Use of NASA Remotely Sensed Products in Streamflow Estimation

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Objectives

- Replace daily PE estimations from manual sky cover lost when ASOS came on line
- Assess the utility of NASA data in National Weather Service River Forecast System (NWSRFS)

Daily Potential Evaporation Computation

- Thompson (1976) is used to compute daily solar radiation

  $R = B + (1 - N^{0.61} * (1 - B)) * Y_{100}$ where

  -- B is a location parameter for the station

  -- N is the fraction of the sky covered by clouds

  -- Y_{100} is the clear sky radiation for day of the year

- Solar radiation (R) is then used in an empirical estimation of the Penman equation

Fractional Sky Cover

- Automated Surface Observing System (ASOS) became operational in the 1990s, manual cloud cover observations were replaced by cloud ceilometer data. Two main issues with the ASOS ceilometer data:
  - The cloud detection is only in five categories, resulting in low precision
  - The detection limit of clouds is only 12000 ft.
- MODIS data can potentially supplement ASOS observations to compute an improved solar radiation estimate. MODIS data compliments ASOS observations:
  - Spatially continuous dataset allows us to quantify the cloud cover with higher precision
  - Ability to detect clouds till the top of the atmosphere
  - Validated, operational product

Three Data Products

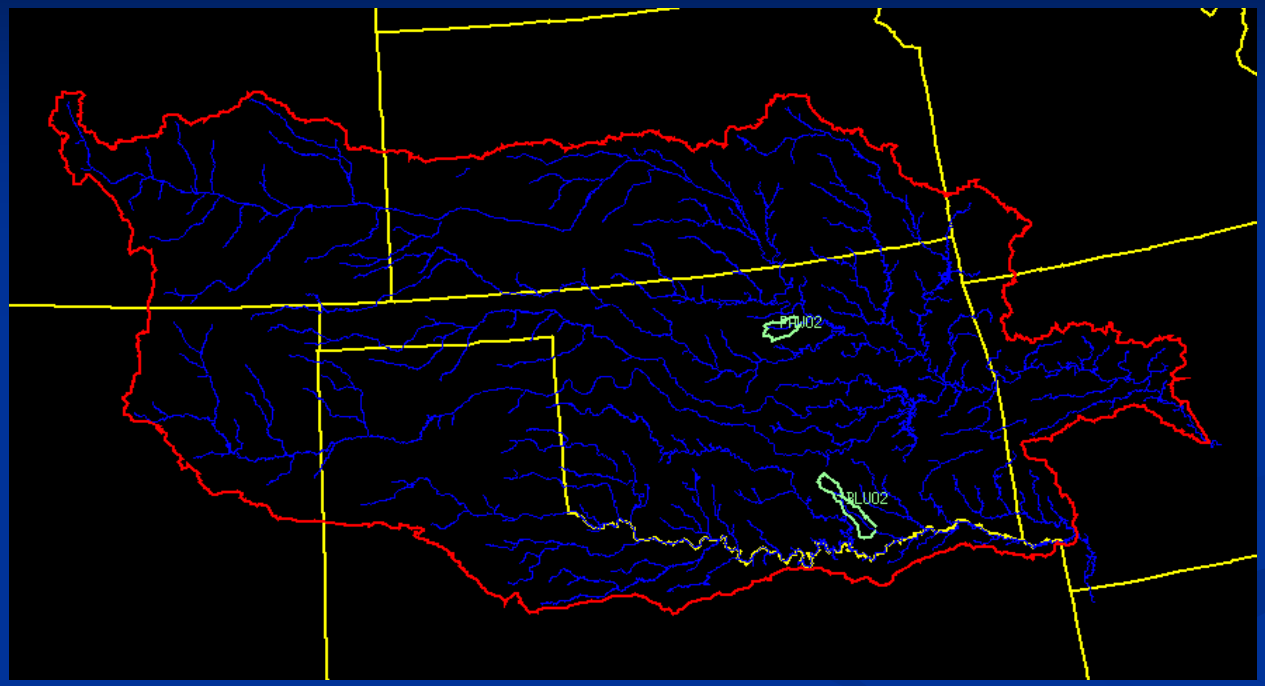
- ASOS is reported every hour as one of 5 categories
  - Clear (no clouds 0-5% sky cover)
  - Few clouds (5-25% sky cover)
  - Scattered clouds (25 – 50% sky cover)
  - Broken clouds (50 – 87% sky cover)
  - Overcast (87 – 100% sky cover)

  the mid-point of each category is used as the cloud fraction and a daily average is computed.
- MODIS is reported twice a day at 10:30 and 1:30, cloud fraction computed as the number of 1x1 km^2 pixels flagged as cloudy divided by total pixels in a 5x5 km^2 area around ASOS site.
- ASOS + MODIS- Simple average of ASOS and MODIS daily values (best agreement with SCAN site radiation measurements).

Approach

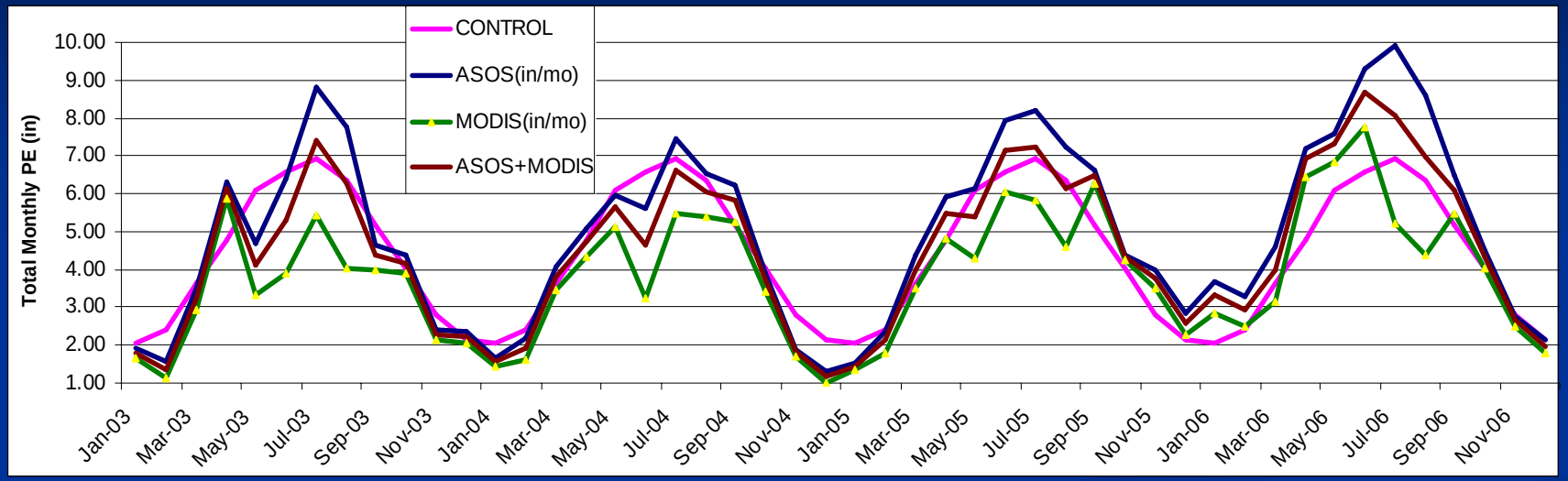
- First- directly inserted 3 daily PE products into lumped calibrated Sacramento model
- Second- used a priori SAC-SMA parameters to mitigate calibration bias
- Third- introduced PE scaling factor to adjust daily products to climate monthly average to isolate the effects of daily and inter-annual variation

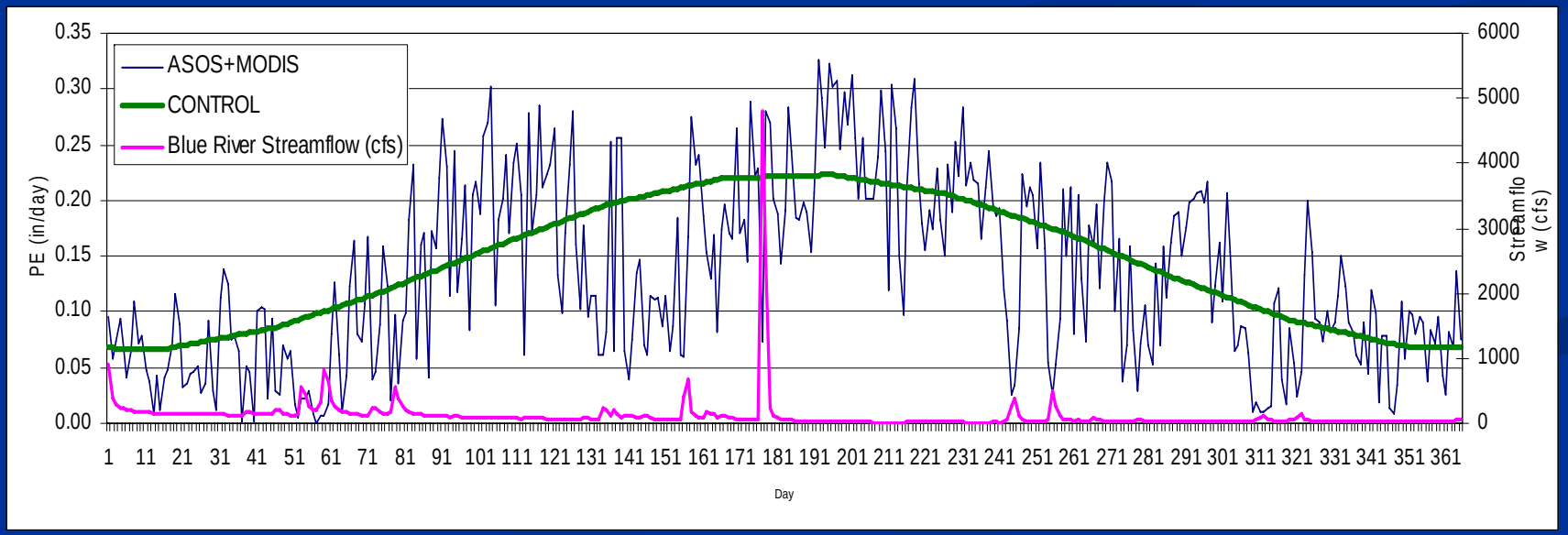
Blue River



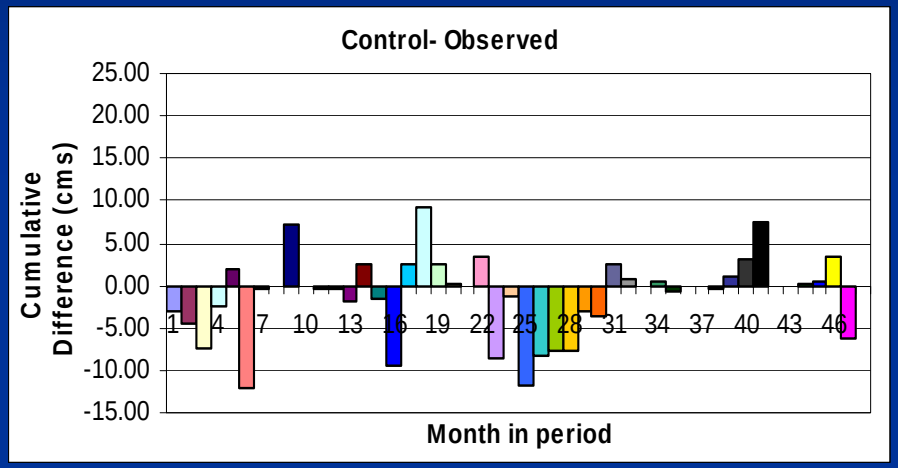
- High PE variation and potential for large streamflow improvements
- Near ASOS site

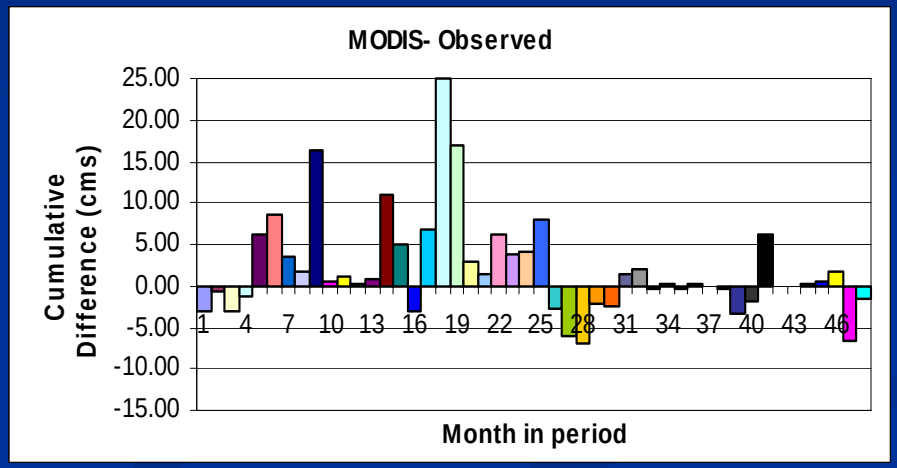
Blue River PE

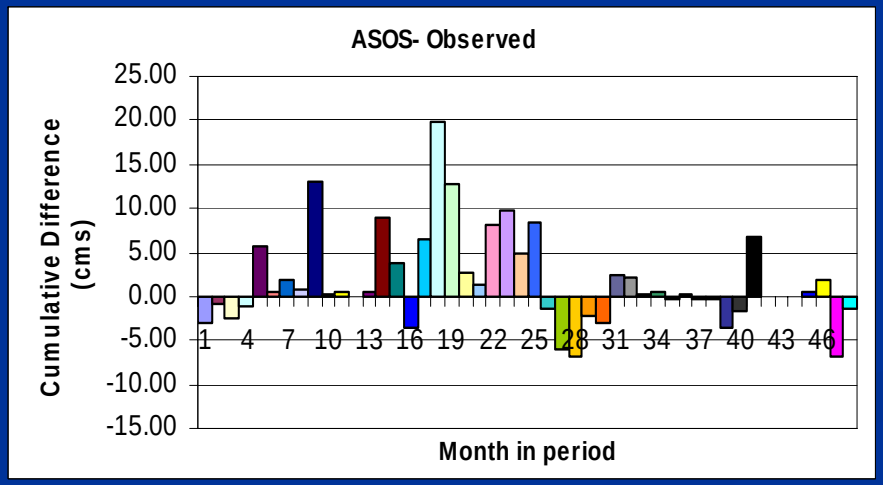


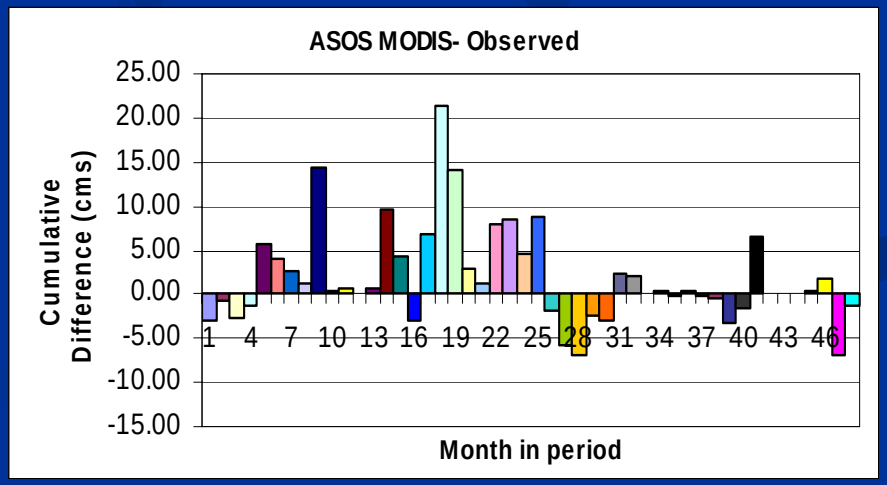


Blue River Streamflow Differences with Calibrated SAC Parameters and No Scaling

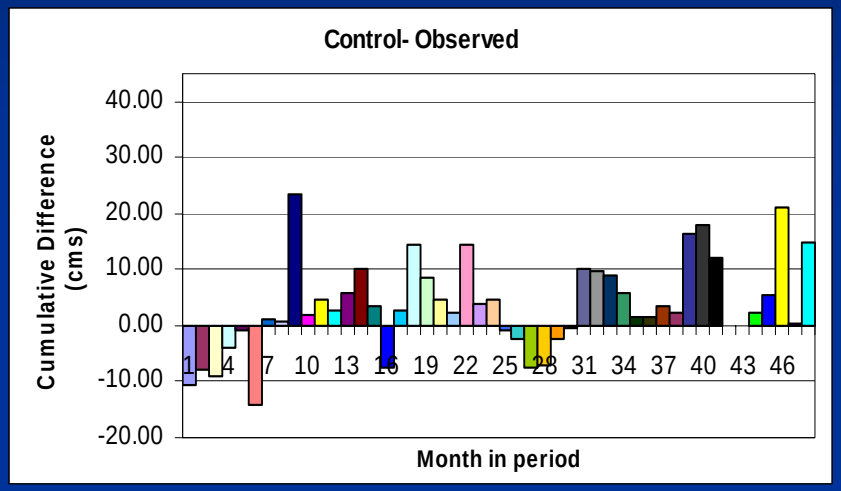


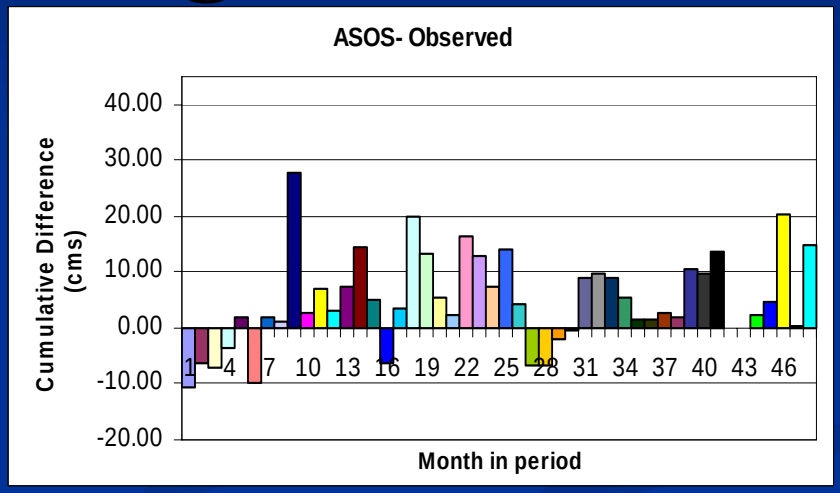


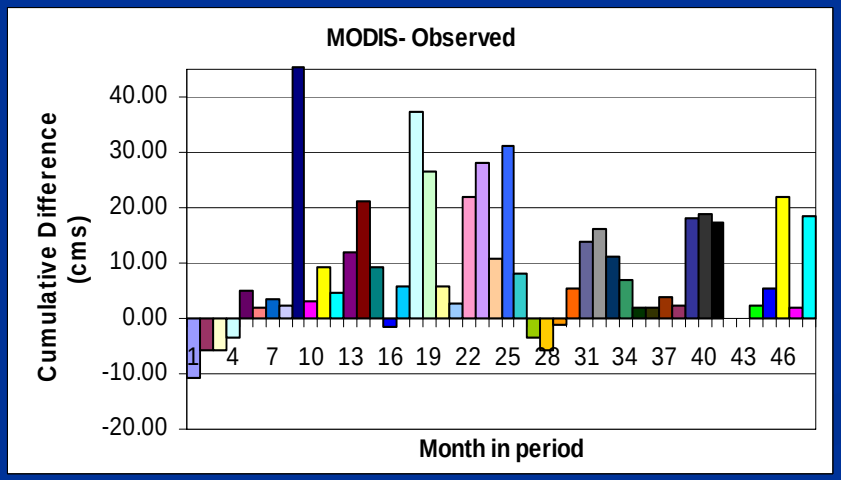


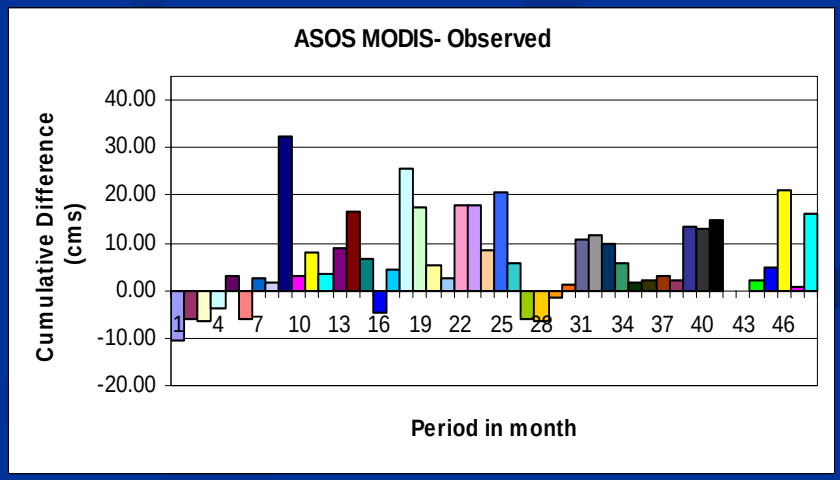


Blue River Streamflow Differences with A Priori SAC Parameters and No Scaling

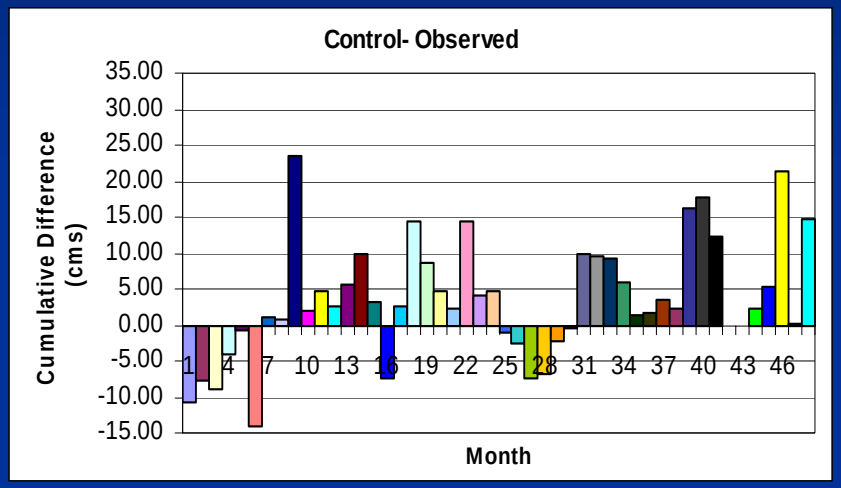


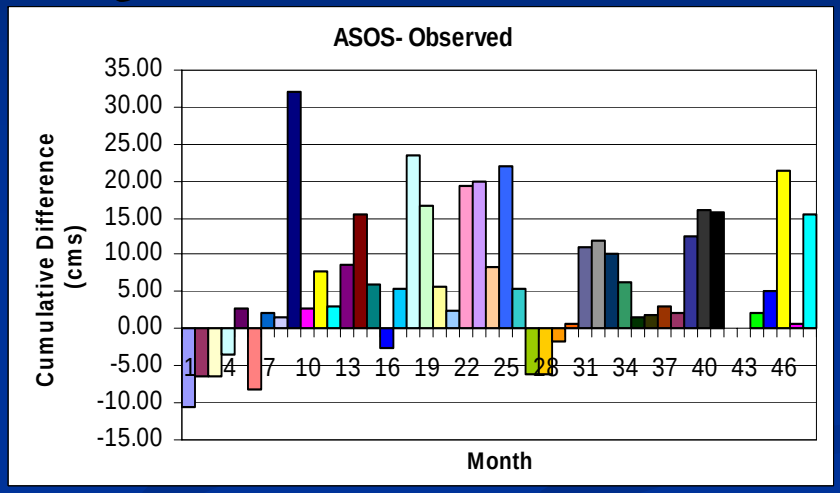


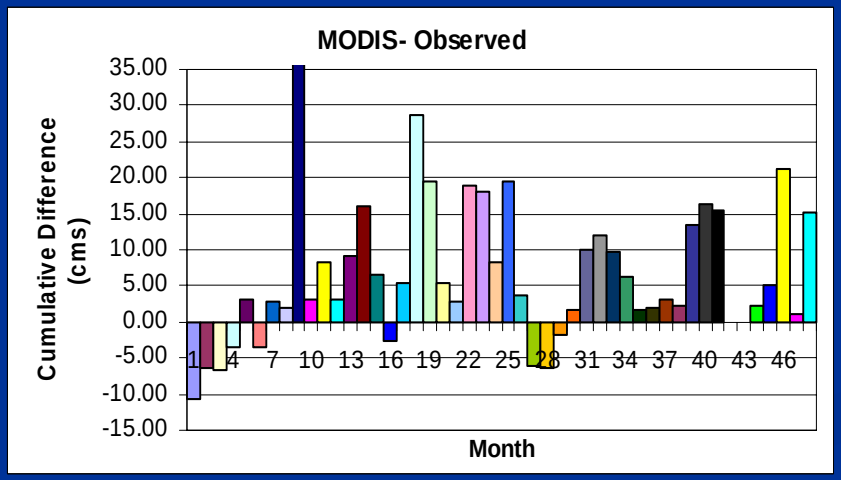


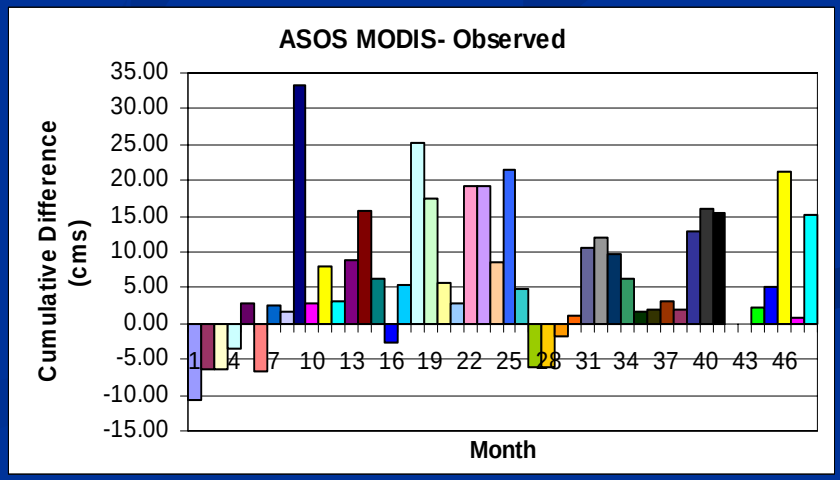


Blue River Streamflow Differences with A Priori SAC Parameters and Scaled PE_ADJ Factors

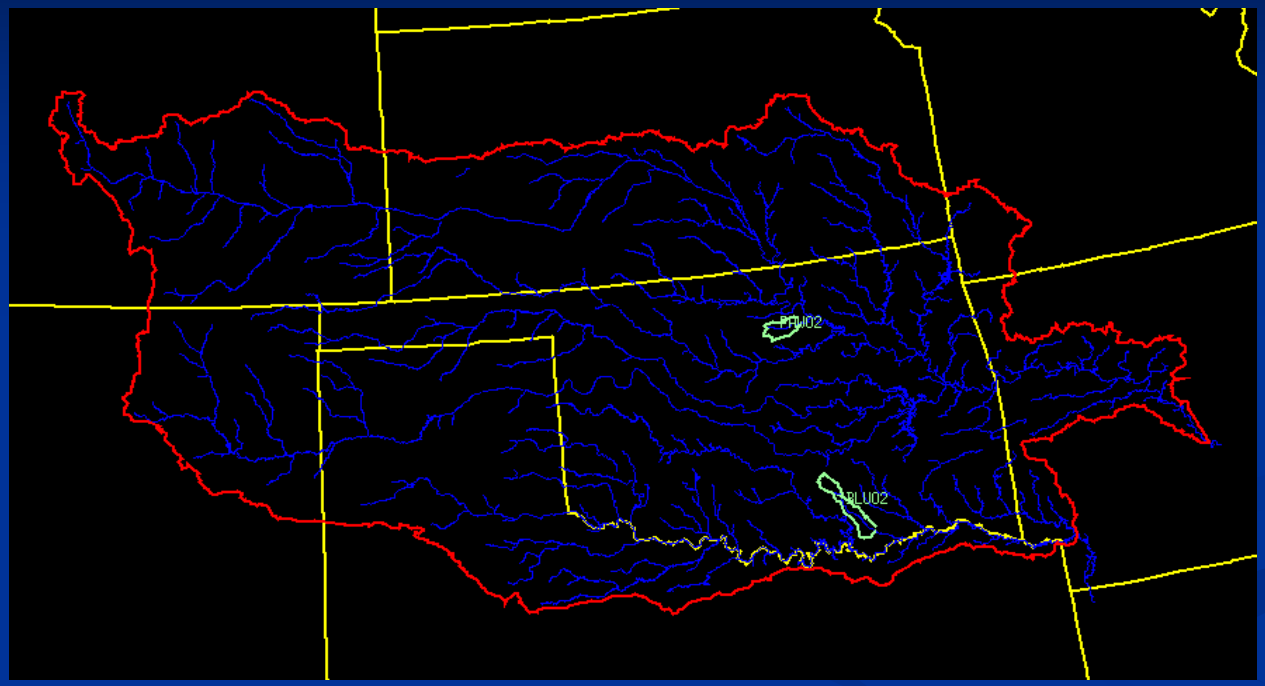






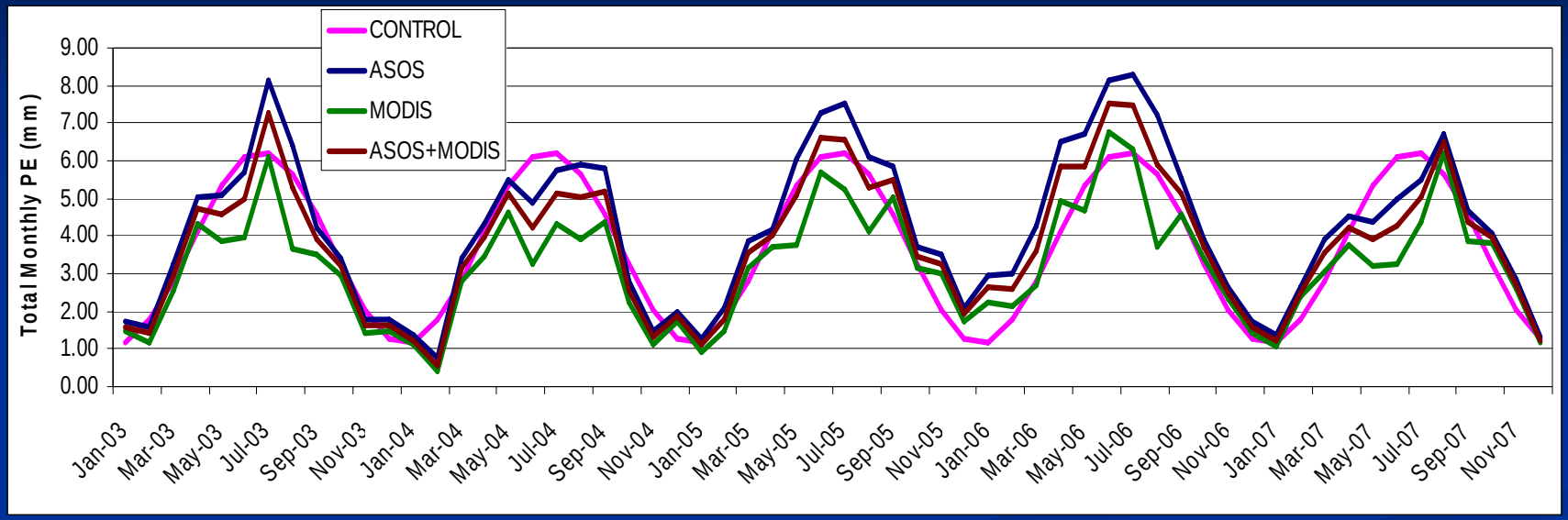


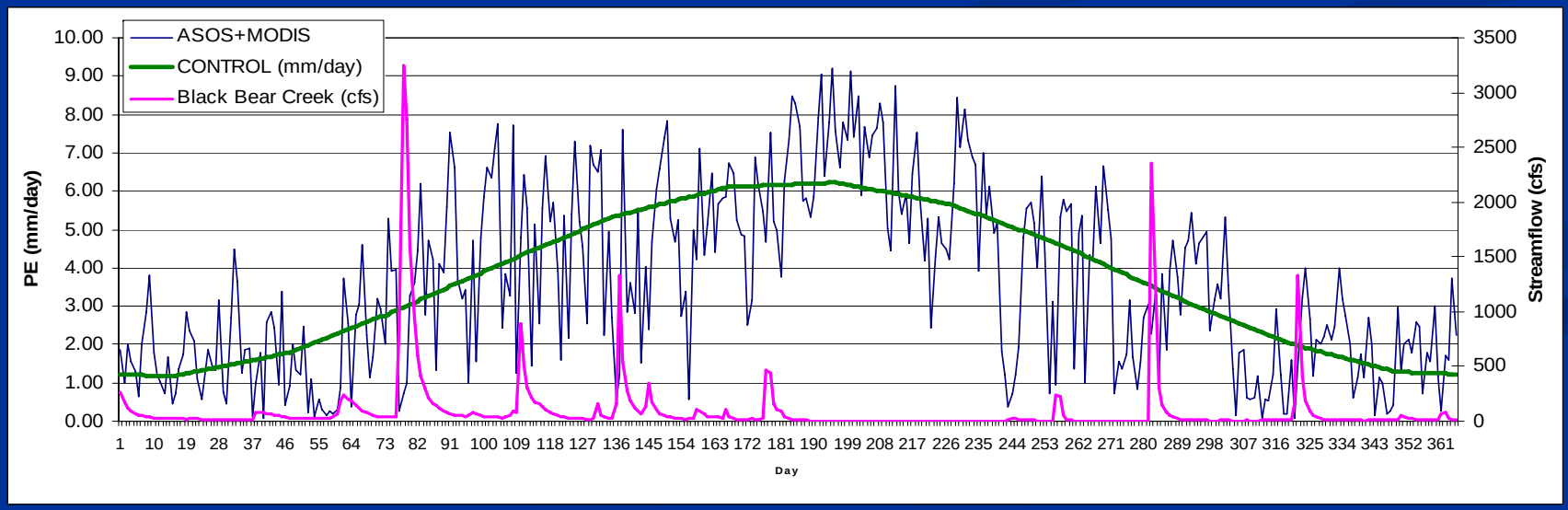
Black Bear Creek



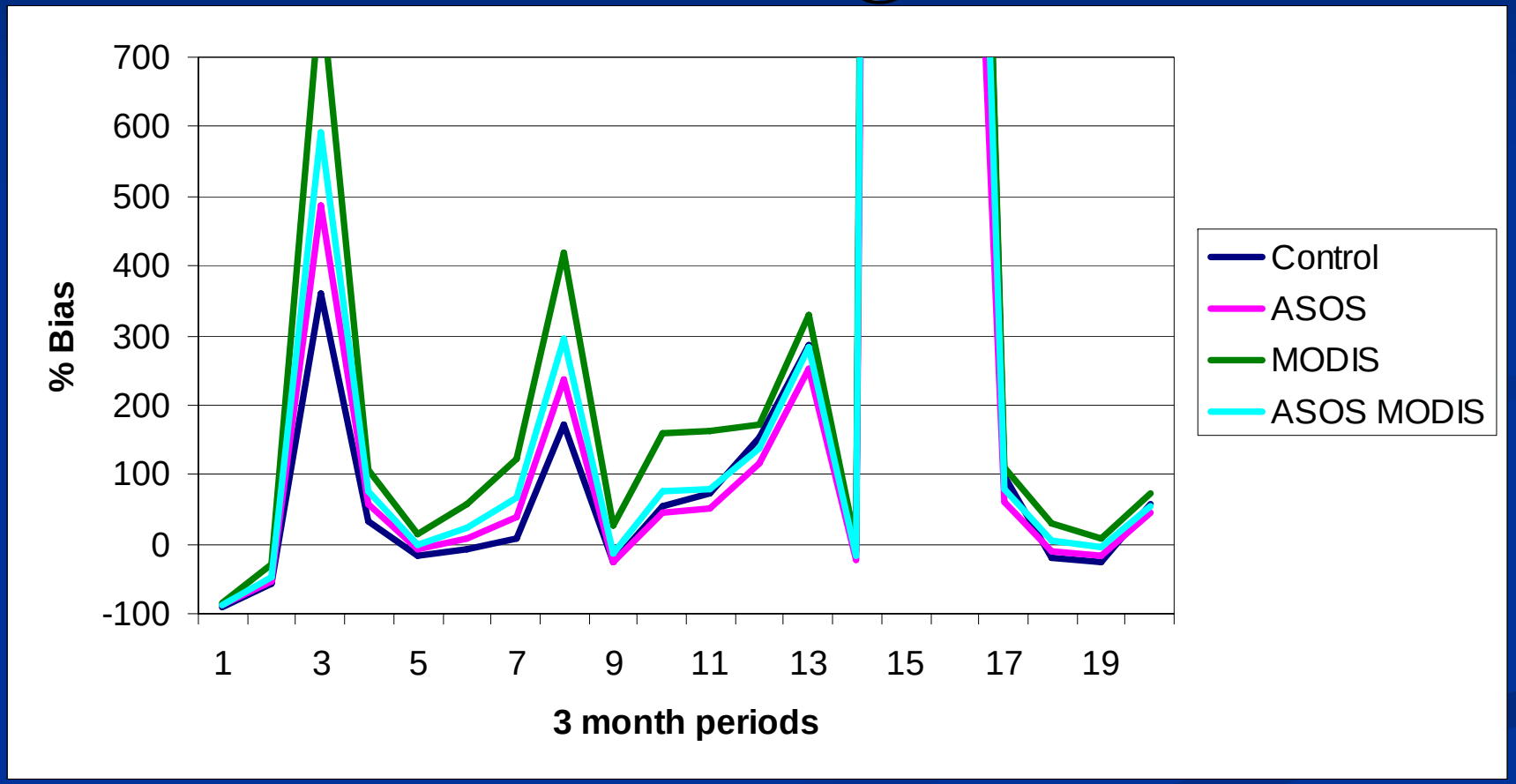
- Provided further validation with second basin
- Blue River complicating factors
  - channel losses
  - largest spring in Oklahoma

Black Bear Creek PE





Black Bear Creek Percent Bias with A Priori SAC Parameters and No Scaling



Conclusions

- Calculated daily PE from MODIS is always less that ASOS on a monthly scale
- In general daily PE time series produce more runoff that climate monthly average
- Simulations from daily PE time series are reasonable but not better than simulations from climate averages.
- Analysis from NASA Marshal have reported seasonal improvements in Winter and Spring

Ongoing Work

- Calibration of SAC model parameters using the daily PE time series.
- Gridded MODIS PE time series for use with Distributed Model.