



COLORADO'S
Decision Support Systems
CWCB/DWR

Arkansas River Decision Support System (ArkDSS) Update

December 8, 2021

ARCA – Garden City, KS



Agenda

- Overview of progress (B. Macpherson)
- StateCU/StateMod Model update (K. Sobieski)
- Update on ET Data/Colors or Water Tool (K. Thompson)



ArkDSS Progress

Phase I:

- GIS ✓
- Admin Tools ✓
- StateMod/StateCU Modeling

Phase II:

- Colors of Water and Forecasting Tool
- Groundwater



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Where to find materials

Task memos and GIS: <https://cdss.colorado.gov/arkansas-river-dss>

Admin Tools: <http://div2waterops.com/>

Colors of Water Training Video:

<https://drive.google.com/file/d/17SEJWtmoA2x5GgjQEKqpamjHuZA0siBH/view>



Progress on Colors of Water and Forecasting Tool

- This Tool will replace the existing Colors of Water Tool with enhancements, all data from HydroBase, and ability to plan and forecast
- Multiple transit loss calculation methods will be possible
- Kelley is working closely with consultant on model engine and calibration
- DWR-OIT is designing web platform to display results



Future Groundwater Work

- Focus on physical parameters
 - Gridded data
 - Physical tests

ArkDSS Modeling Effort

ARCA MEETING

DECEMBER 8, 2021

ArkDSS Model Background

- **Arkansas Decision Support System**

- Suite of tools and data to assist decision makers at the state and basin level with water supply planning
 - Irrigated acreage
 - Water rights
 - Diversion, Transmountain, Storage, Pumping data
 - Agricultural, municipal, industrial, and instream flow demands
 - Major operations
 - Consumptive Use
 - Ground Water
 - Surface Water Modeling
- Standard DSS approach, consistent with DSS in other basins in the state
- More information available on the CDSS website (<https://cdss.colorado.gov/arkansas-river-dss>)

ArkDSS Surface Water Model

- Surface Water Allocation Model
 - StateMod platform; publicly available on CDSS website
 - Allocates water based on demands, water rights, capacities, and operations
 - Allocates water according to Prior Appropriation
 - 65+ years of variable hydrology (1950 through Current Year)
 - “Baseline” dataset serves as starting point to determine the impact of “What-if” future scenarios
 - Baseline scenario reflects current demands and operations over the entire model period
 - Implement “what-if” future conditions into the model, simulate, and compare results back to Baseline
 - E.g. changes to reservoir operations, hydrology, and/or demands

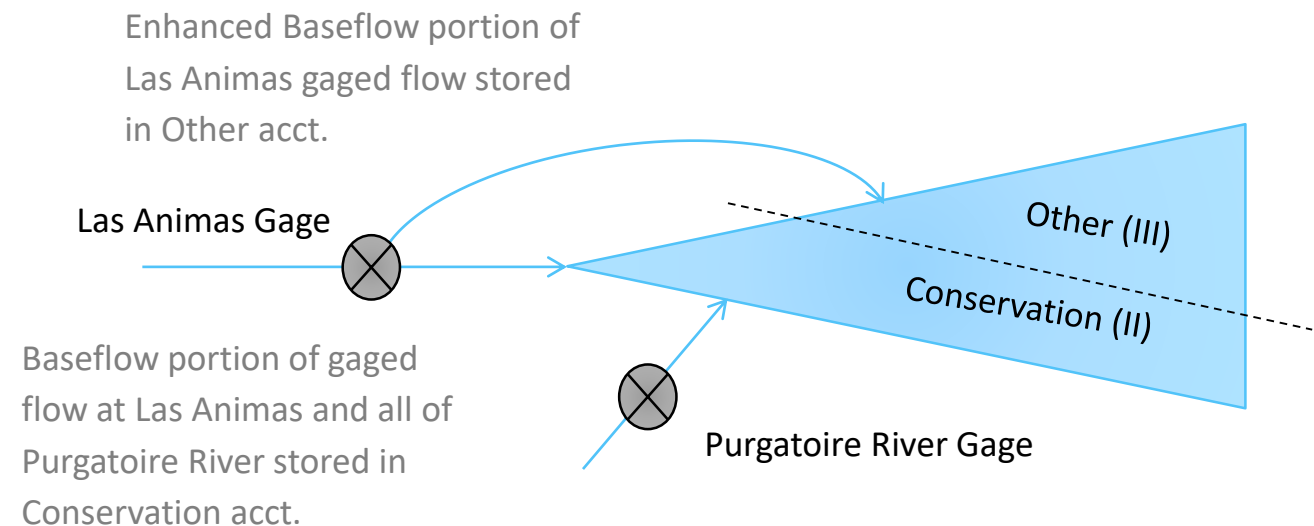
ArkDSS Surface Water Model

- Surface Water Allocation Model
 - Data collection and processing complete
 - Water Commissioner, DWR, Water User Interviews
 - Project Operating Criteria
 - DWR Accounting, Water Use Records (Hydrobase), and Decrees
 - Currently in Historical calibration stage
 - Compare simulated results from the model to measured data at streamflow gages, diversions, and reservoir contents
 - Adjust return flows, operations to improve calibration
 - Working upstream to downstream

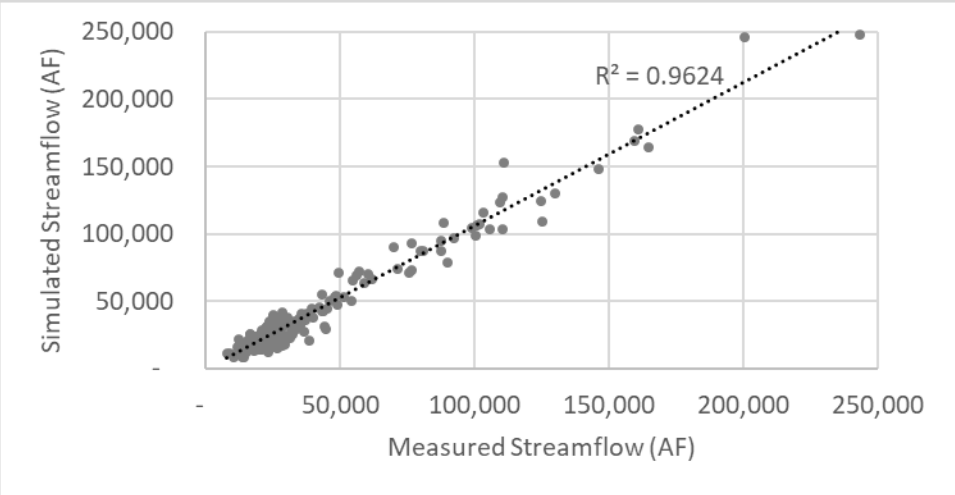
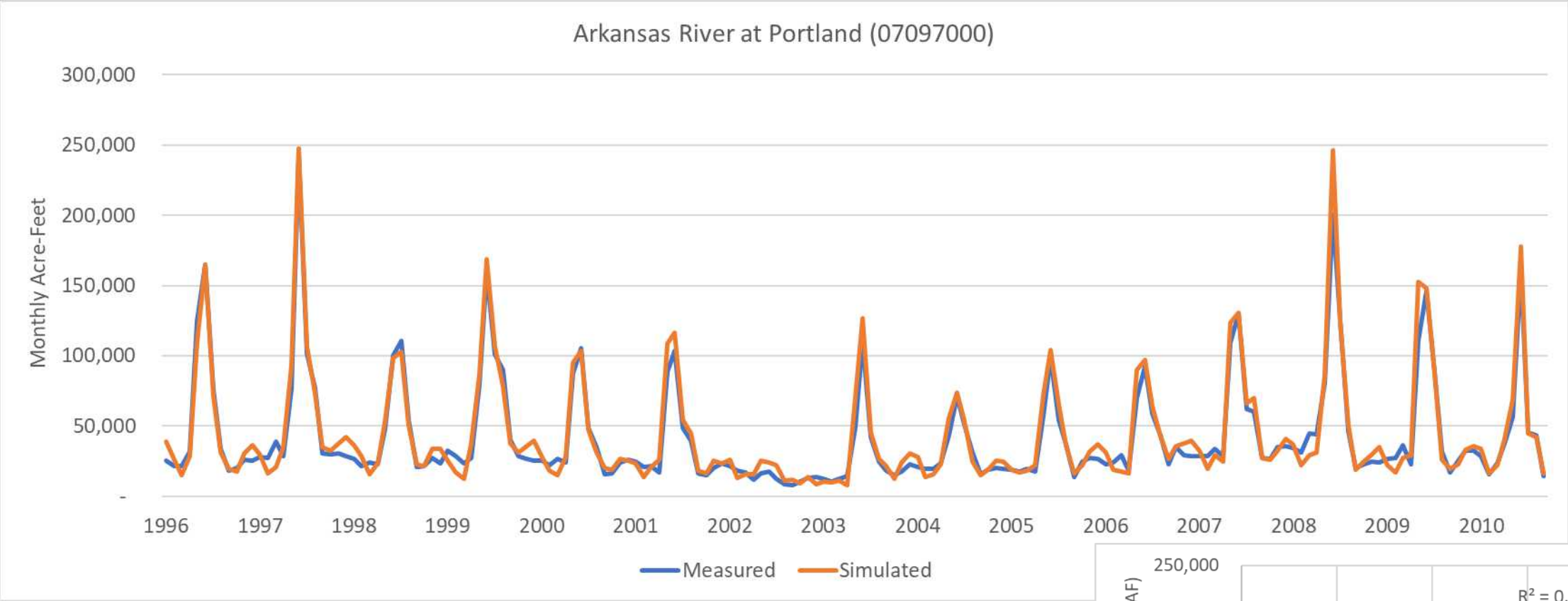
StateMod Operations Unique to the Arkansas Basin

1. Review operating criteria
2. Discuss operations with DWR and water users
3. Develop new operations within StateMod
4. Test and calibrate results of new operations

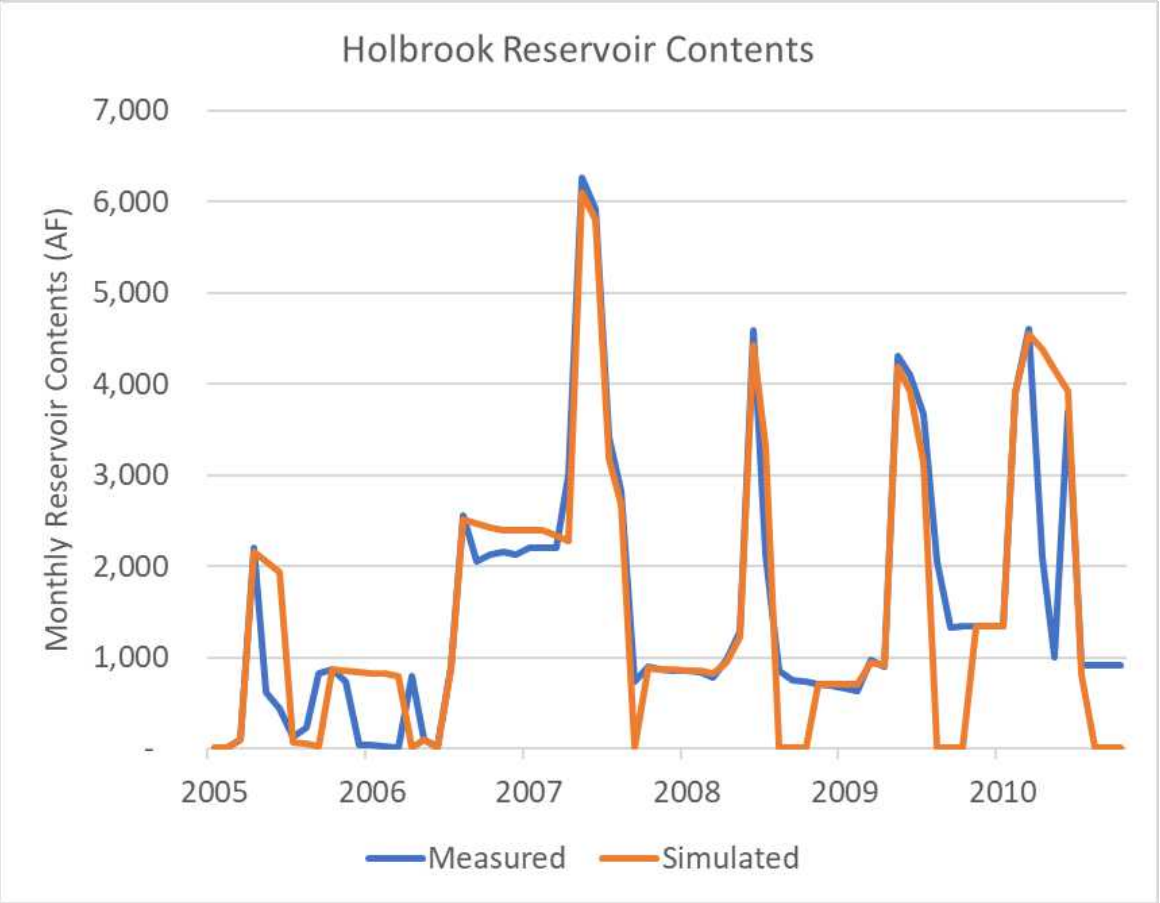
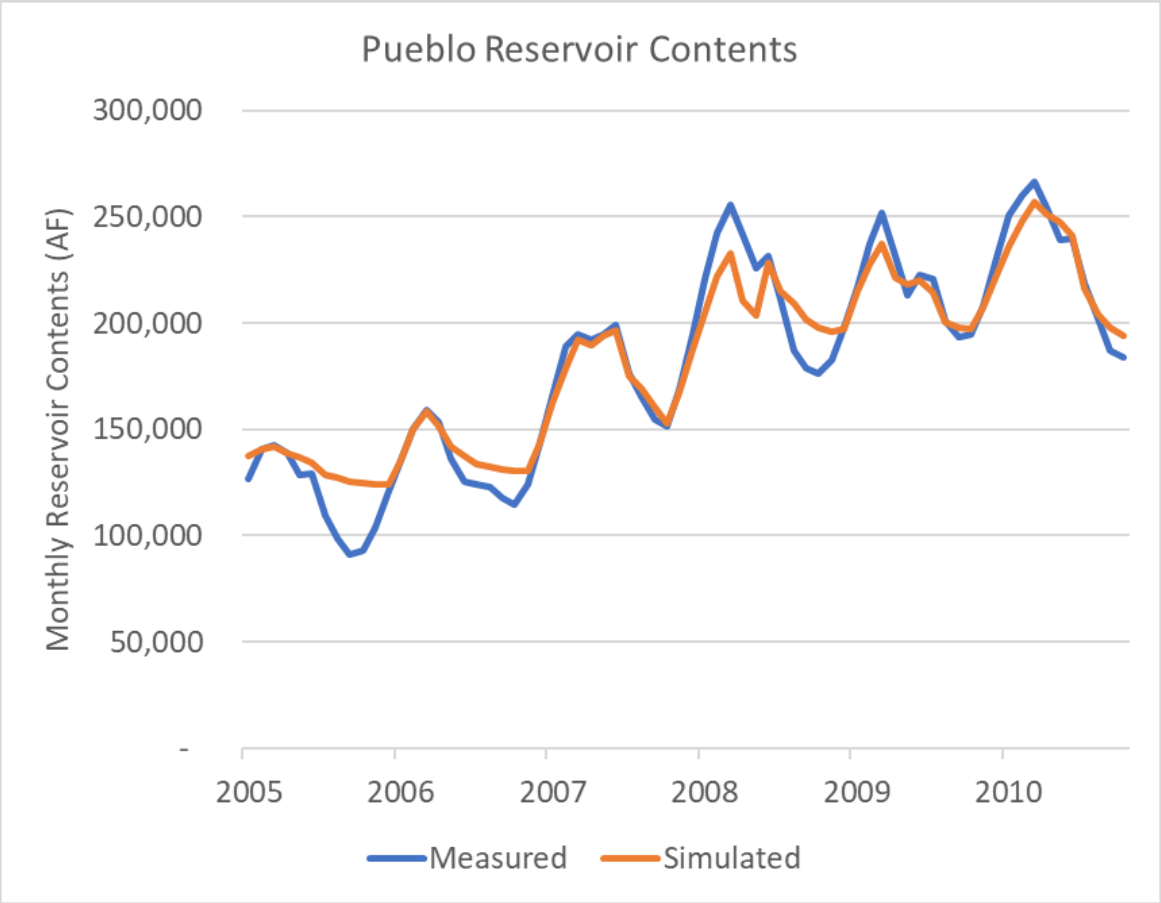
- Winter Water Storage Program
 - Track WWSP supplies stored in numerous reservoirs, releases by a variety of users, and carry-over supplies
- Trinidad Project Operations
 - Refer to the November 5, 2021 Trinidad Project Meeting presentation for summary and draft calibration results
- John Martin Reservoir Storage



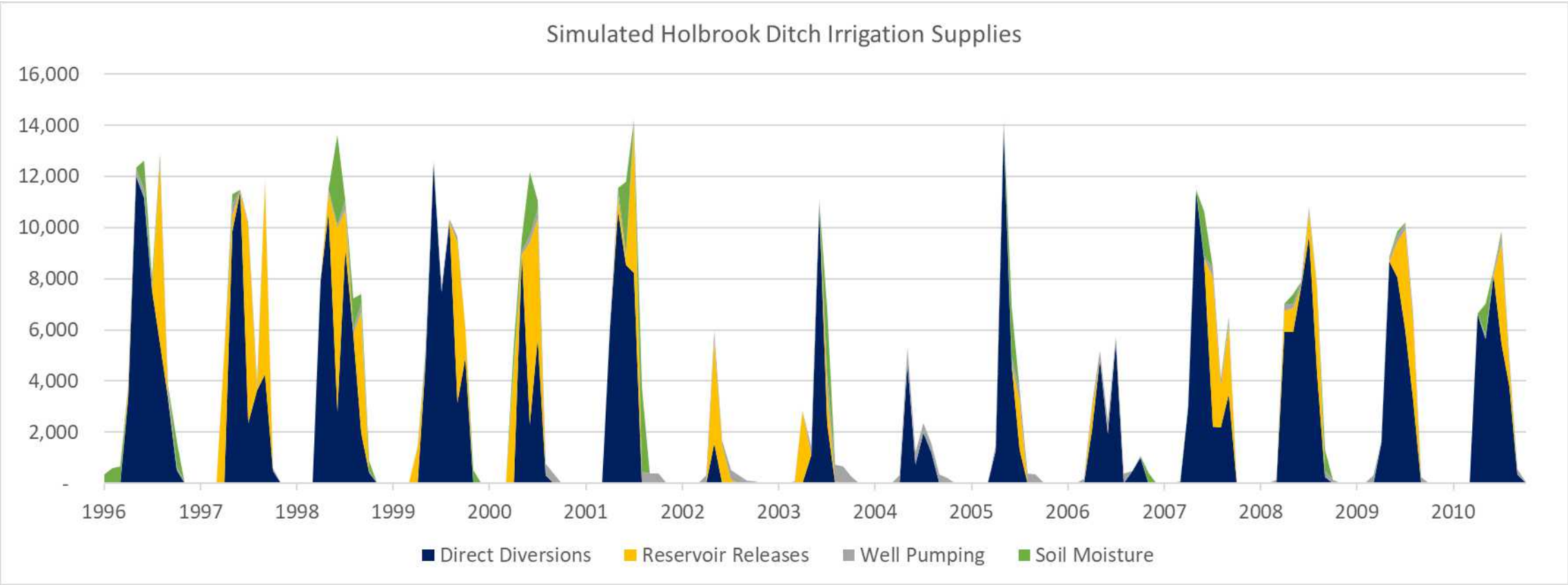
ArkDSS Draft Calibration



ArkDSS Draft Calibration



ArkDSS Draft Calibration



ArkDSS ET Report Now Available for Review

ArkDSS Task 3.2 - Climate Data

ArkDSS Task 3.3 - Crop Coefficients

ArkDSS Task 3.4 - Climate Stations

ArkDSS Task 3.5 - Reservoir Evaporation

- ET Dataset Report (224 pages / 64 tables / 122 figures)
- Appendix C-D figures (141 figures)
- ET Data and StateCU Tool (datafile-265MB, tool, doc)

Available at:

a) CDSS Webpage:

<https://cdss.colorado.gov/arkansas-river-dss>

b) ArkDSS Kansas shared drive

ArkDSS REPORT

Development of Arkansas Basin Evapotranspiration (ET) Datasets

FROM: Kelley Thompson, P.E.; Division of Water Resources Modeling and DSS Team

REVIEW BY: Tom W. Ley, Ph.D., P.E.; Natural Resources Consulting Engineers, Inc.

Erin Wilson, P.E., and staff; Wilson Water Group, LLC.

DATE: 12/2/2021



ArkDSS ET Dataset Report

SECTION 1: Correction of CoAgMet/RET Station Climate Data

- 15 Ark Basin CoAgMet Stations (including 7 HI Model Stations)
- QC/correct missing and bad data (using HI Model methods/software)
- Station aridity corrections (using data from Hoehne and other stations)

SECTION 2: Correction of NOAA Station Data

- 34 Ark Basin NOAA Stations
- combination/filling for 1950-current daily temperature/precip
- station aridity correction using comparison with CoAgMet Stations

SECTION 3: Simulation/Calibration of Long-Term Climate Data

- 1950-2020 daily Tmax/Tmin/ea/solar/wind/ASCE Std Ref ET at all Stations
 - primarily literature/Allen methods plus some gridded data
- application to 2.5 mile grid points covering basin
 - elevation, cloudiness, and wind changes
 - individual ditches/structures based on nearest grid points

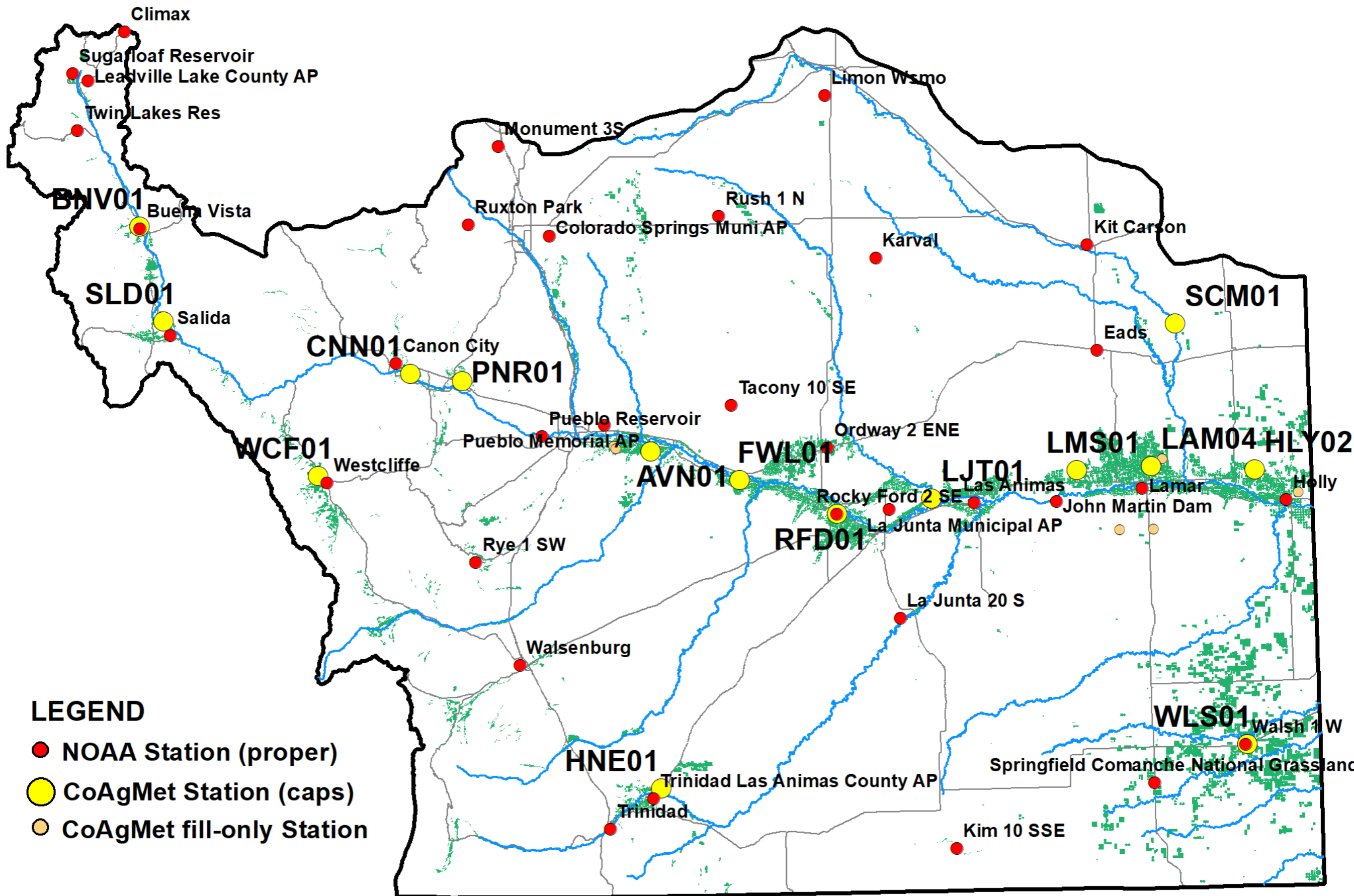
SECTION 4: Development of Crop ET Datasets

- crop coefficients/parameters based on Manual 70 and Lysimeter

SECTION 5: Reservoir Evaporation

- pan / ice cover data where available - JMR, Pueblo, Trinidad, Turquoise, Twin
- 53 Reservoirs – ETos estimate evaporation, Temp30 estimate ice cover

Arkansas Basin Climate Stations



QC of CoAgMet Station Daily Data (Holly-2 a)

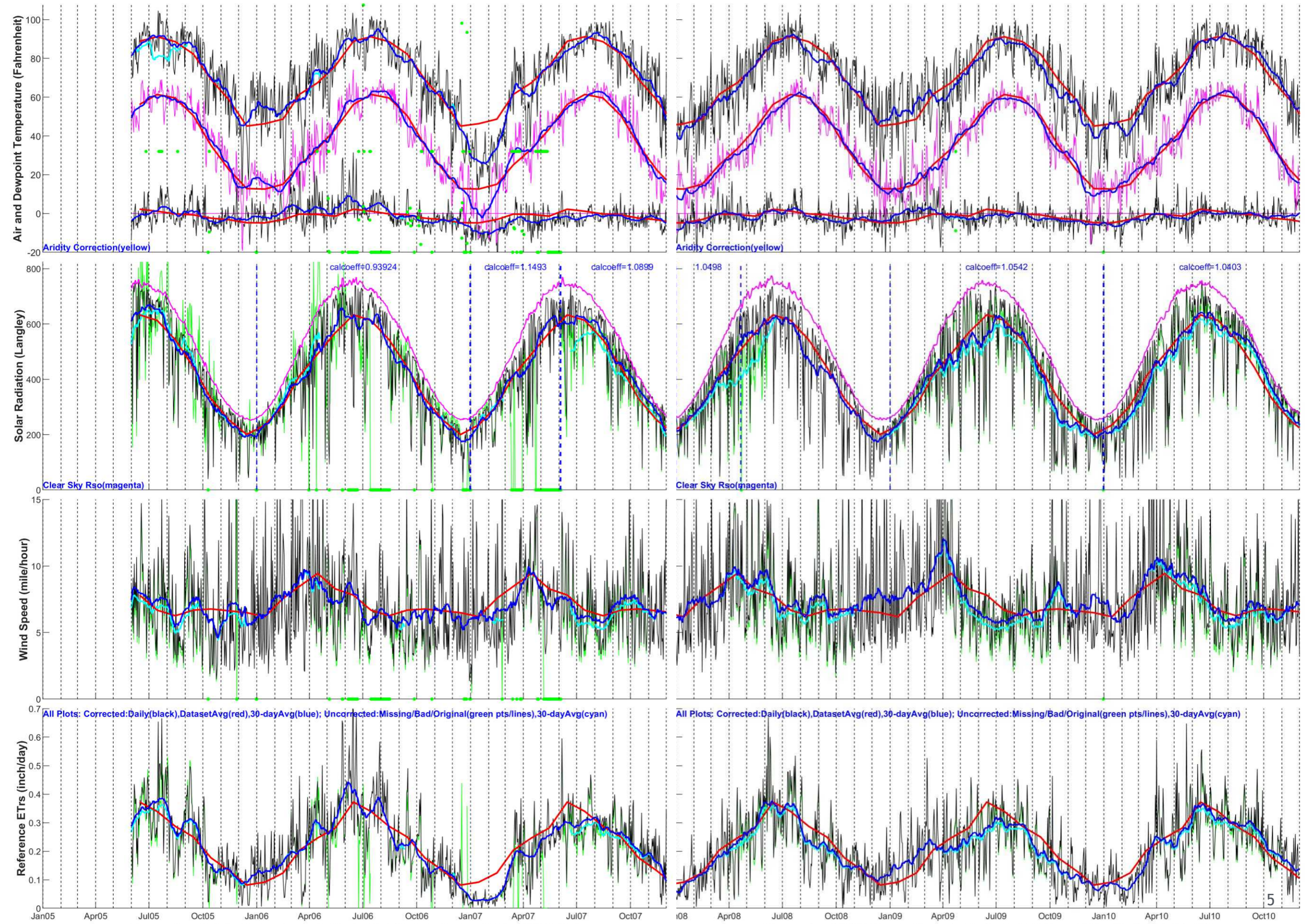
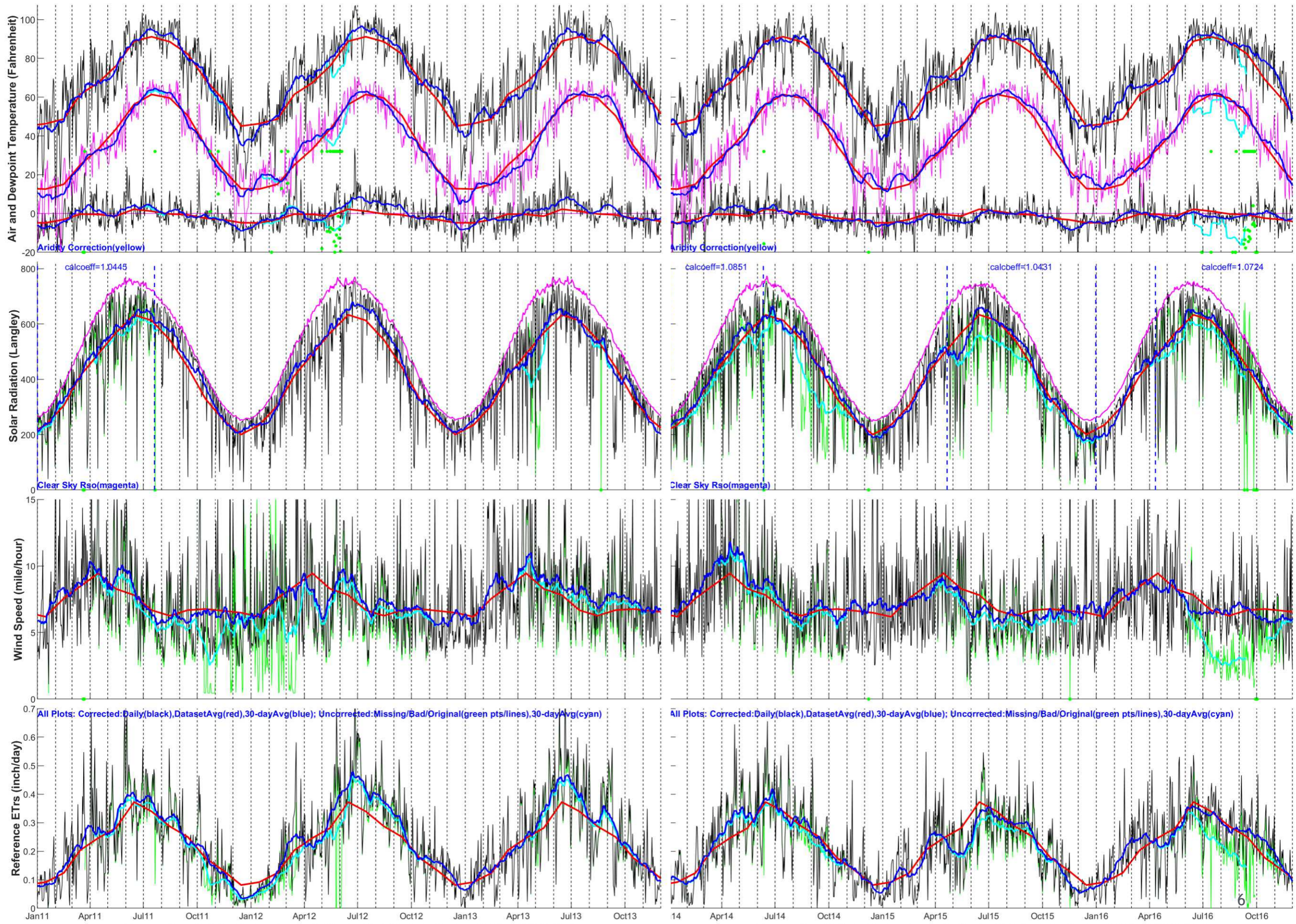


Figure AppC.7.1 Corrections to CoAgMet Station Data - Holly #2 (hly02)

Figure AppC.7.2 Corrections to CoAgMet Station Data - Holly #2 (hly02)

QC of CoAgMet Station Daily Data (Holly-2 b)



QC of CoAgMet Station Daily Data (Holly-2 c)

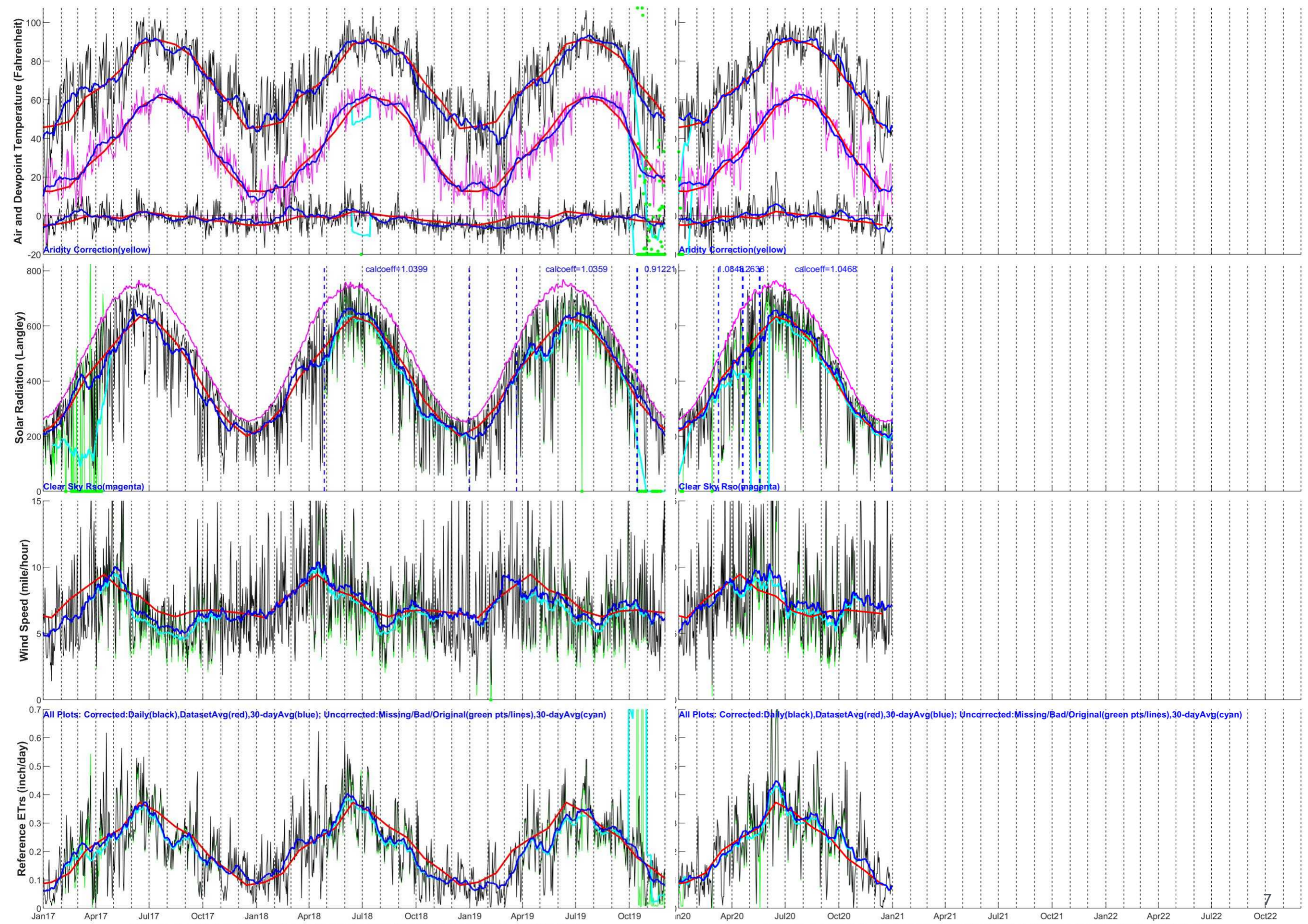
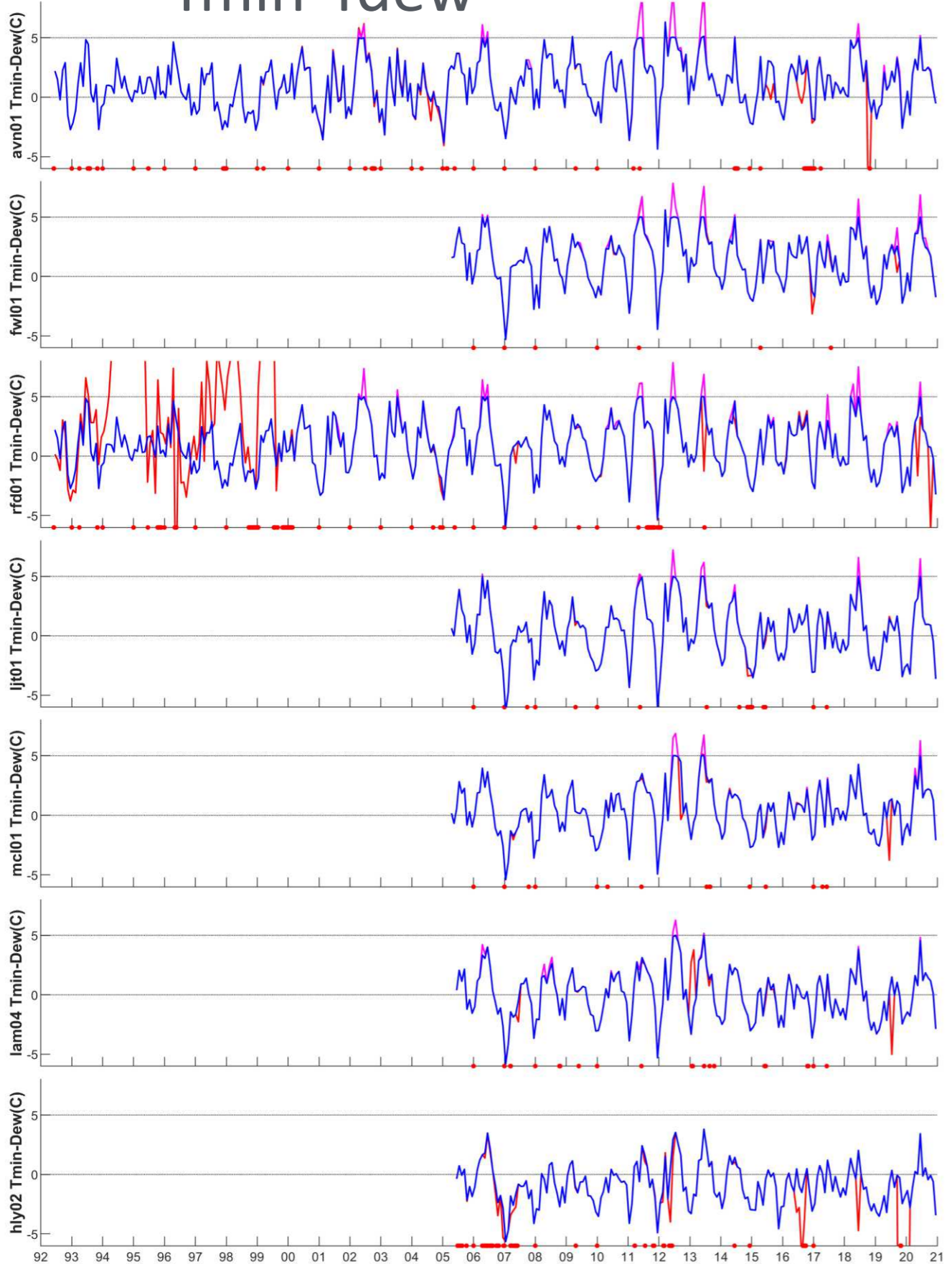


Figure AppC.7.5 Corrections to CoAgMet Station Data - Holly #2 (hly02)

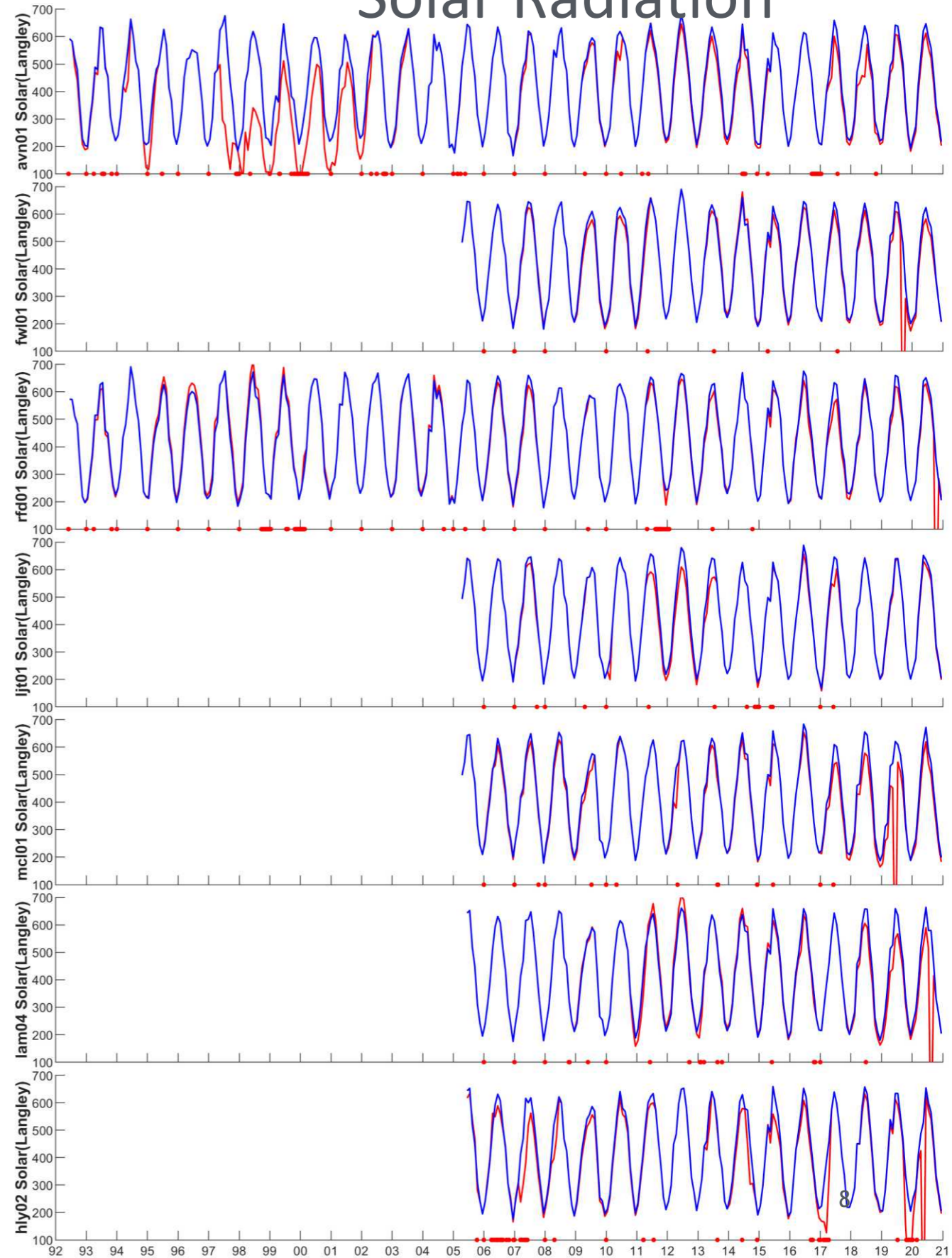
Figure AppC.7.6 Corrections to CoAgMet Station Data - Holly #2 (hly02)

QC of CoAgMet Data – Monthly (HI Model Stations)

Tmin-Tdew

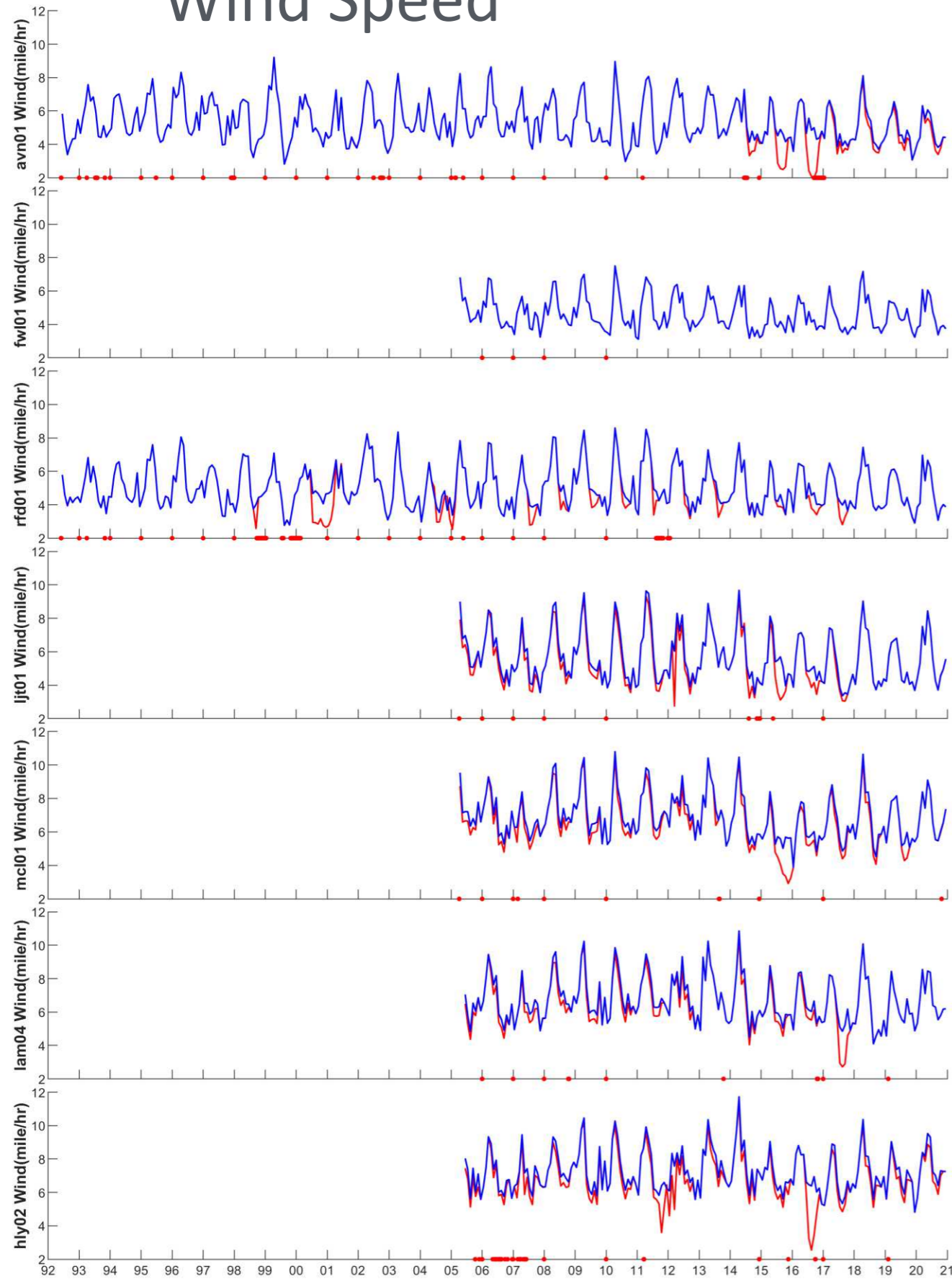


Solar Radiation

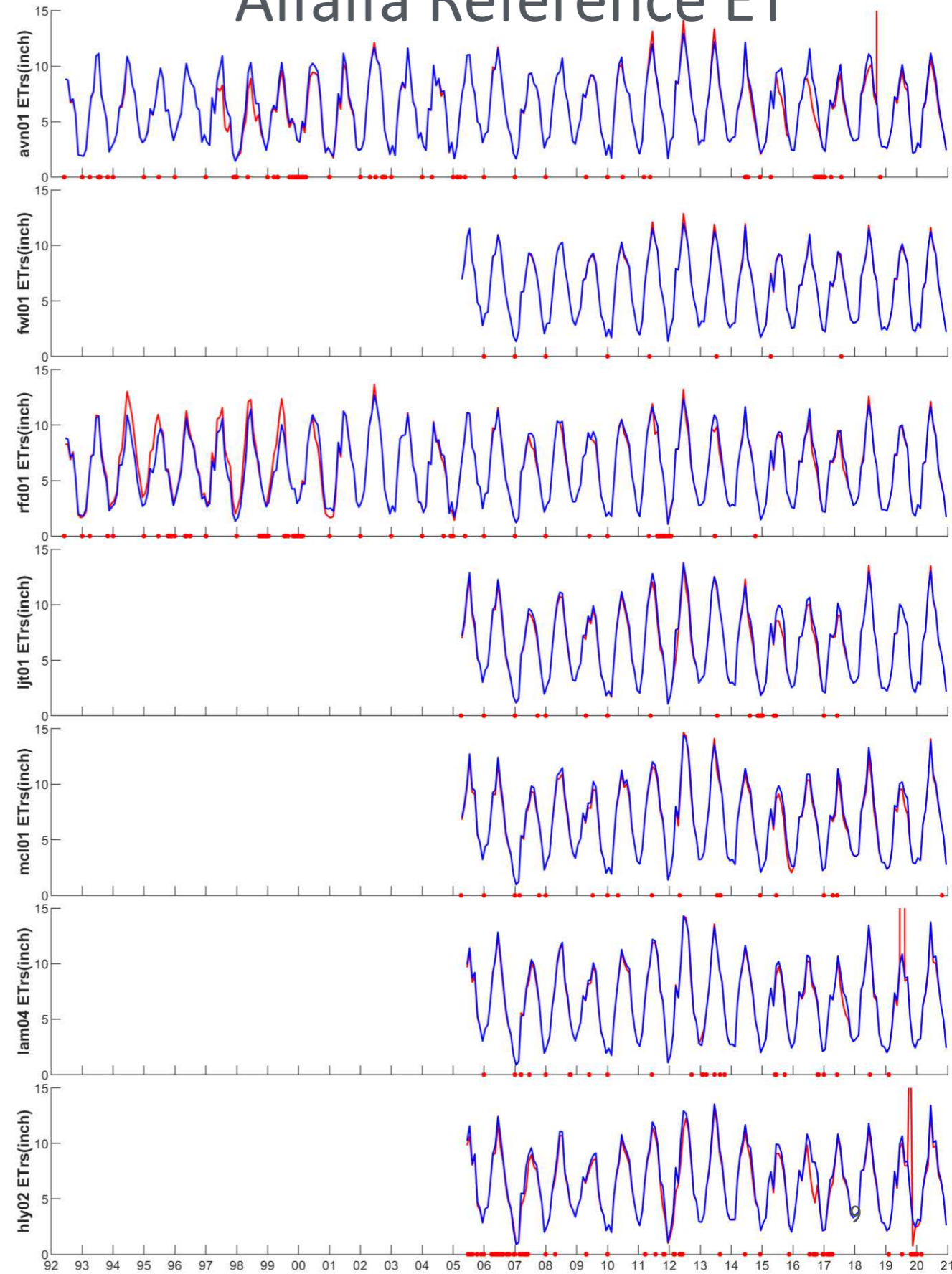


QC of CoAgMet Data – Monthly (HI Model Stations)

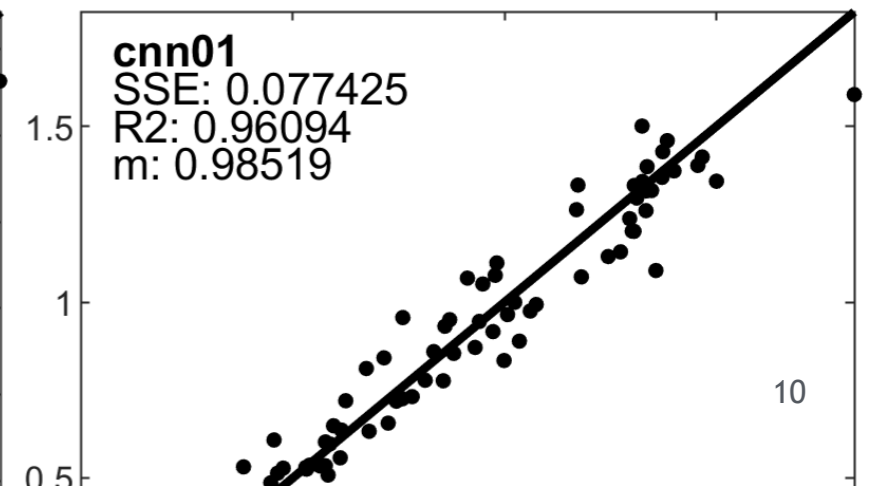
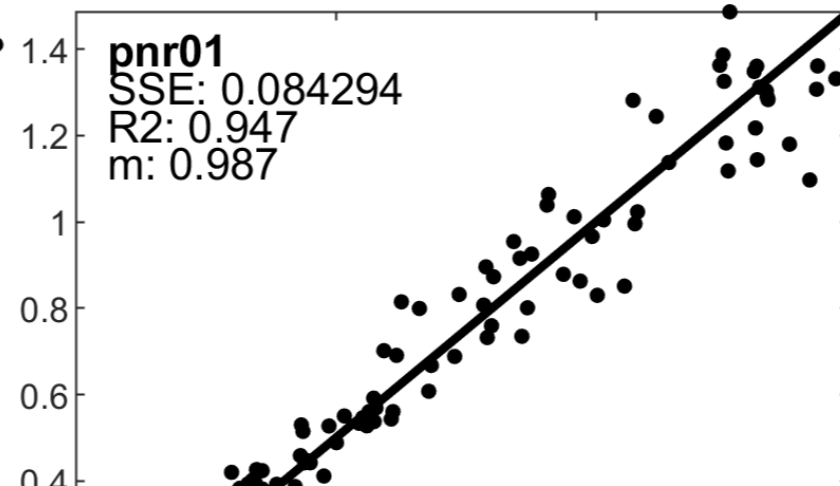
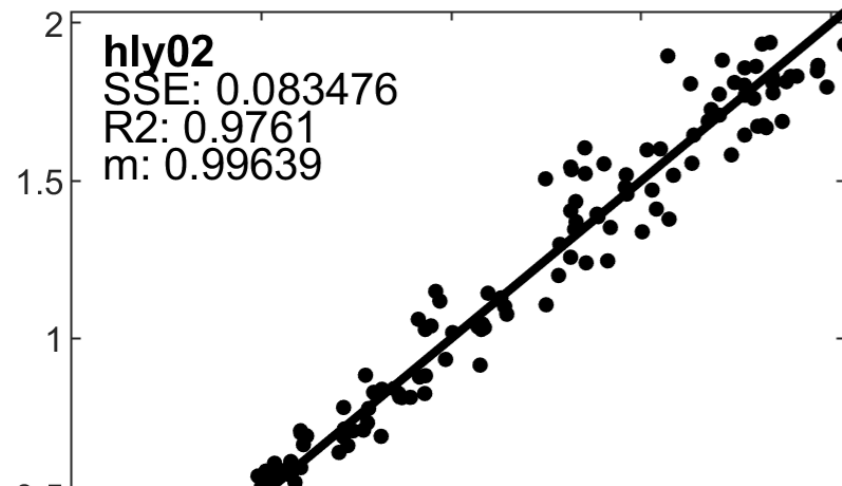
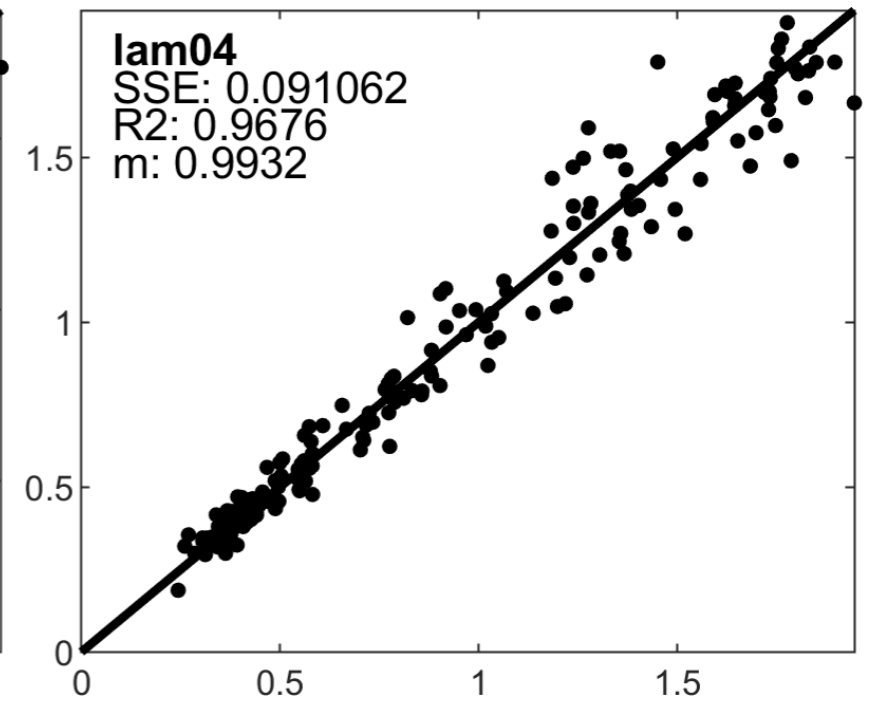
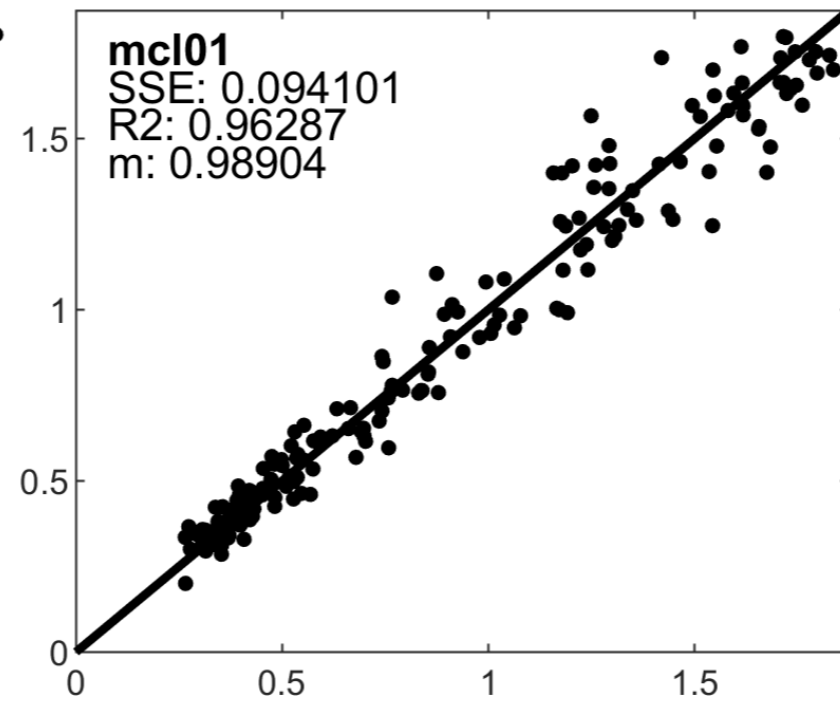
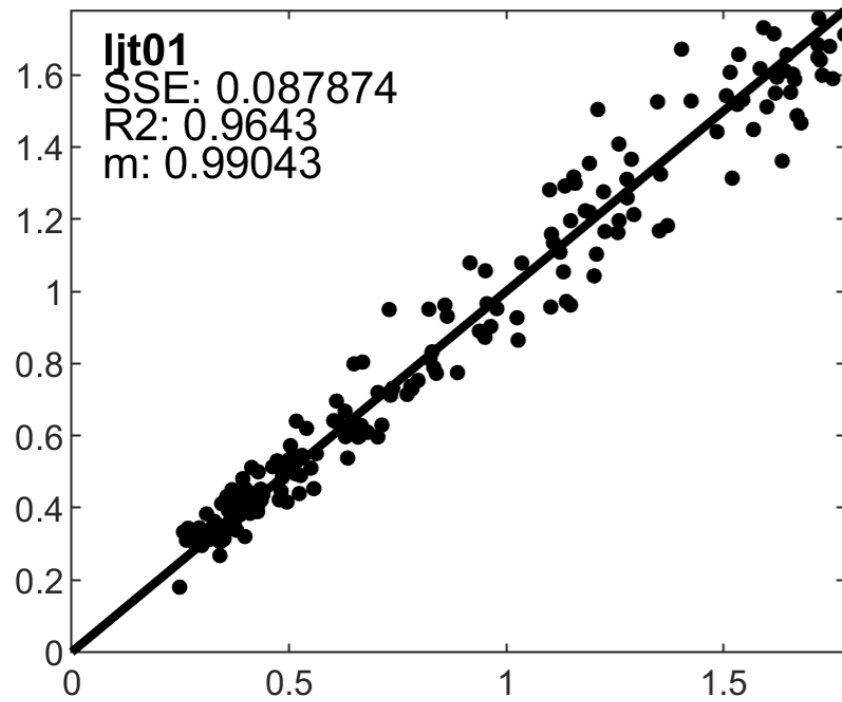
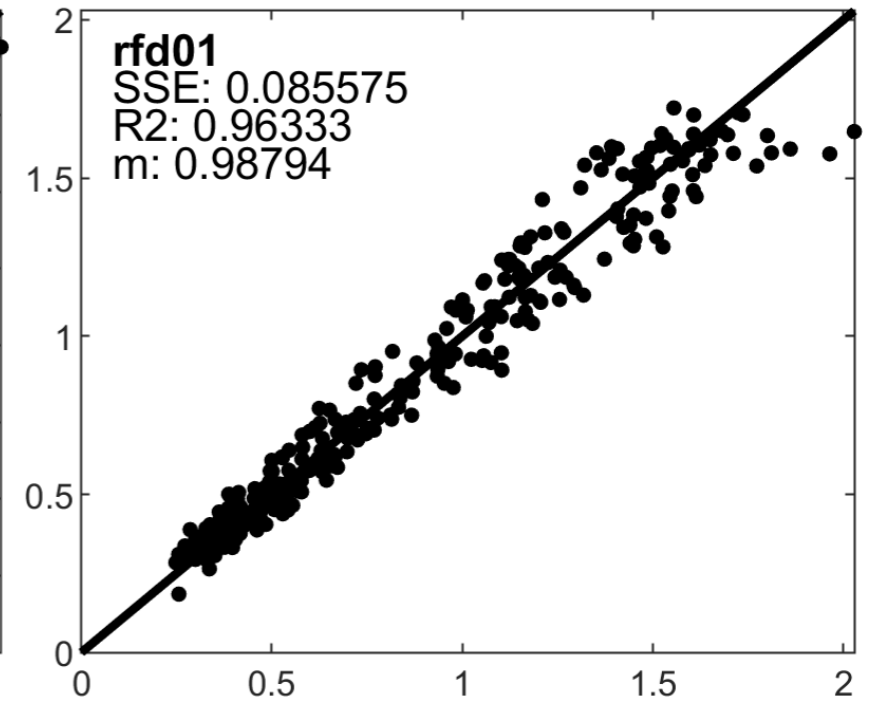
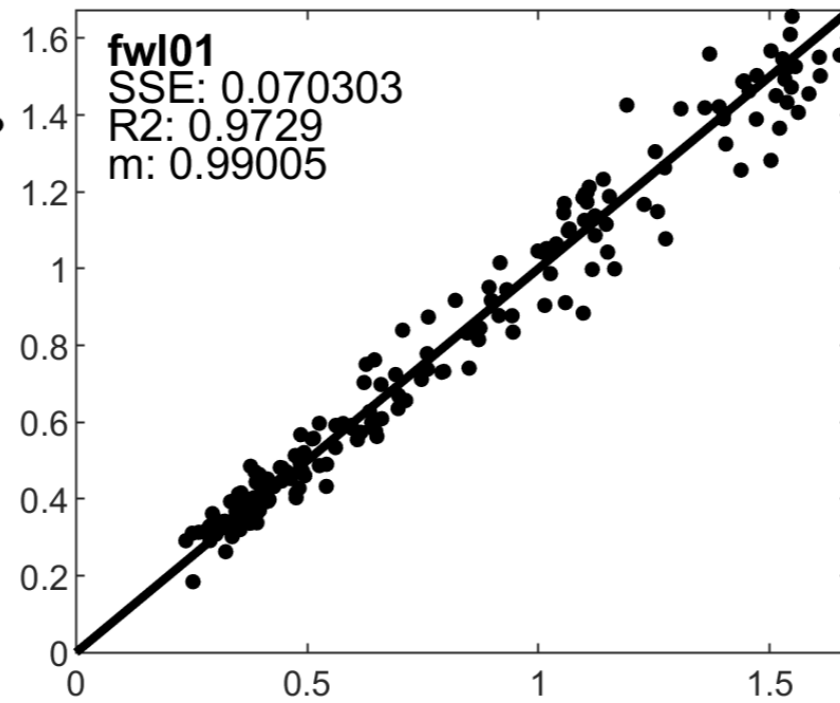
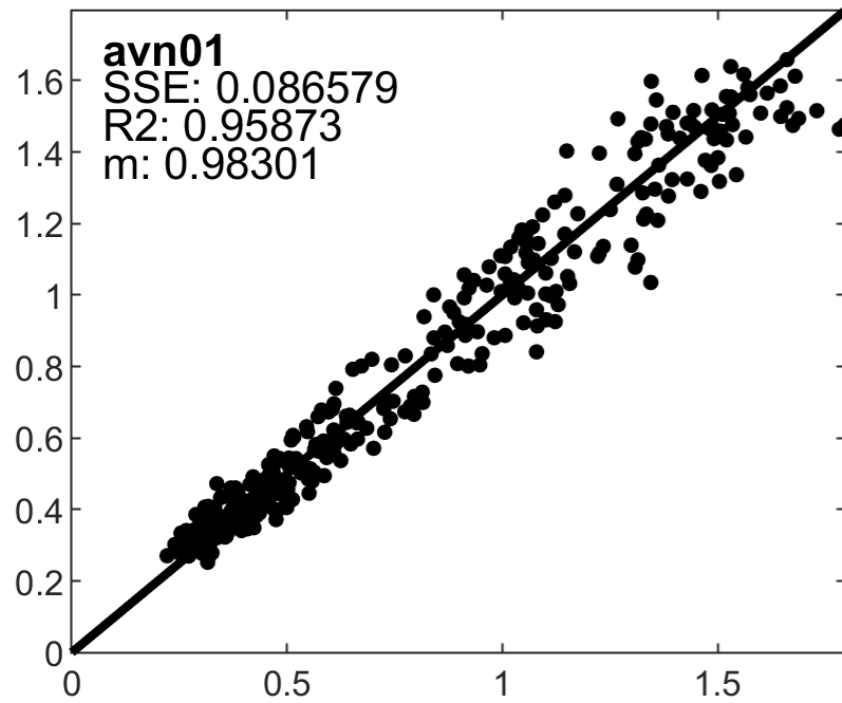
Wind Speed



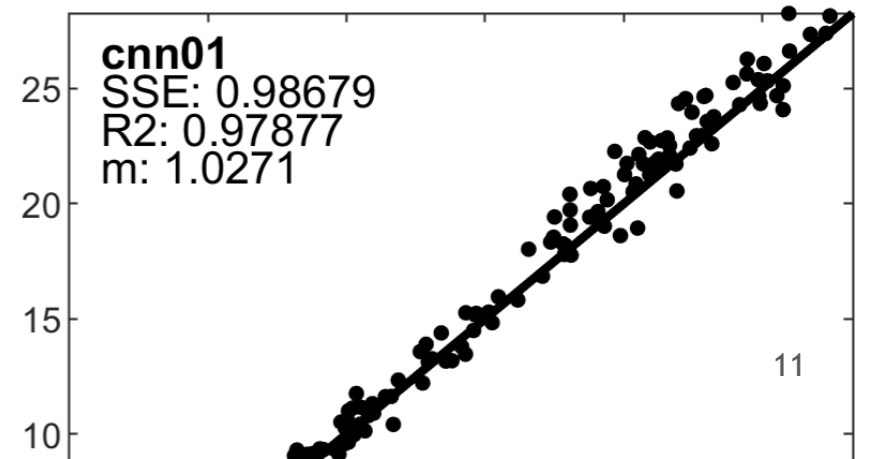
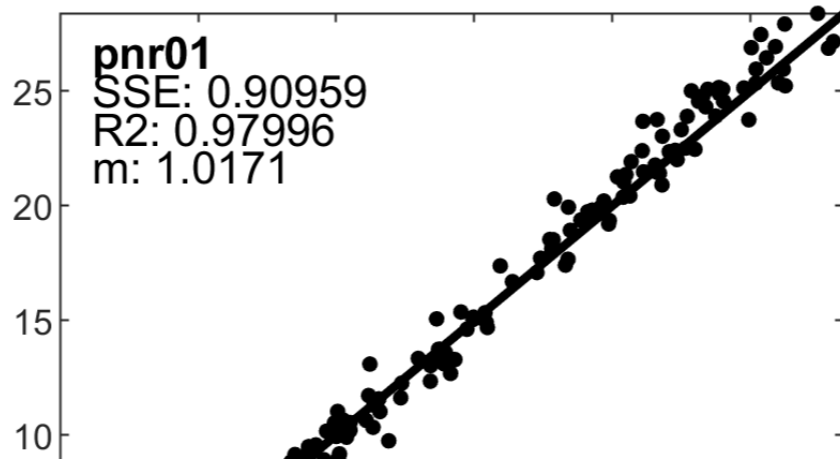
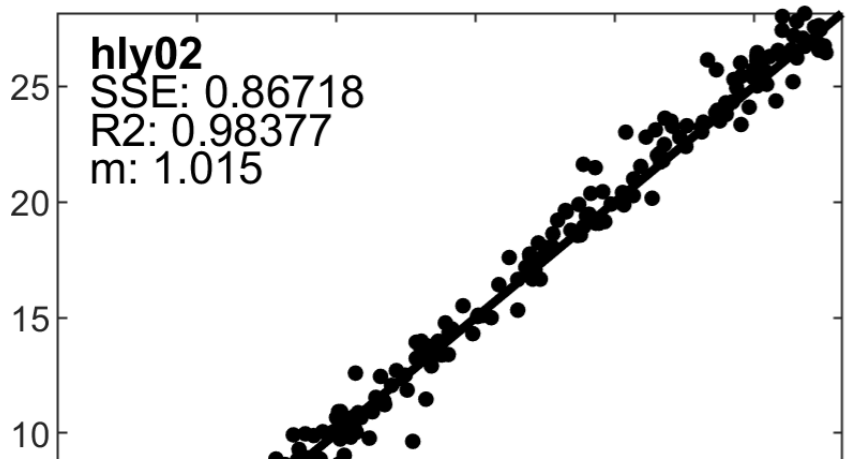
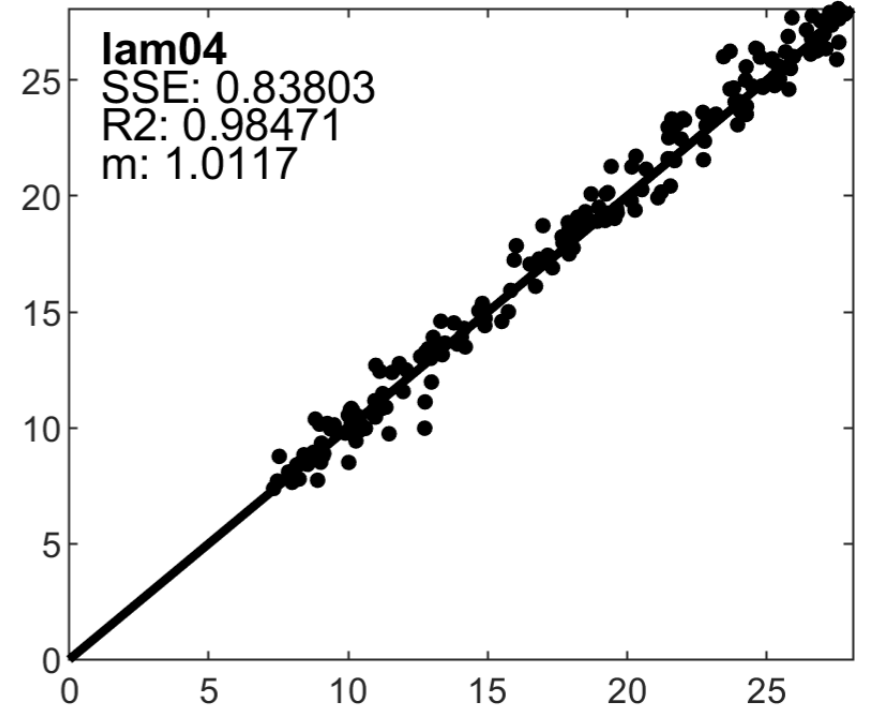
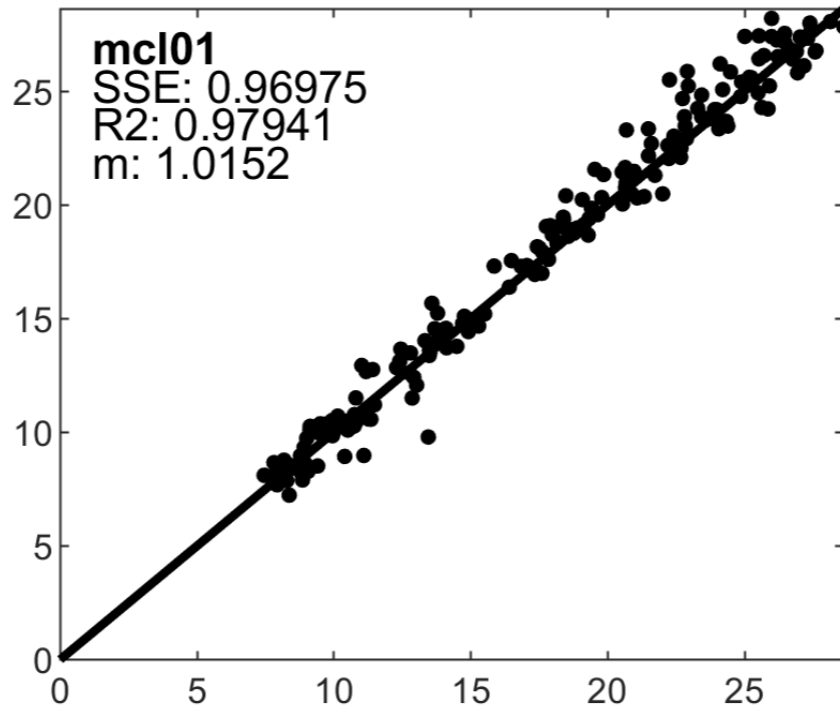
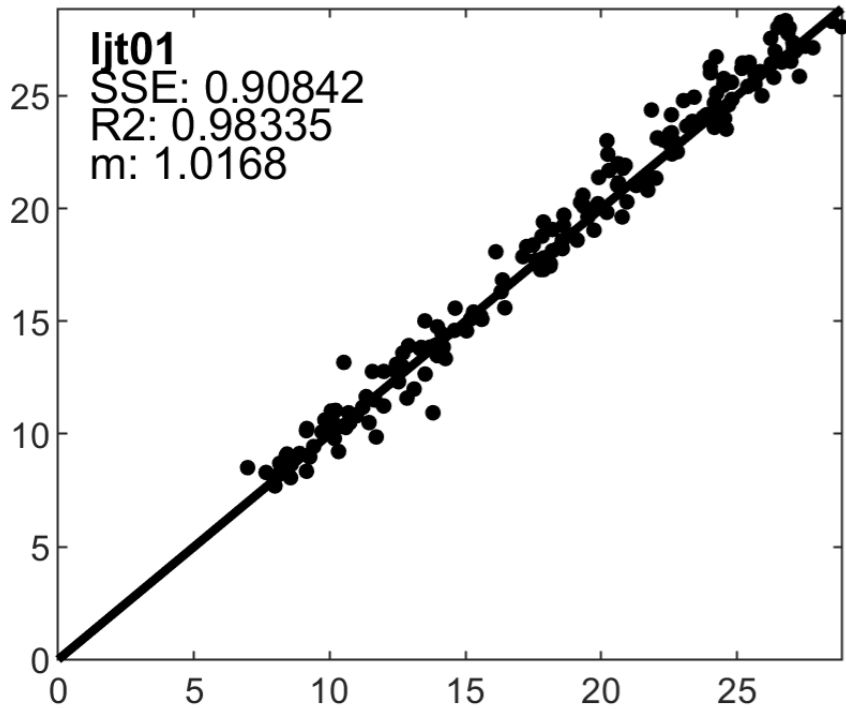
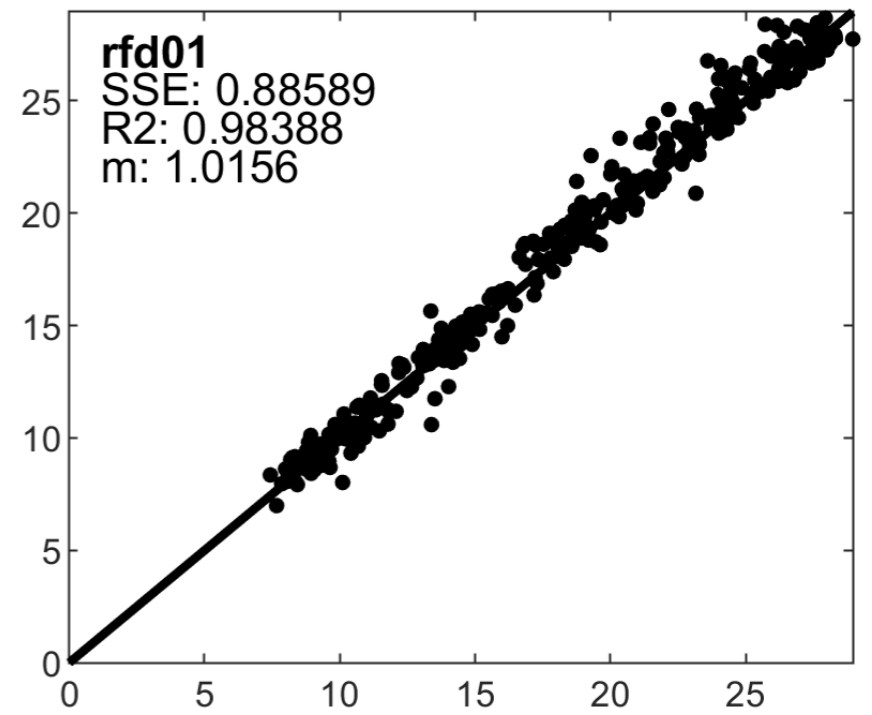
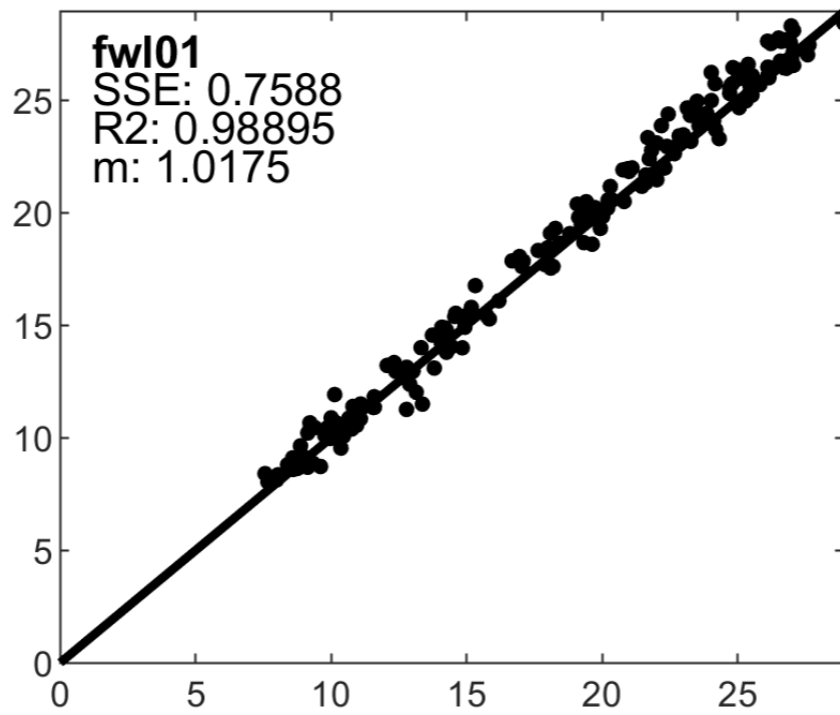
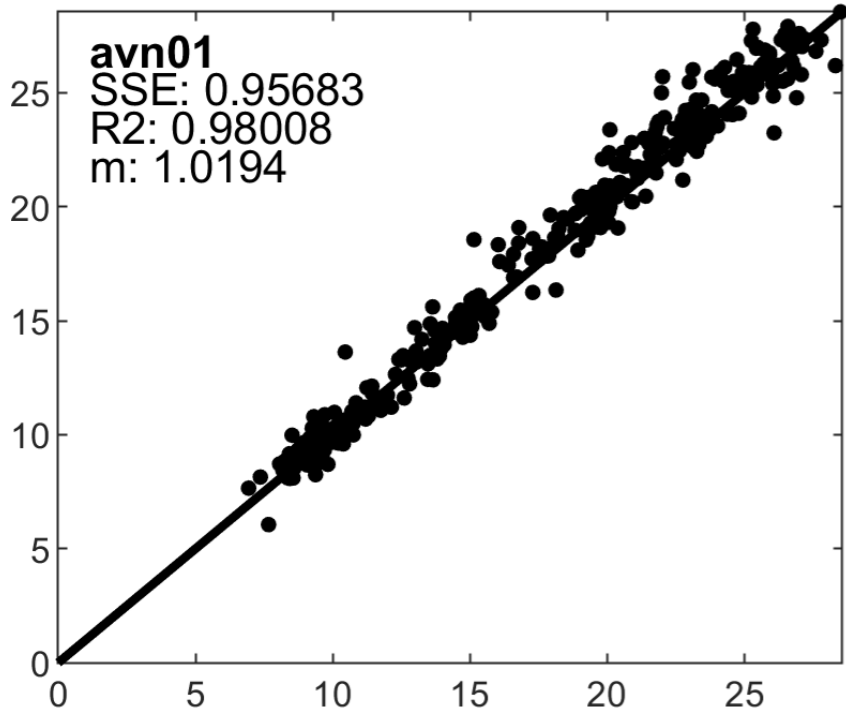
Alfalfa Reference ET



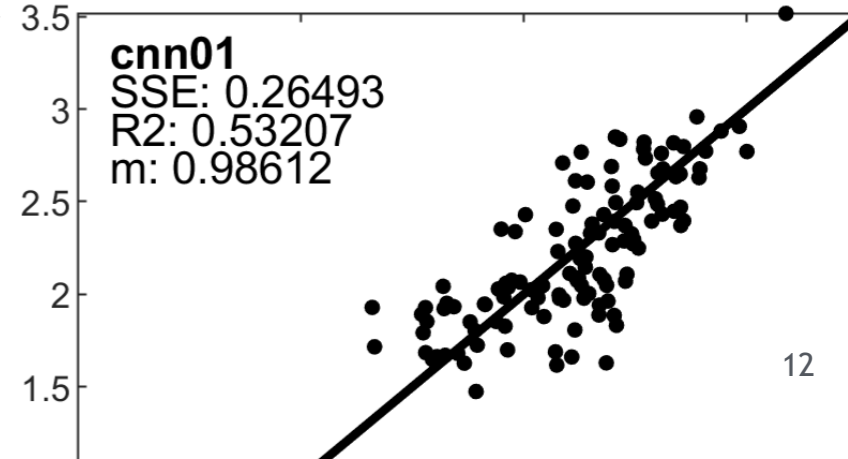
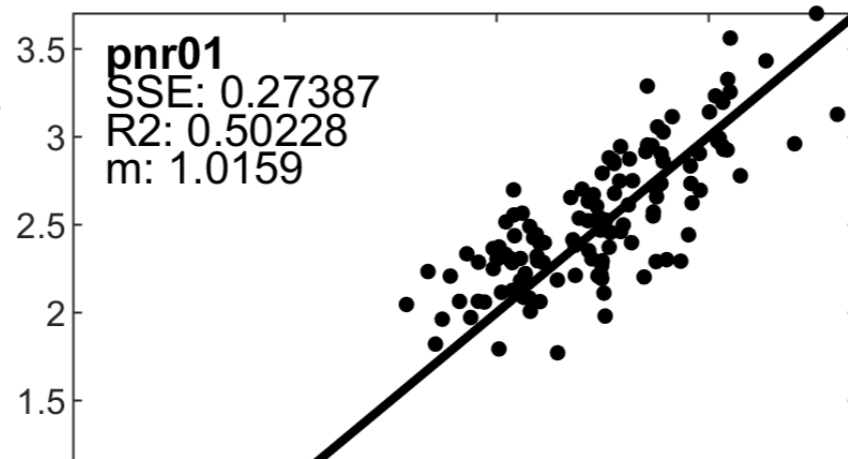
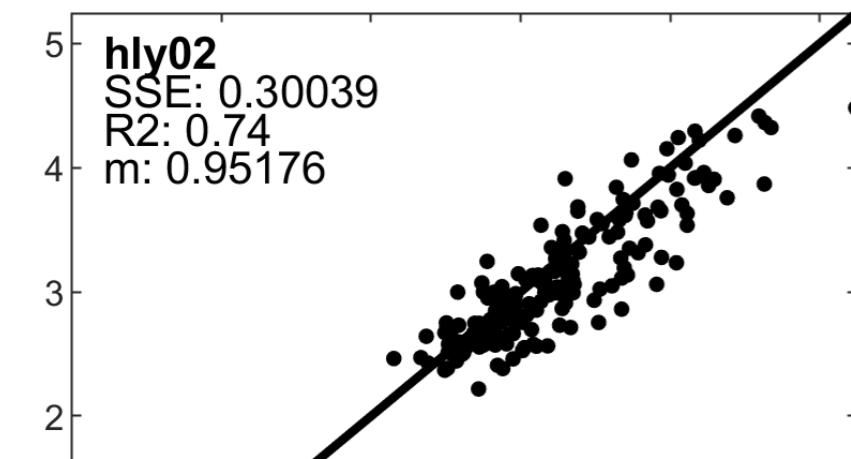
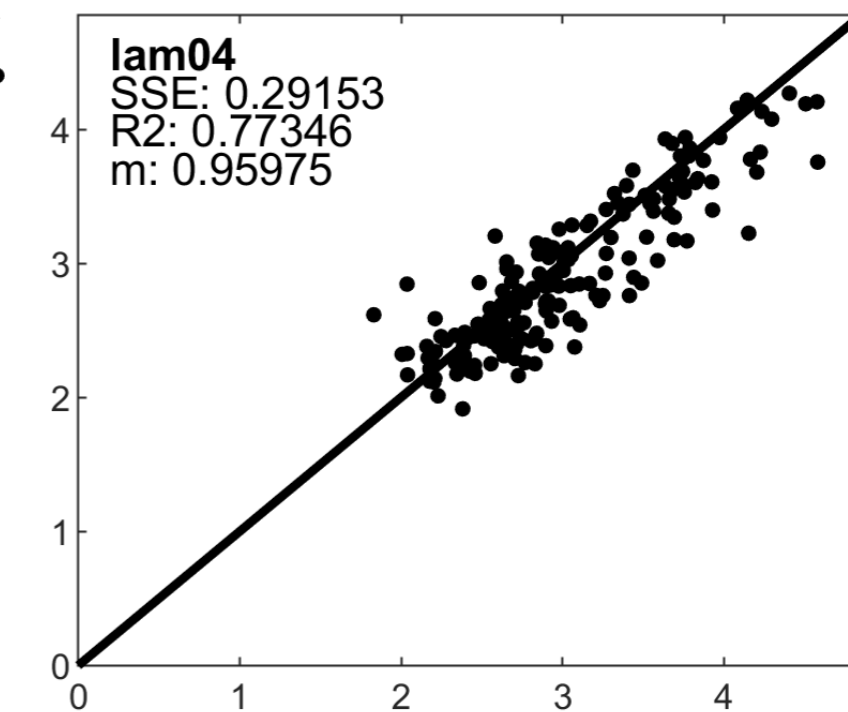
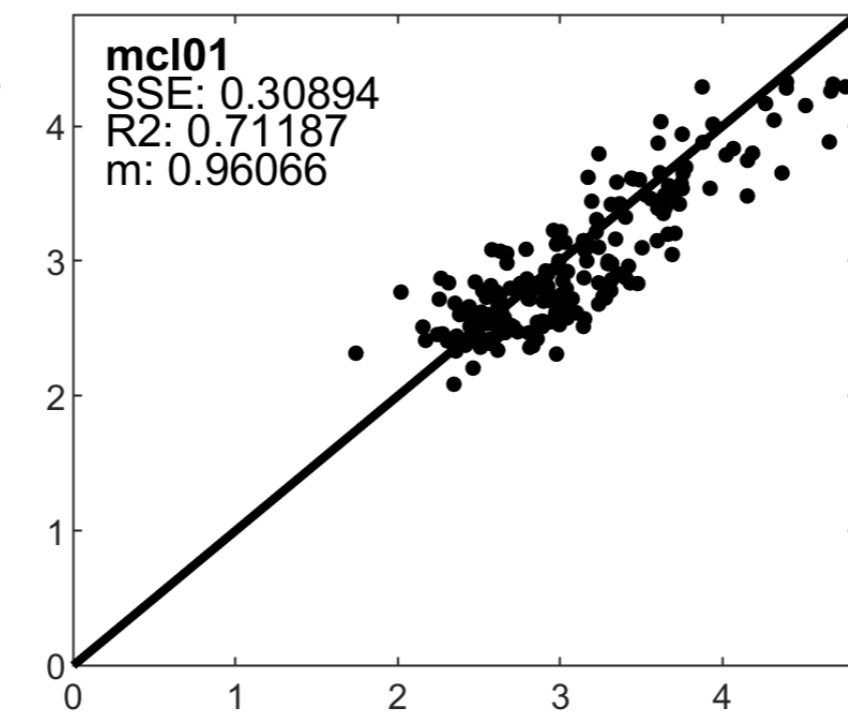
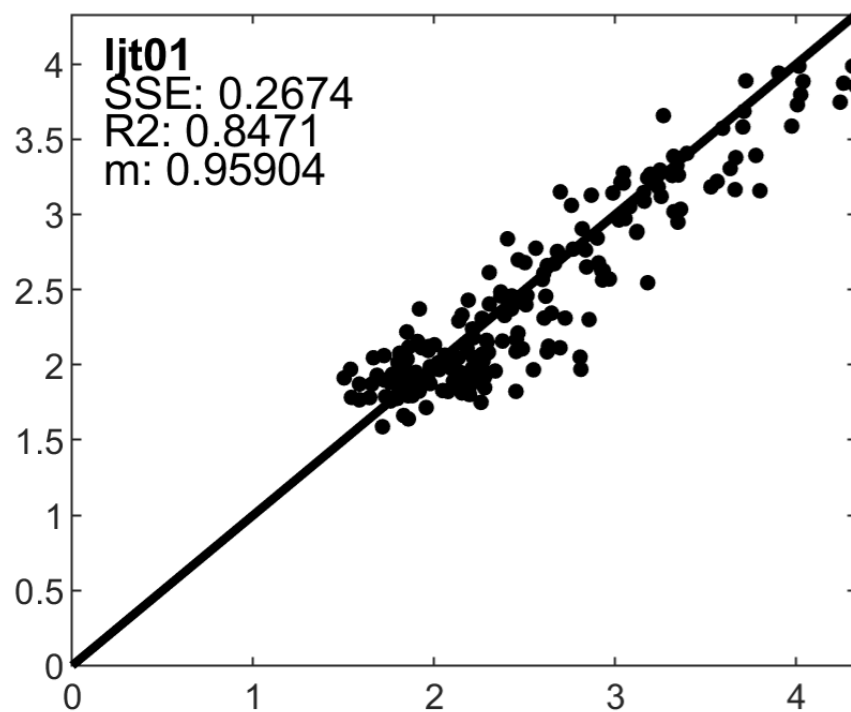
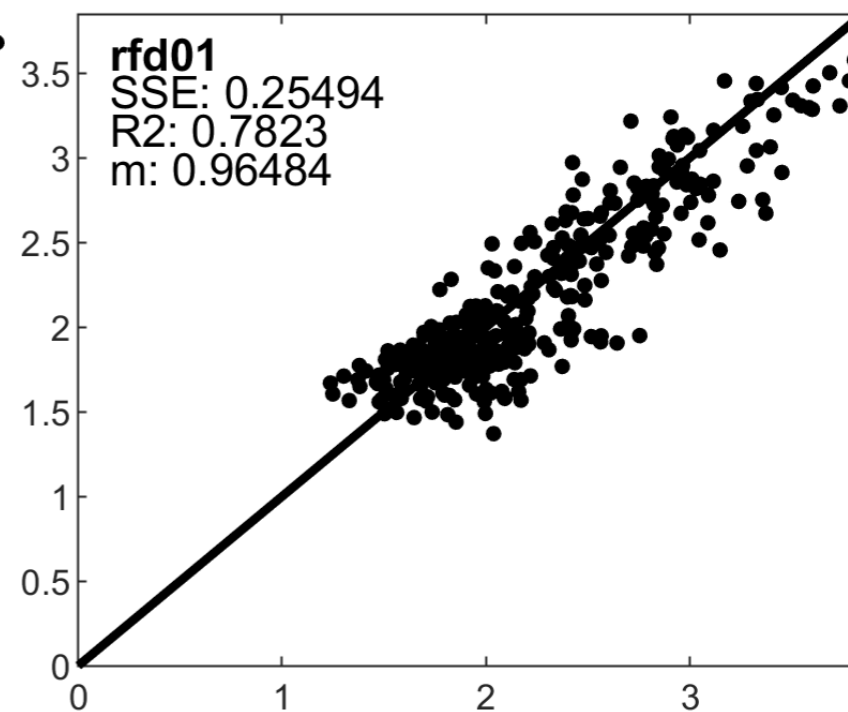
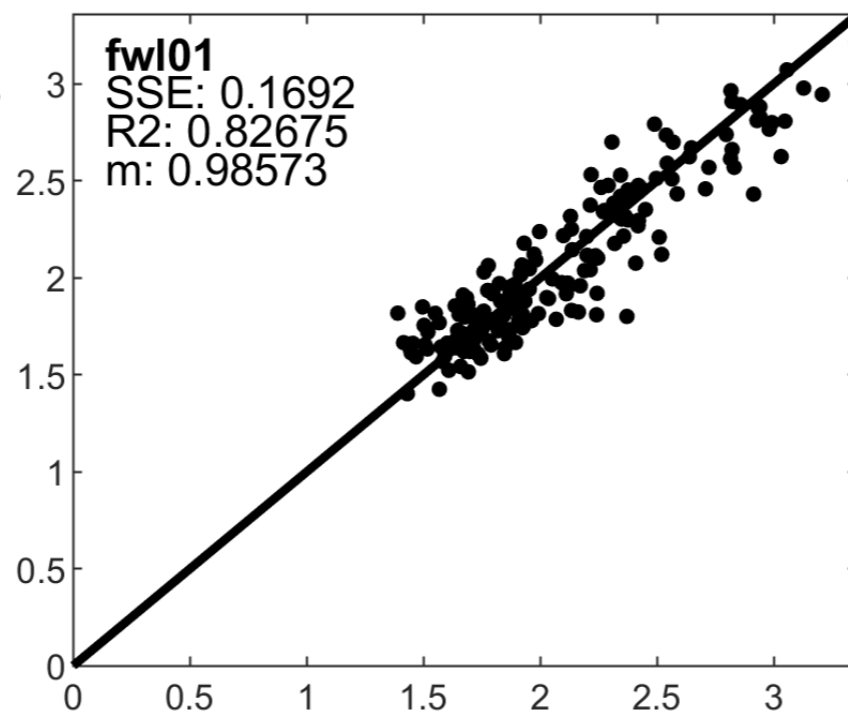
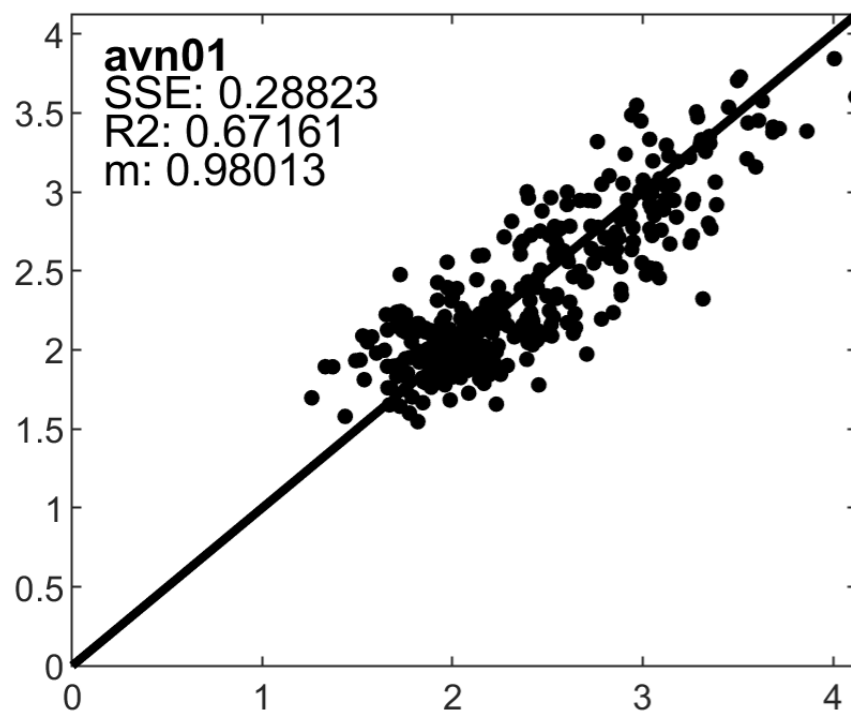
Simulated vs Observed Data – Monthly Vapor Pressure



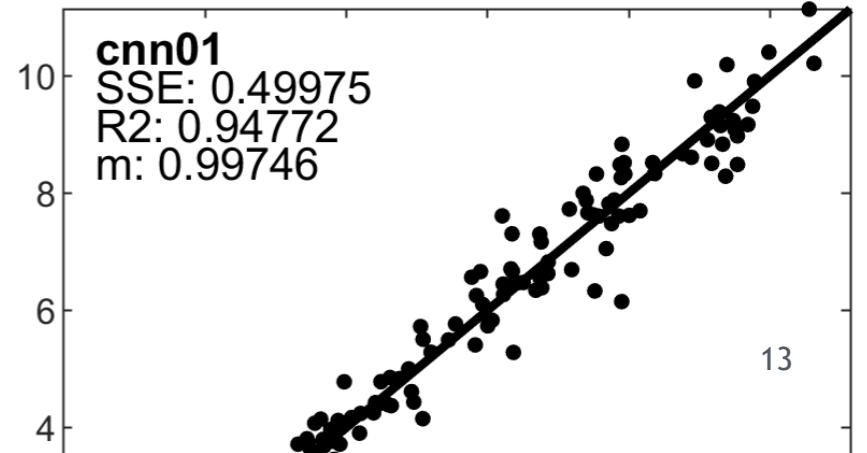
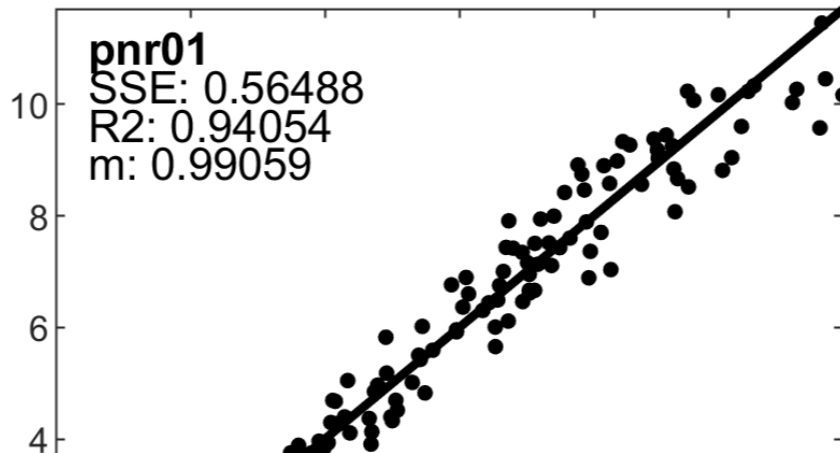
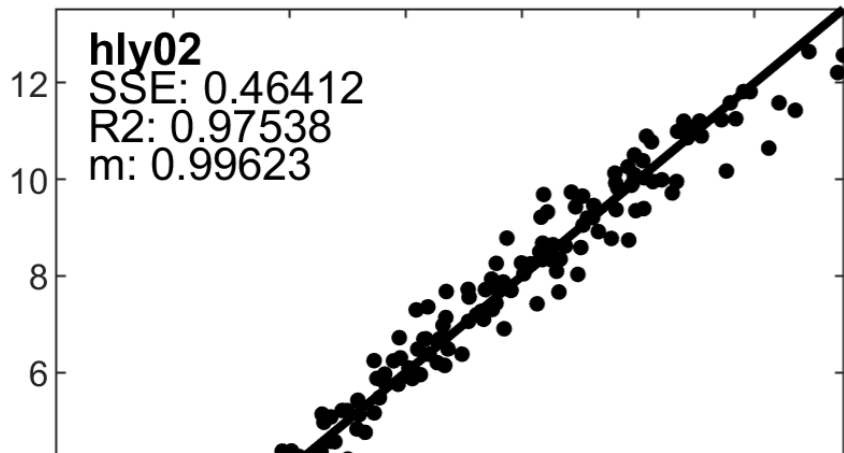
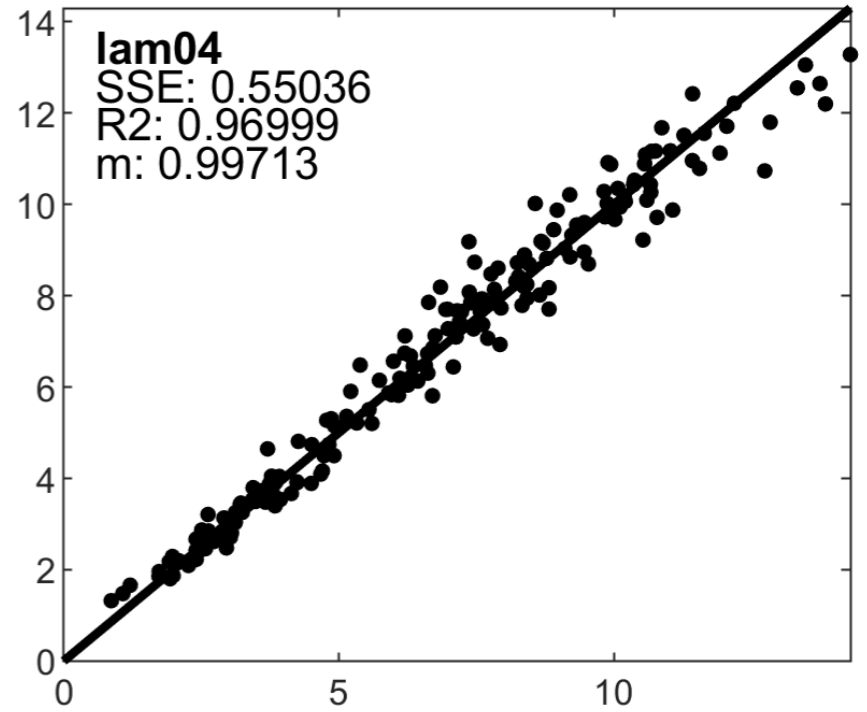
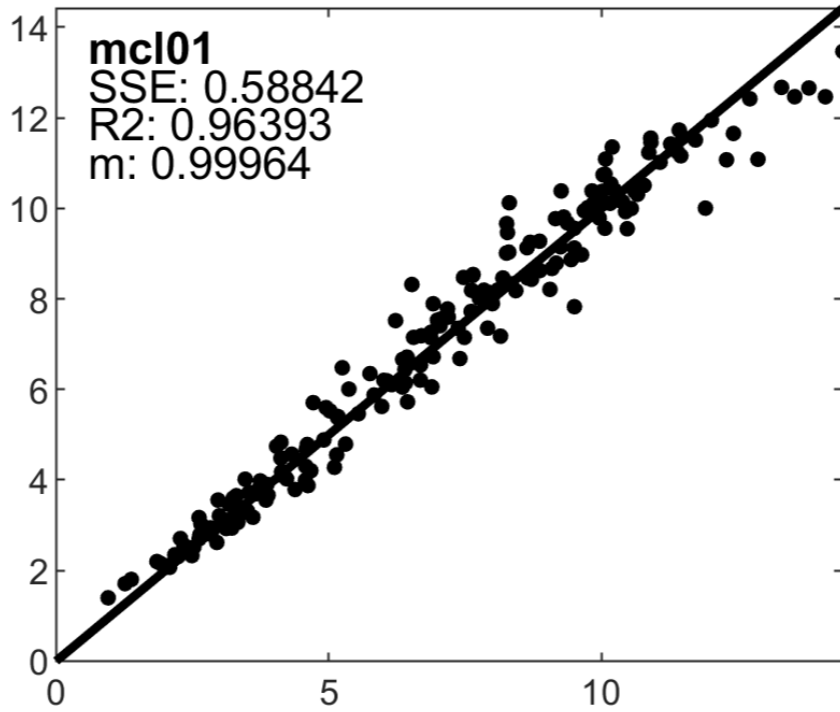
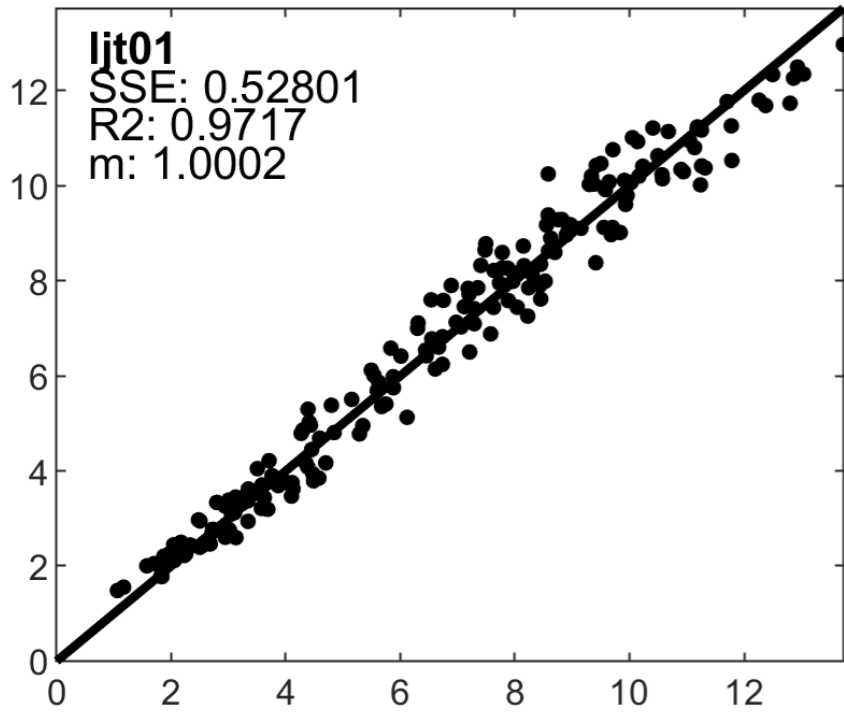
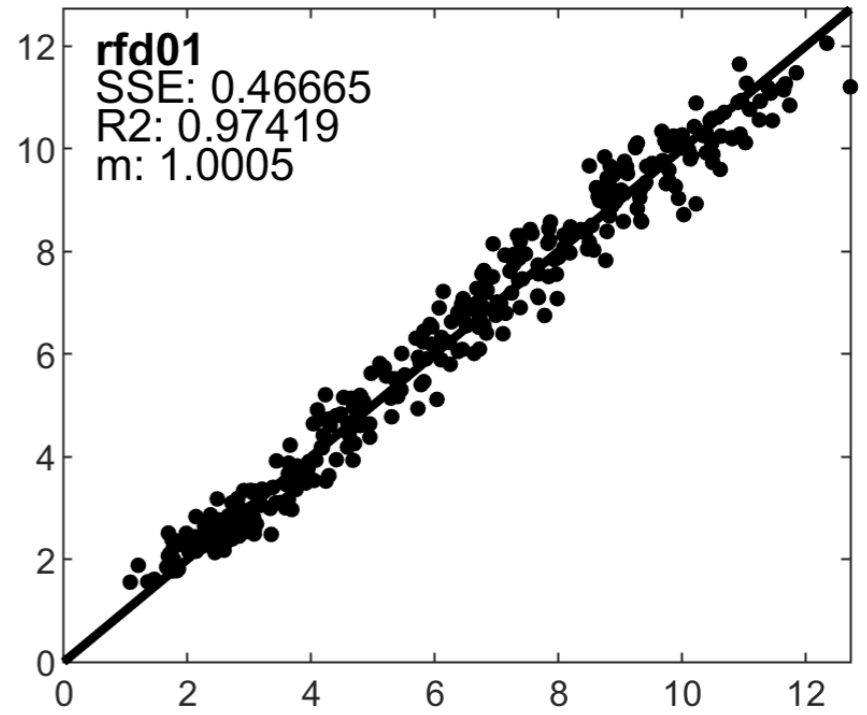
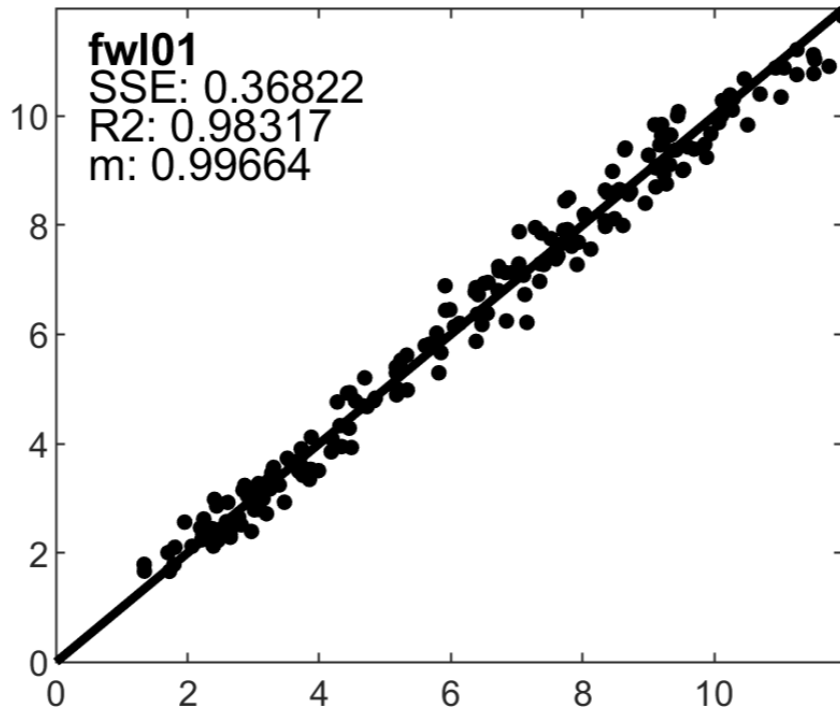
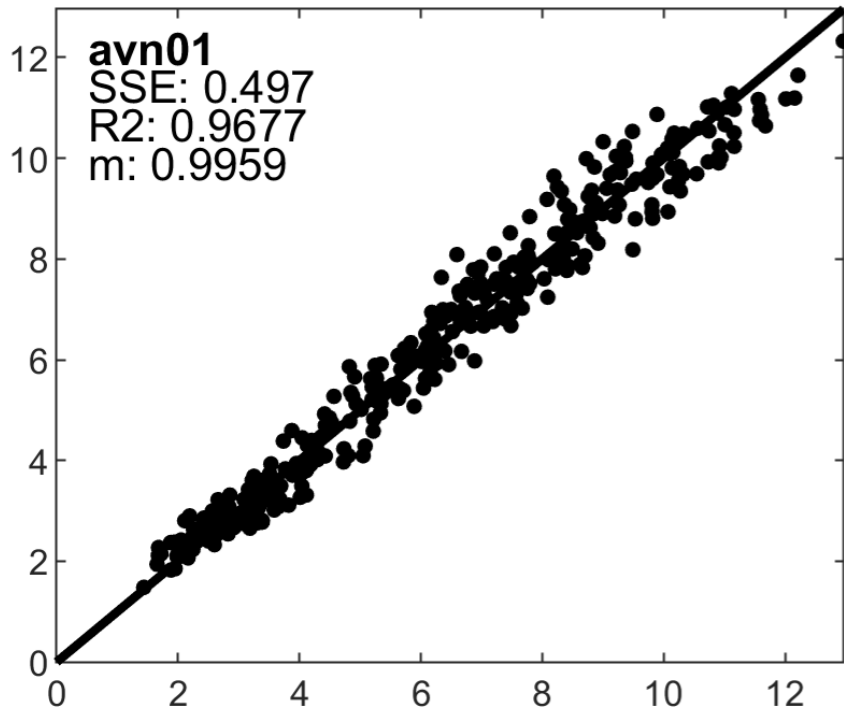
Simulated vs Observed Data – Solar Radiation



Simulated vs Observed Data – Wind Speed

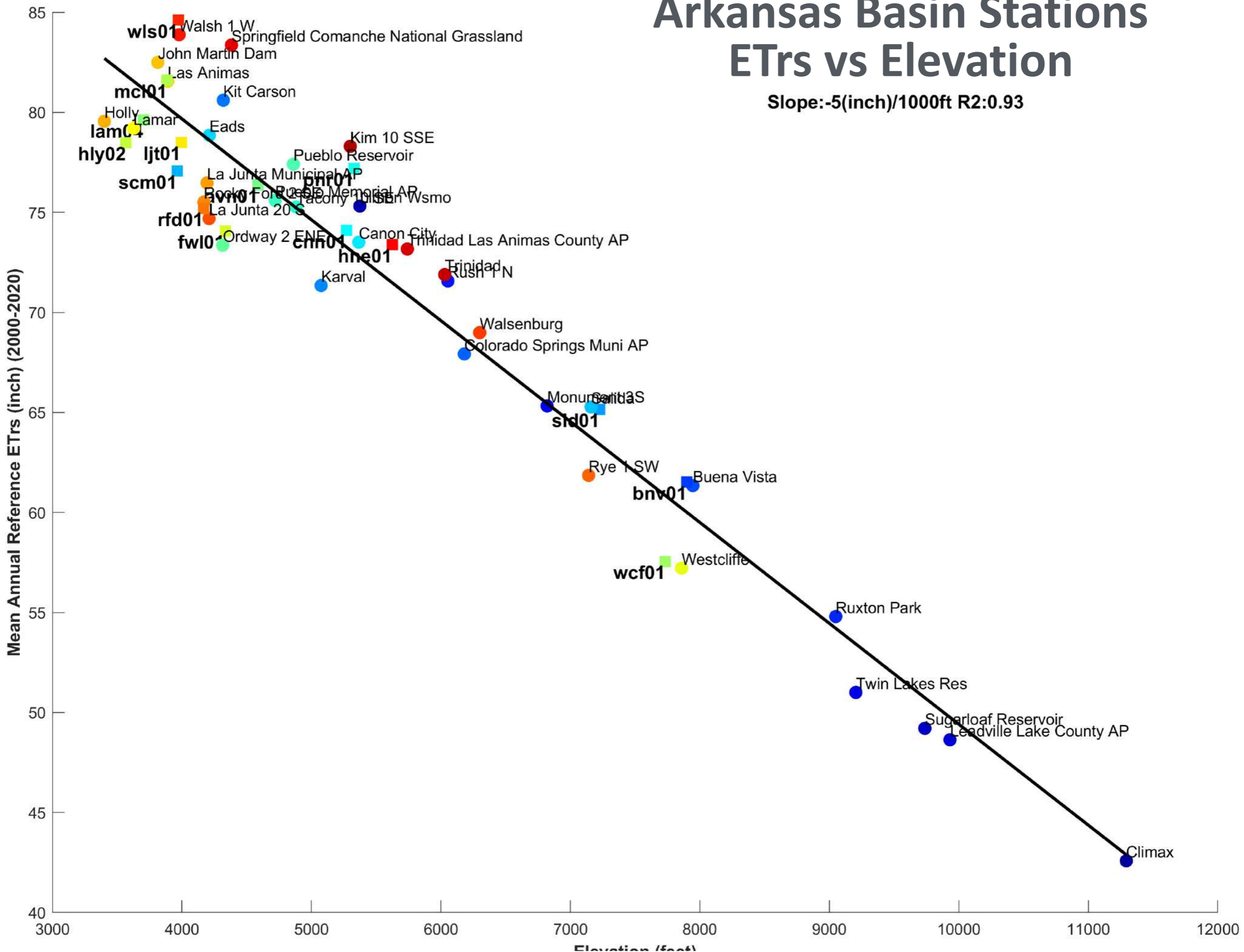


Simulated vs Observed Data – Alfalfa Reference ET

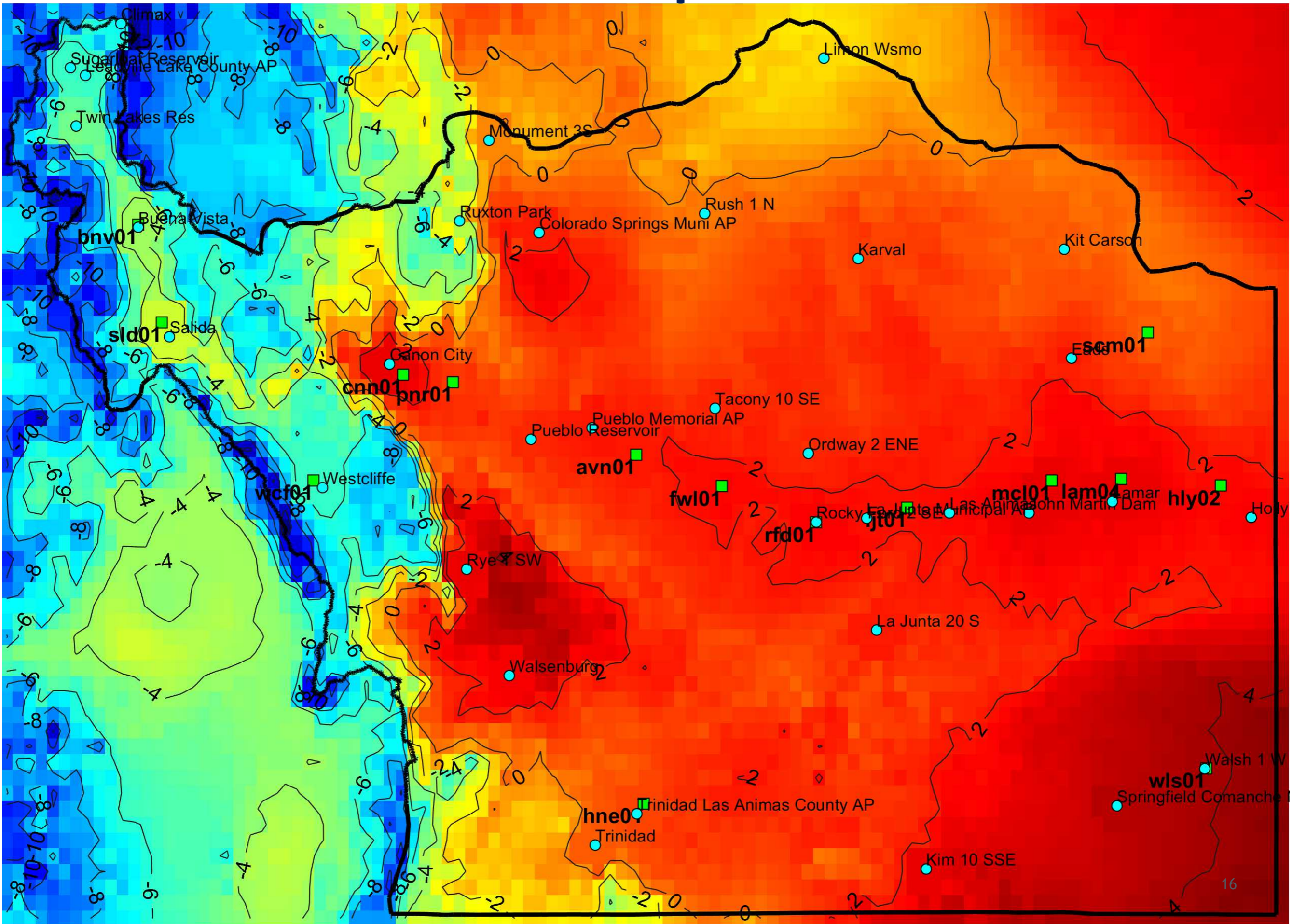


Arkansas Basin Stations ETrs vs Elevation

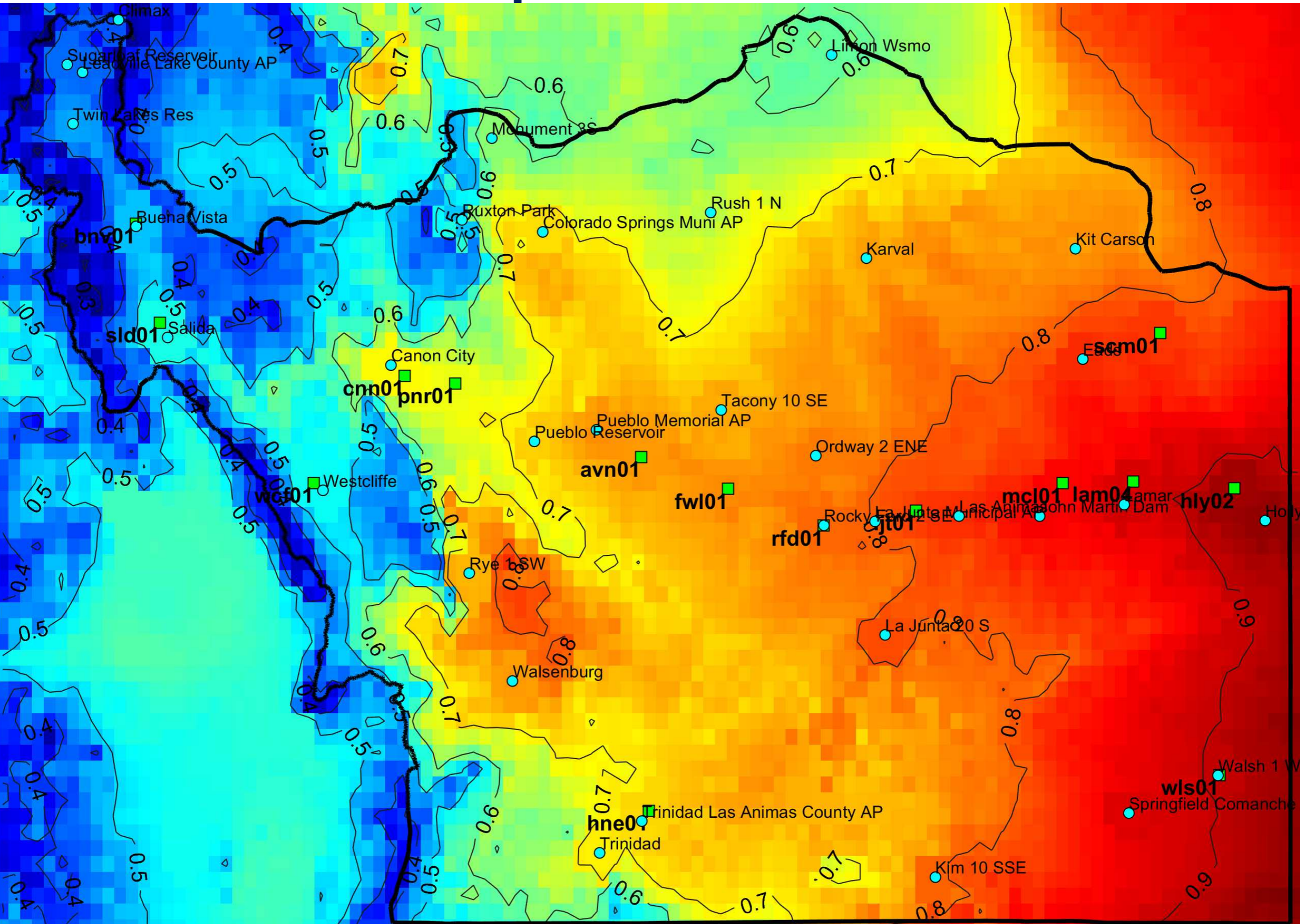
Slope: -5(inch)/1000ft R2:0.93



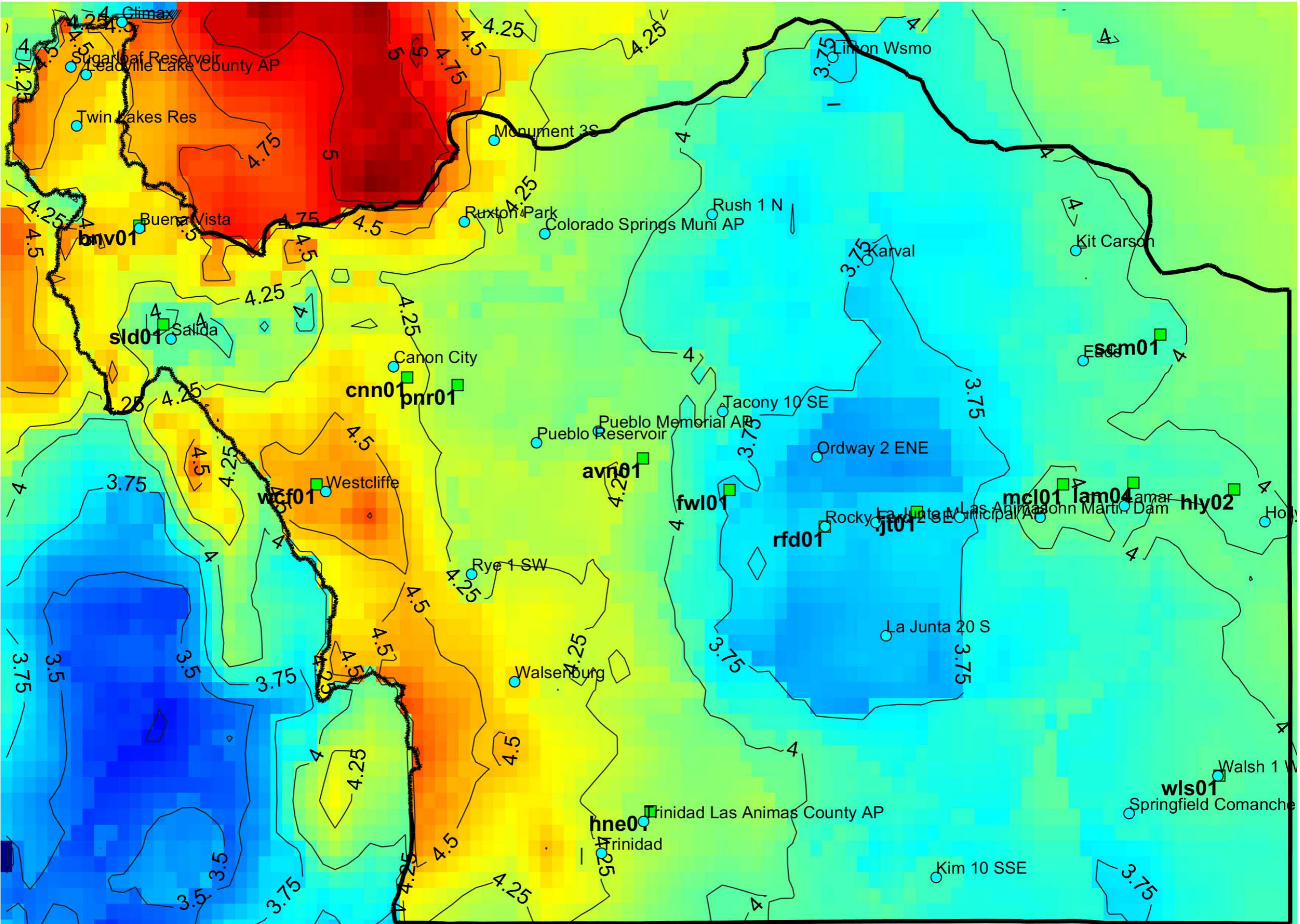
Arkansas Basin – Min Temperature (Avg Annual 2000-2020)



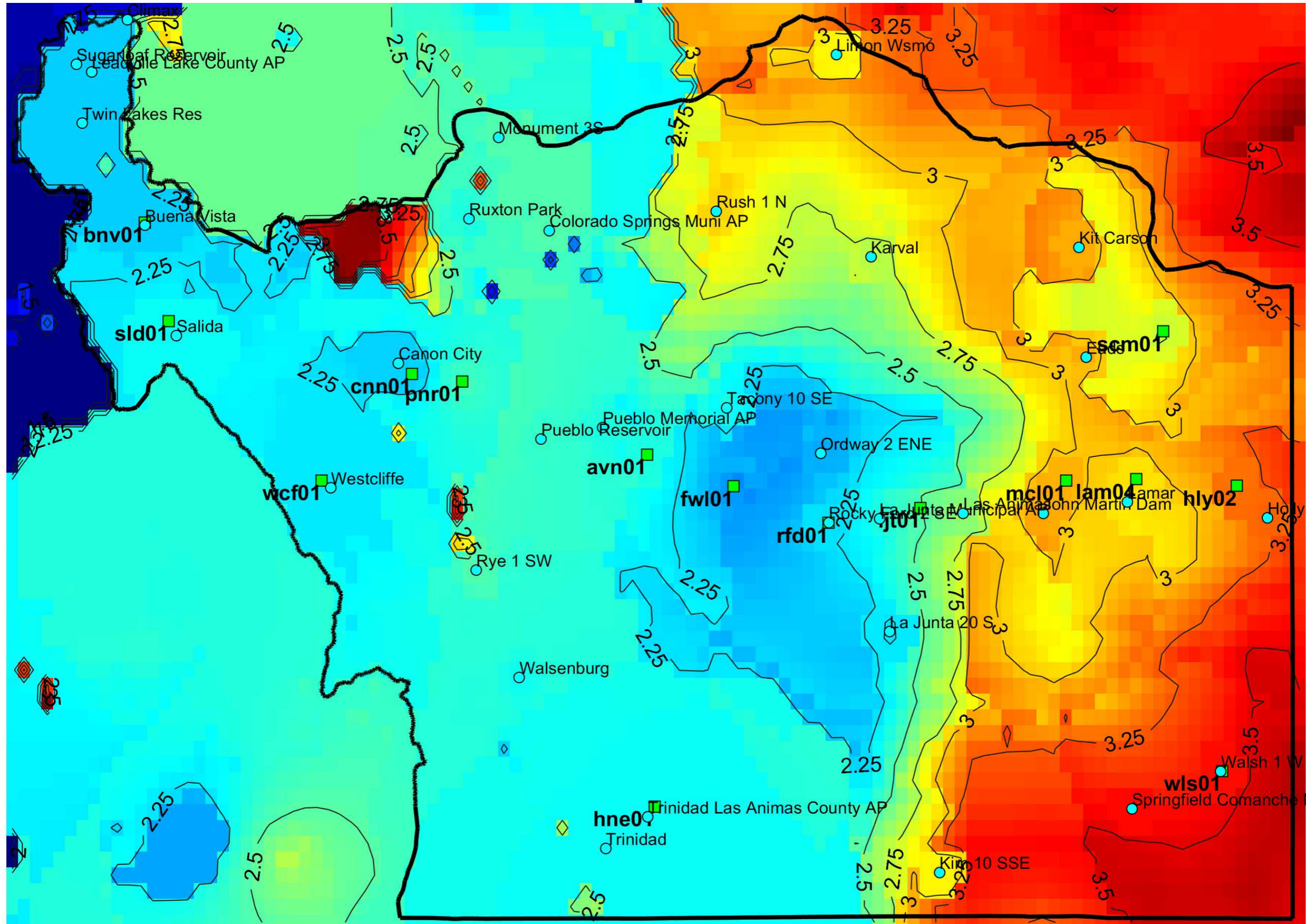
Arkansas Basin – Vapor Pressure (Avg Annual 2000-2020)



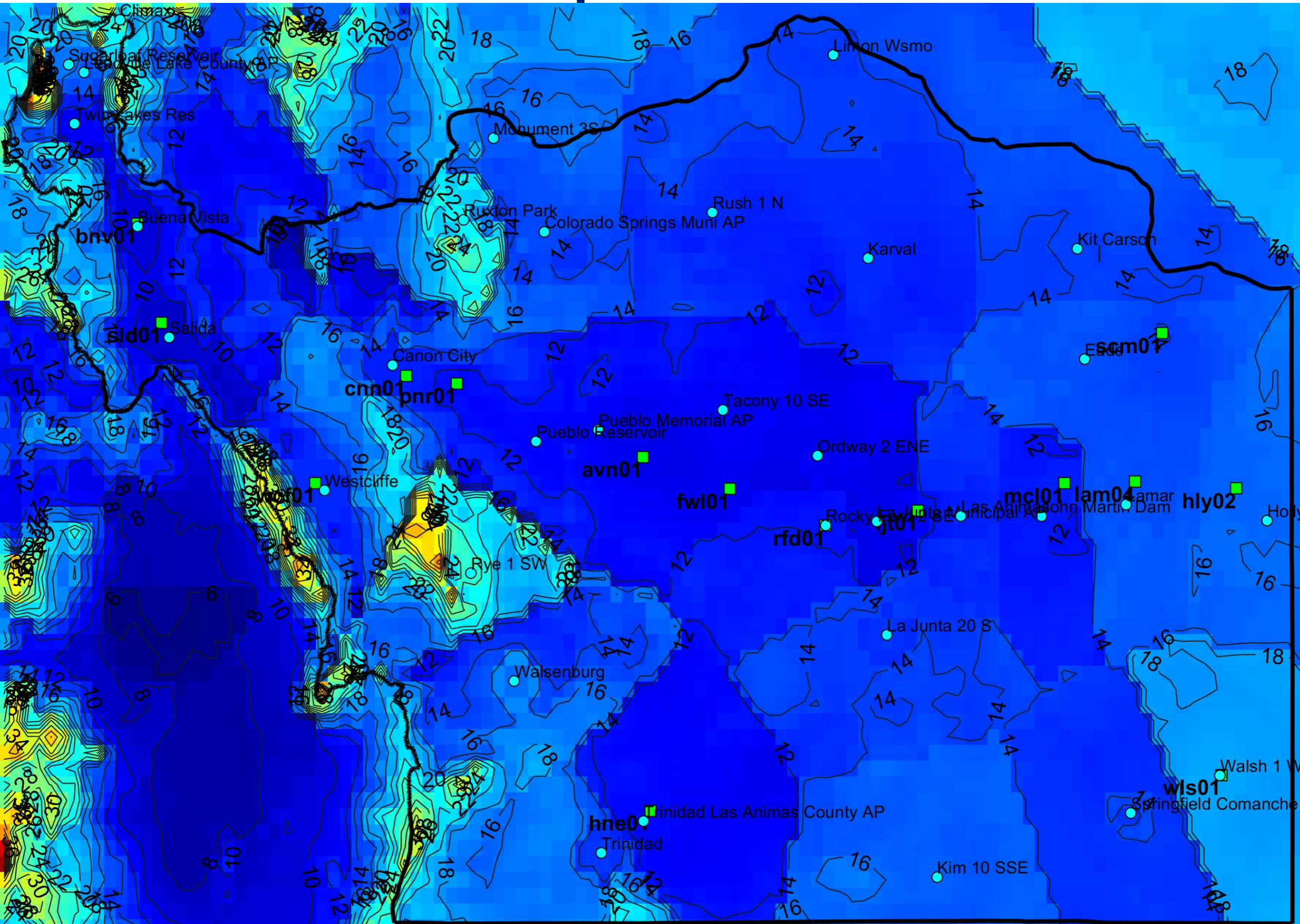
Arkansas Basin – Cloudiness (Avg Annual 2000-2020)



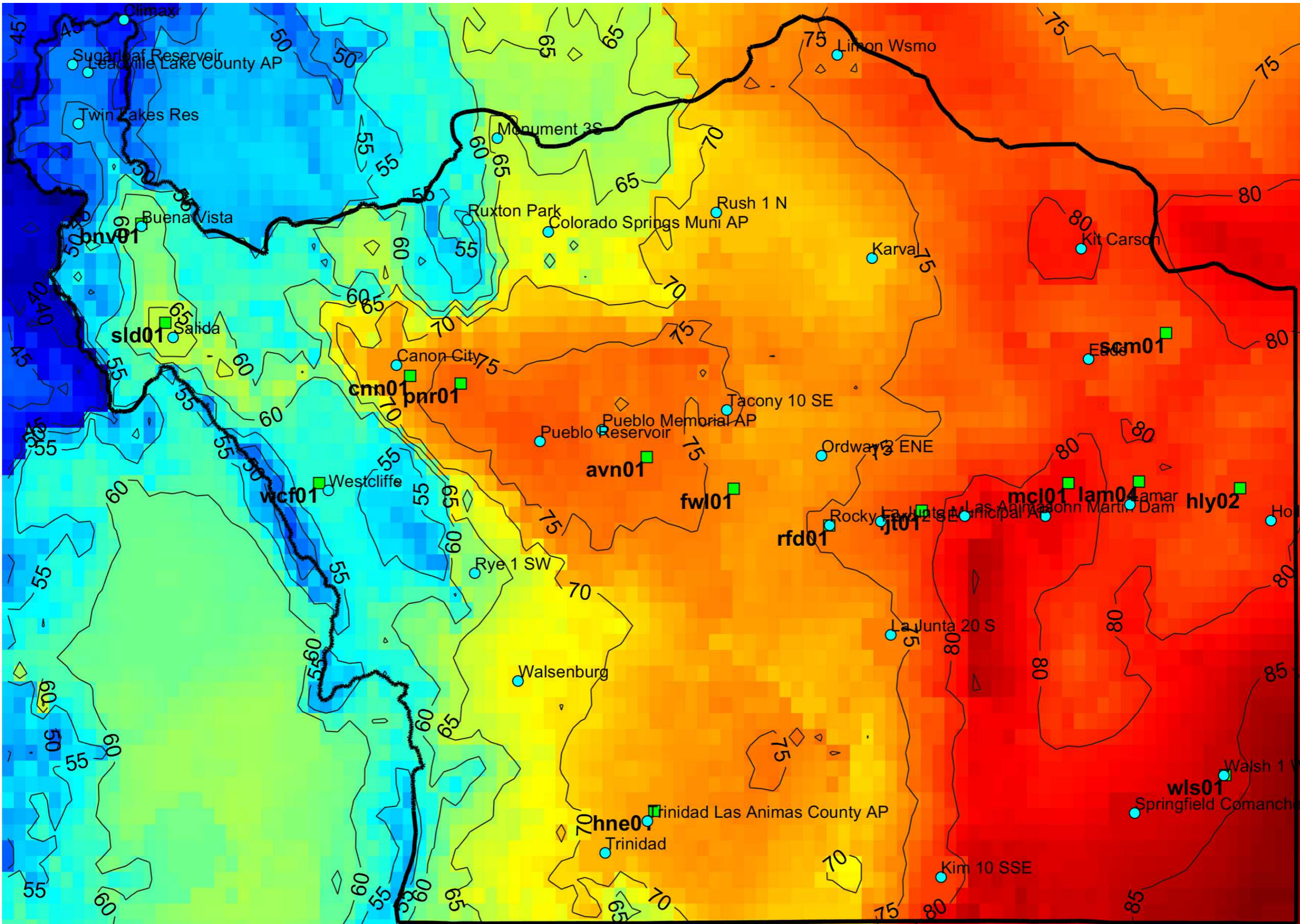
Arkansas Basin – Wind Speed (Avg Annual 2000-2020)



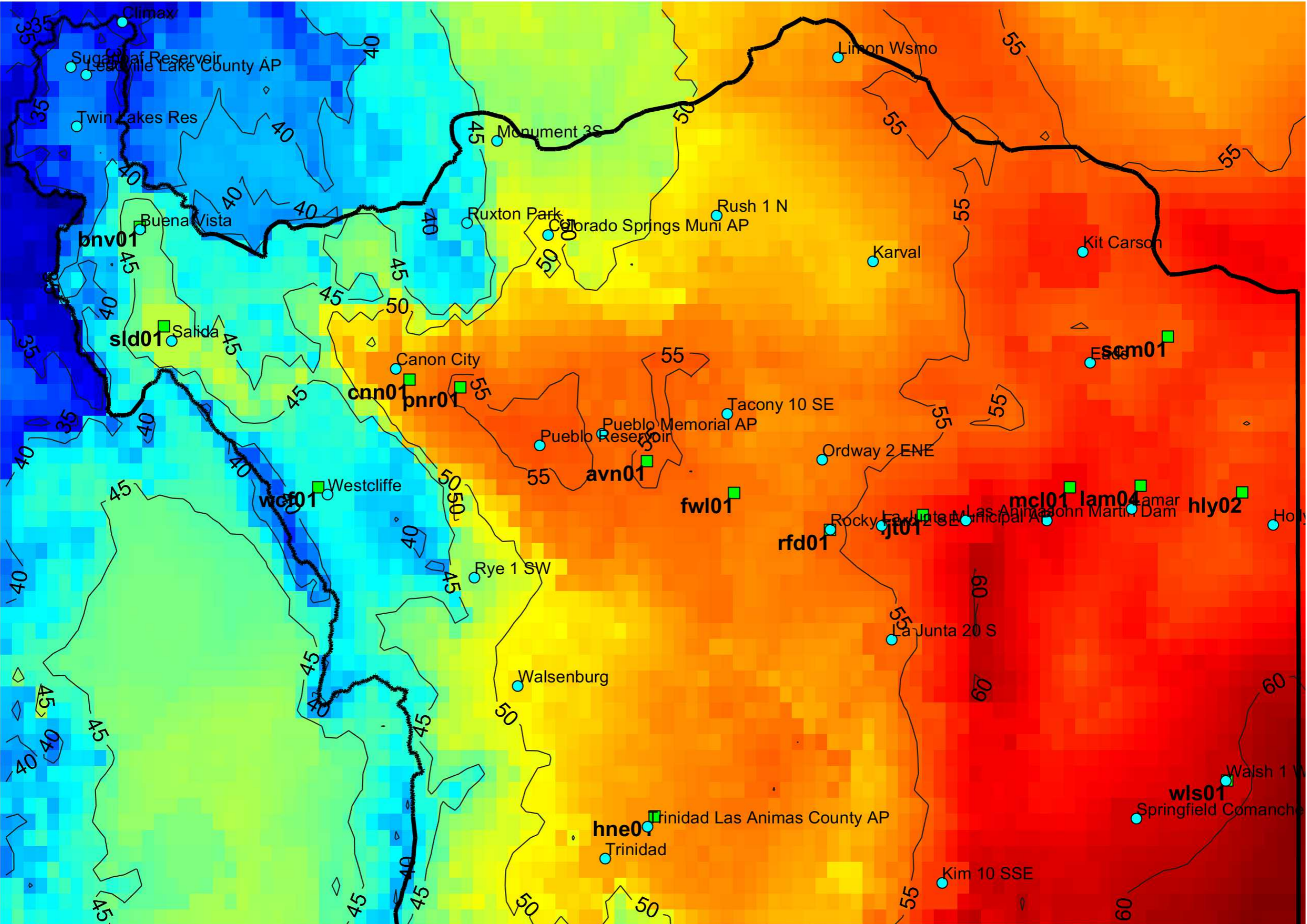
Arkansas Basin – Precipitation (Avg Annual 2000-2020)



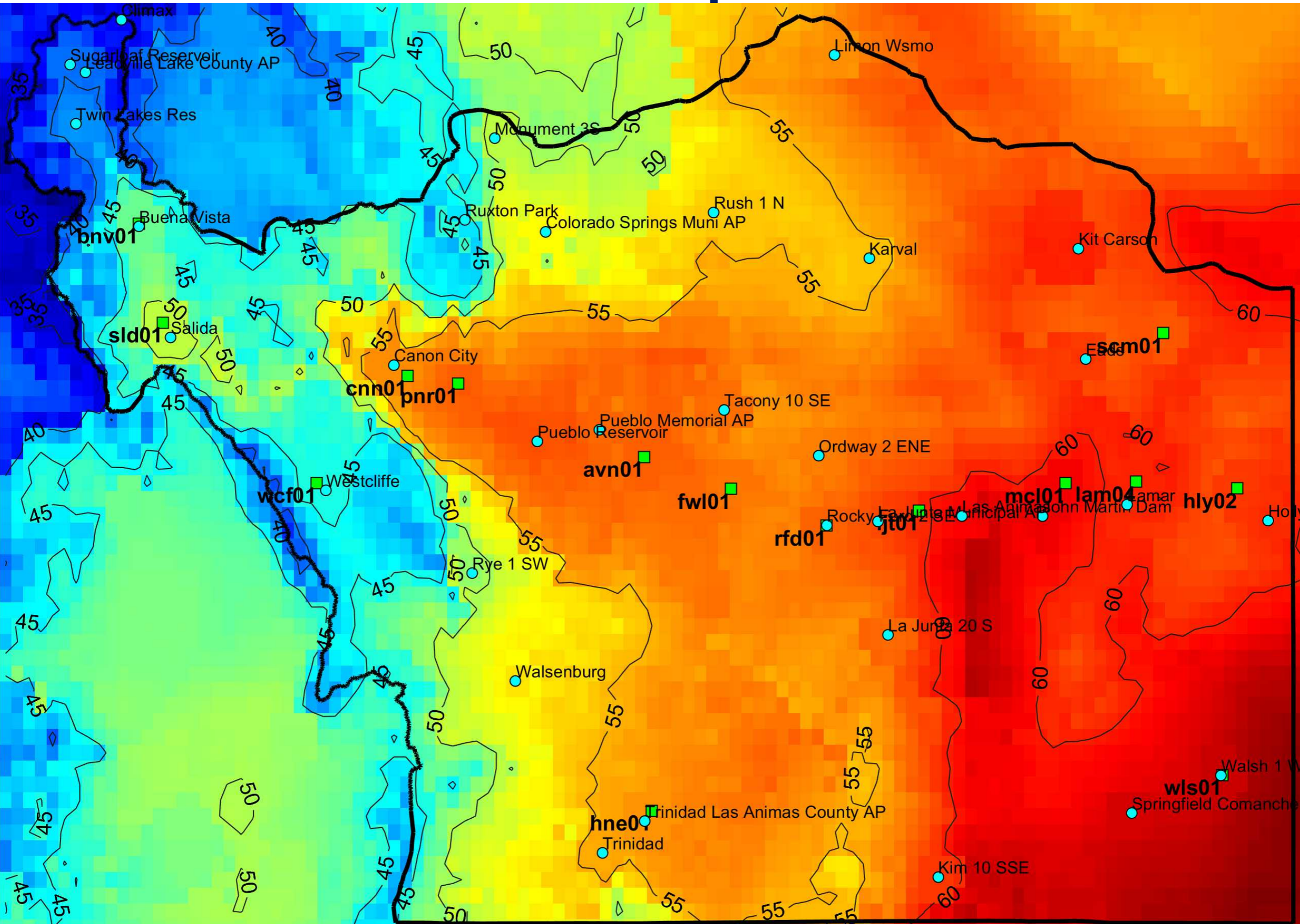
Arkansas Basin – Alfalfa Reference ET (Avg Annual 2000-2020)



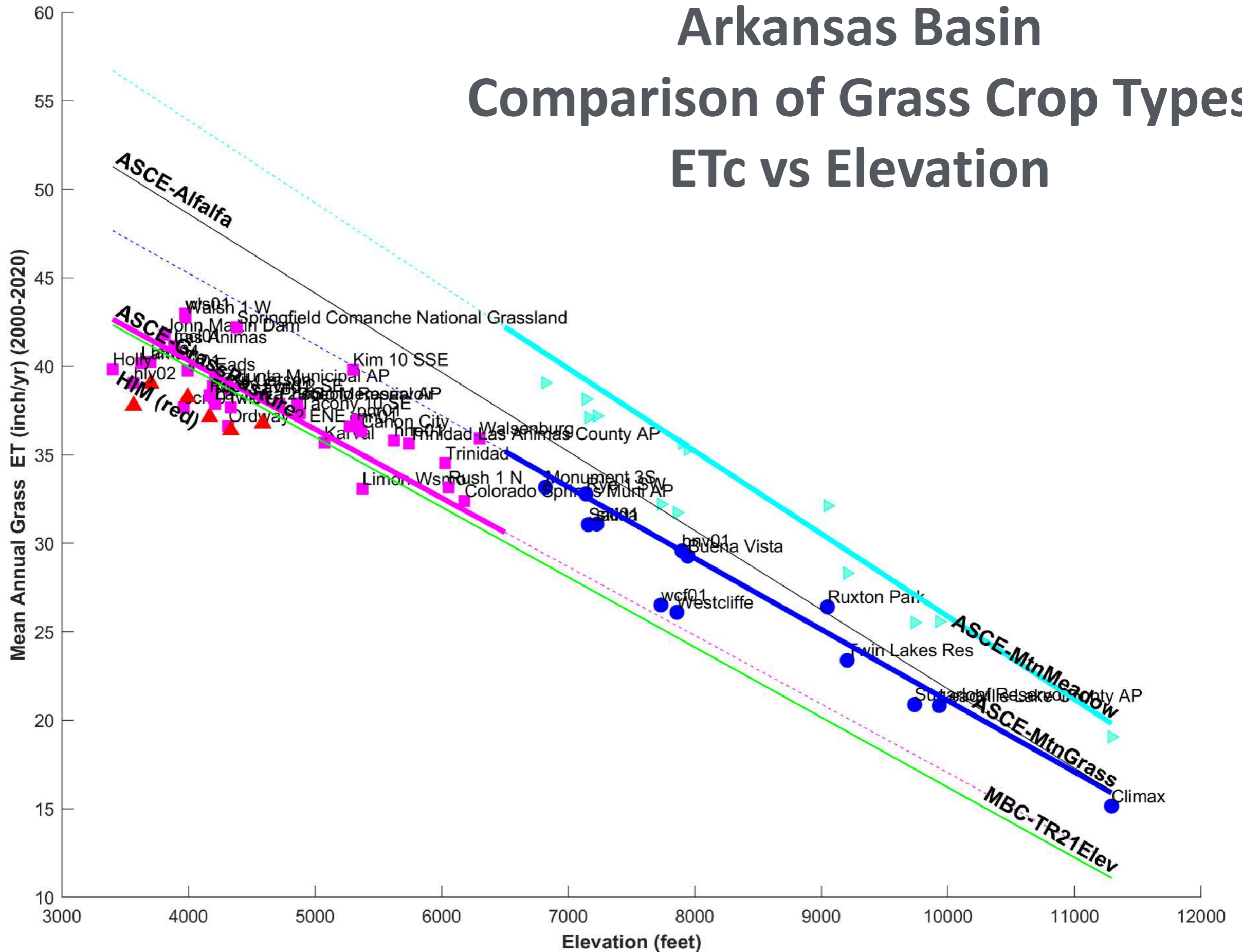
Arkansas Basin – Grass Reference ET (Avg Annual 2000-2020)



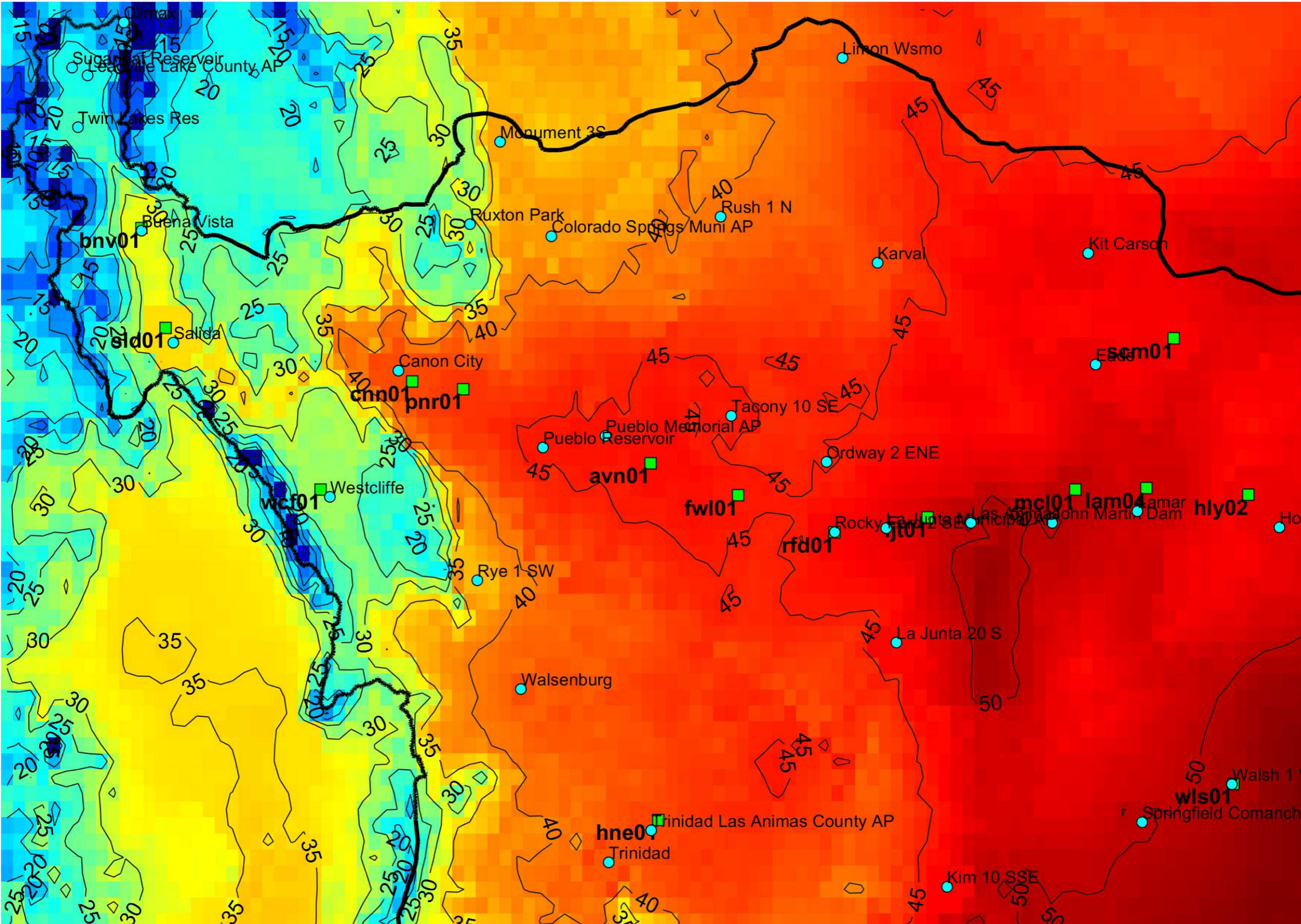
Arkansas Basin – Water Evaporation (Avg Annual 2000-2020)



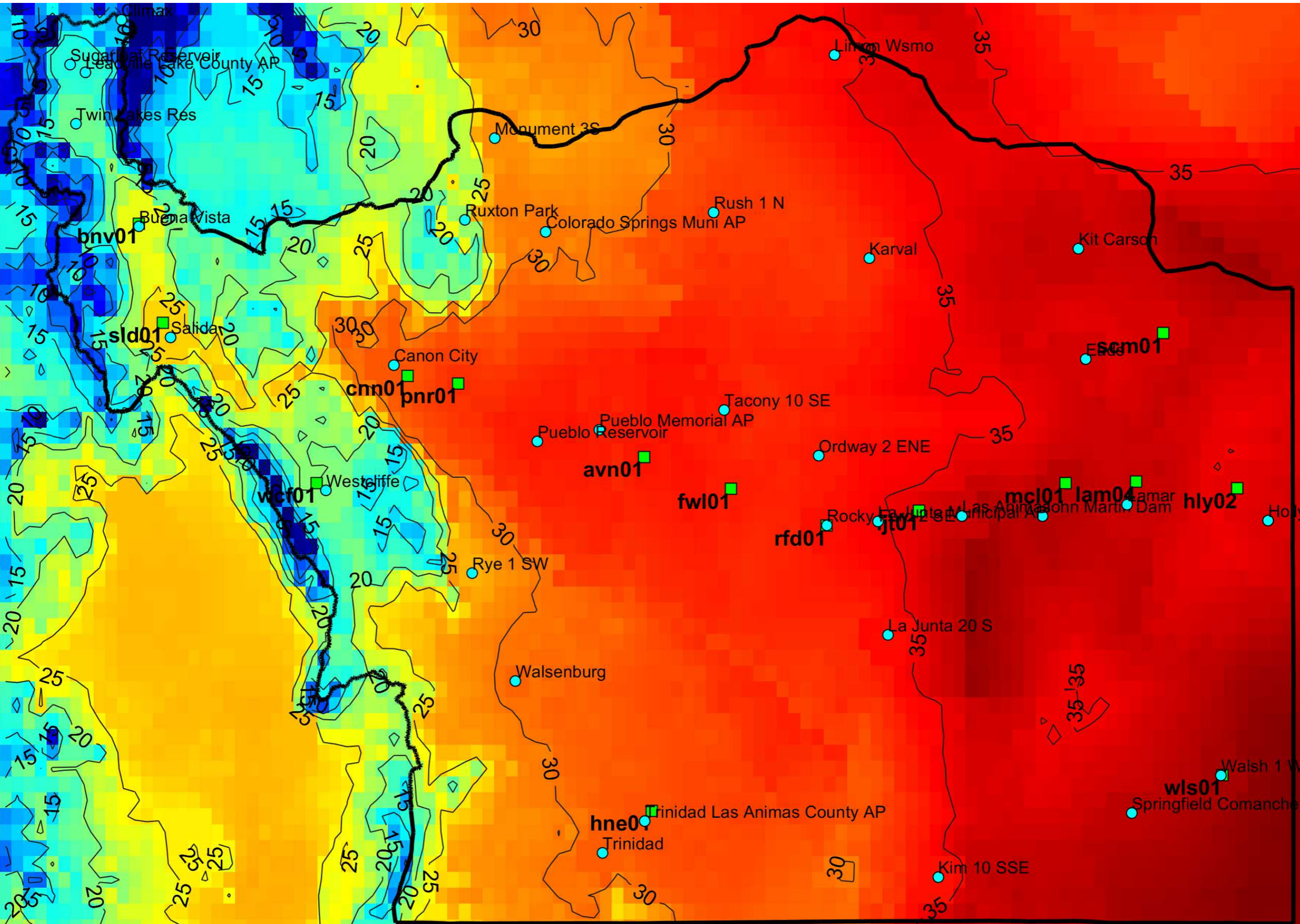
Arkansas Basin Comparison of Grass Crop Types ETc vs Elevation



Arkansas Basin – Alfalfa PET (Avg Annual 2000-2020)



Arkansas Basin – Corn Grain PET (Avg Annual 2000-2020)



Phase 2 Colors of Water Tool

1. Transparency of “Colors of Water” for Water Users

- Water Users understand what's in the river in front of their headgate

2. Functionality of Livingston Transit Loss Models (TLAP)

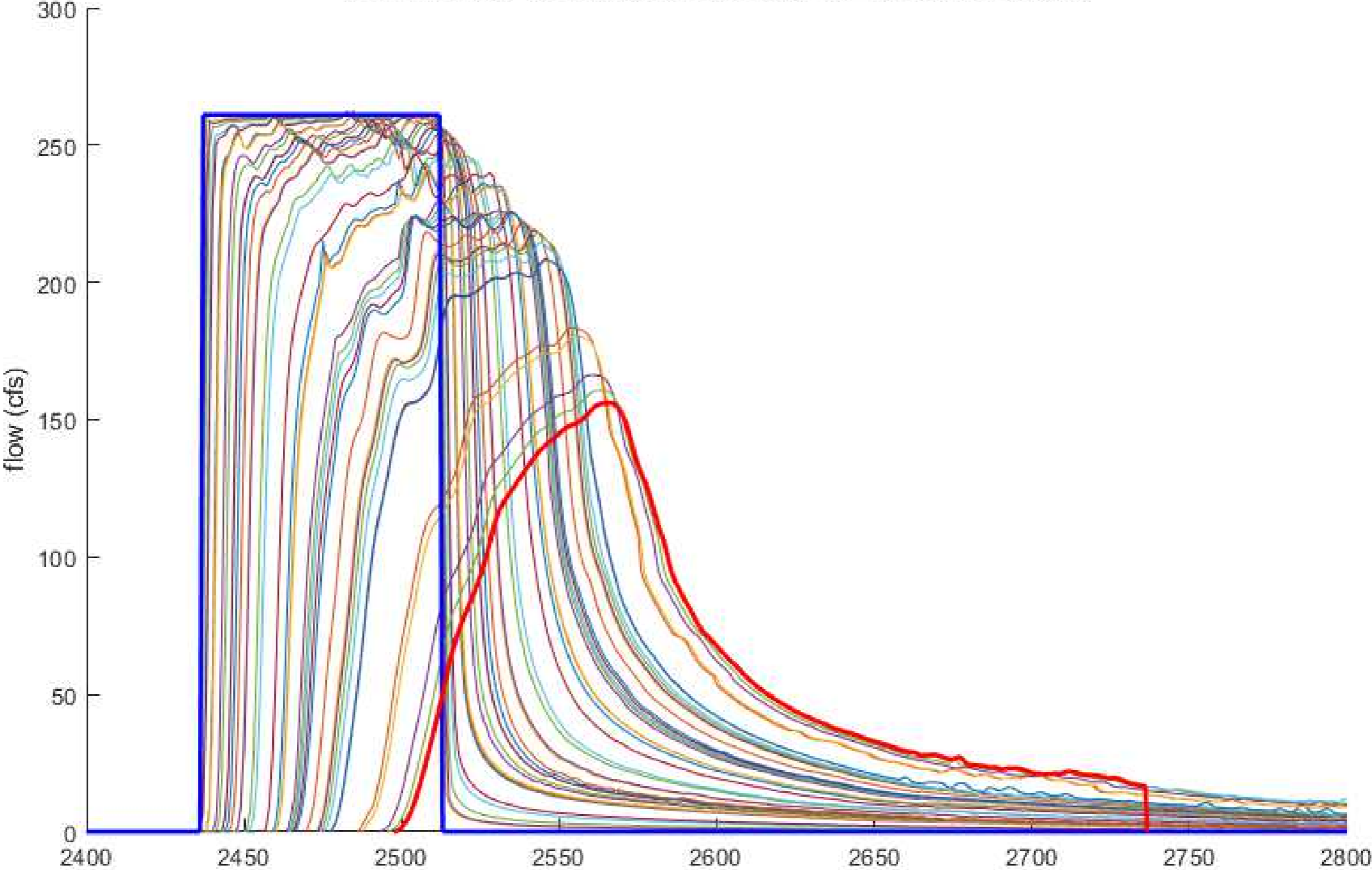
- Goal to be able to use determine transit losses in WD17/WD67
- Based on TLAP/J349 for bank and channel storage/routing
- Different from current TLAP as using dynamic, non-steady state flows
 - Transit losses and timing based on actual/forecasted flows
 - Evaporation based on gridded/real-time estimates
 - More nodes (i.e. new aug stations) and new channel lengths
 - B&C will recalibrate WD17 and WD67 plus new reaches

3. Based on Hydrobase Data and CDSS web interface

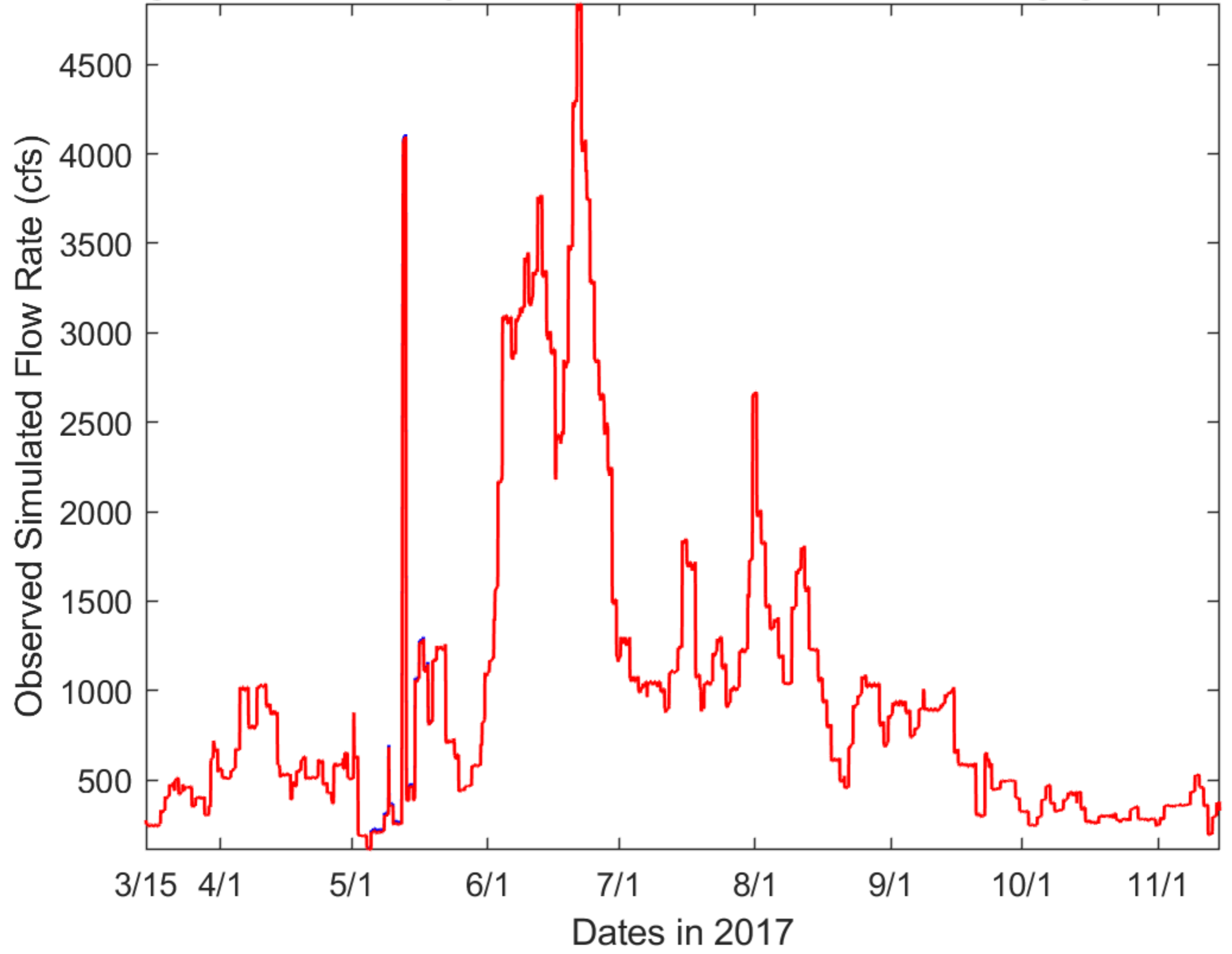
- Enterprise solution integrated into state systems

Release from Pueblo Res to JMR Offset Account

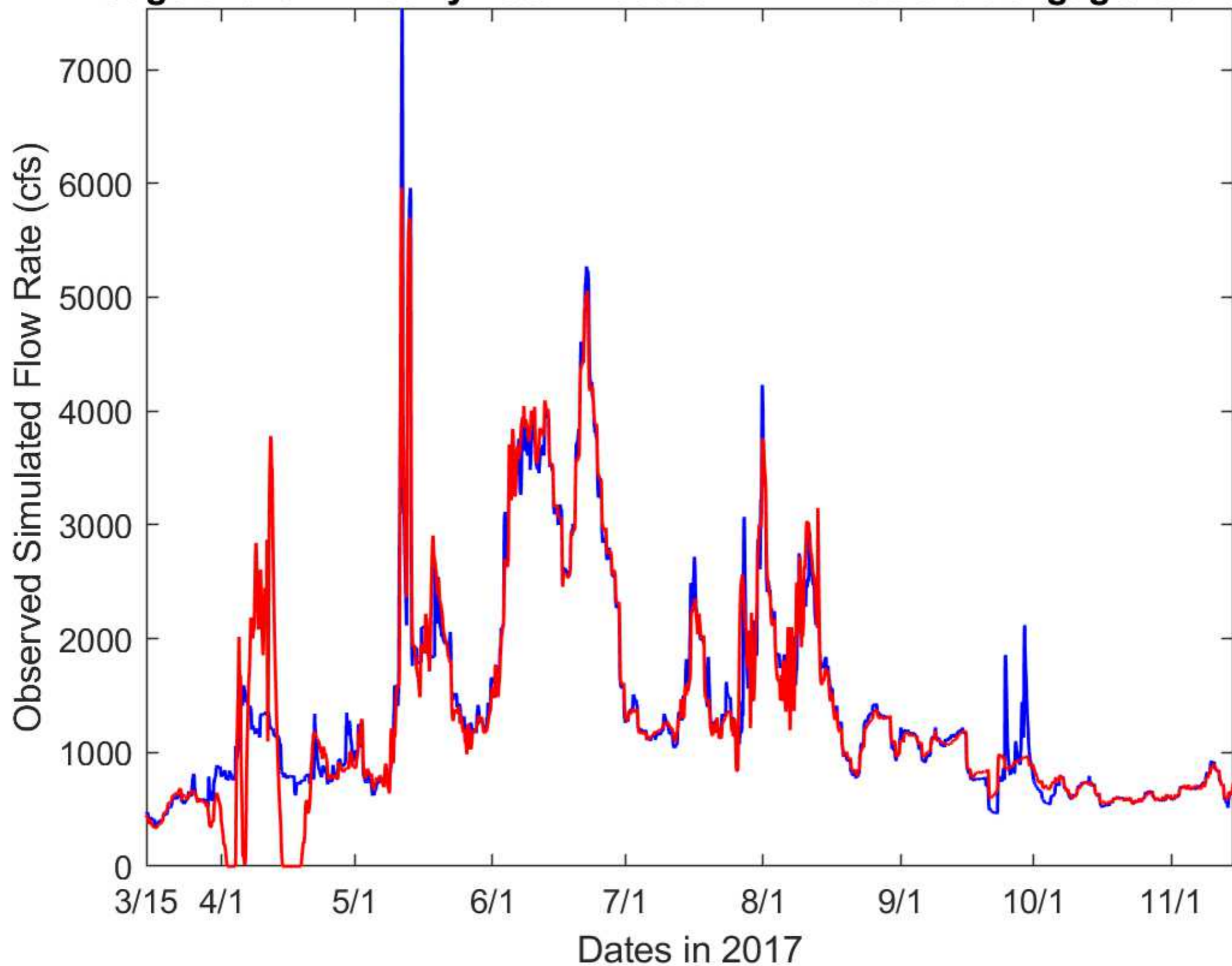
2018 W154237 1403526.091 S:2 F: U:Q T:7 G: To:6703512.034



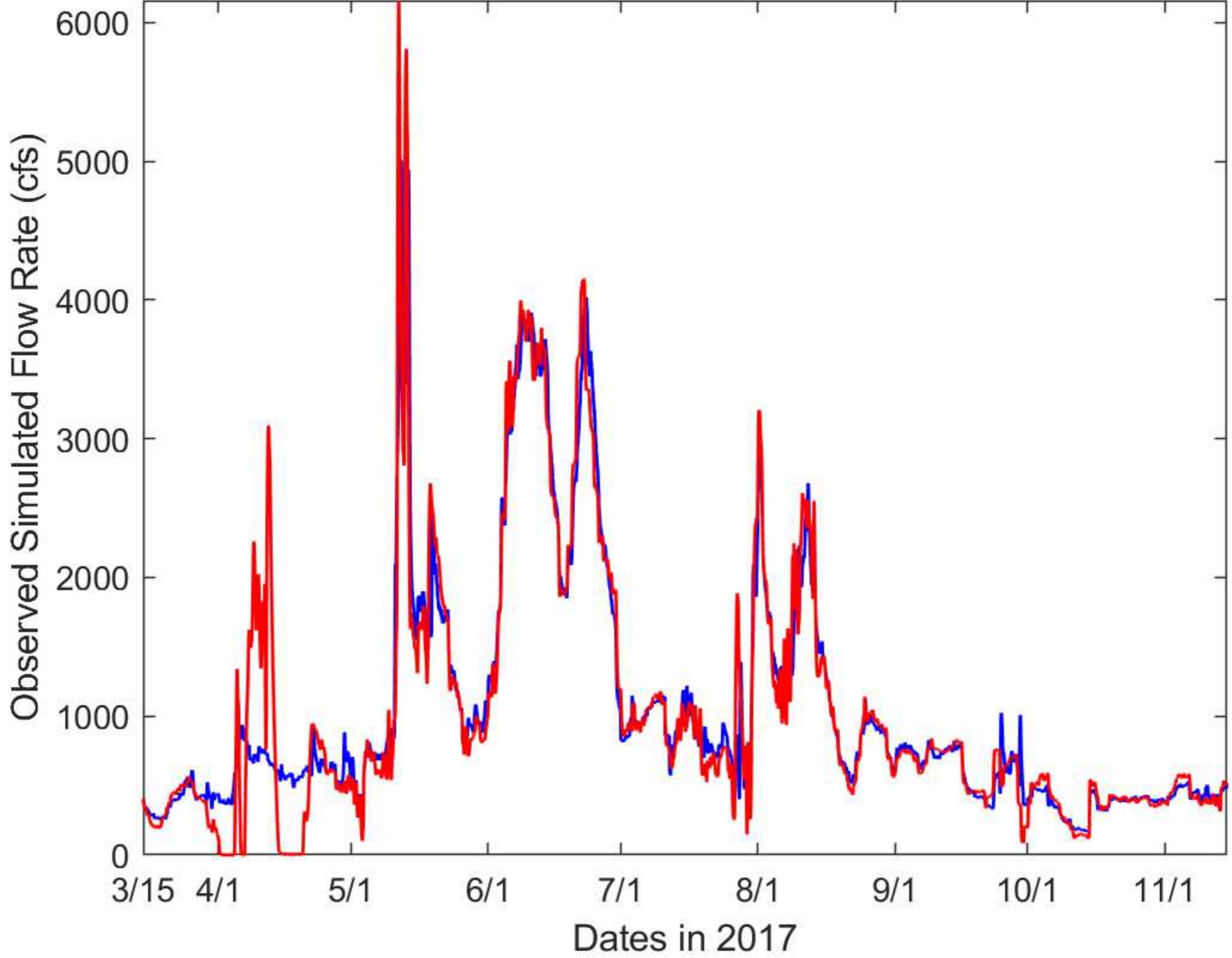
Gage and Sim Hourly Data-1409500-ARKPUECO blue=gage/red=sim



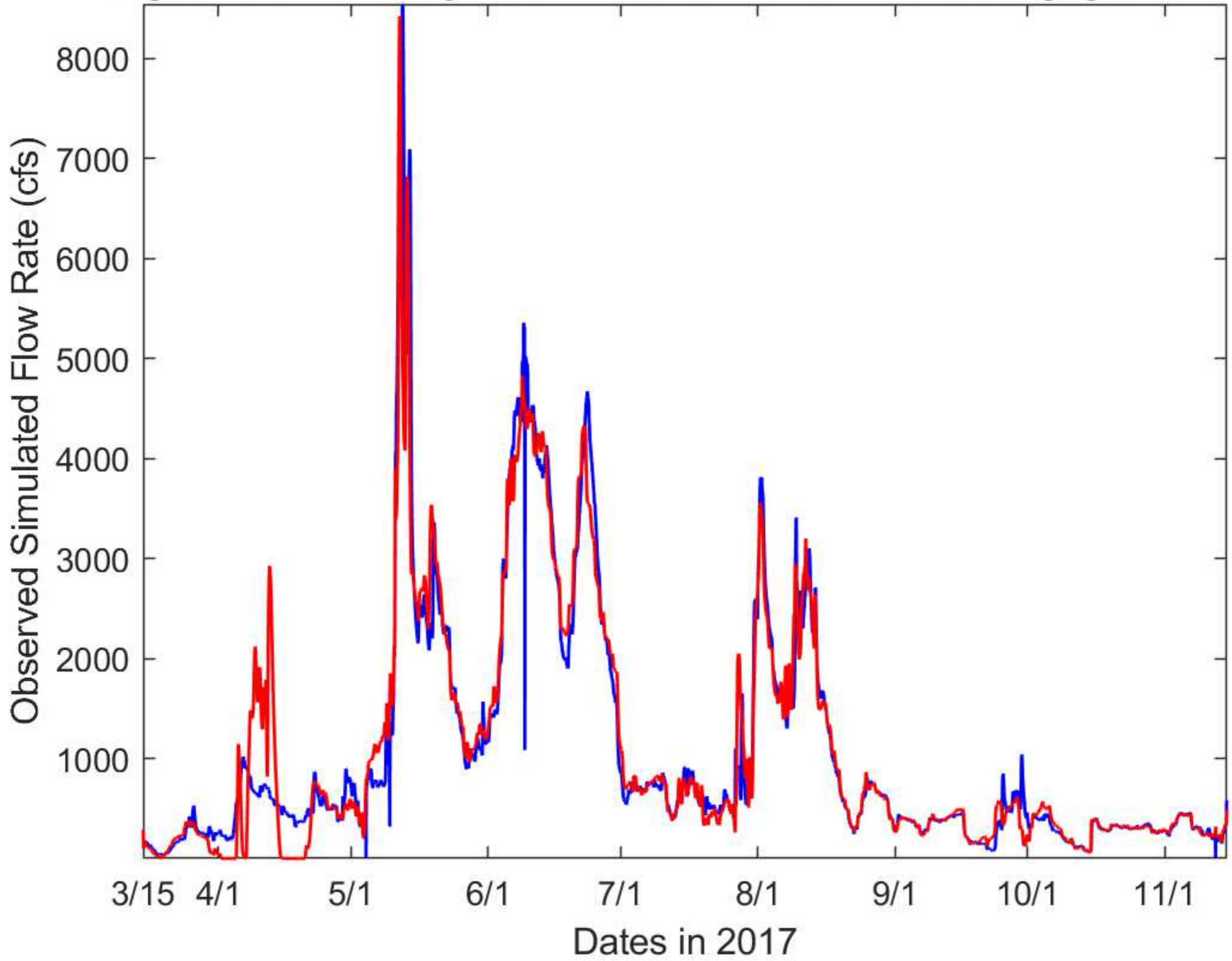
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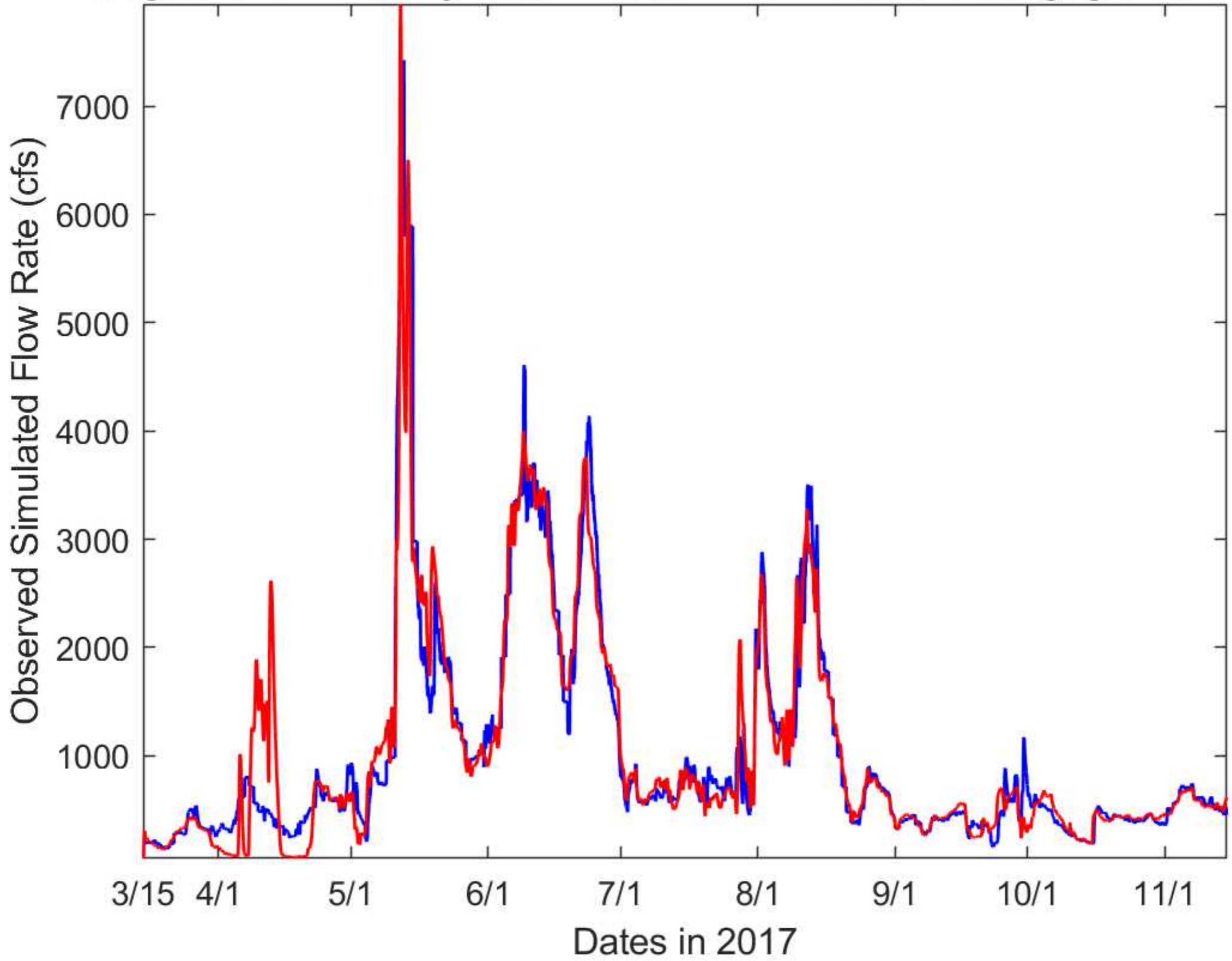
Gage and Sim Hourly Data-1409502-ARKNEPCO blue=gage/red=sim



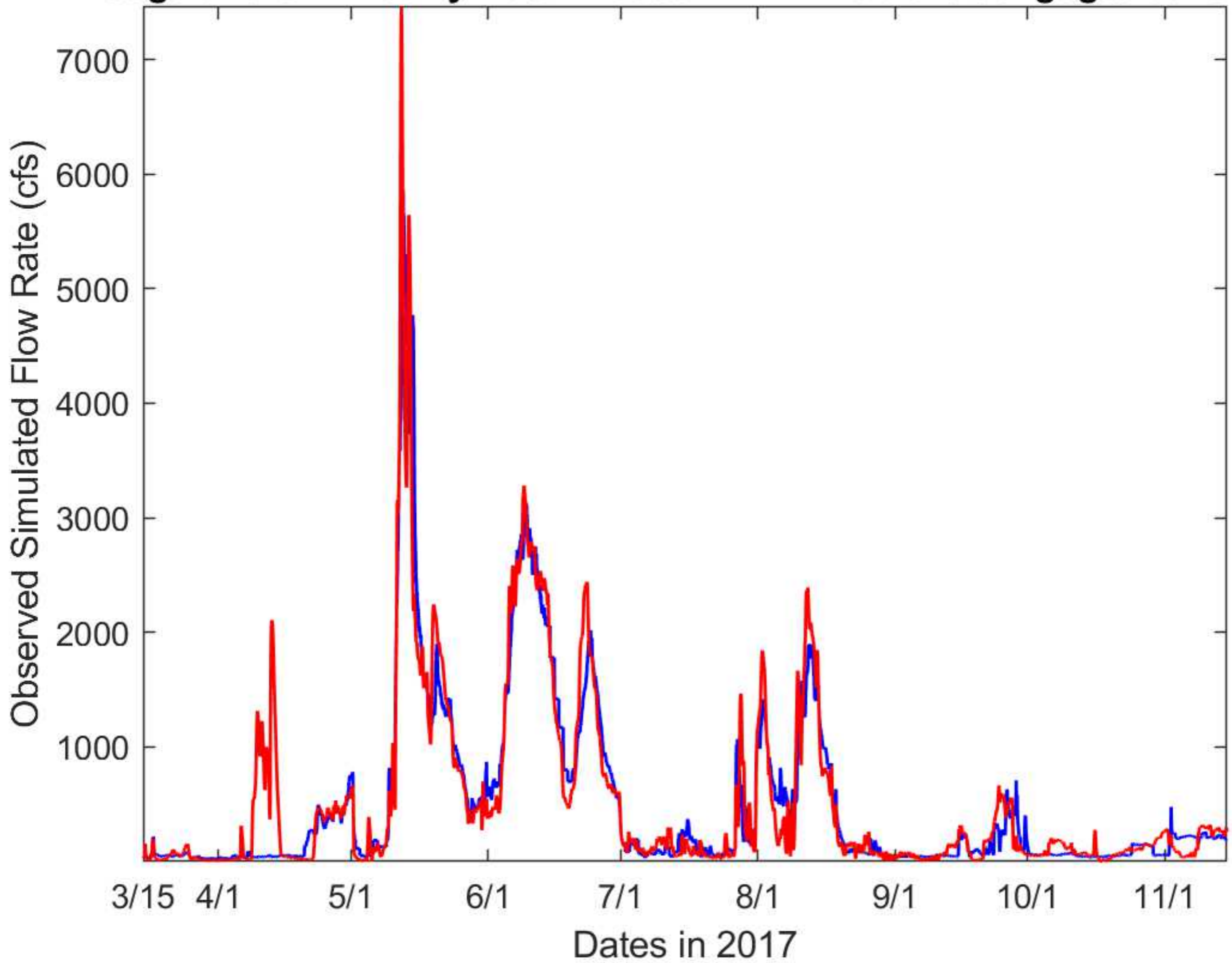
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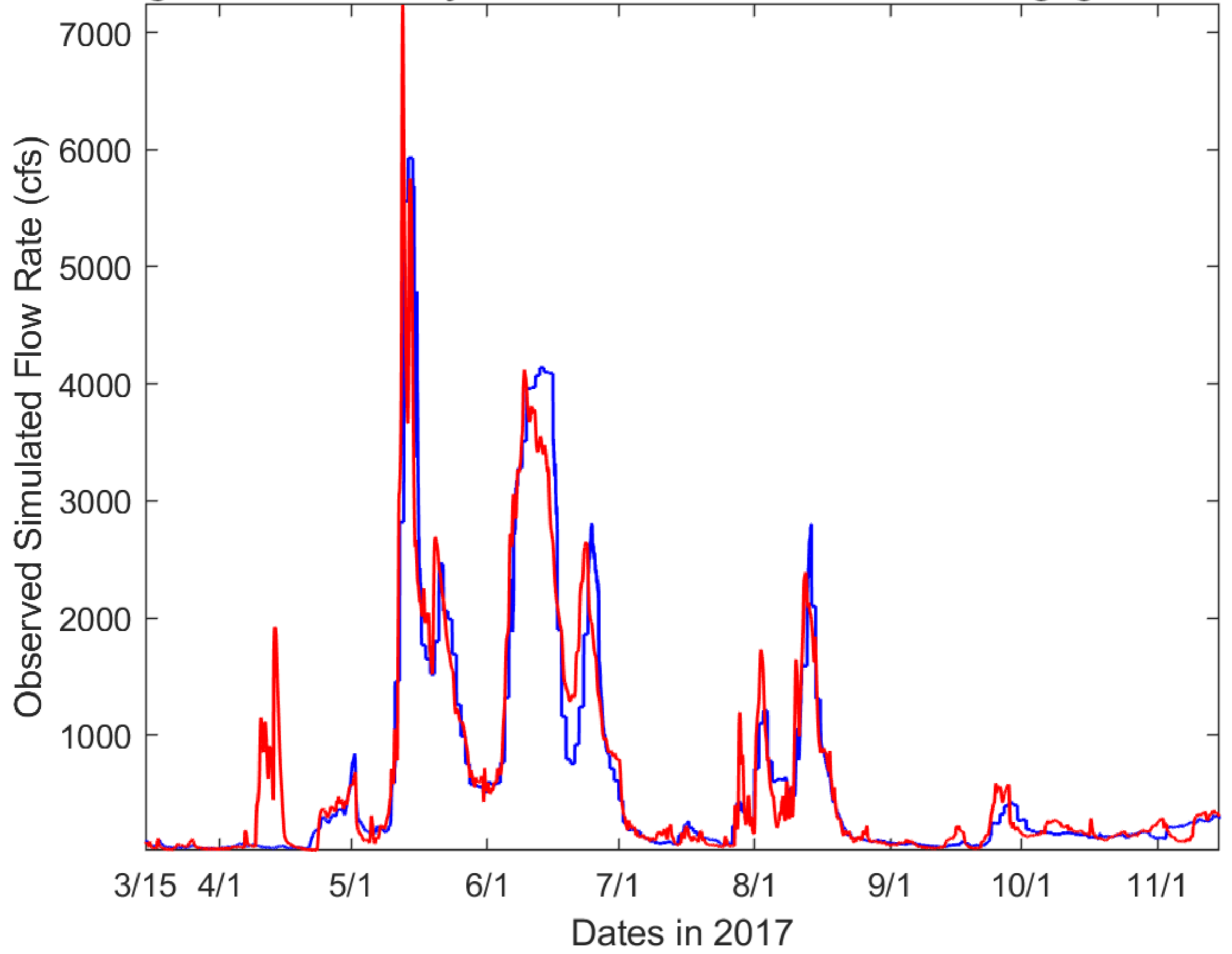
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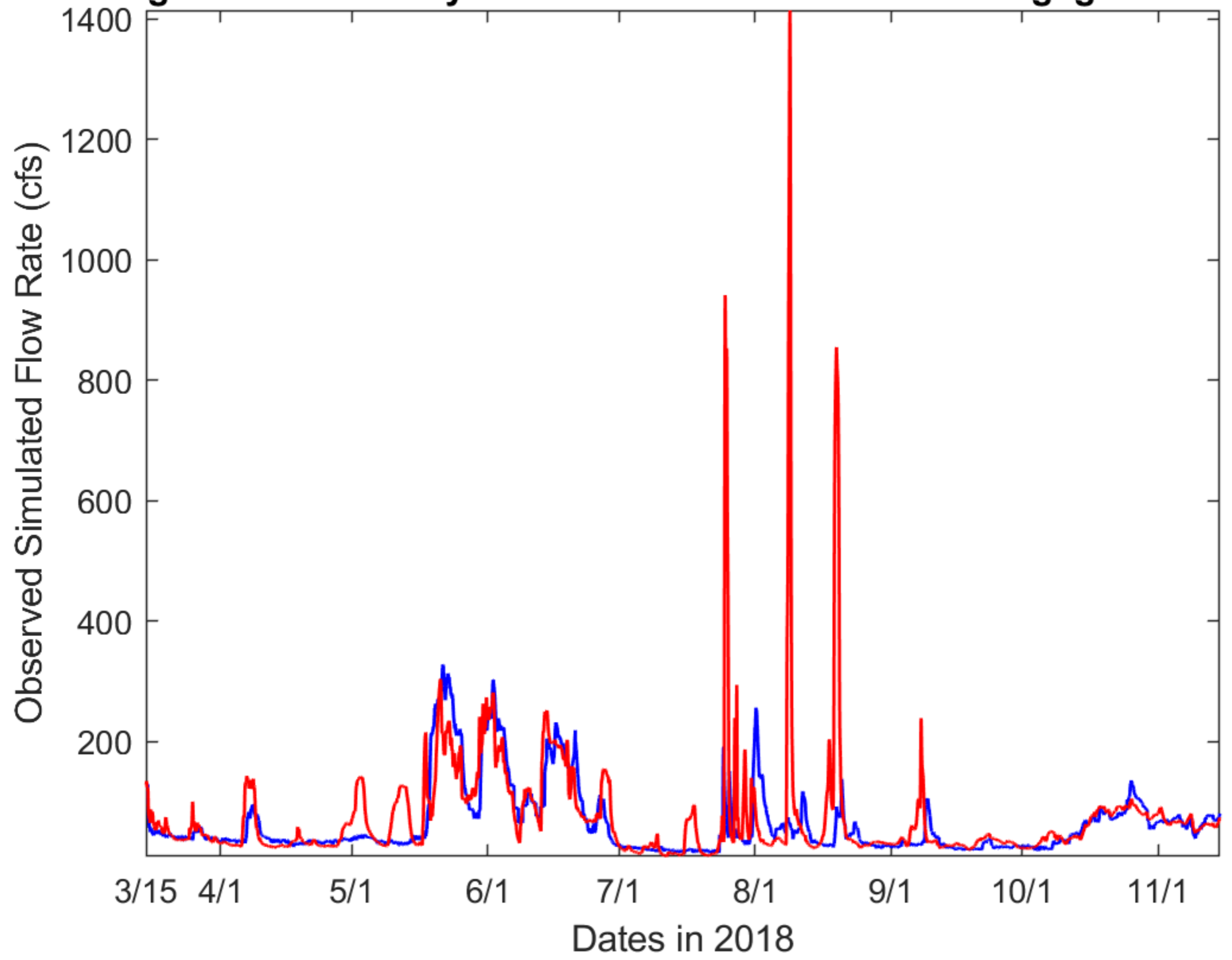
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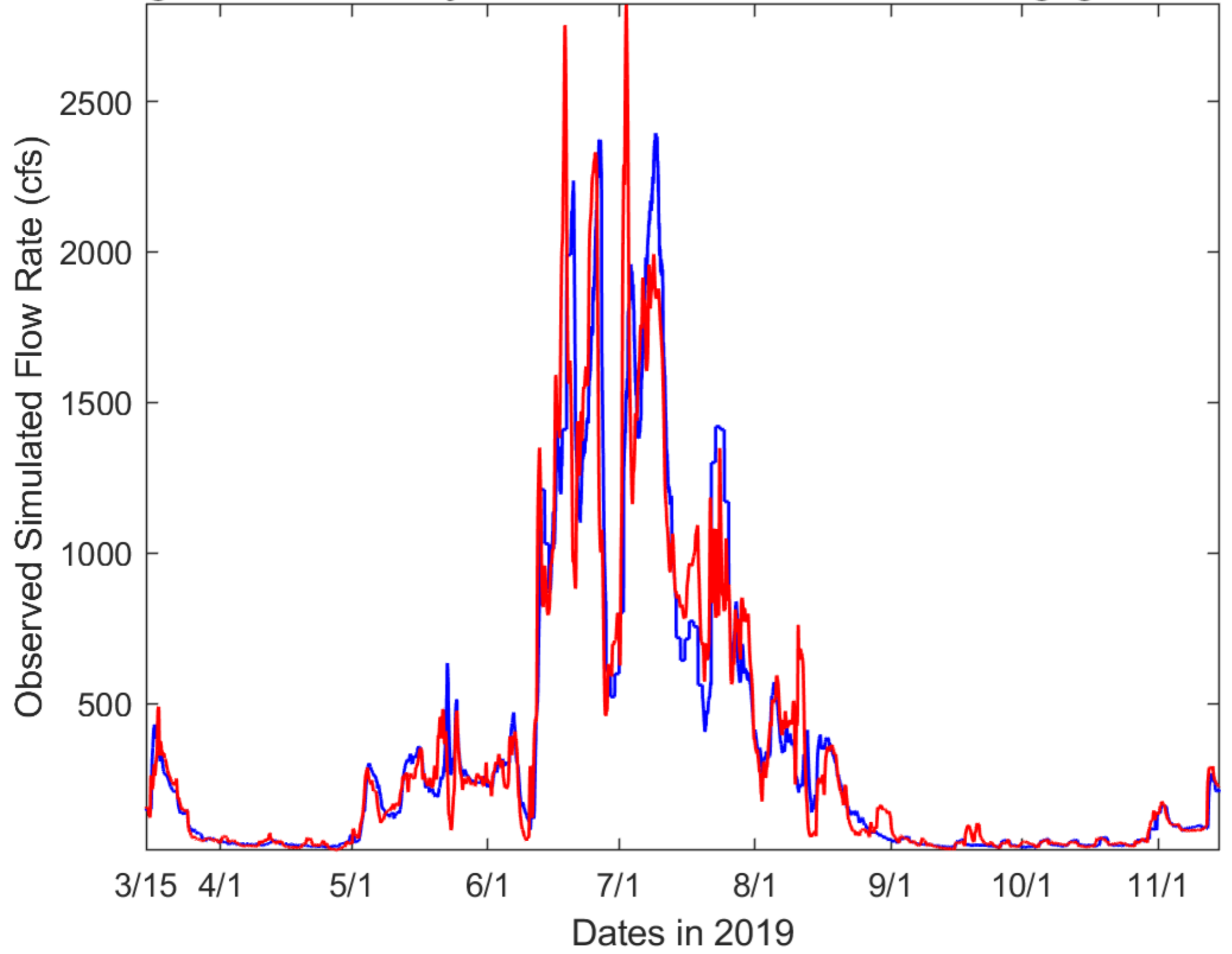
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Gage and Sim Hourly Data-1709505-ARKLASCO blue=gage/red=sim



Gage and Sim Hourly Data-1709505-ARKLASCO blue=gage/red=sim



Gage and Sim Hourly Data-1709505-ARKLASCO blue=gage/red=sim

