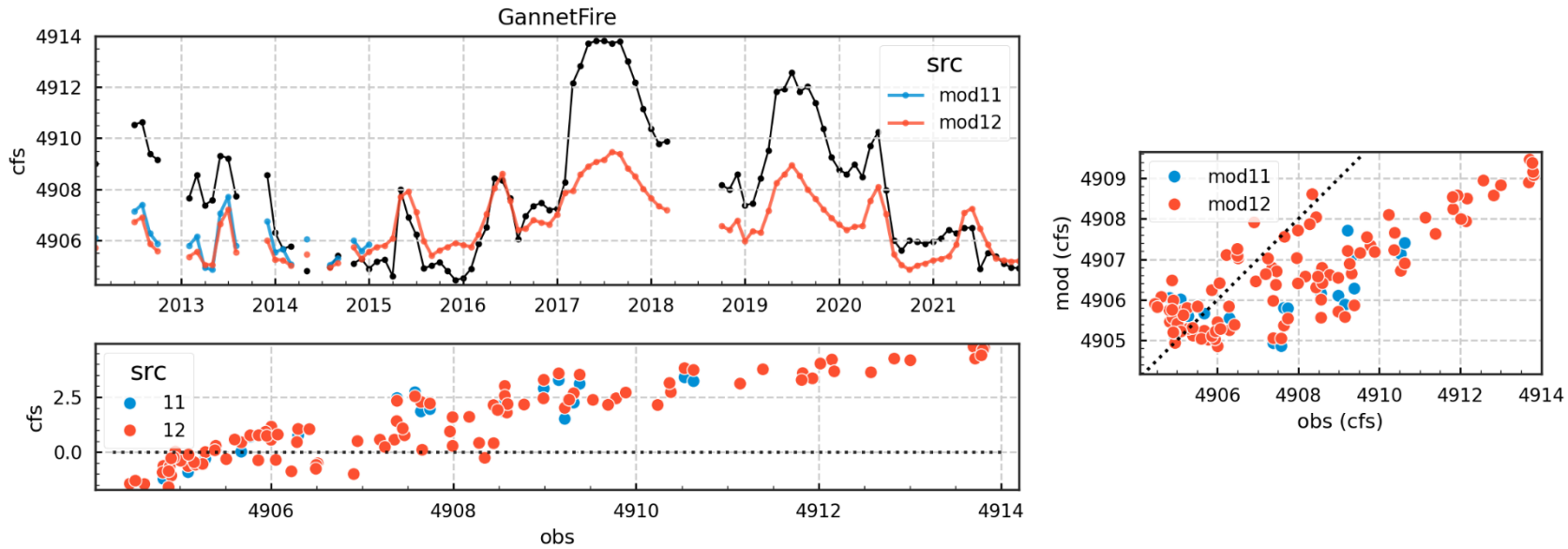
4925.0
obs (cfs)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cfs
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0.0
src
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12
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4908
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4912
4914
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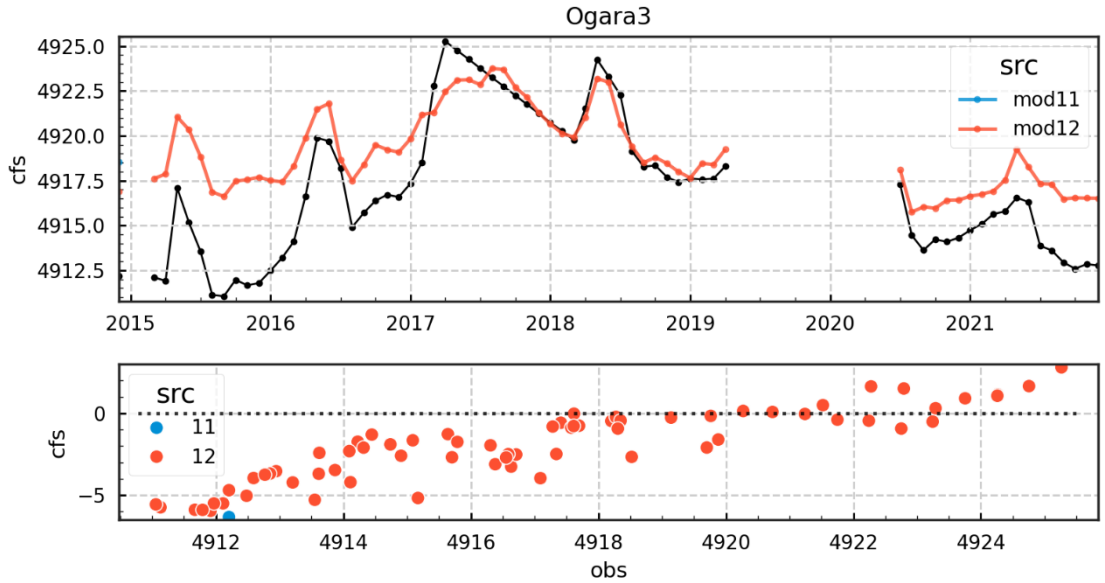
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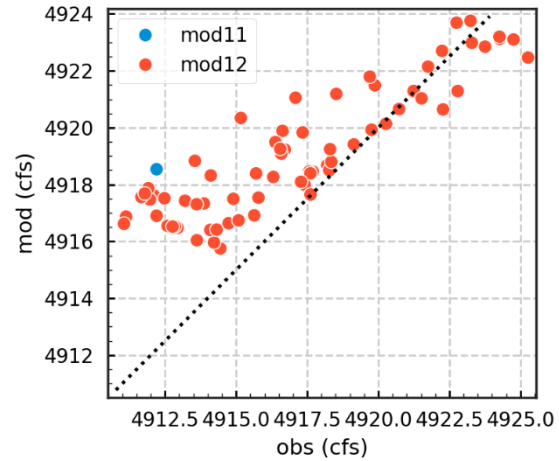
obs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mod12
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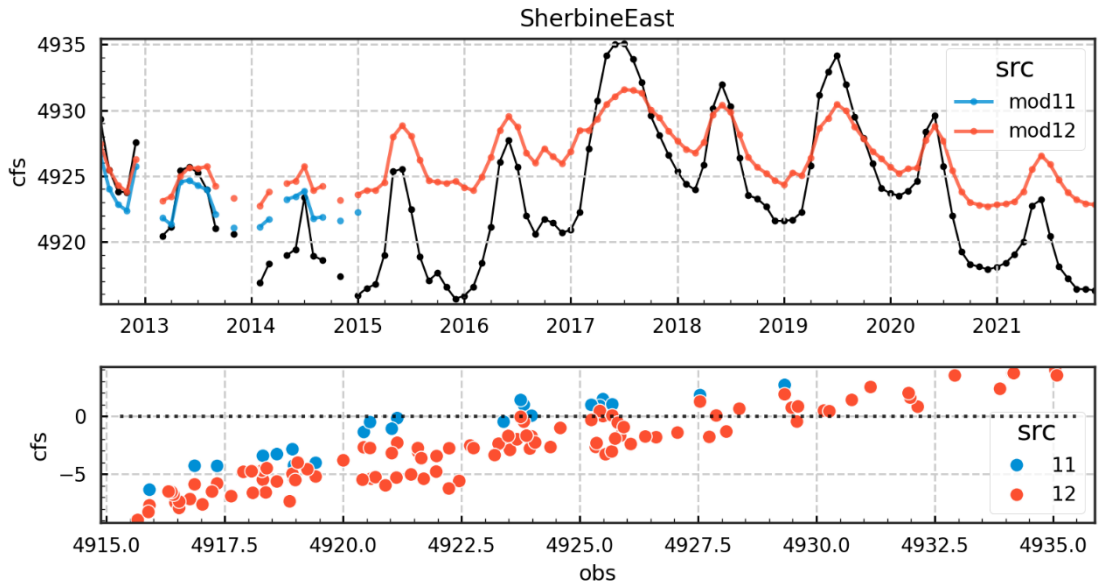
obs (cfs)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src
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mod12
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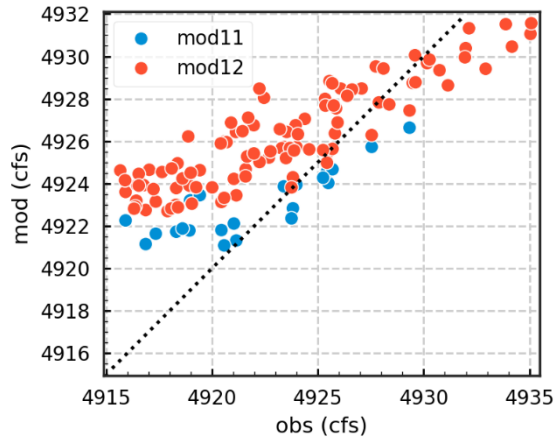
12
obs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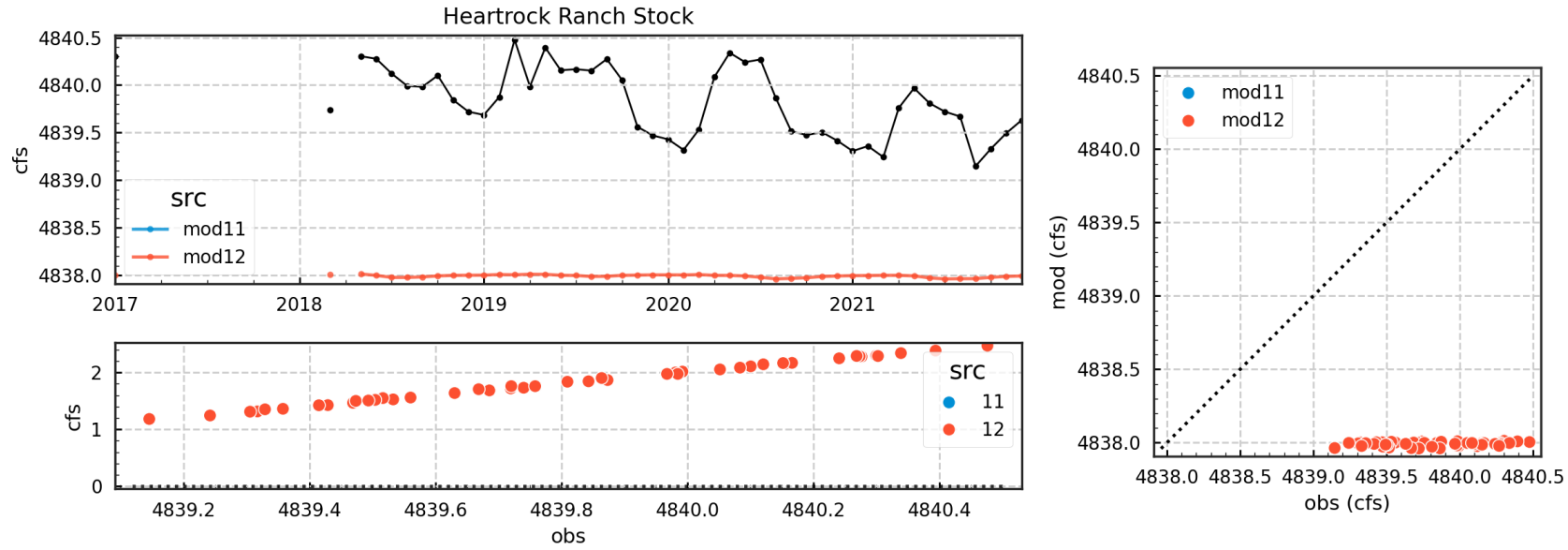
mod12
mod (cfs)
obs (cfs)


Heartrock Ranch Stock
cfs
src
mod11
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2018
2019
2020
2021
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4838.5
4838.0
cfs
src
11
12
obs
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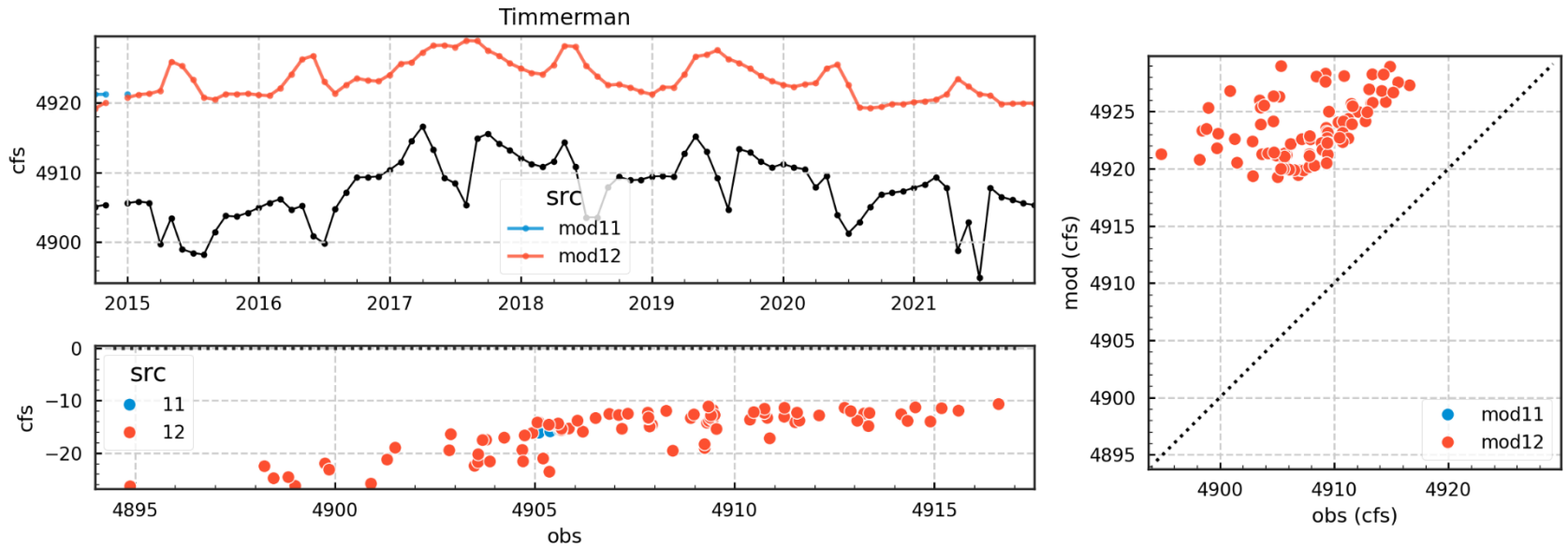
4840.2
4840.4
mod (cfs)
obs (cfs)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cfs
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obs
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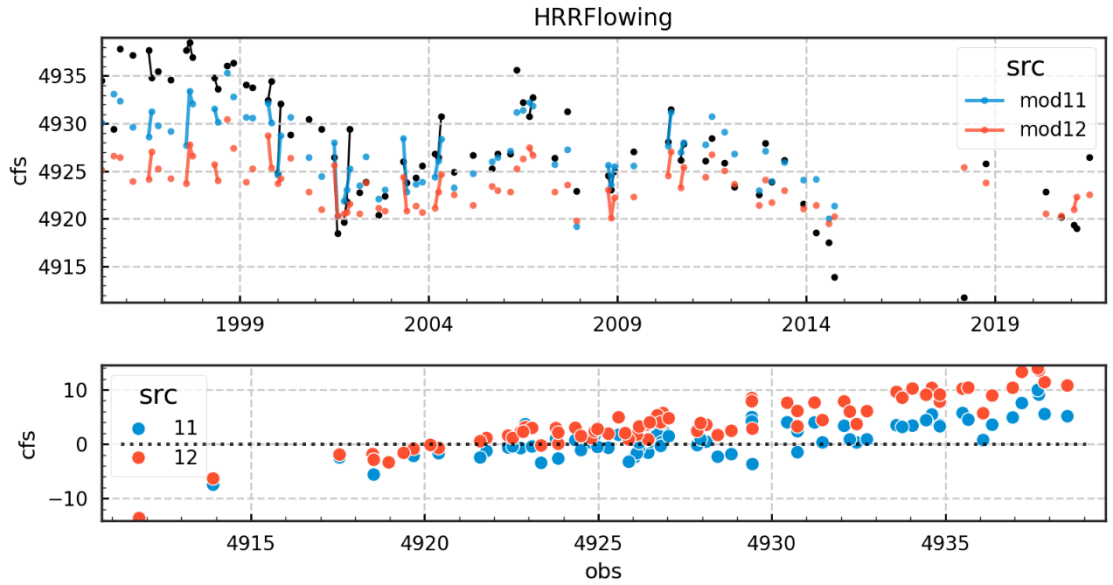
4910
4915
mod (cfs)
obs (cfs)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src
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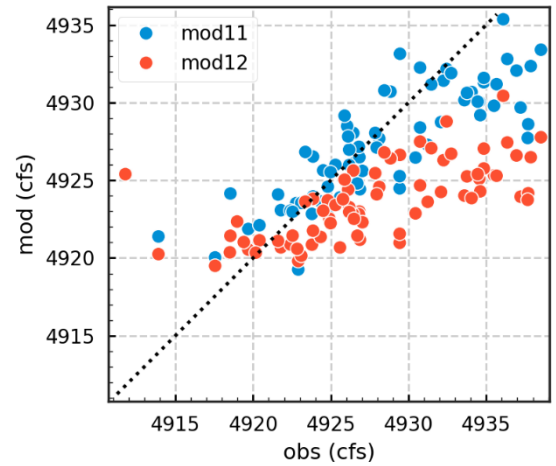
−10
11
12
obs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mod12
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obs (cfs)
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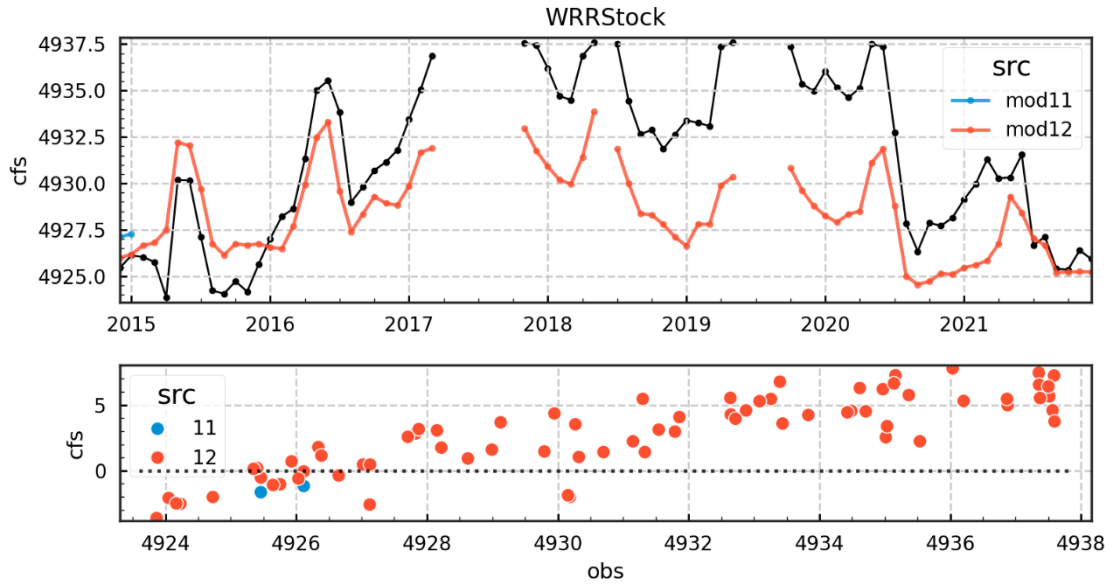
WRRStock
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2016
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2018
2019
2020
2021
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4935.0
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4930.0
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4934
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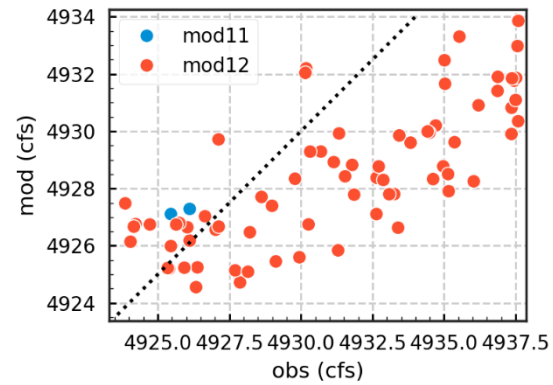
4938
obs


mod11
mod12
mod (cfs)
obs (cfs)
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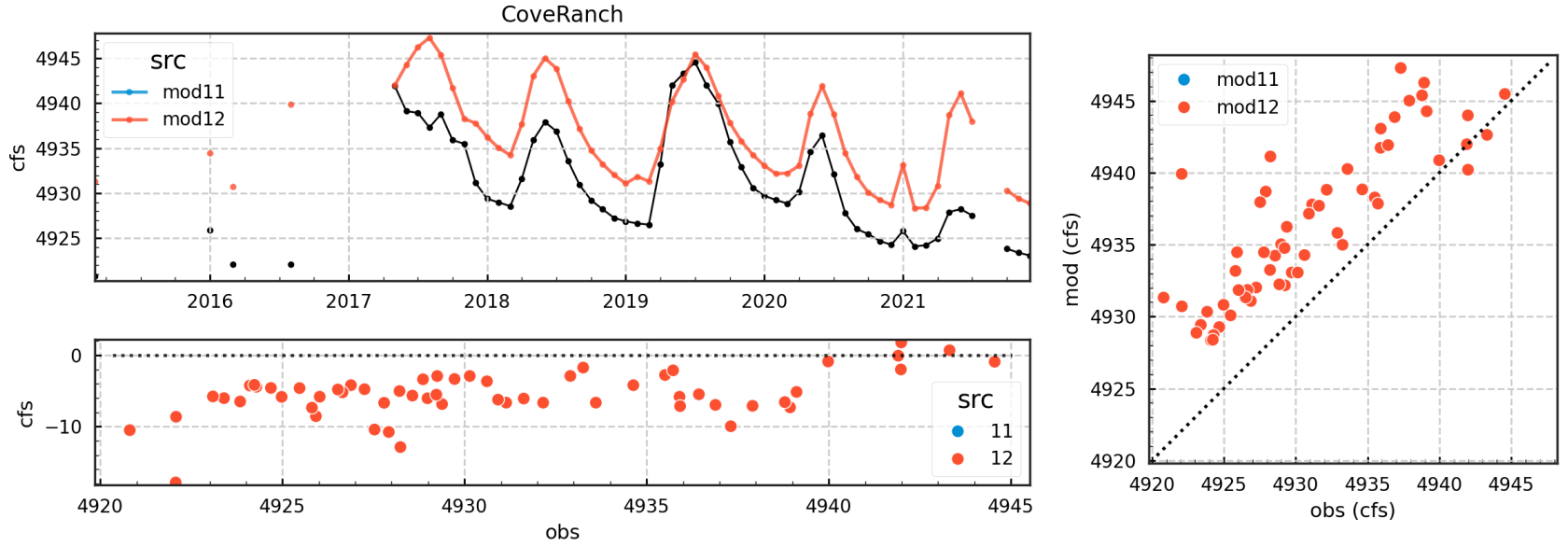
4935.0
4937.5


CoveRanch
src
mod11
mod12
cfs
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4940
4935
4930
4925
2016
2017
2018
2019
2020
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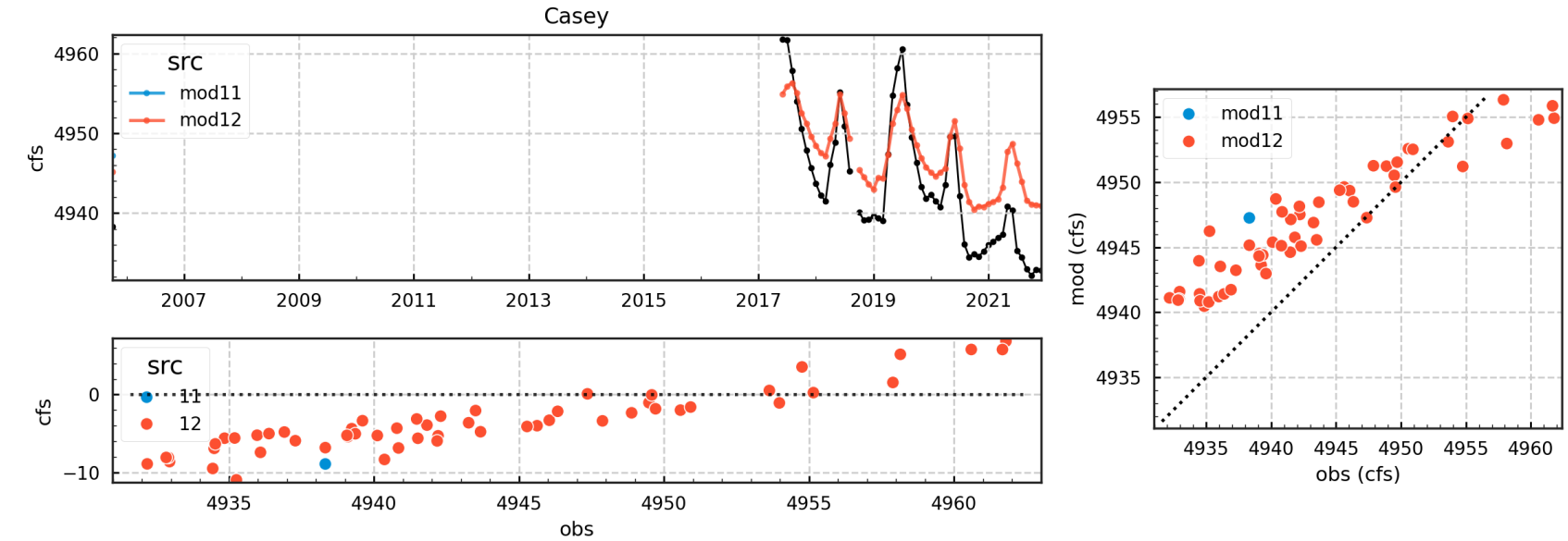
4930
4935
4940
4945
obs
11
12
mod (cfs)
obs (cfs)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mod12
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2009
2011
2013
2015
2017
2019
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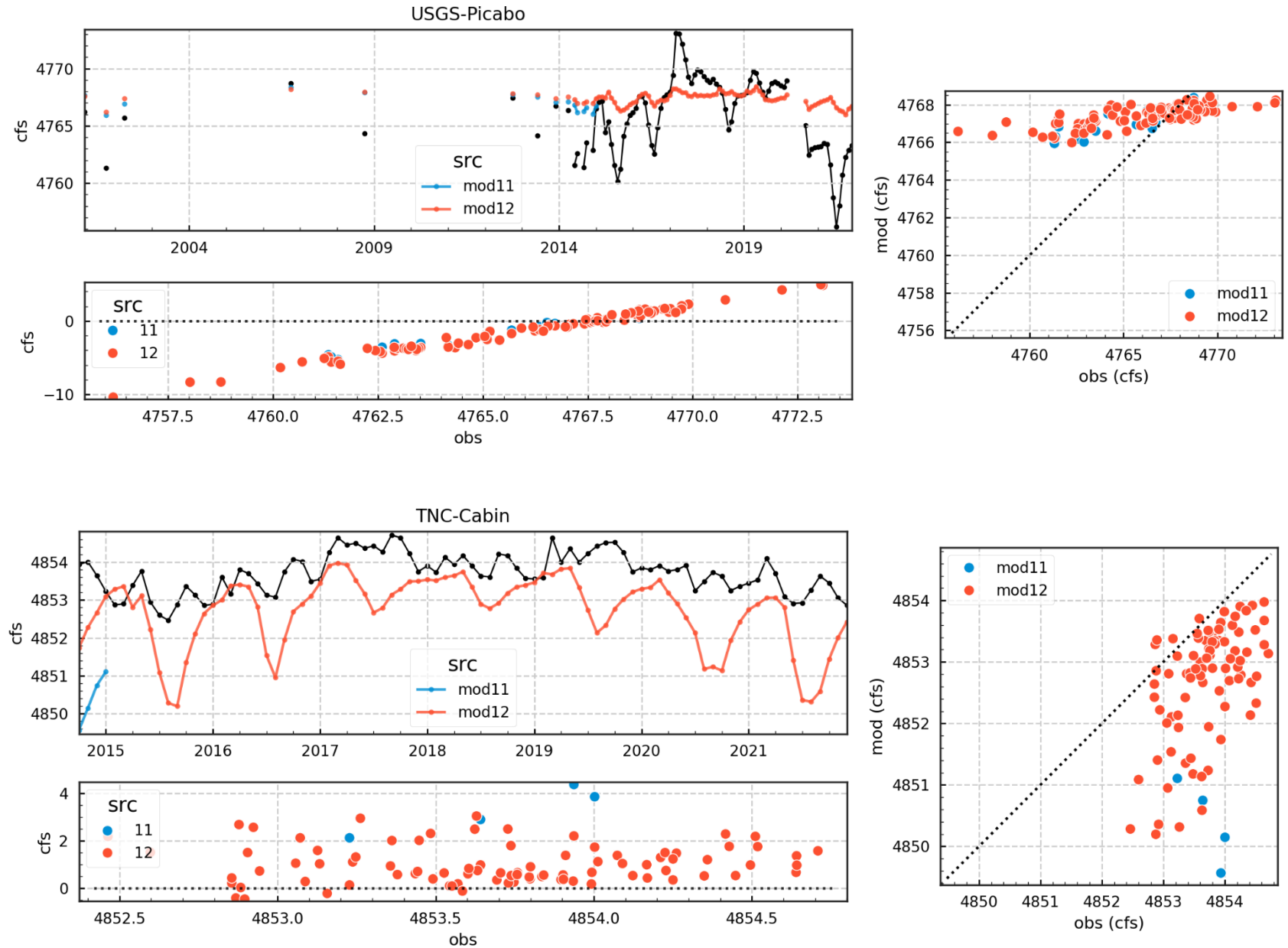
obs
11
12
mod (cfs)
obs (cfs)


USGS-Picabo
cfs
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2014
2019
src
mod11
mod12
src
11
12
cfs
0
−10
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4762.5
4765.0
4767.5
4770.0
4772.5
obs
mod (cfs)
4768
4766
4764
4762
4760
4758
4756
4760
4765
4770
obs (cfs)
mod11
mod12
TNC-Cabin
cfs
4854
4853
4852
4851
4850
2015
2016
2017
2018
2019
2020
2021
src
mod11
mod12
src
11
12
cfs
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2
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4852.5
4853.0
4853.5
4854.0
4854.5
obs
mod (cfs)
4854
4853
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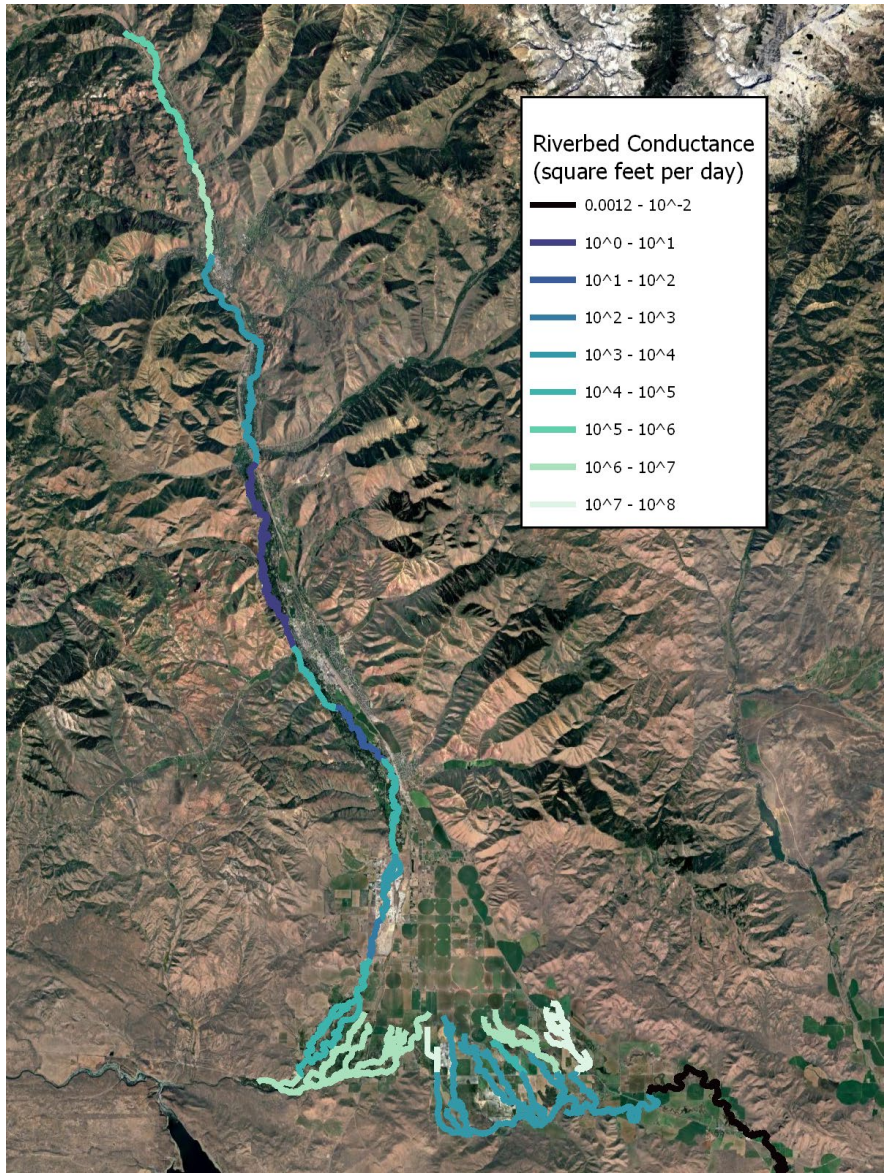
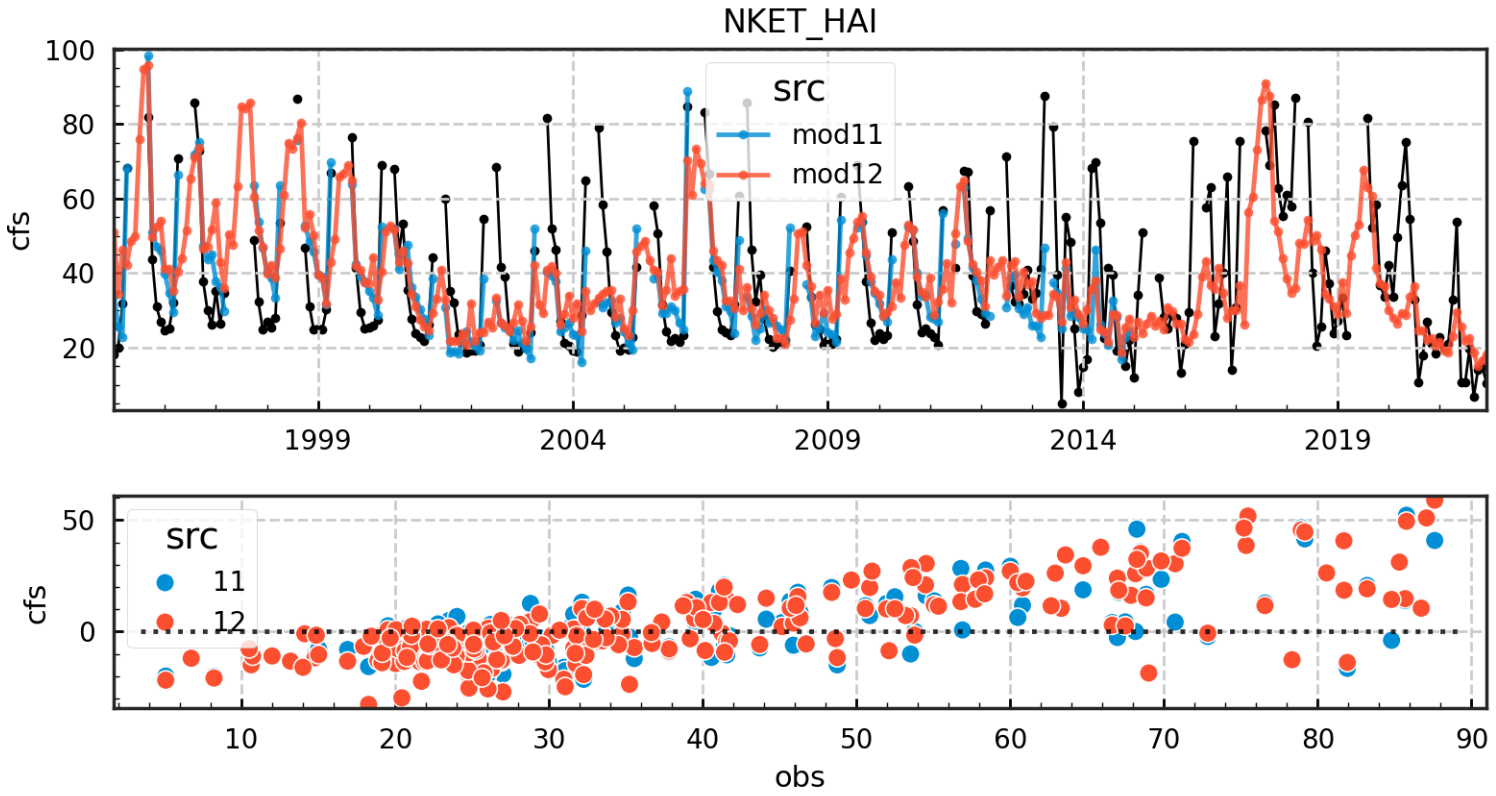
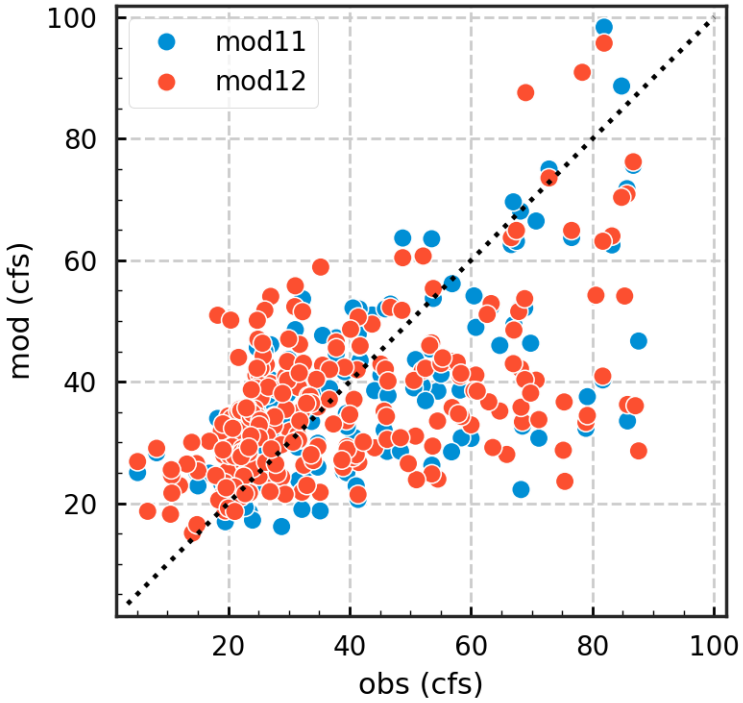
4851
4850
4850
4851
4852
4853
4854
obs (cfs)
mod11
mod12

Riverbed Conductance

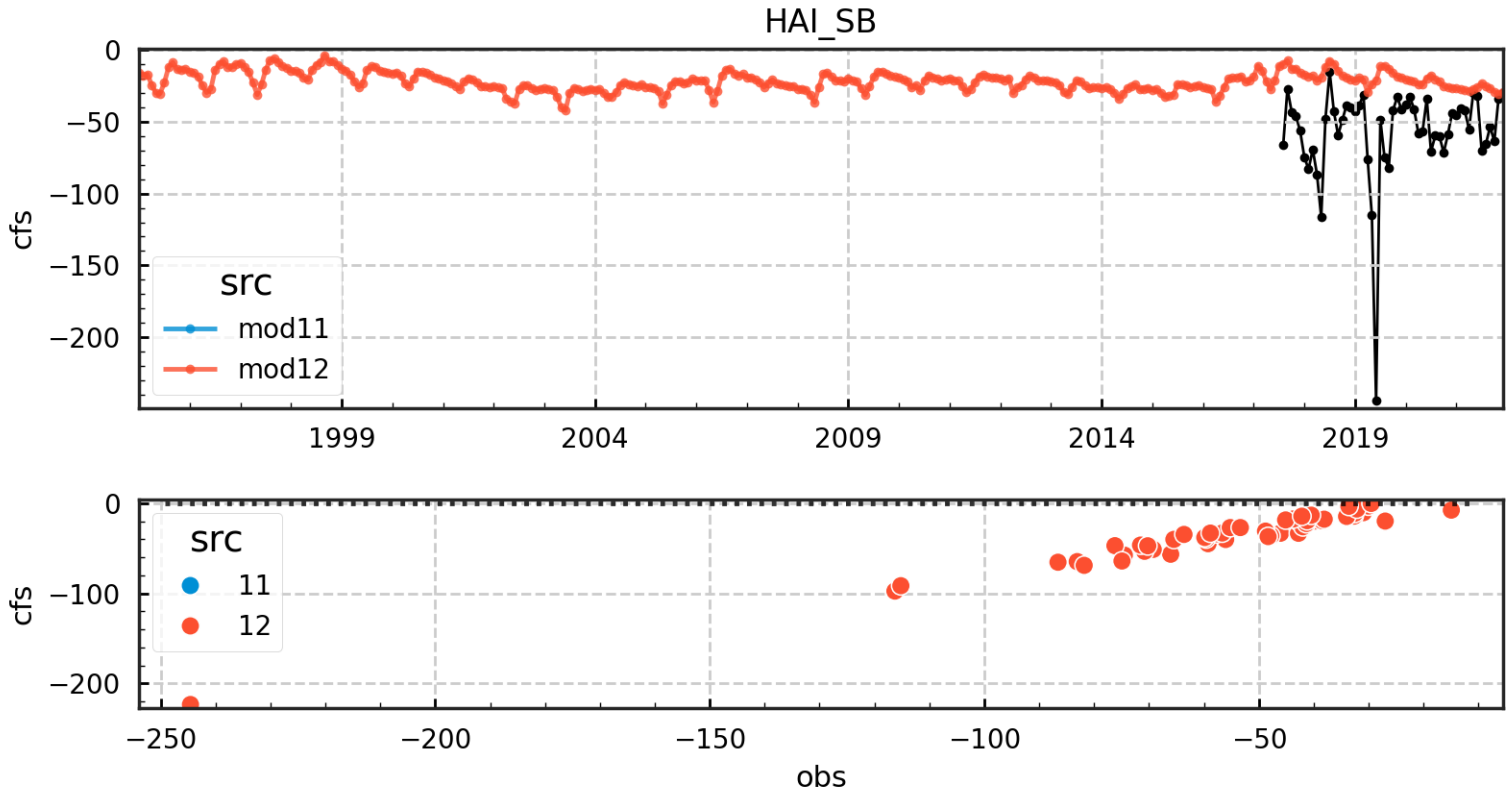


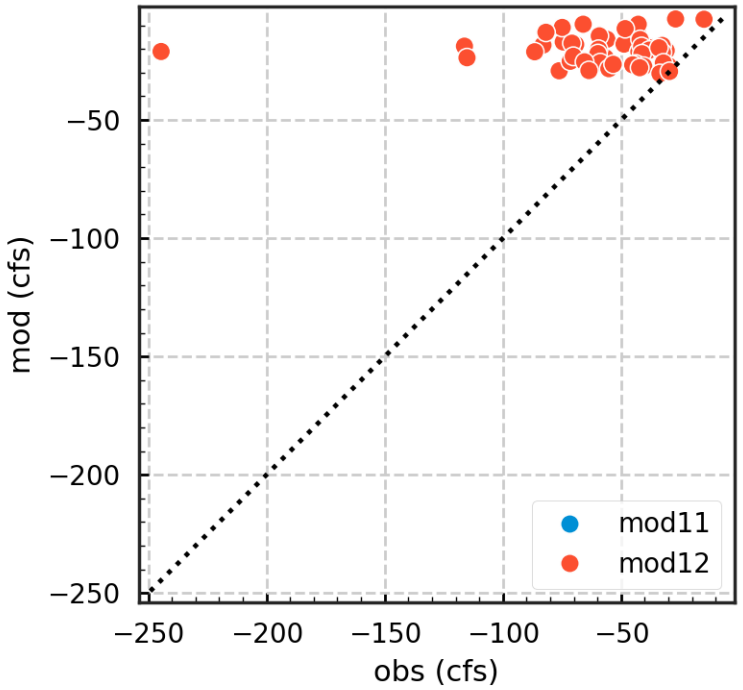
Near Ketchum to Hailey, Big Wood



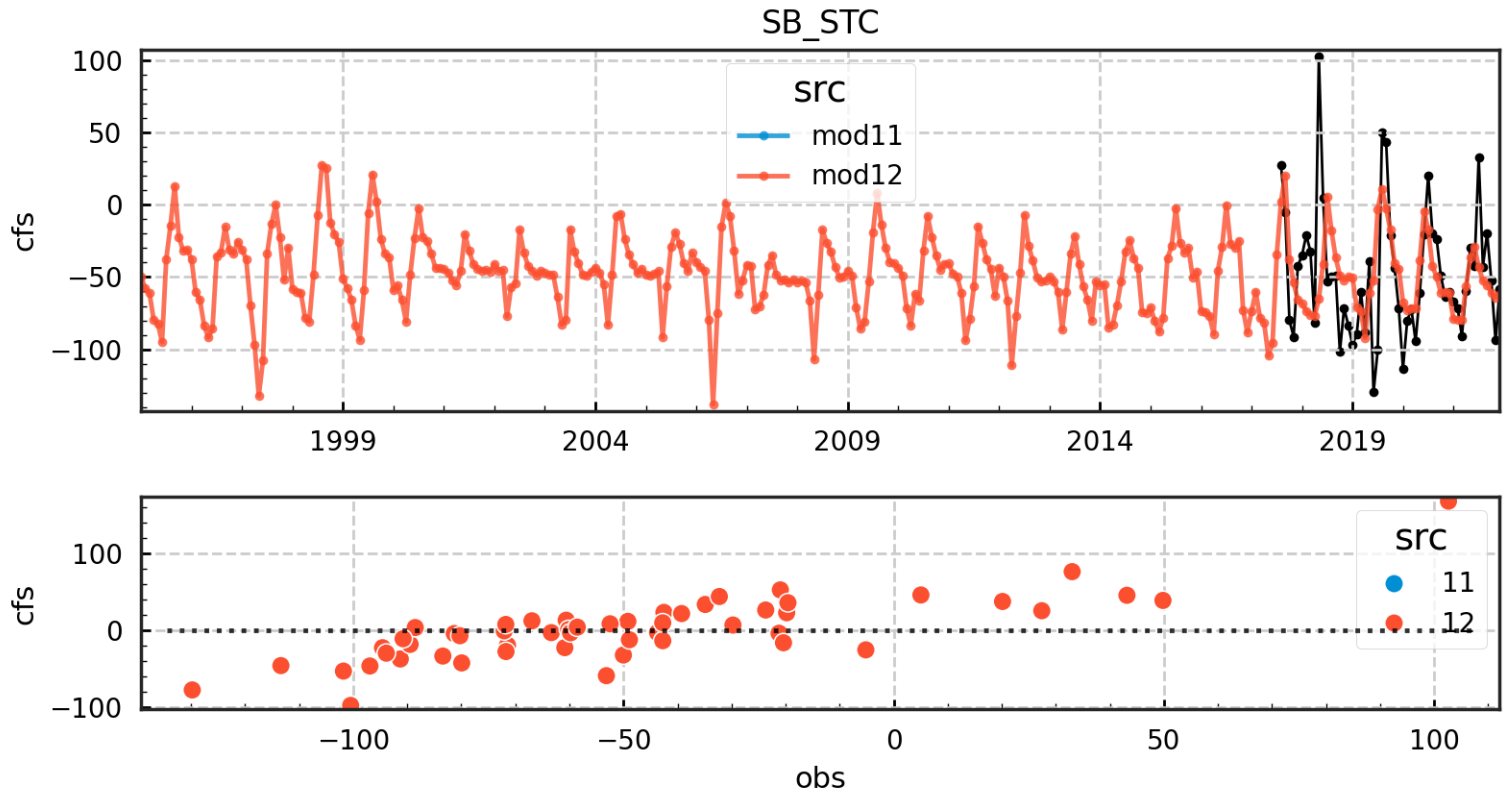


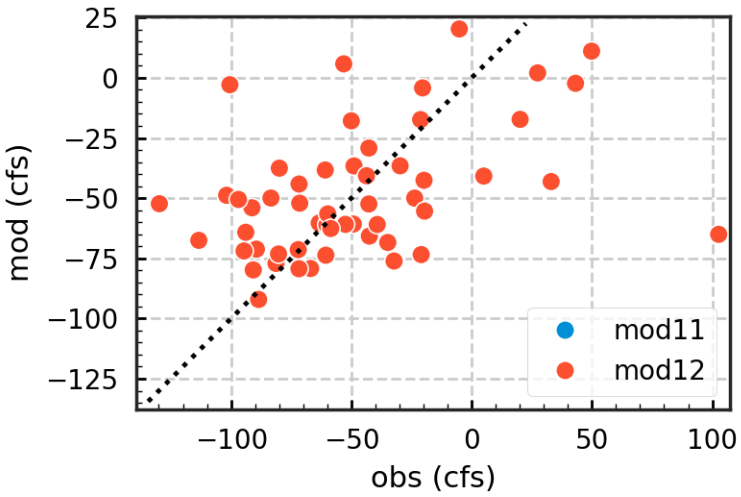
Hailey to South Broadford, Big Wood



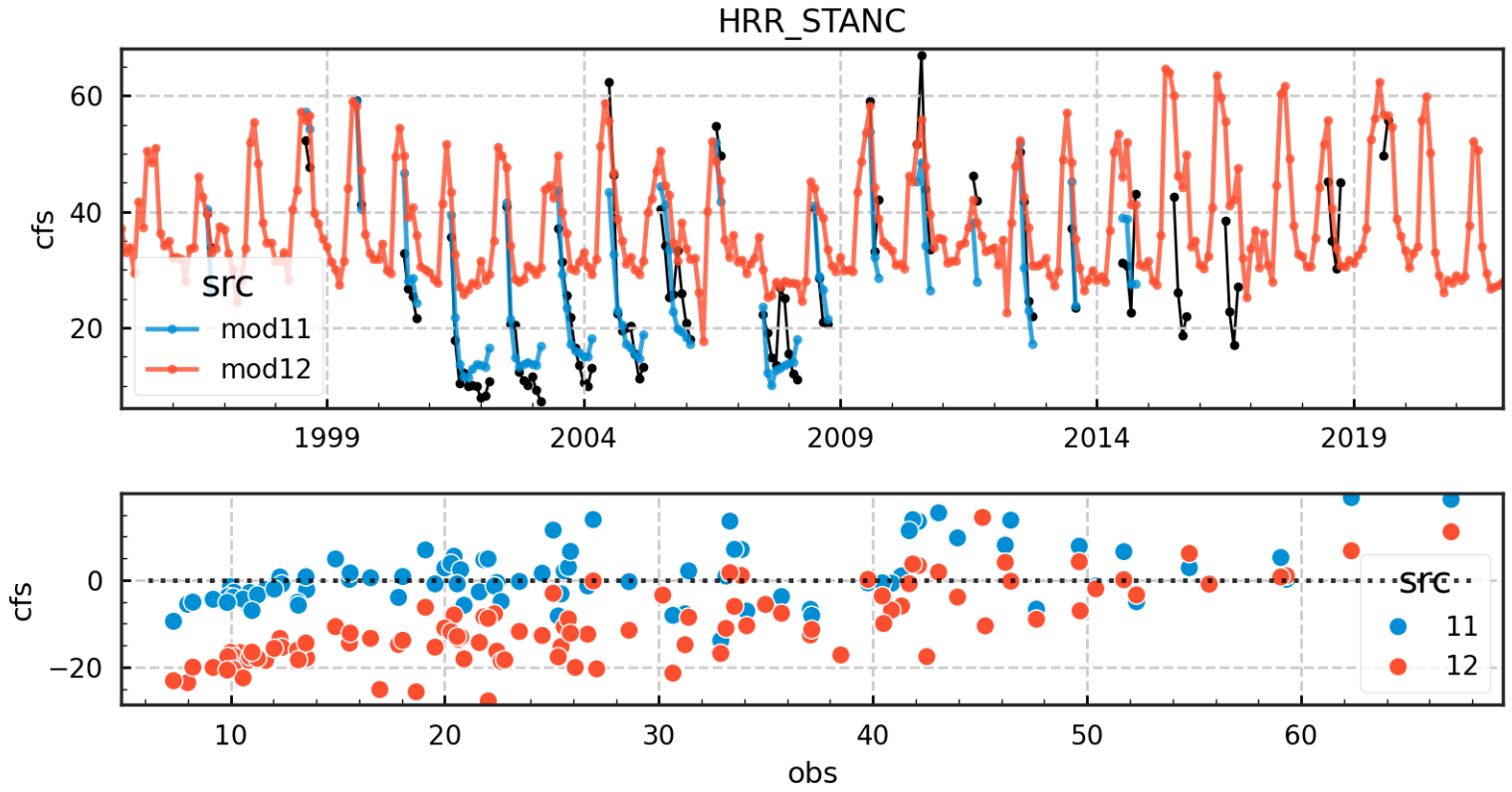


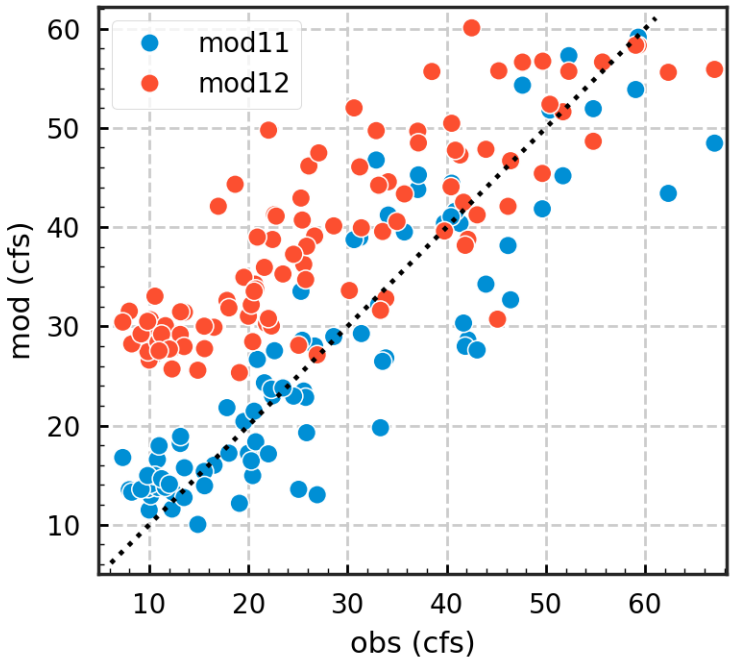
South Broadford to Stanton Crossing, Big Wood



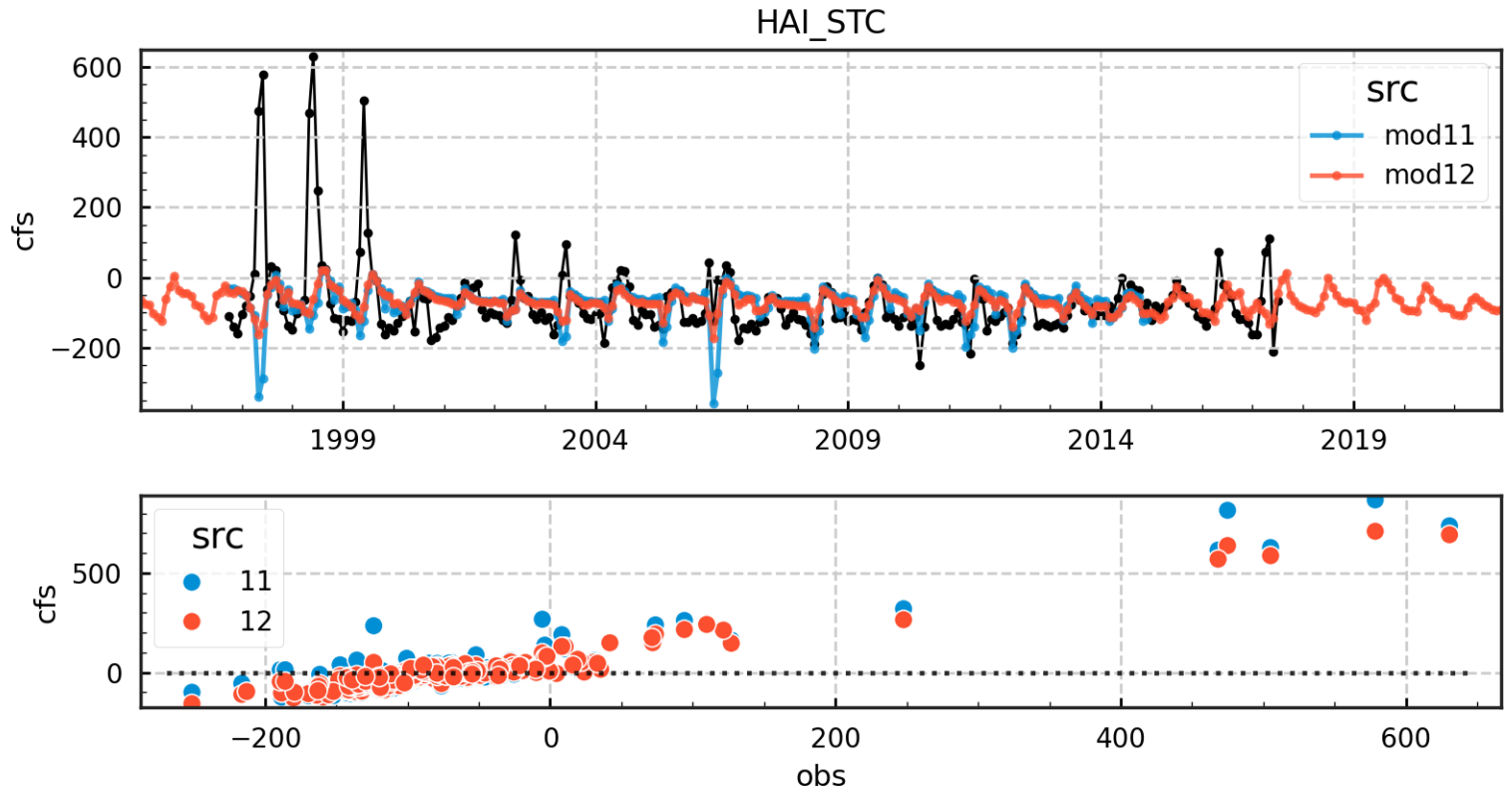


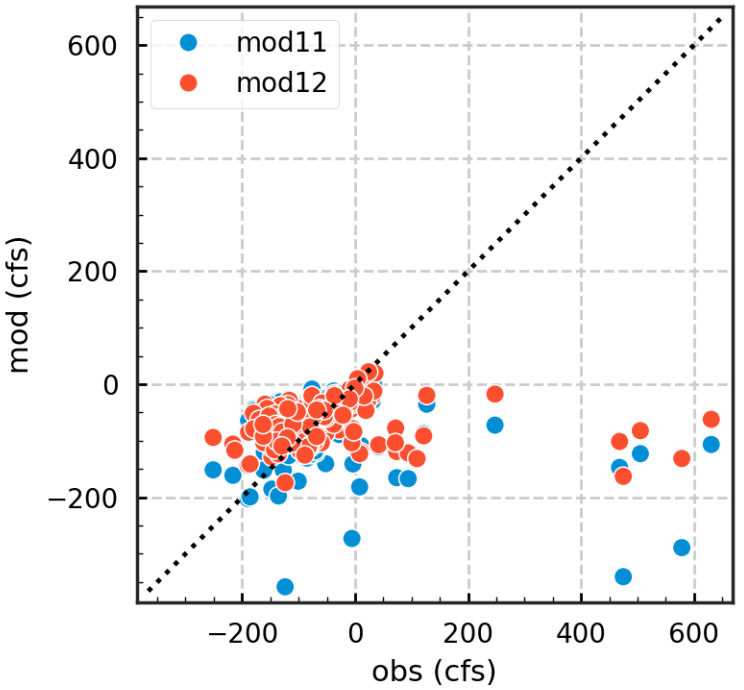
Heart Rock Ranch to Stanton Crossing, Big Wood



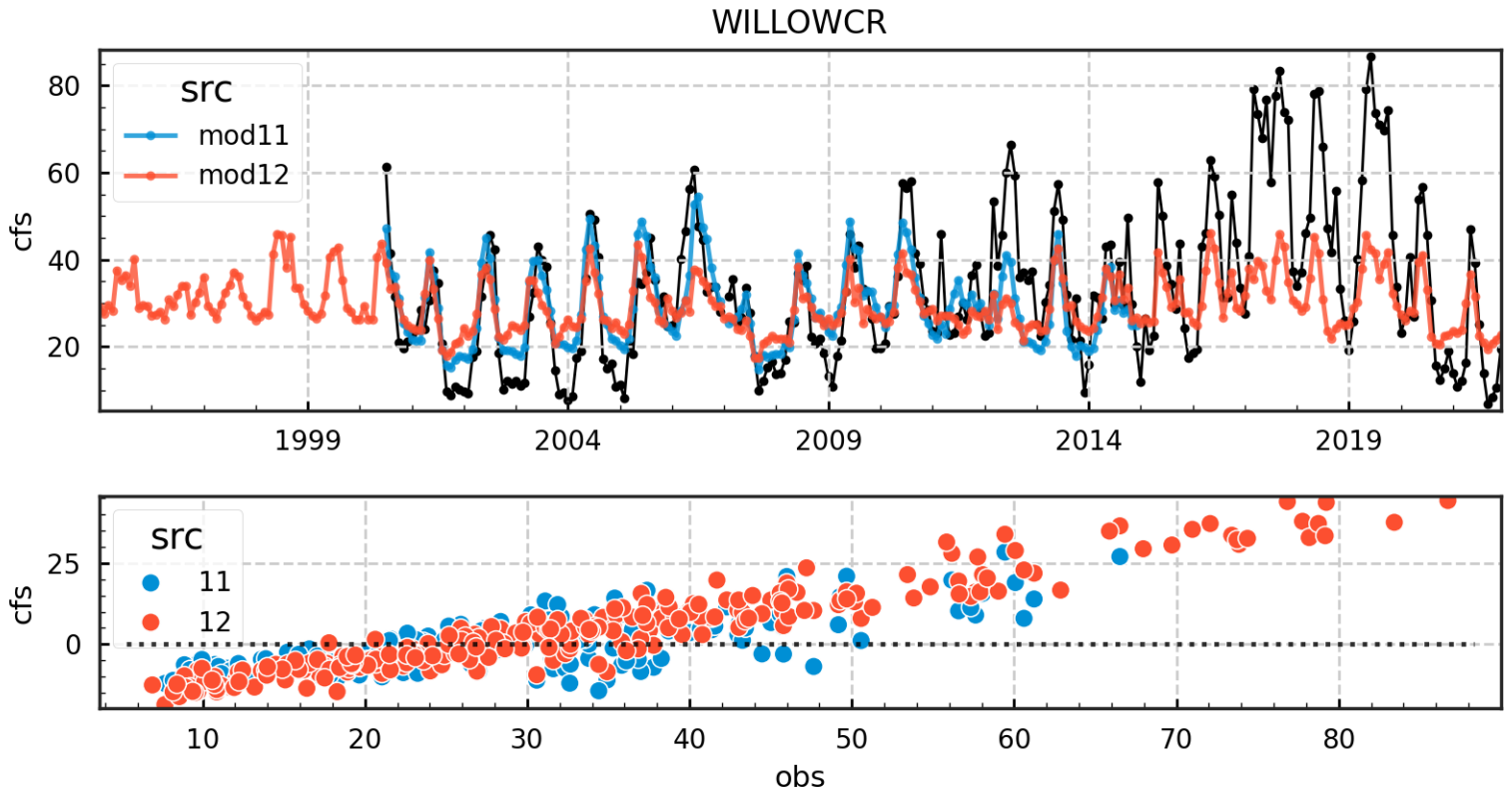


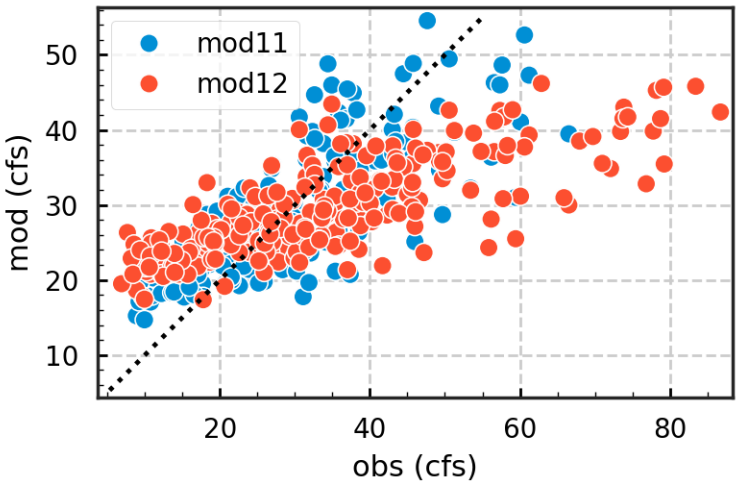
Hailey to Stanton Crossing, Big Wood



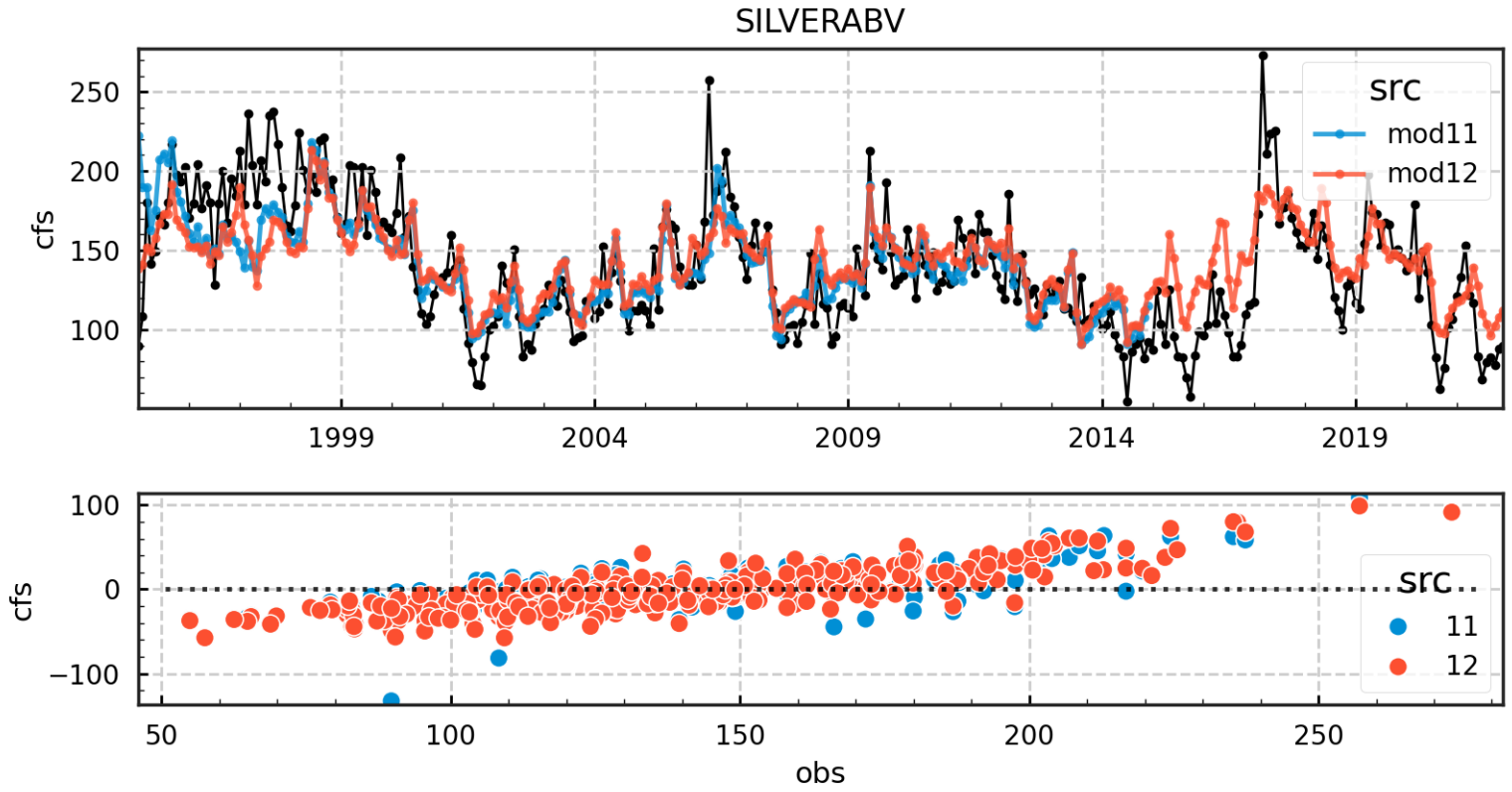


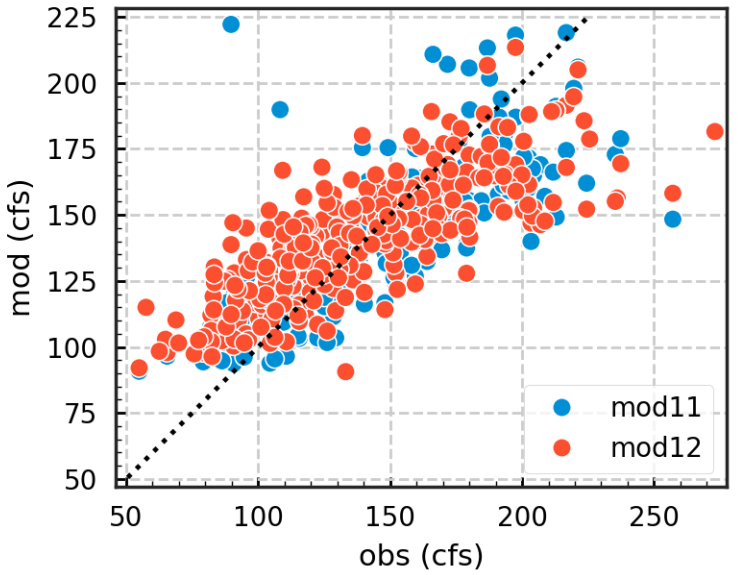
Willow Creek



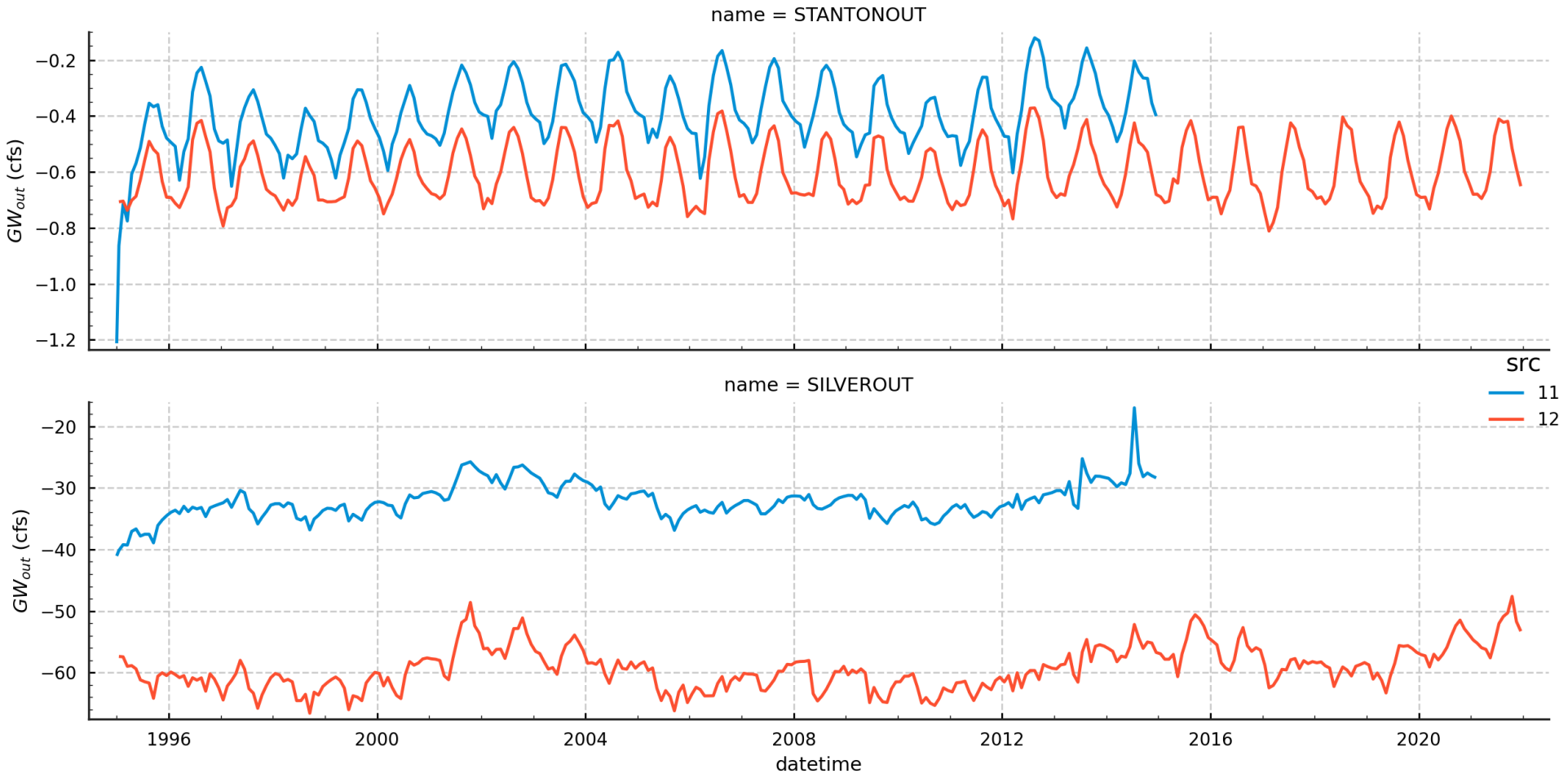


Silver Creek above Sportsman's

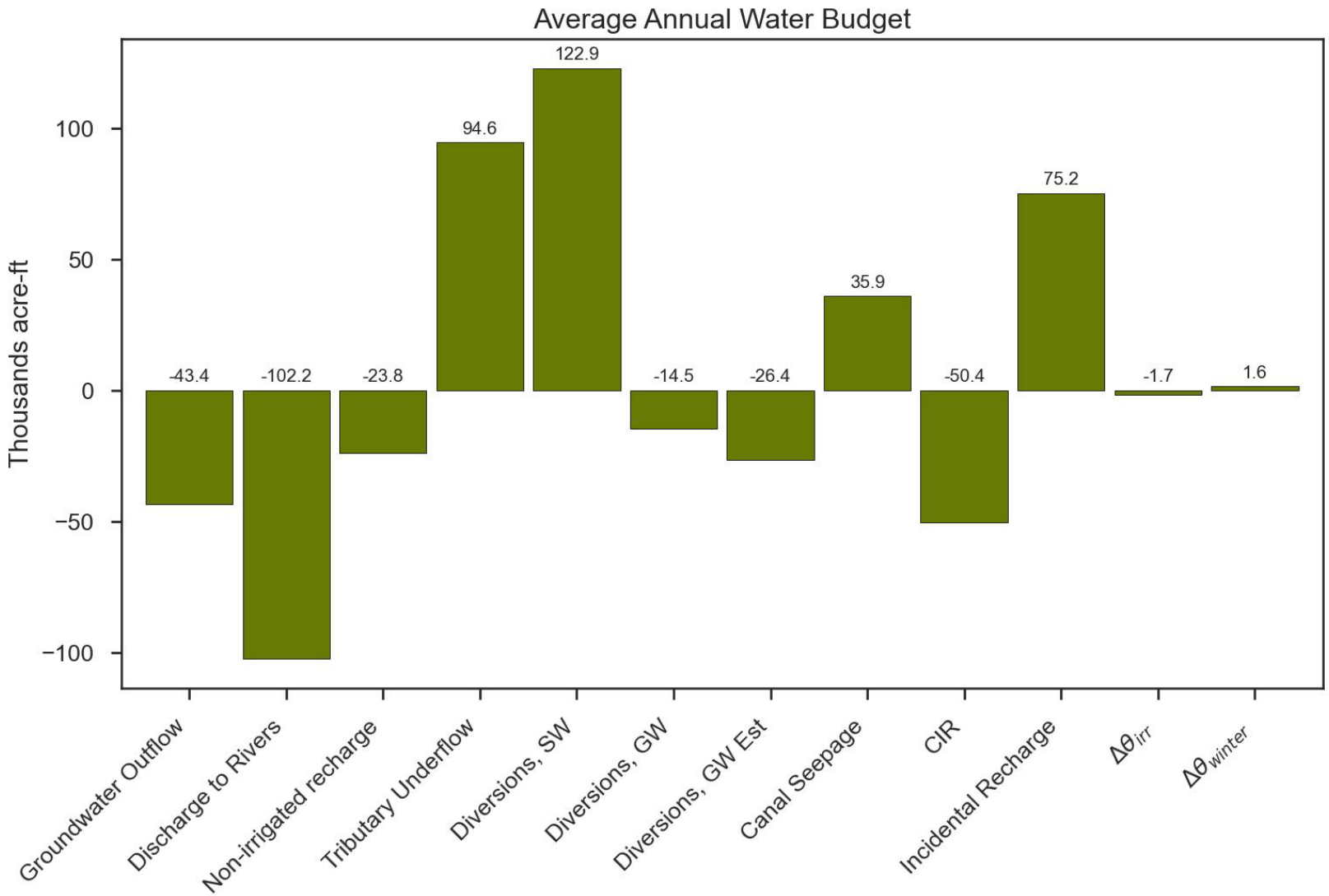




Drains (Model Outflow)

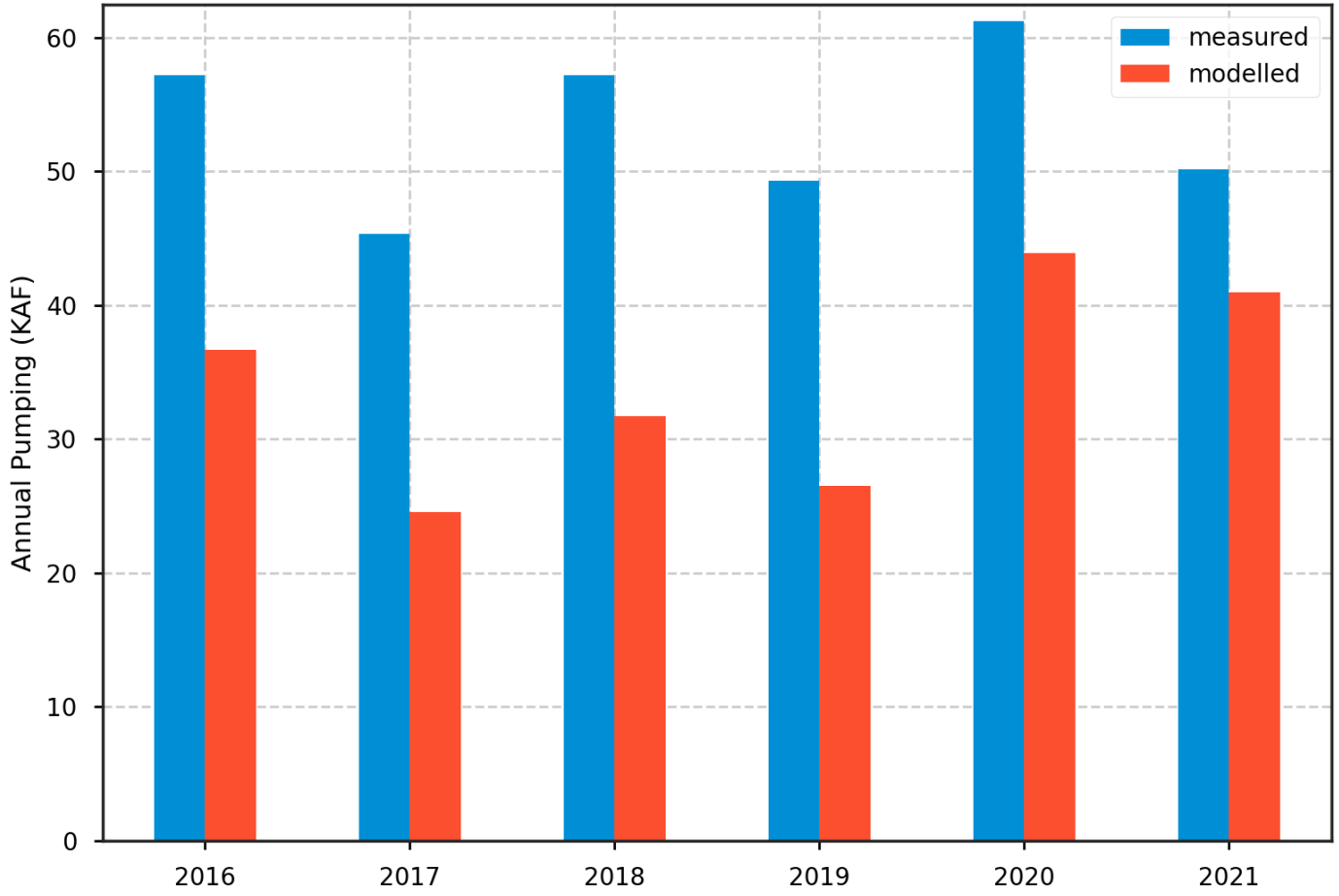


Annual Water Budget



Pumping Predictions

- GLM can provide forecast uncertainty estimates while calibrating (mean, standard deviations of prediction)
- Tracking annual pumping after 2016 as compared to total pumping from WMIS, city records, and watermaster
- ~ 64% less total pumping in model (estimated and recorded)



Precipitation Distribution

Winter Precip Distribution

- Currently use a fixed approximation to redistribute winter snowfall into available precipitation.

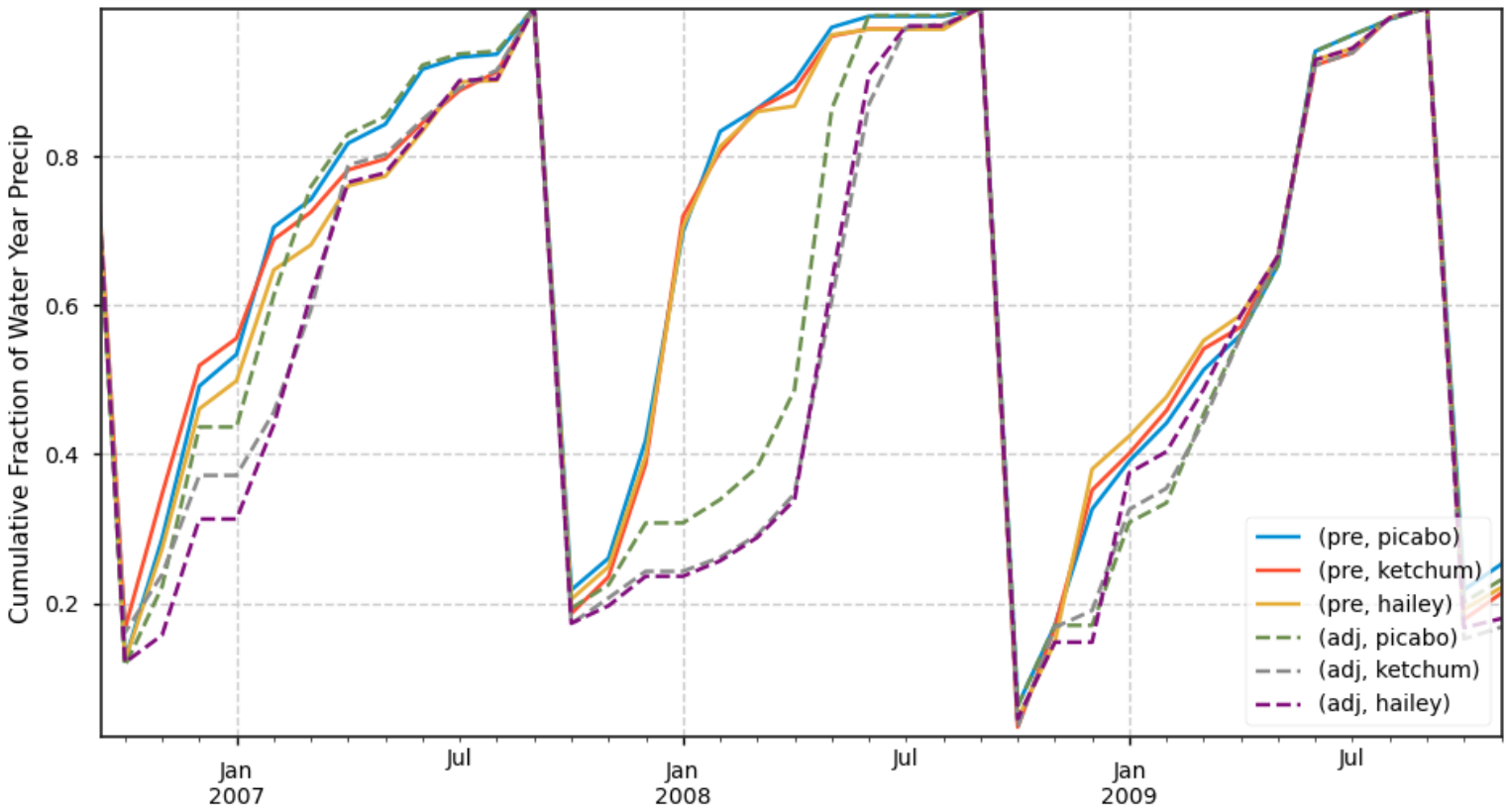
- Easy to implement but does not allow for variable melt.

- Peak precip always occurs in the same month

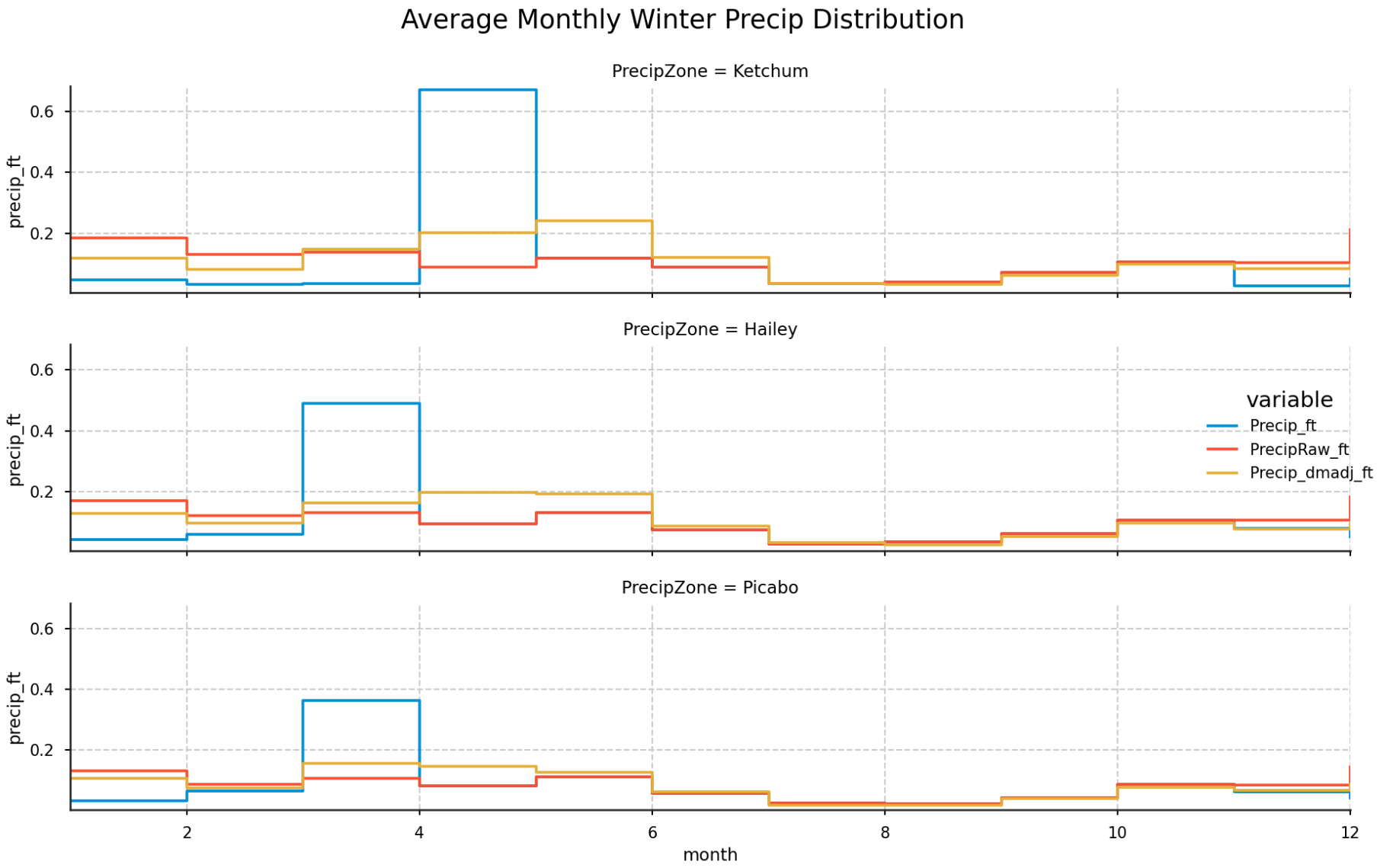
Precip Zone	Nov	Dec	Jan	Feb	Mar	Apr
Ketchum	25%	25%	25%	25%	25%	75% Nov + 75% Dec + 75% Jan + 75% Feb + 75% Mar + 100% Apr
Hailey	75%	25%	25%	50%	25% Nov + 75% Dec + 75% Jan + 50% Feb + 100% Mar	100%
Picabo	75%	25%	25%	75%	25% Nov + 75% Dec + 75% Jan + 25% Feb + 100% Mar	100%

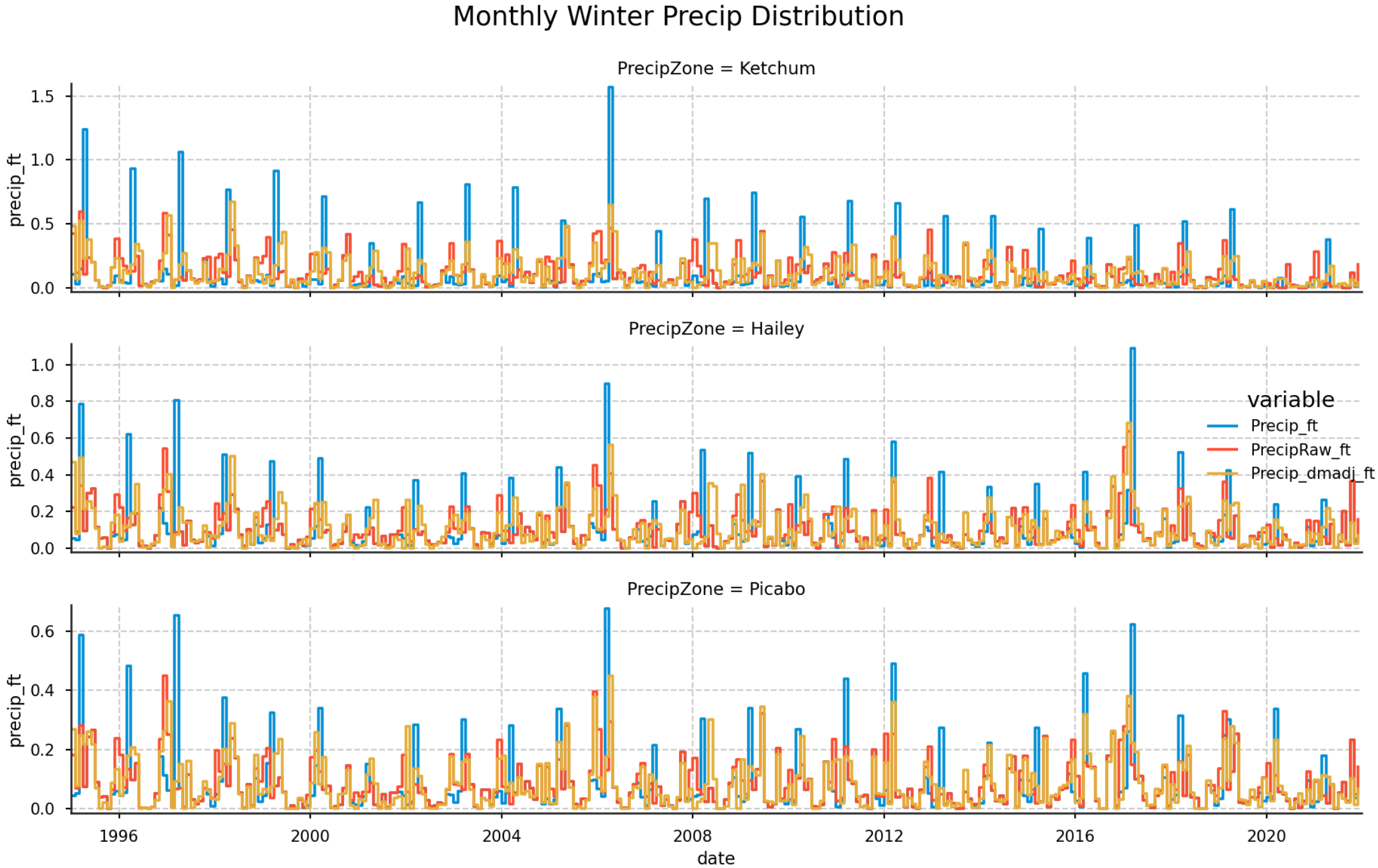
Variable SWE Accumulation and Melt Method

- Propose using Daymet snow water equivalent to determine snow accumulation and melt rates
- Calculate monthly liquid % of water year total precip
- Captures interannual variability in snowmelt



Prominent precip peaks smoothed over several months




Monthly Winter Precip Distribution
PrecipZone = Ketchum
PrecipZone = Hailey
PrecipZone = Picabo
precip_ft
1.5
1.0
0.5
0.0
0.8
0.6
0.4
0.2
1996
2000
2004
2008
2012
2016
2020
date
variable
Precip_ft
PrecipRaw_ft
Precip_dmadj_ft

Discretization

Revisiting alluvium and basalt thickness and extent

Layering Rules

Bedrock Surface: Pre-Quaternary bedrock surface (Land surface – alluvium thickness)

* Bottom of basalt assumed to be 52 m below land surface

Top of aquitard is above alluvium bottom and is within clay extent

Clay surface (Moreland, 1977): 30 m below surface, 5 m thick.

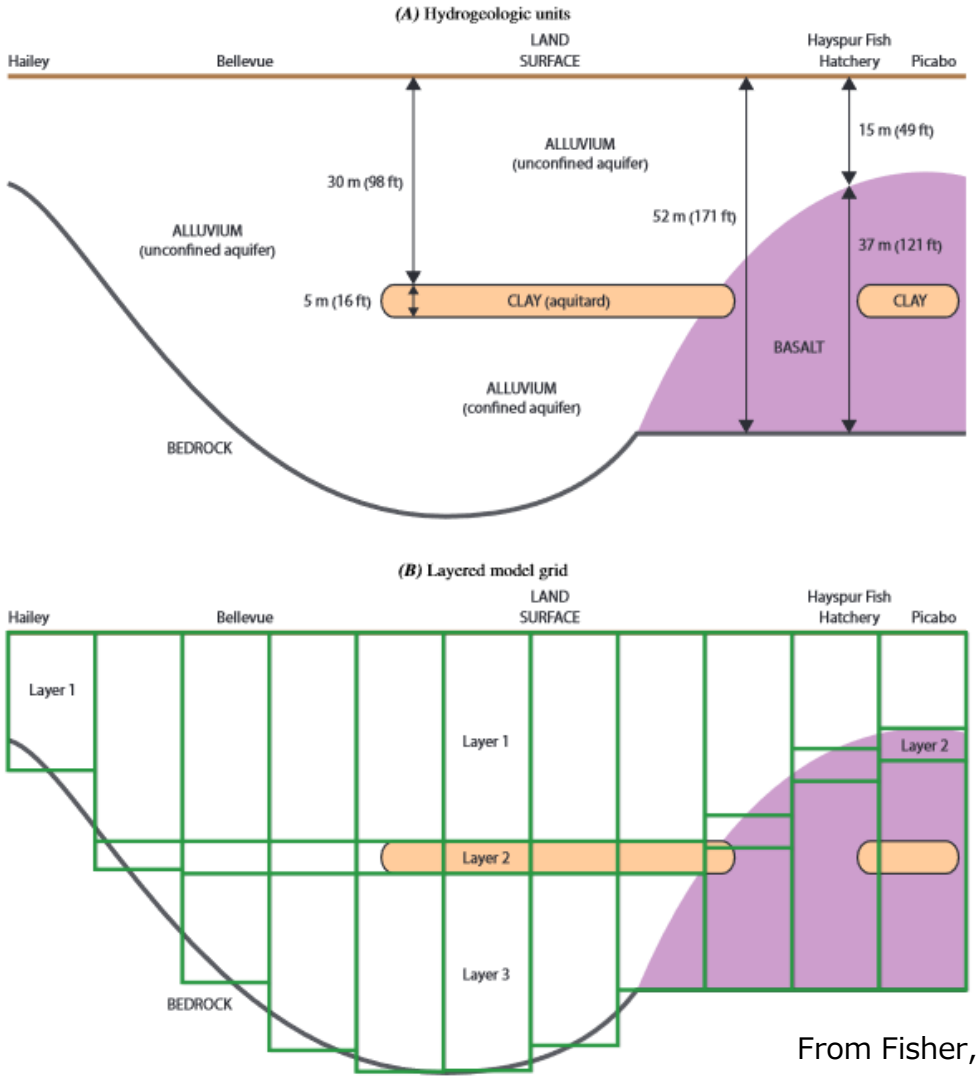
Minimum cell thickness: 1 m

Minimum Vertical overlap: 2 m

Layer 1 bottom: Max of land aquitard depth or bedrock depth

Layer 2 bottom: Max of Layer 1 bottom minus aquitard thickness or bedrock depth

Layer 3 bottom: Top of bedrock surface

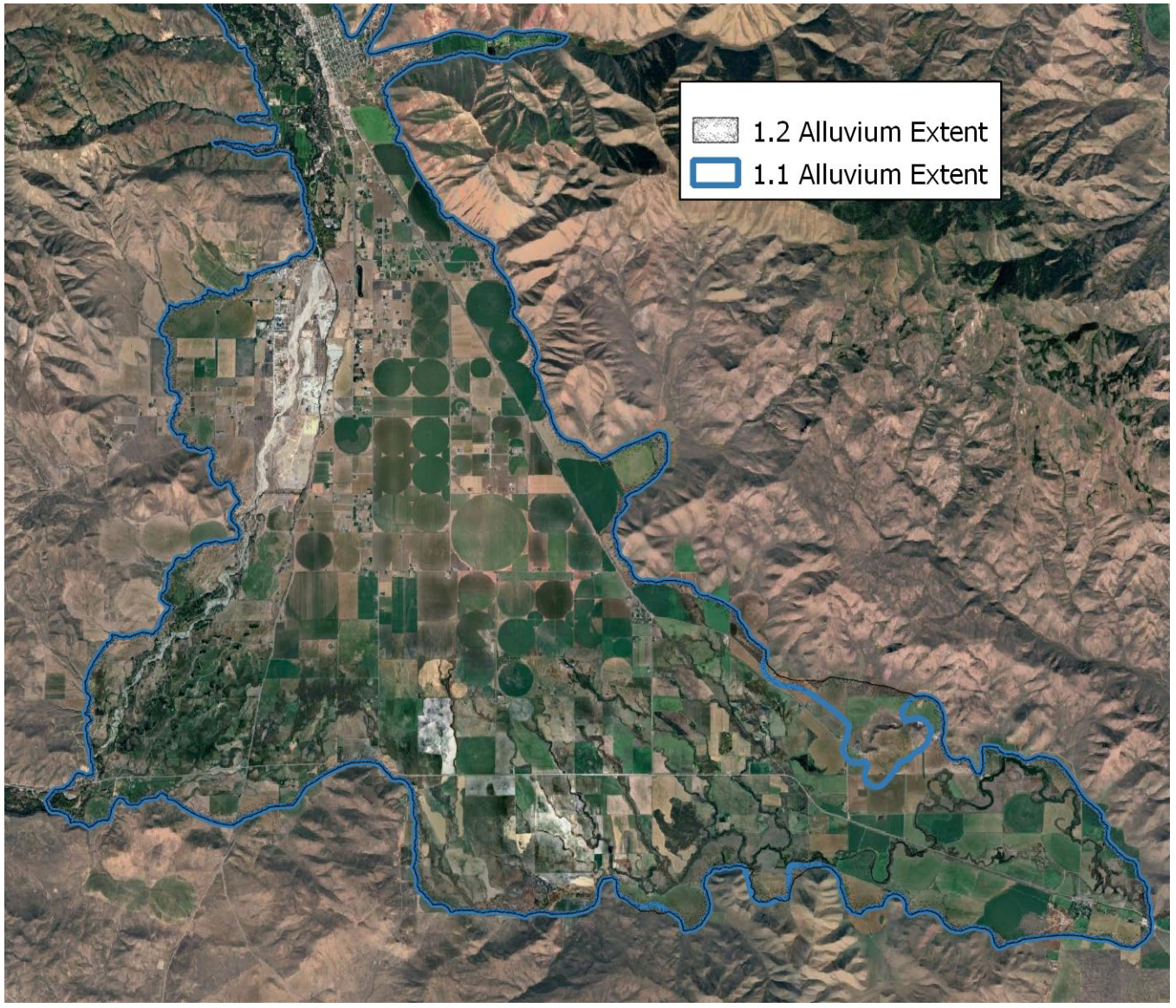


From Fisher, 2016

Figure D7. Schematic cross-section representation of (*A*) hydrogeologic units and (*B*) the layered model grid.

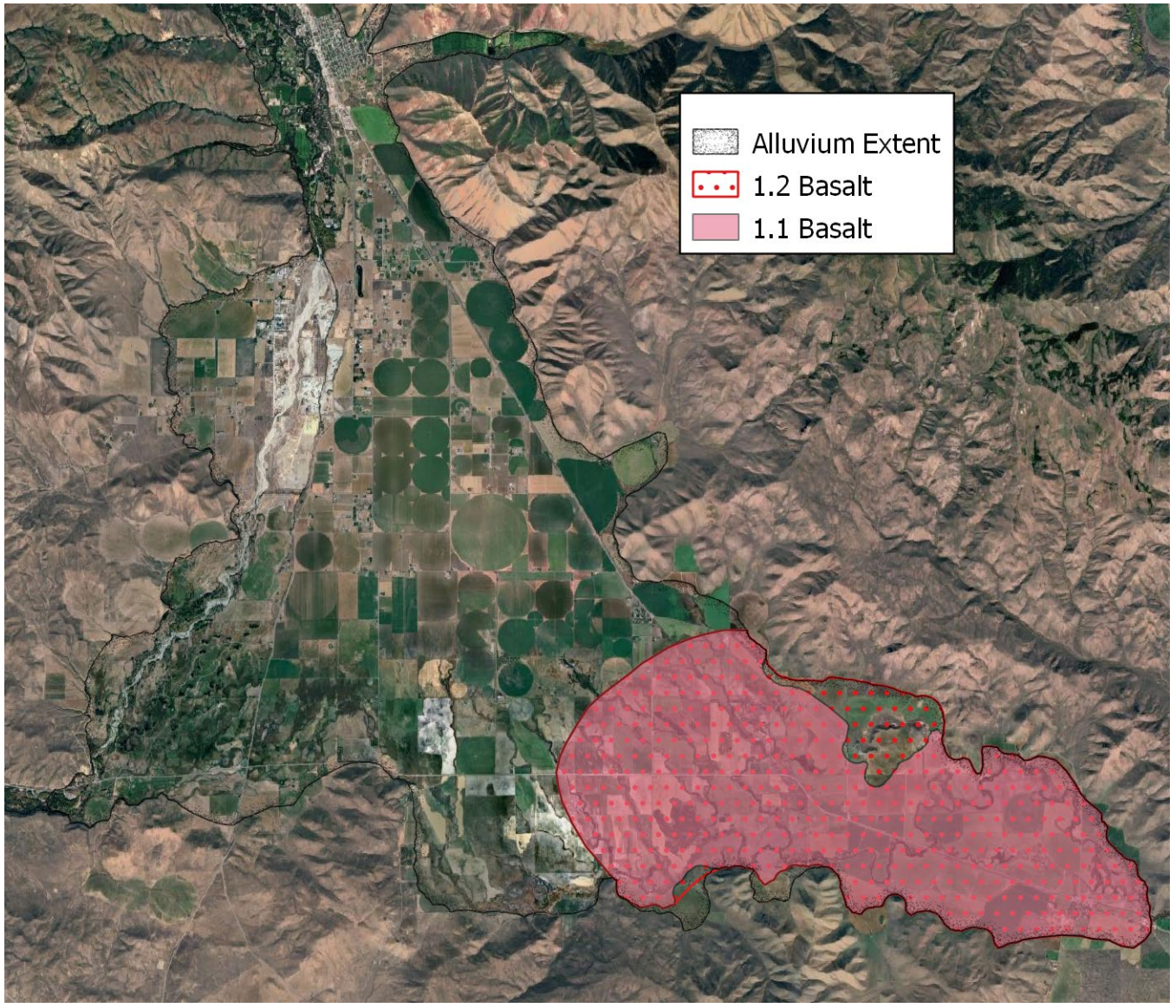
Alluvium Extent

- Alluvium extent modified north of near Sportsman's Access gage to include lands



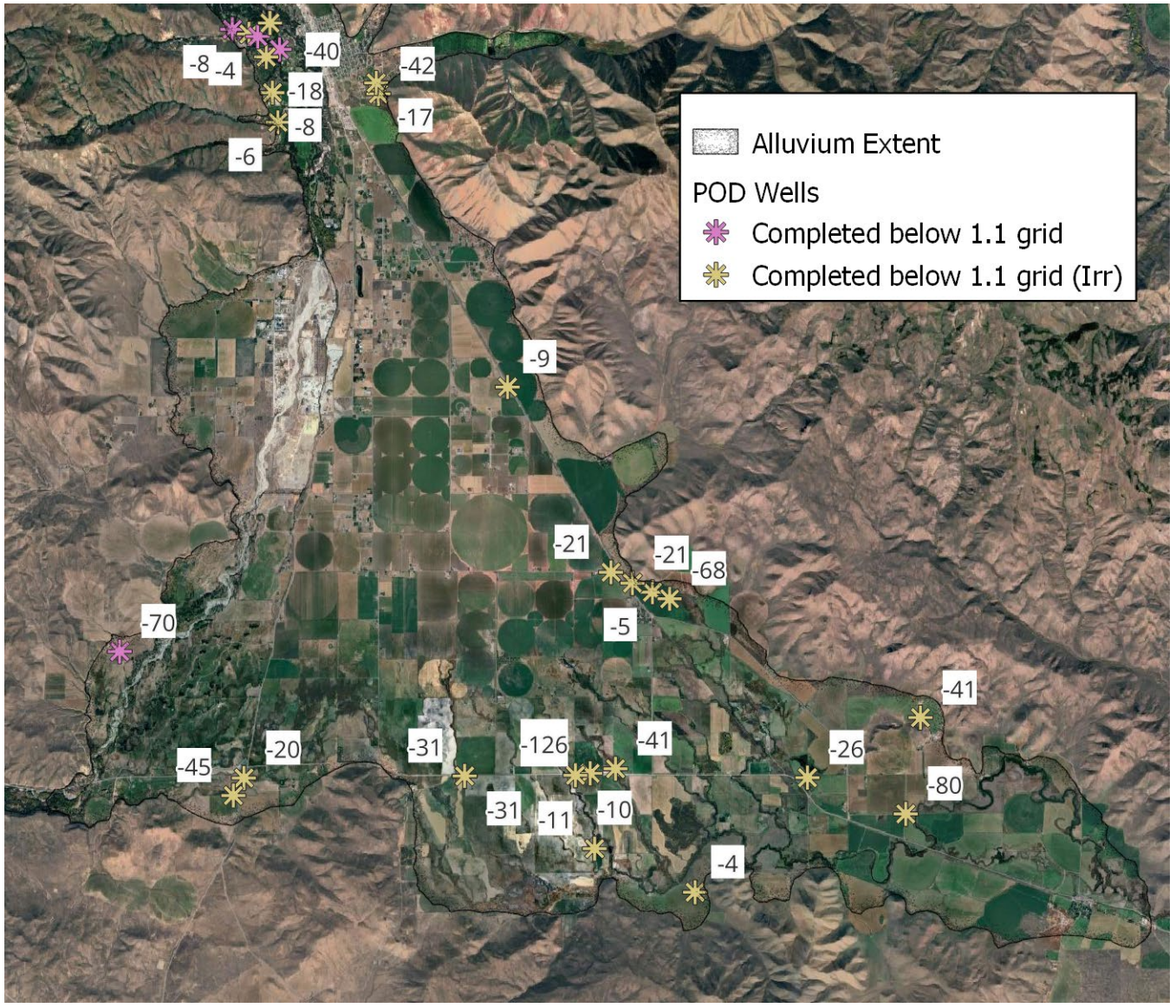
Basalt Extent

- Extended basalt into new model extent in SW based on well logs
- Basalt depth below 2nd layer increased from 52 meters to 68 meters based on thicker sequences in well logs



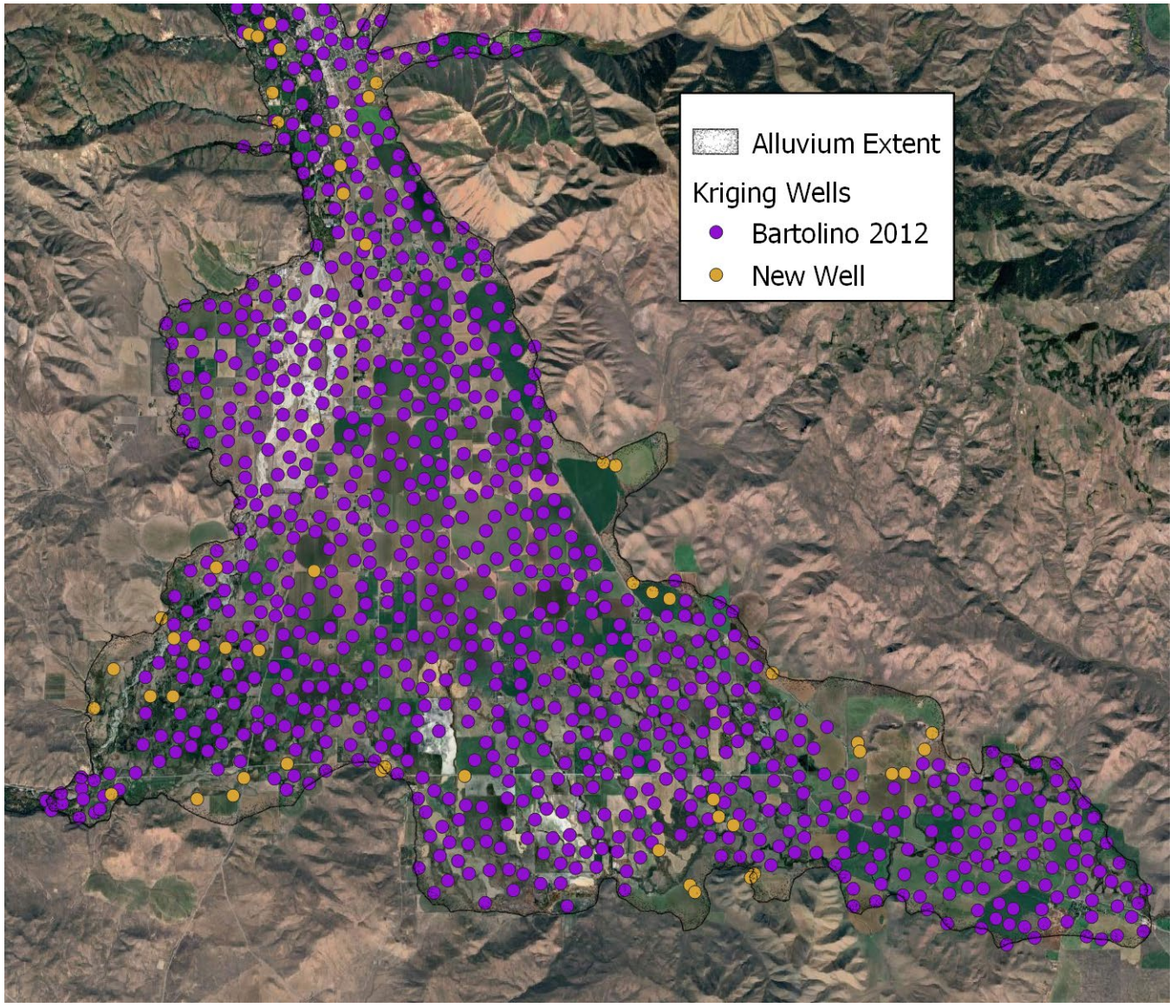
Model thickness

- Some groundwater PODs pump from below bottom of 1.1 grid
- Previously adjusted to pump from layer 3

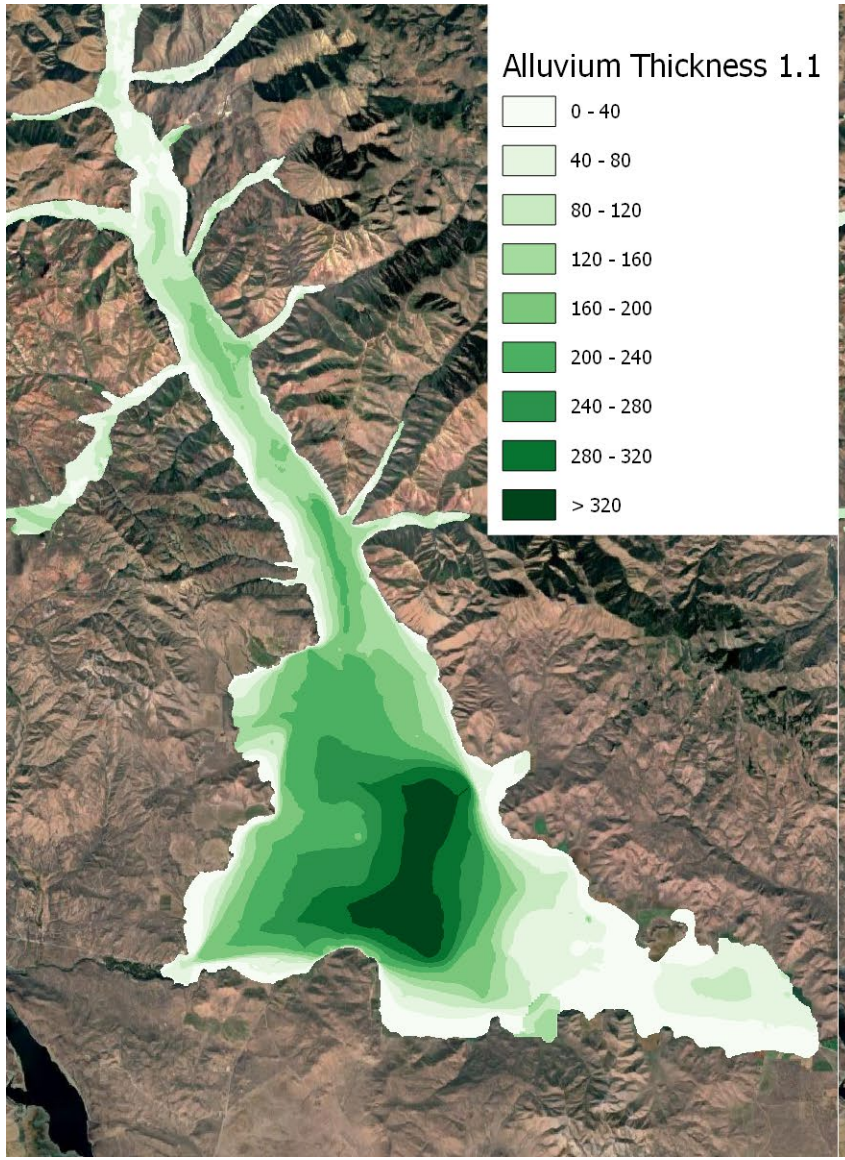


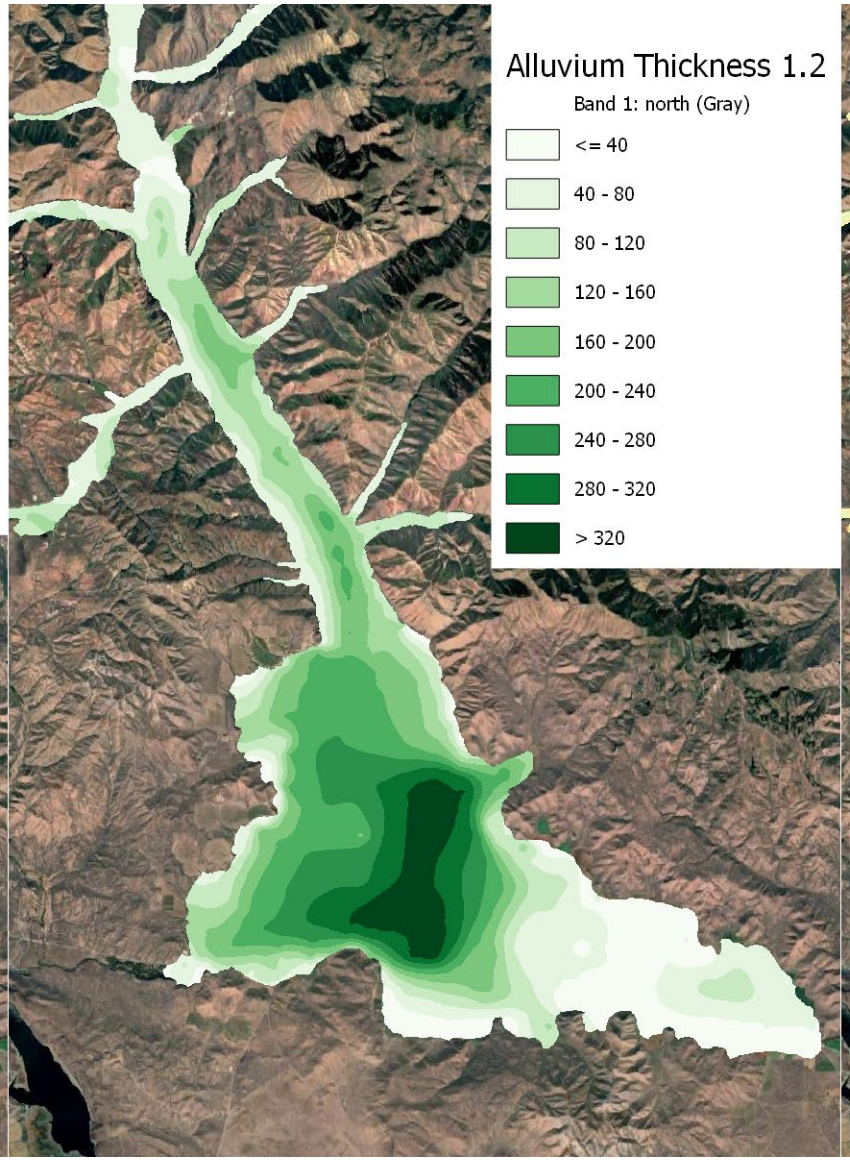
Model thickness

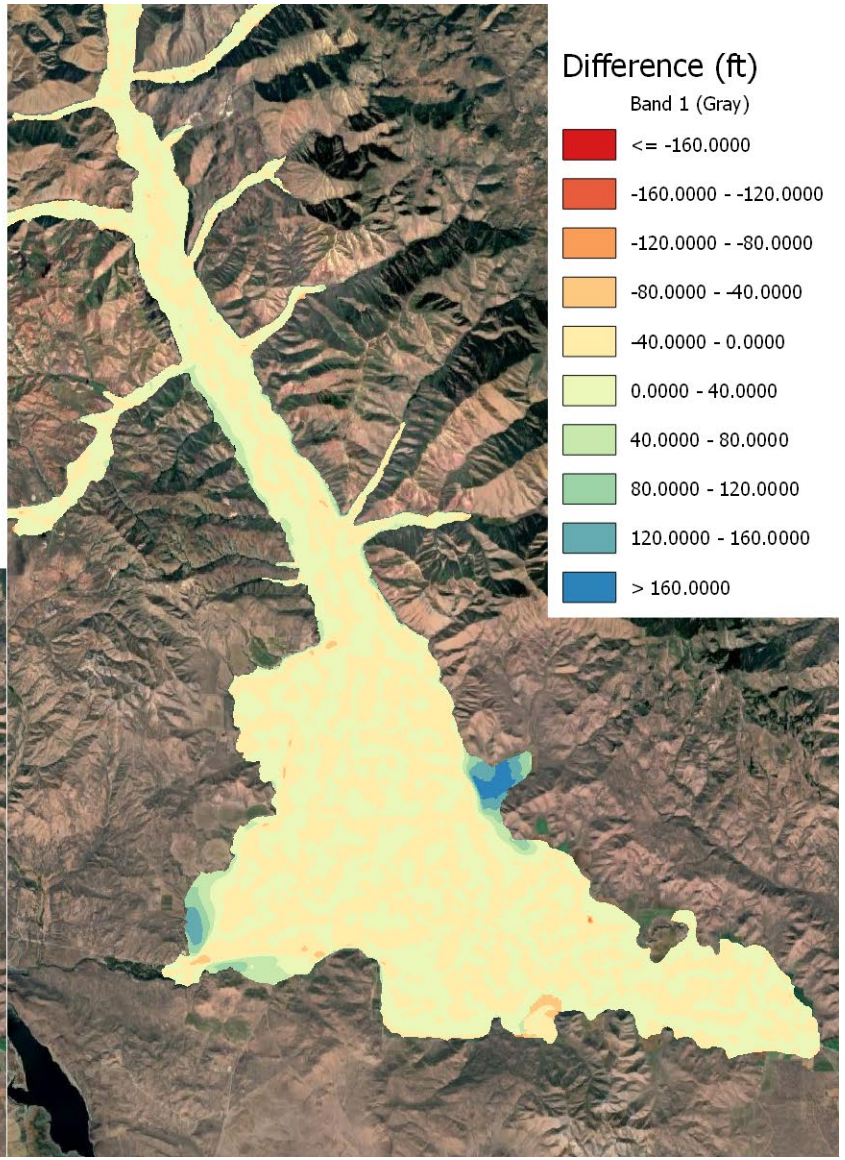
- **Fix known errors of confined wells pumping from upper aquifer.**
  - Timmerman
  - Add data to extended boundary
- **Kriged alluvium thickness**
  - Sampled Bartolino, 2012 alluvium thickness to preserve hand contouring (some wells corrected for location)
  - Added new wells not included in Bartolino 2012
  - Kriged Bellevue triangle separately



Alluvium Thickness

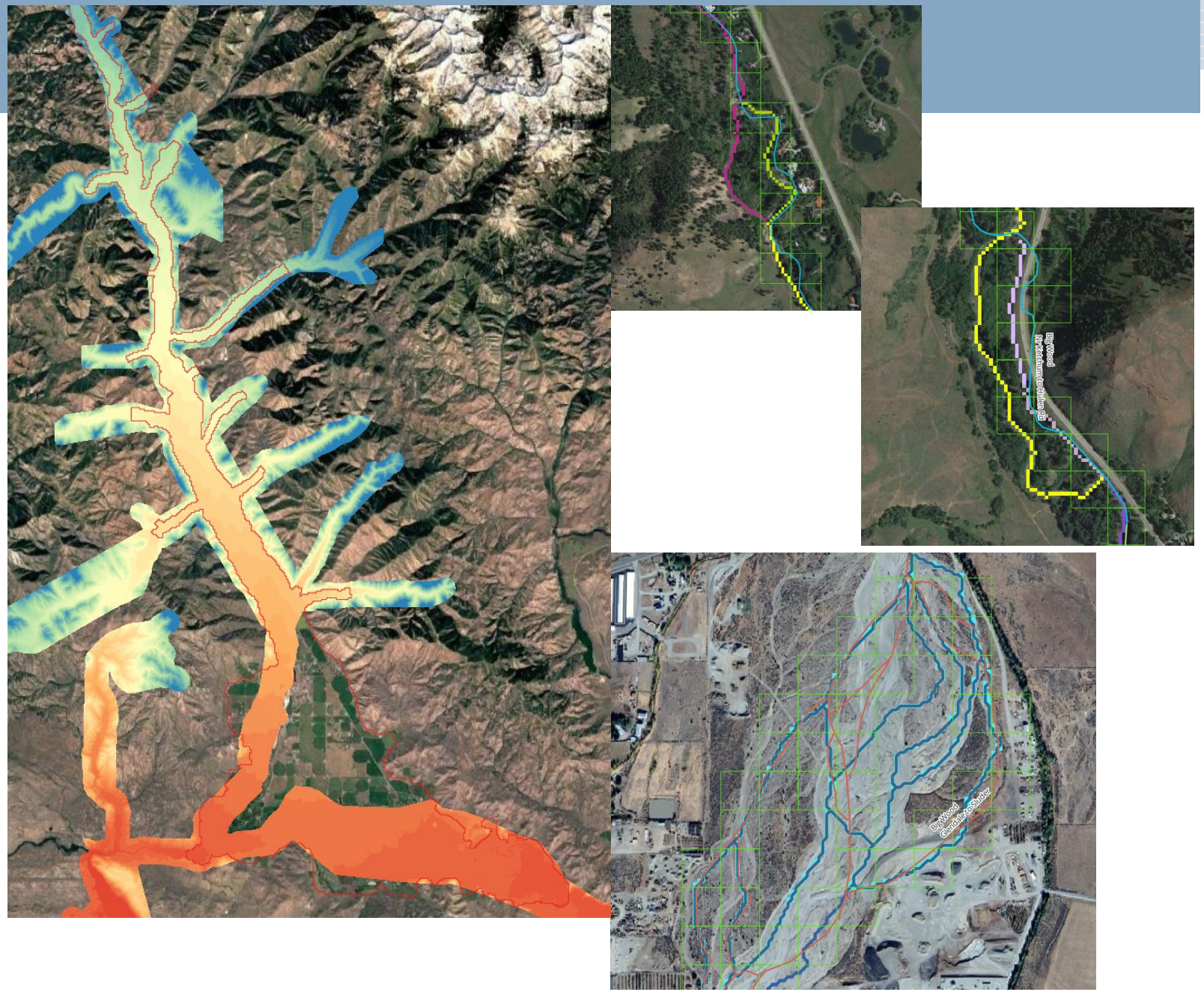






River Boundary

- LIDAR collected April to July 2015 by Oregon Lidar Consortium
- 1 m horizontal DEM resolution
- Purpose: Refine extent of RIV boundary extent and river bottom with new dataset



- **Flow accumulation with multiple flow directions used on resampled 10m DEM to estimate stream path**
- **Big Wood River cells**
  - Currently 1,067
  - With new LIDAR: 1,556
- **Increase in RIV cells would primarily occur in dry bed**