PRISM Climate Data Effect on Flow Calibration and Uncertainty of a SWAT Model Including Septic Systems

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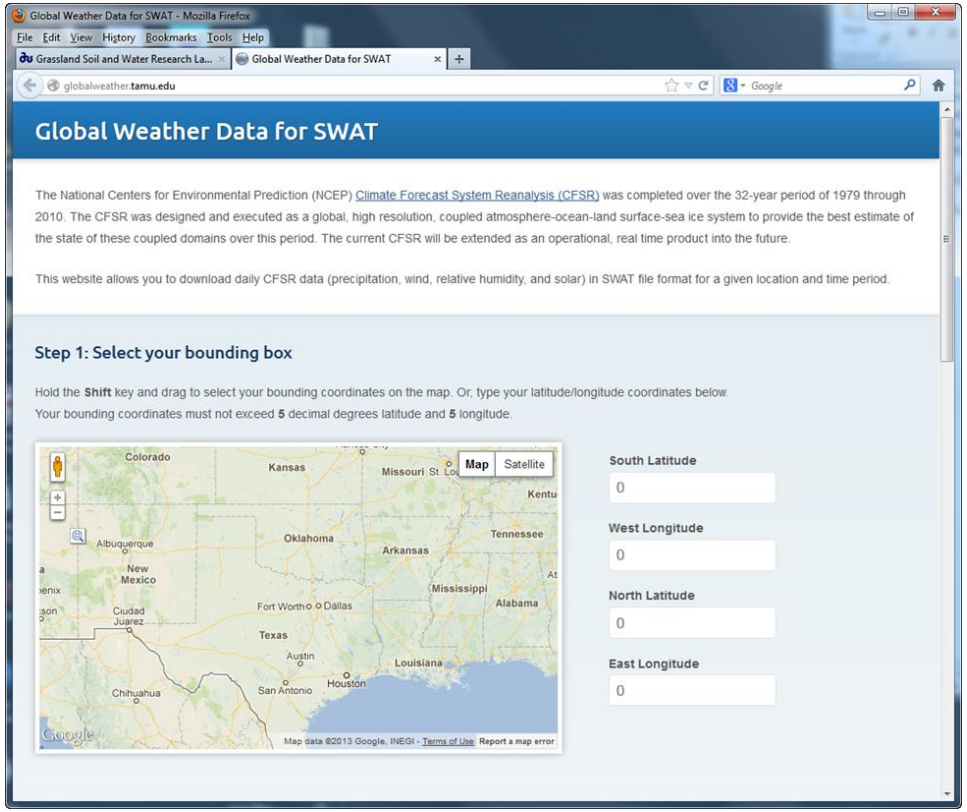
Model Sensitivity to Rainfall Data

- Weather one of most important drivers in watershed models
  - Obled et al. 1994. The sensitivity of hydrological models to spatial rainfall patterns: an evaluation using observed data.
  - Beven. 2001. Rainfall-runoff modeling: the primer.
  - Andreassian et al. 2001. Impact of rainfall knowledge on the efficiency and the parameters of watershed models.
  - Andreassian et al. 2004. Impact of spatial aggregation of inputs and parameters on the efficiency of rainfall-runoff models: a theoretical study using chimer watersheds.

CFSR Weather Data

- Climate Forecast System Reanalysis
- http://globalweather.tamu.edu/
- 1979-2014
- Interpolated dataset based on NWS Global Forecast system
- 38-km grid
- Commonly used in SWAT projects



PRISM Weather Data

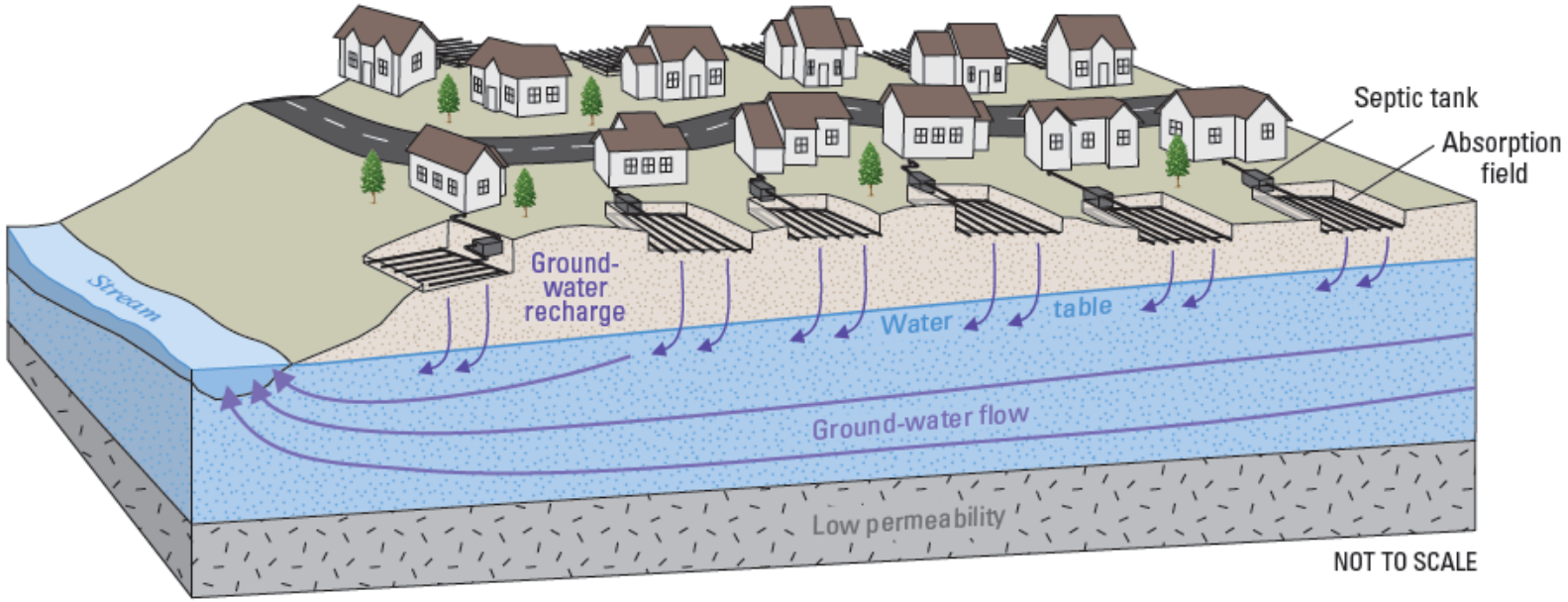
- Parameter-elevation Relationships on Independent Slopes Model
  - http://www.prism.oregonstate.edu/documents/PRISM_datasets_aug2013.pdf
- Daily weather product accessed through the Applied Climate Information System (ACIS)
  - http://www.rcc-acis.org/
- Starting in 2002, data based in part on long-term climate averages and radar
- Modeling resolution is 30 arc-seconds (about 800 m) or 2.5 arc-minutes (about 4 km)
- No studies using SWAT that we know of

NCDC Weather Data

- National Climate Data Center (now the National Centers for Environmental Information – NCEI)
- http://gis.ncdc.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=precip&layers=01&node=gis
- Hourly precipitation for over 7000 stations located primarily in the US
- Collected by variety of sources including National Weather Service reporting stations, volunteer cooperative observers, Federal Aviation Administration, utility companies, etc.
- Data checked and edited by NOAA

Septic Systems

- USA
  - 24 million homes
  - 24.1%
- Georgia
  - 1.0 million homes
  - 36.8%



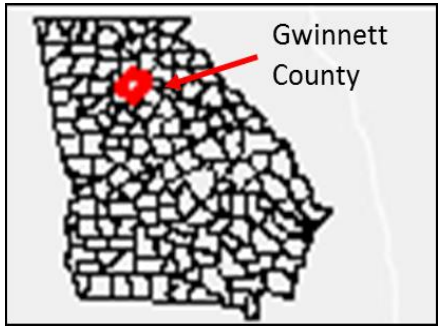
USEPA, 2002

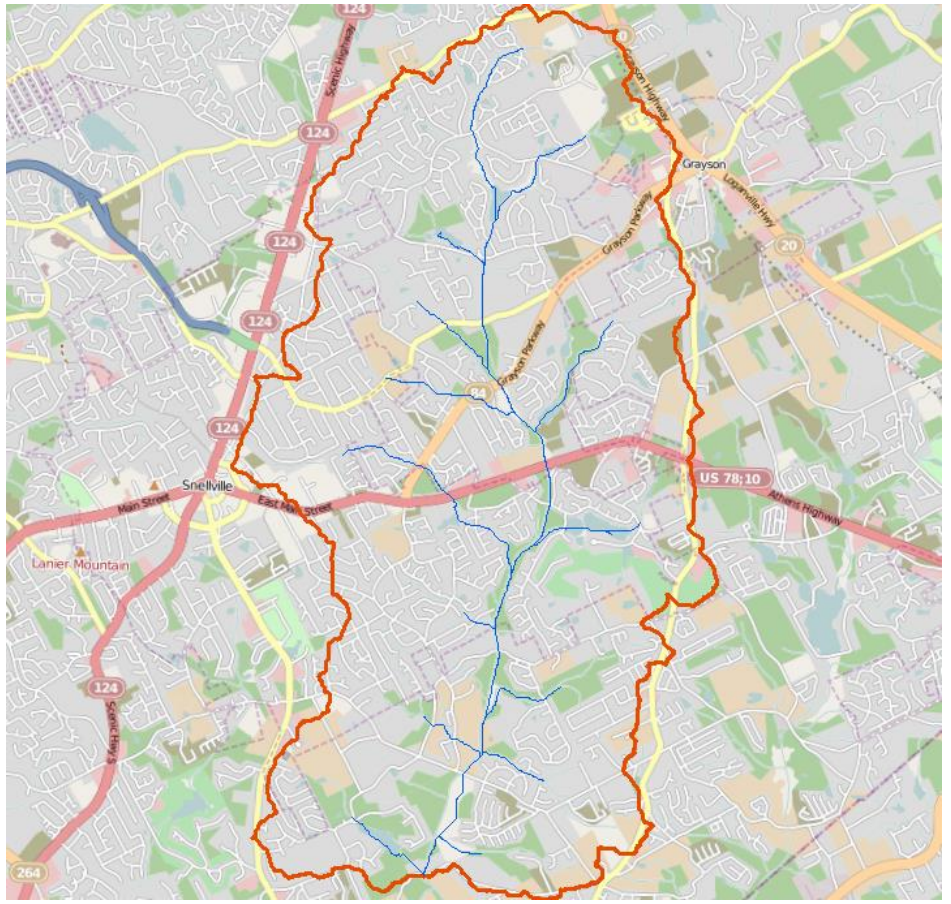
Objective

- Compare CFSR, PRISM, and NCDC weather data for effect on modeling stream flow in a suburban watershed near Atlanta, Georgia where septic systems are commonly used

Big Haynes Creek Watershed

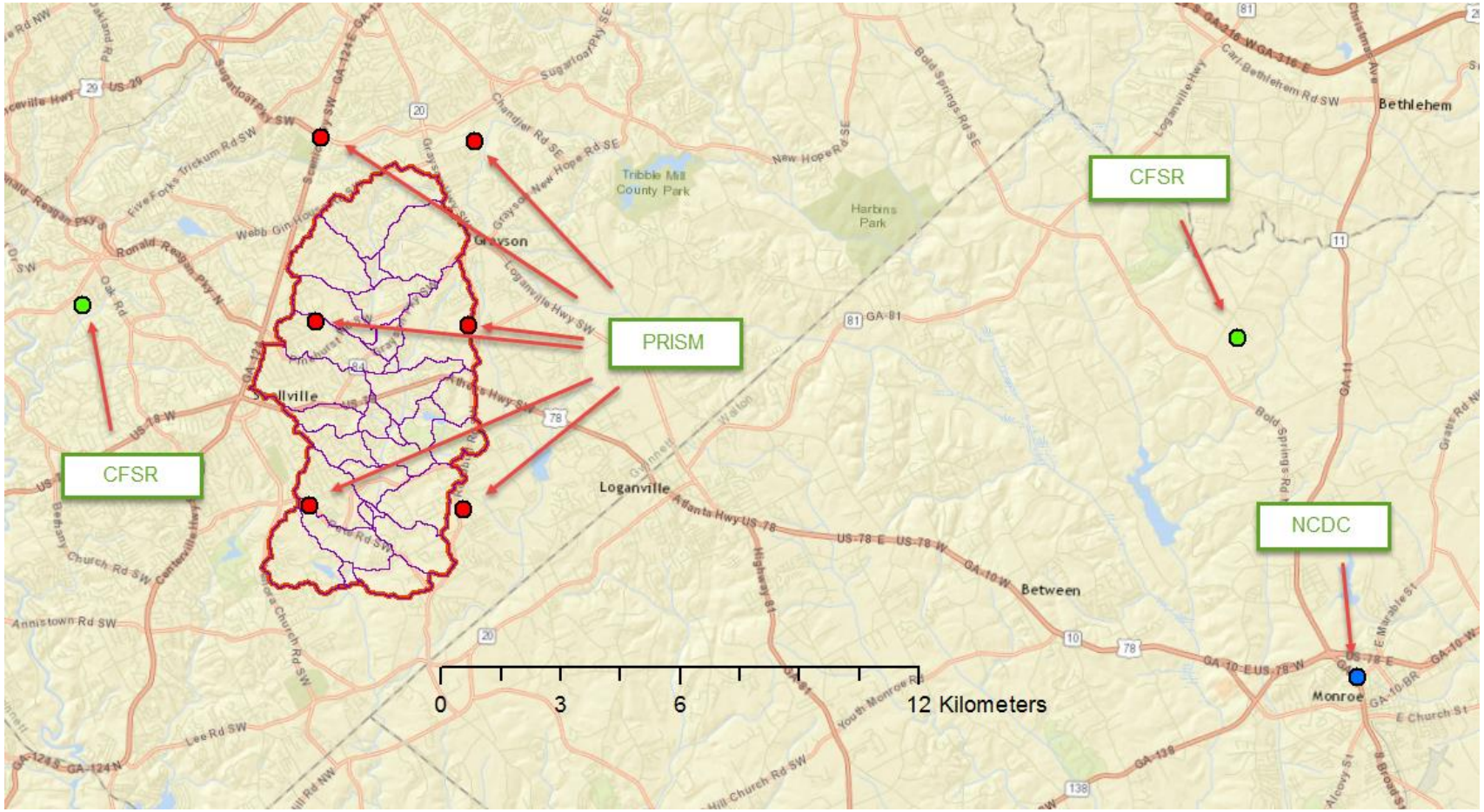
- 44.7 km^2
- 3,854 septic systems
- 58% urban
- 25% forest
- 10% farmland





Big Haynes Creek

Precipitation Data

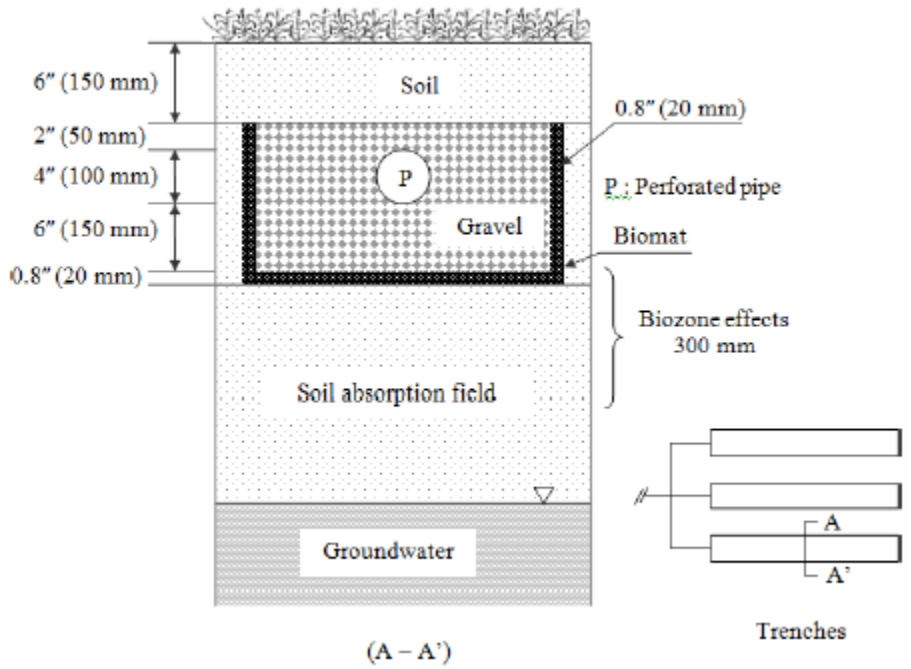


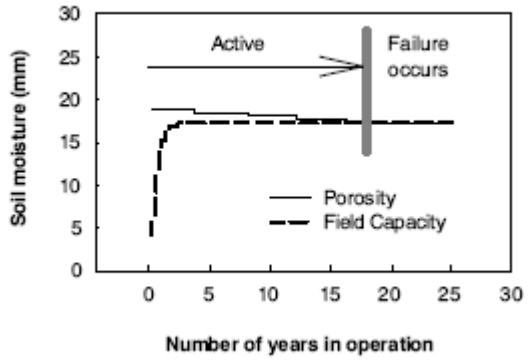
SWAT Model

- 31 subbasins
- Daily time step
- 4 years warm-up
- Calibration 1/1/2003 – 12/31/2006
- Validation 1/1/2007 – 12/31/2010
- SWAT-CUP SUFI2
  - NSE for Objective Function
- Started with 22 parameters and 1000 runs
- After 3-4 iterations there were 12 (PRISM and NCDC) and 10 (CFSR) parameters

SWAT Septic System Routine

- New in SWAT2009
- Septic HRU
- Daily septic inflow
- When biomat clogs systems fail
- For failed systems effluent becomes part of runoff



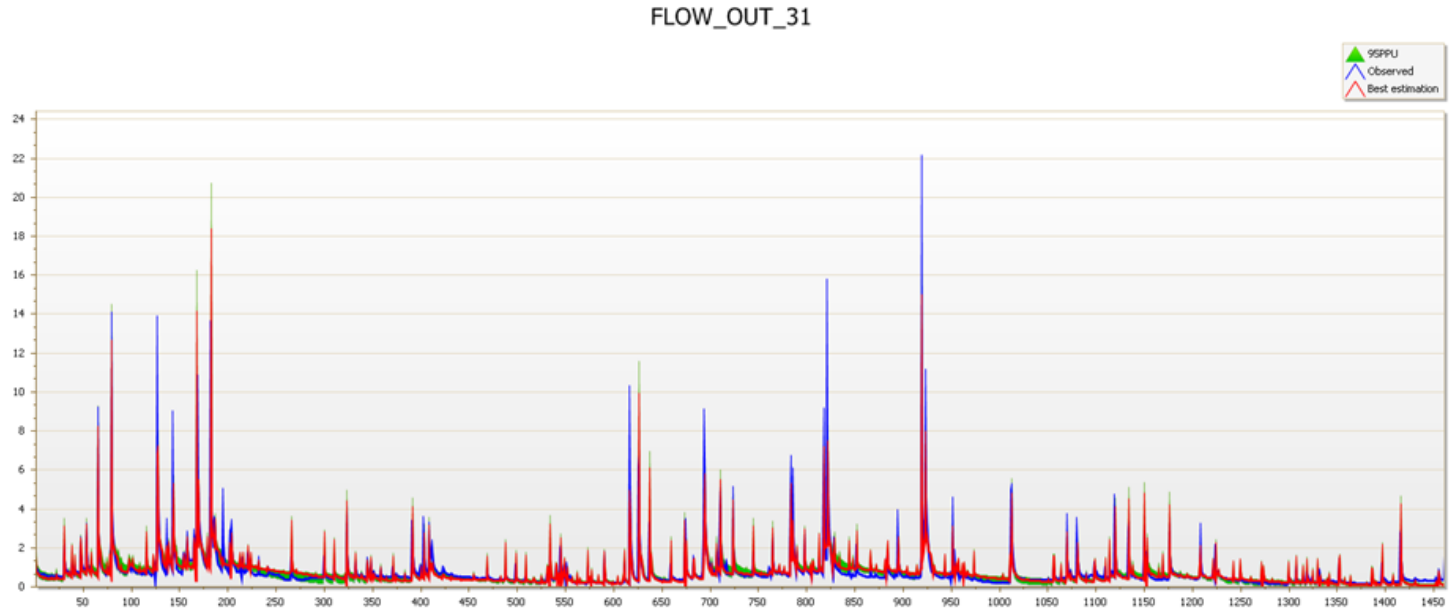


Failing Septic Systems

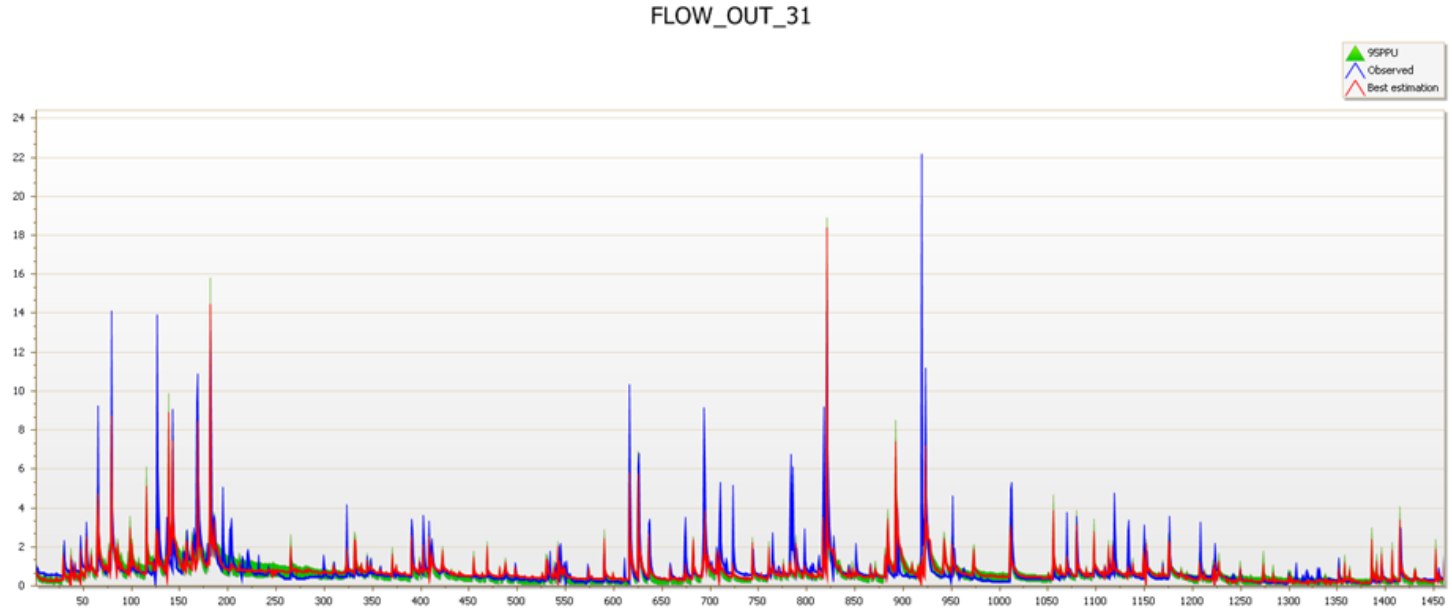
- Biomat clogging would not occur within timeframe of simulations (8 years)
- To include failing systems
  - Set HRU threshold for soil class to 0%
  - For all HRUs with Class D soil hydrologic group and septic systems, set them to permanent failure
  - Resulted in 1% of septic systems in failure

Calibration

PRISM
NS = 0.66
p-fact = 0.72
r-fact = 0.27

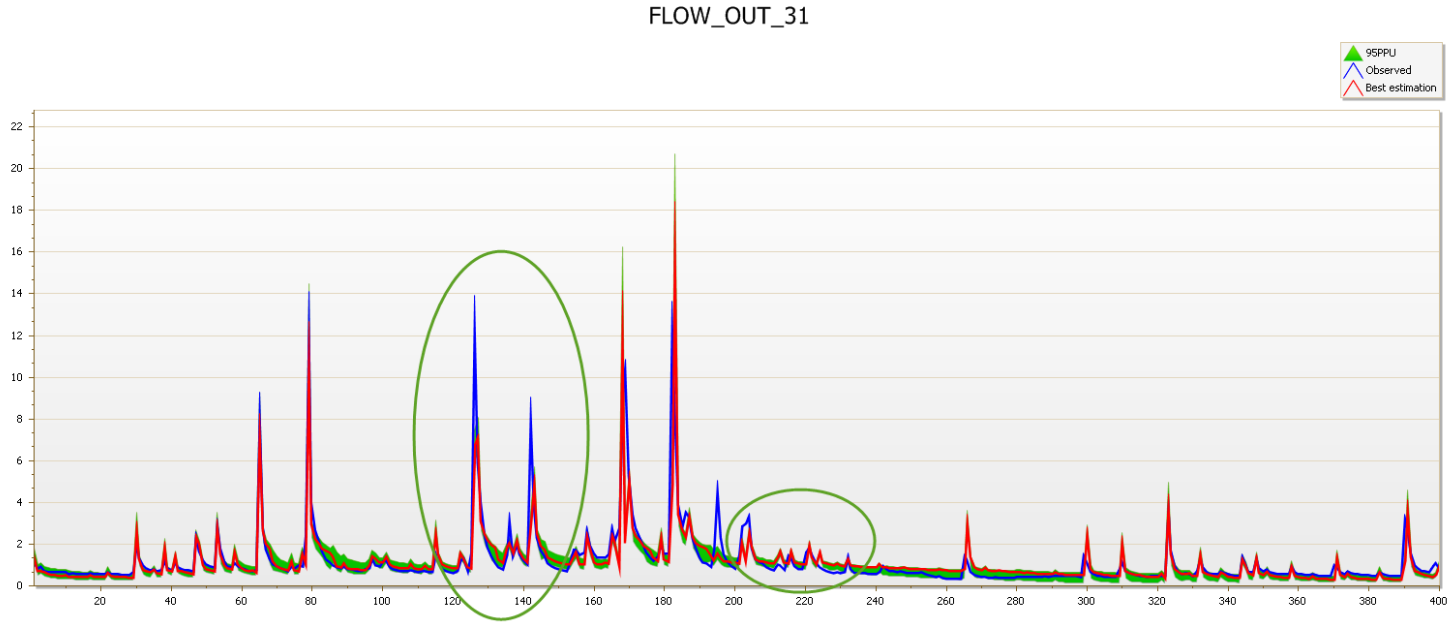


CFSR
NS = 0.45
p-fact = 0.75
r-fact = 0.52

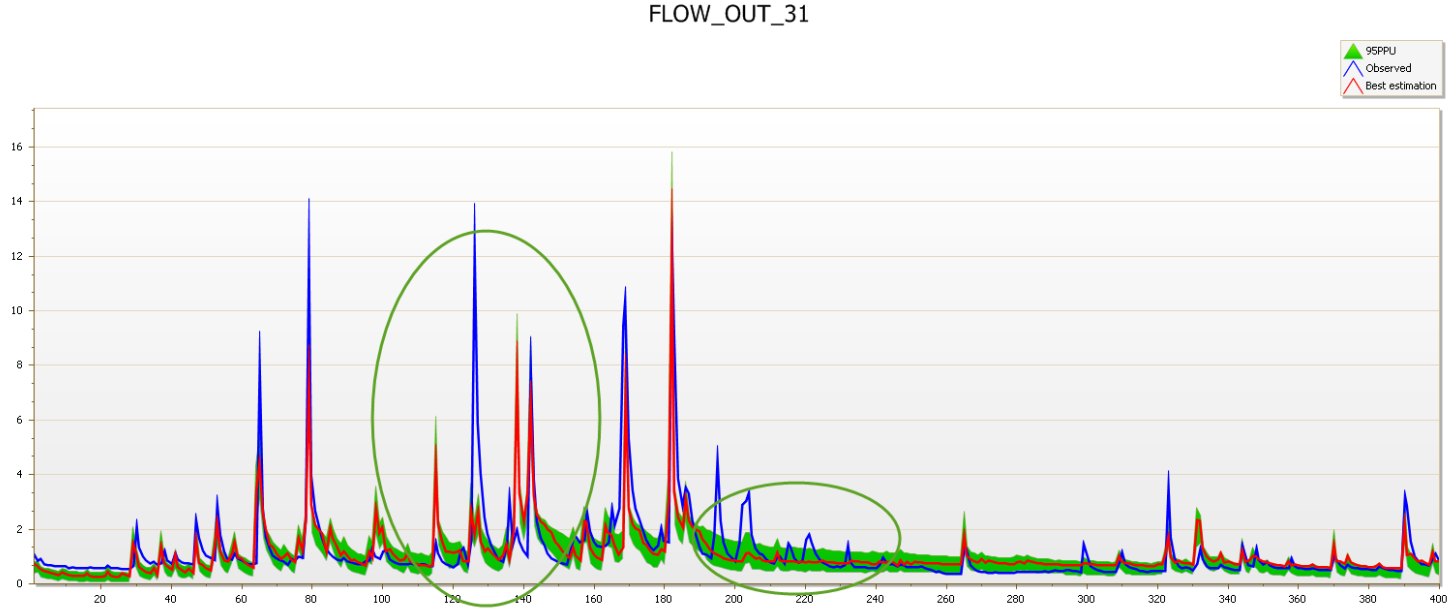


Calibration

PRISM

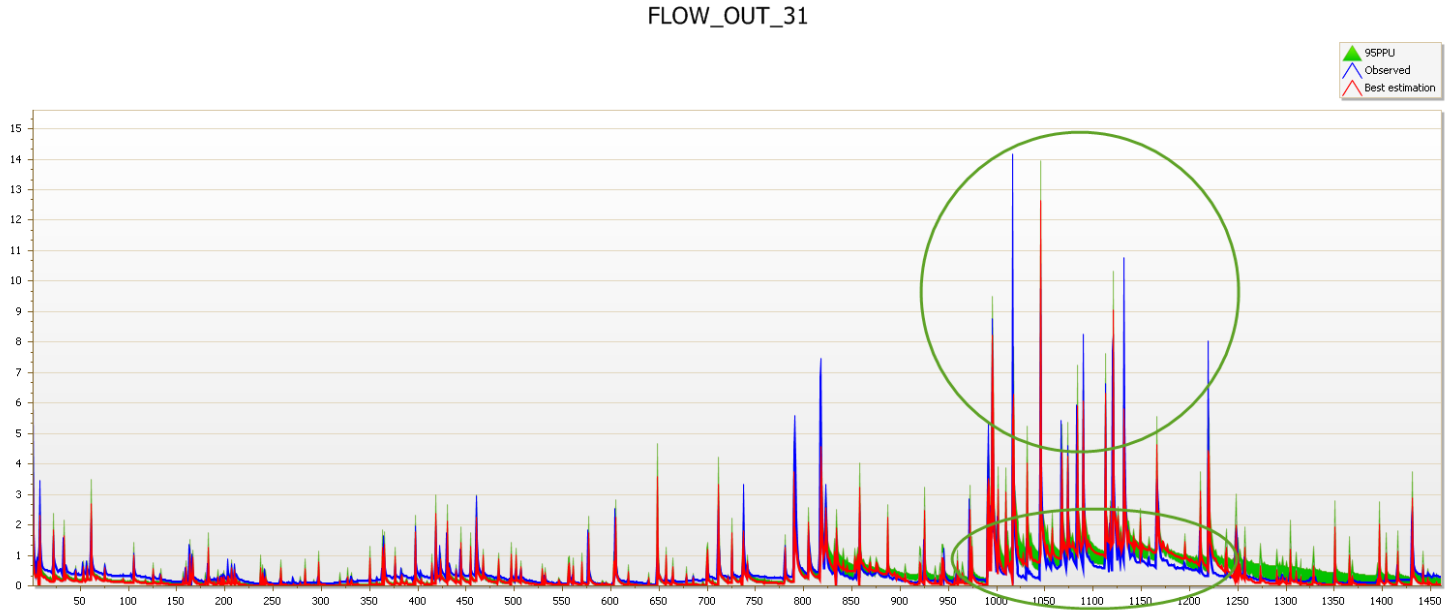


CFSR

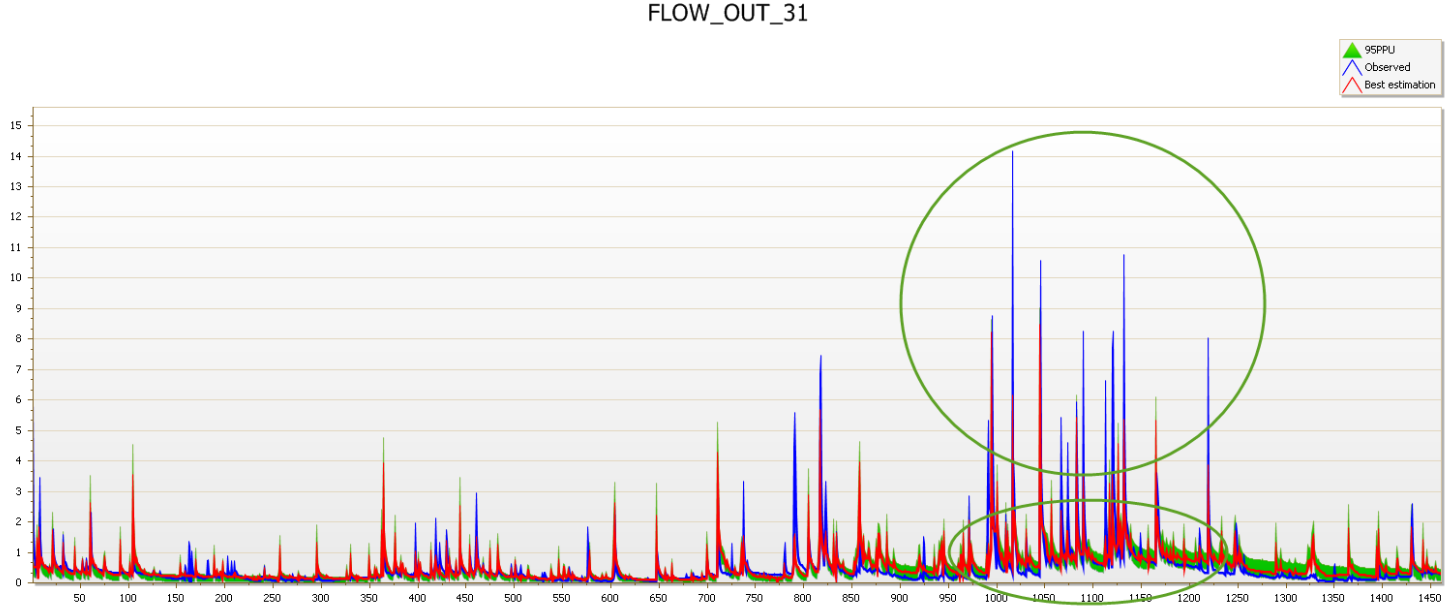


Validation

PRISM
NS = 0.69
p-fact = 0.36
r-fact = 0.28

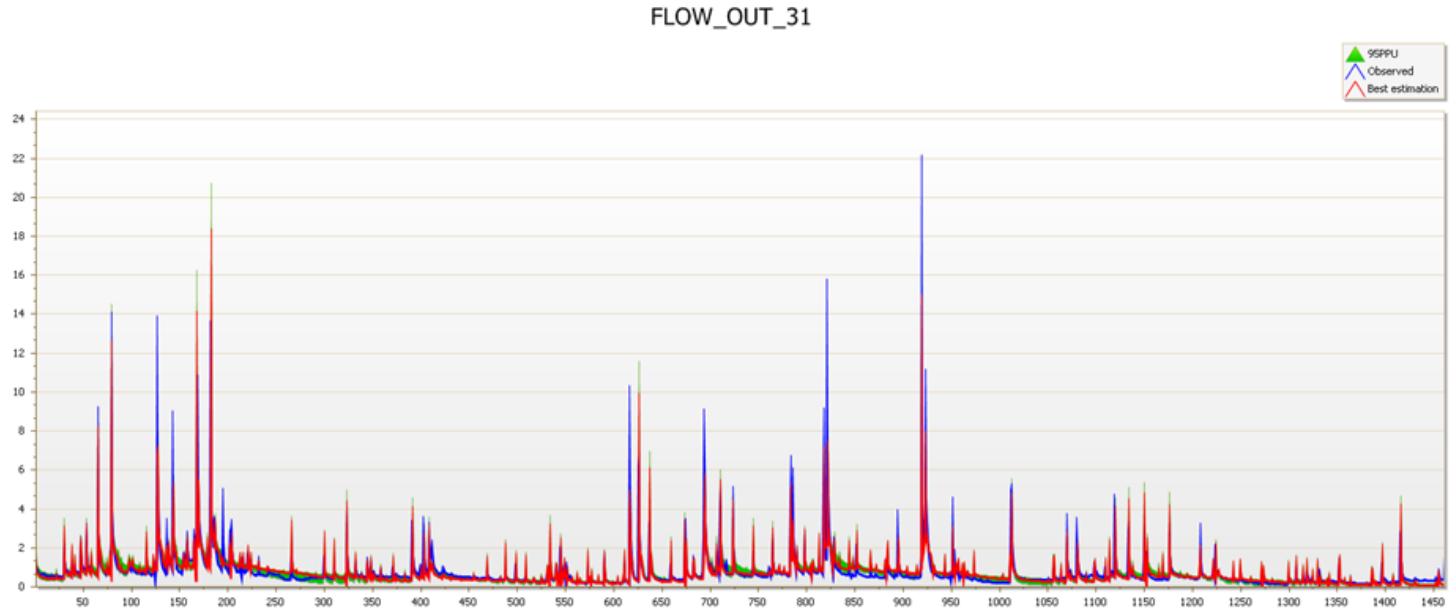


CFSR
NS = 0.51
p-fact = 0.72
r-fact = 0.46

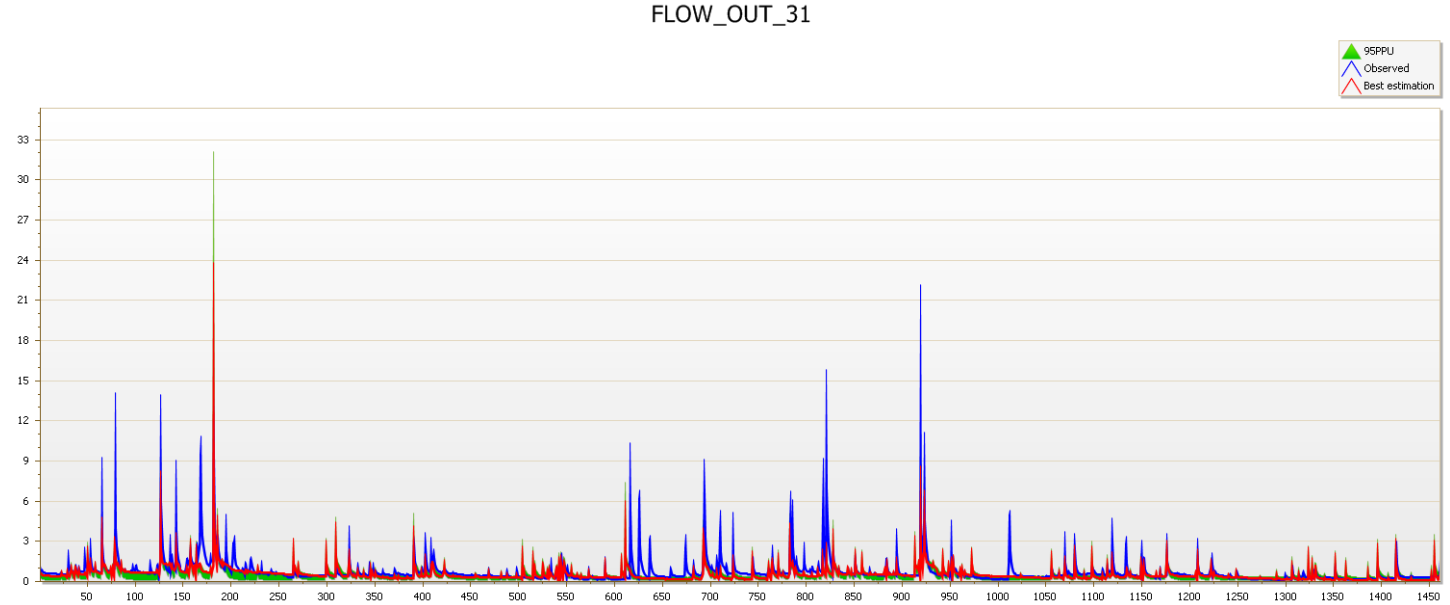


Calibration

PRISM
NS = 0.66
p-fact = 0.72
r-fact = 0.27



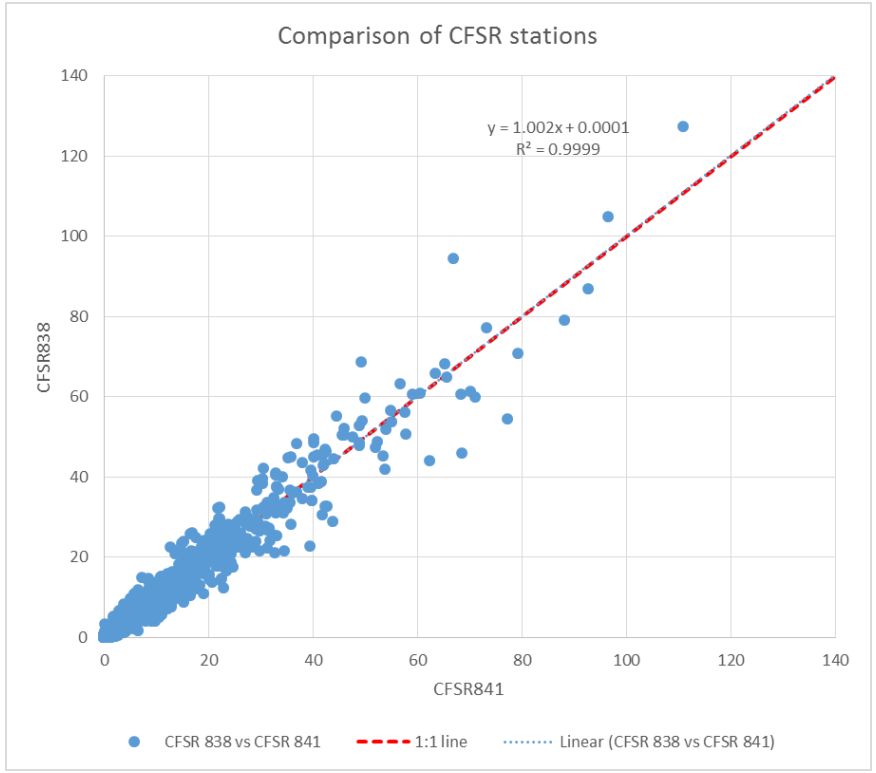
NCDC
NS = 0.36
p-fact = 0.44
r-fact = 0.32

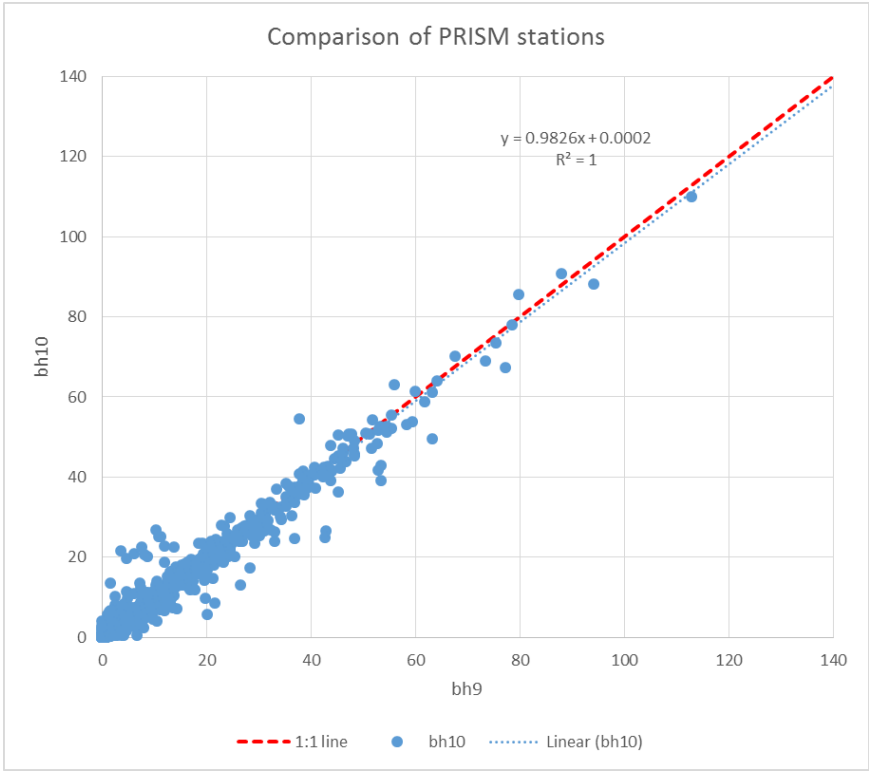


Daily NSE Summary

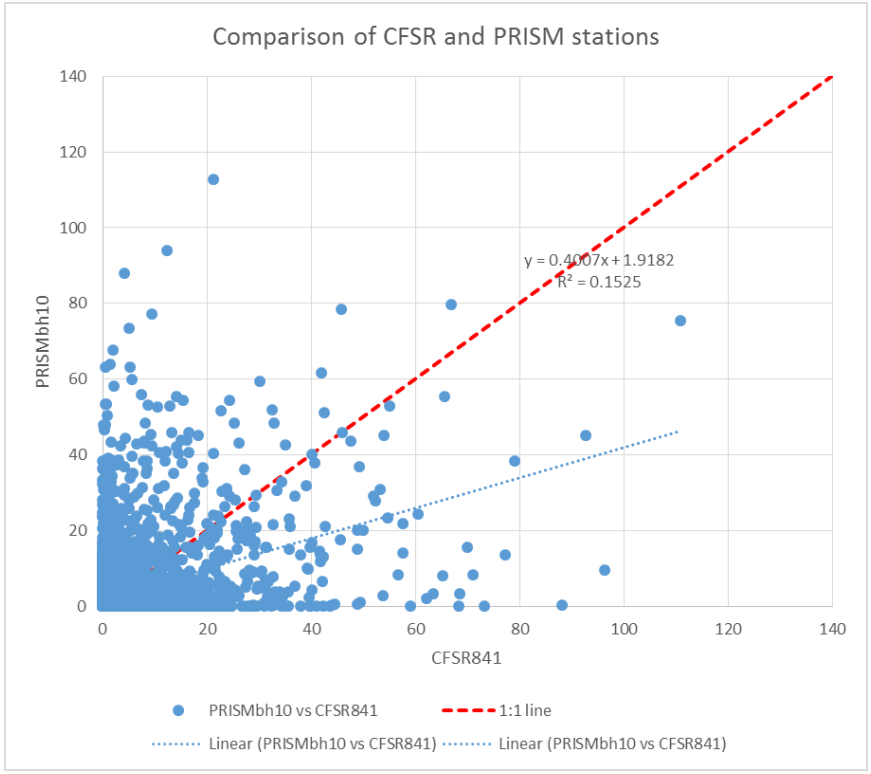
Data	Calibration	Validation
PRISM	0.66	0.69
CFSR	0.45	0.51
NCDC	0.36	

Variation Within Interpolated Stations

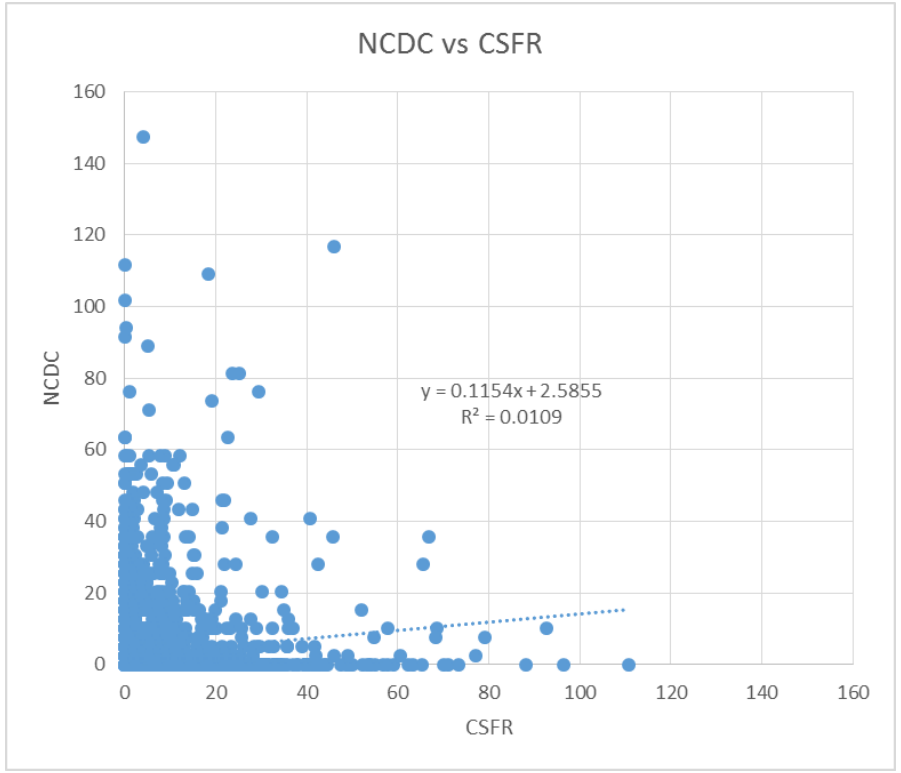


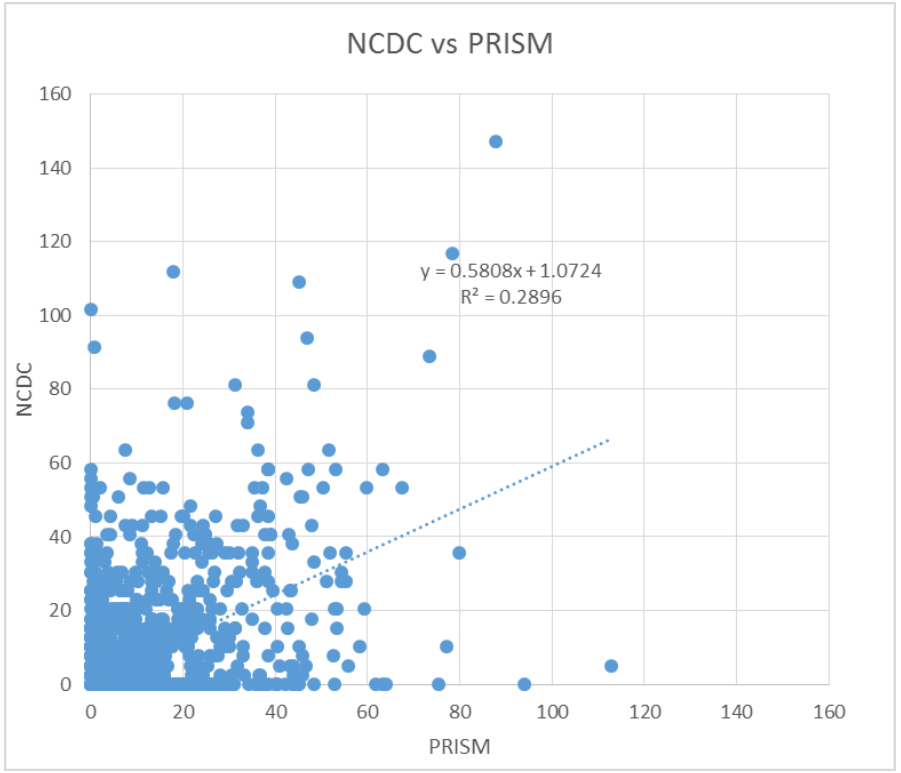


Variation Between Interpolated Stations

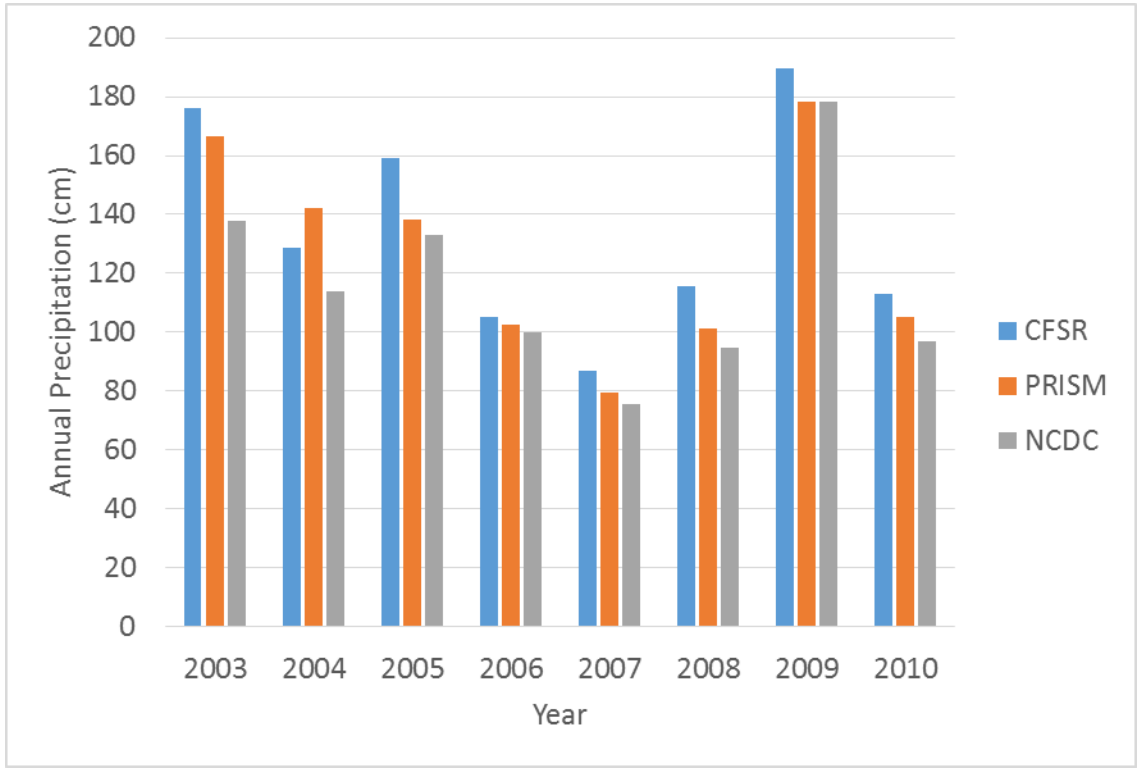


Comparison of Interpolated and NCDC Stations





Comparison of Basin Total Precipitation

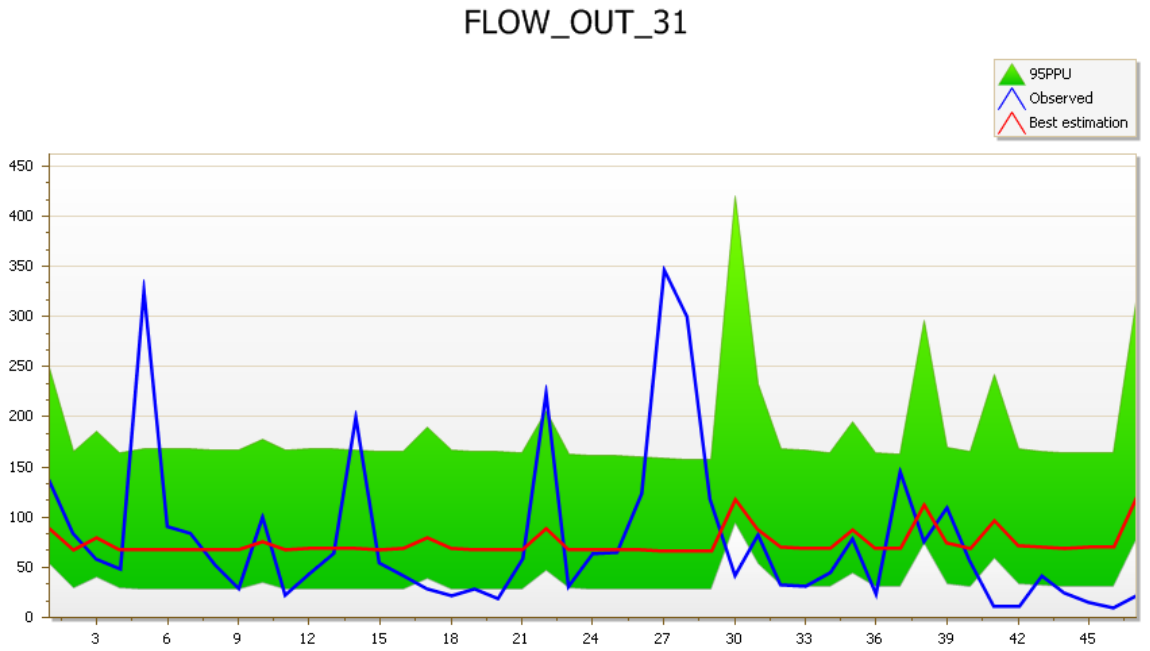


Sensitive Parameters

Parameters	Units	CFSR	PRISM
CH_K1	mm/hr	328	326
CH_K2	mm/hr	25	16
CH_N2	-	0.05	0.02
CN2	-	-0.09r	-0.10r
GW_DELAY	days	297	64
GW_QMN	mm	471	133
GW_REVAP	-	0.05	0.06
RES_RR	m^3/s	1.69r	1.71r
REVAPMN	mm	207	194
TRNSRCH	-	0.005	0.004
RES_EVOL	10^4 m^3		0.27r
SOL_K	mm/hr		0.51r

N model

- Developed N model using limited data measured at the outlet
  - 47 NO_3-N concentrations over 4 years measured mostly during baseflow
- No effect of precipitation data on calibration fit (which was poor)
  - PRISM: NSE = -0.06, p-factor = 0.43, r-factor = 0.73
  - CRSR: NSE = - 0.05, p-factor = 0.79, r-factor = 1.25



Conclusions

- PRISM precipitation data resulted in better model fit to flow than CRSR or NCDC data
- Probably due to better estimate of total rainfall within basin
- No effect on modeling N