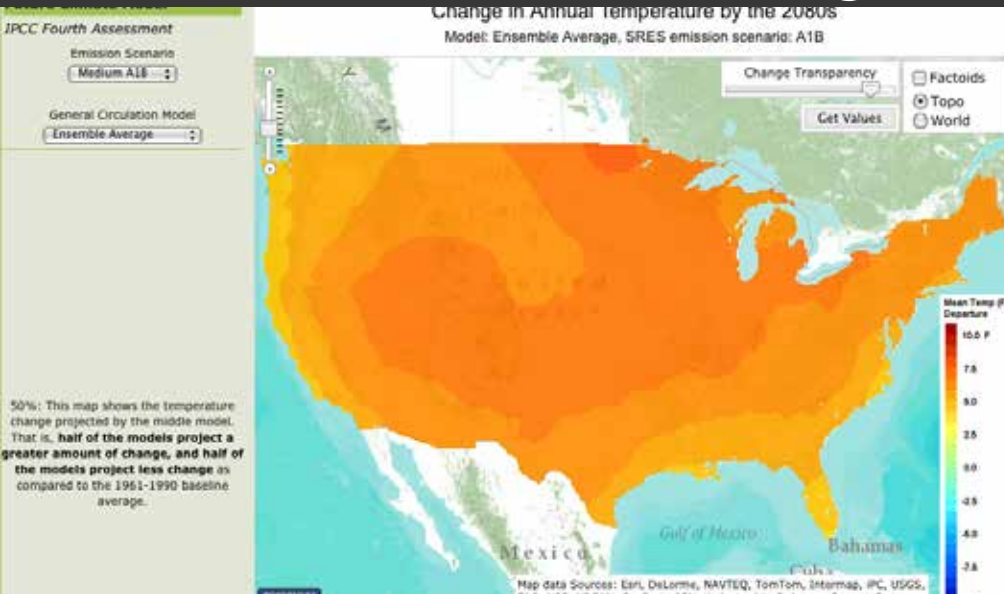




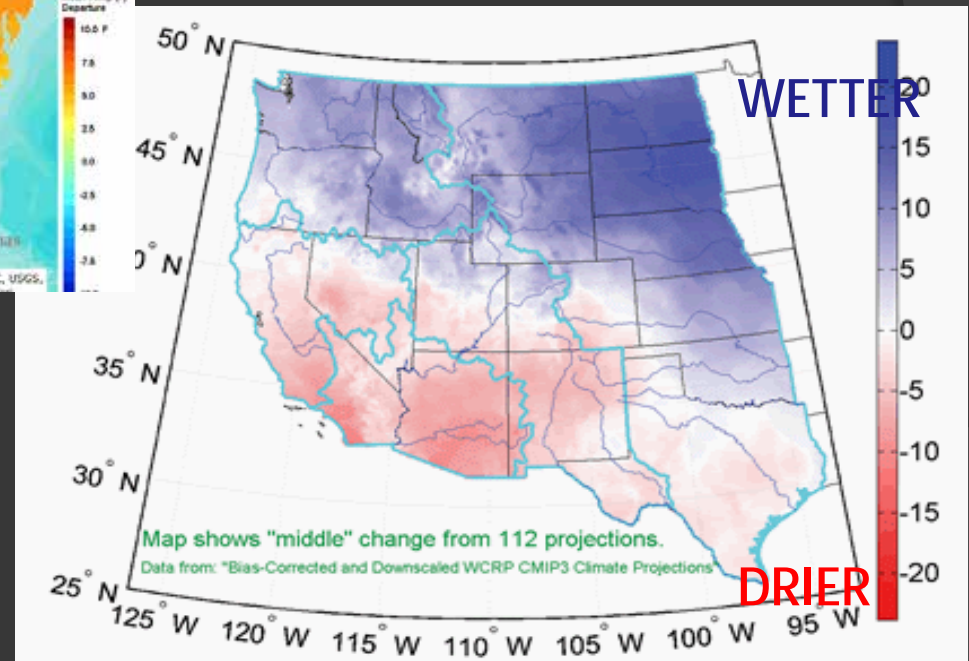
# CLIMATE CHANGE AND SALT LAKE CITY'S WATER SUPPLY

Laura Briefer, SLCDPU  
Tracie Kirkham, SLCDPU  
Jeff Niermeyer, SLCDPU  
Tim Bardsley, WWA  
Andy Wood, CBRFC

# Global Climate Models – Temperature and Precipitation Changes



Projected change in annual precipitation by **2070-2090** over 1950-1979 baseline; *median* of 16 downscaled GCMs x 3 emissions scenarios



Source: Climate Wizard  
[www.climatewizard.org](http://www.climatewizard.org)

Source: Bureau of Reclamation (2011)

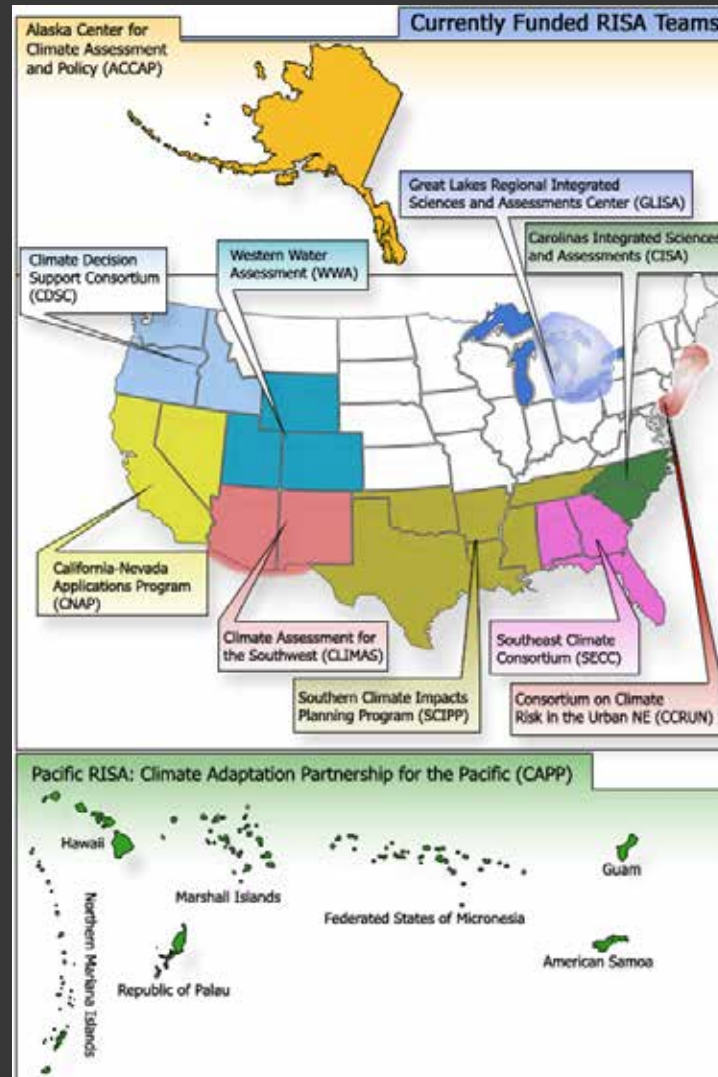
# Navigating Water Supply Planning in a Changing Climate



- ž Warmer temperatures
- ž Precipitation changes
- ž Snowpack changes
- ž Runoff changes (timing, quantity)
- ž Surface water is majority of water source

# Salt Lake City Partners

- Western Water Assessment – one of eleven NOAA Regional Integrated Sciences and Assessment Programs
- Help water suppliers work to plan for climate variability and change
- WWA helps us to connect with other partners

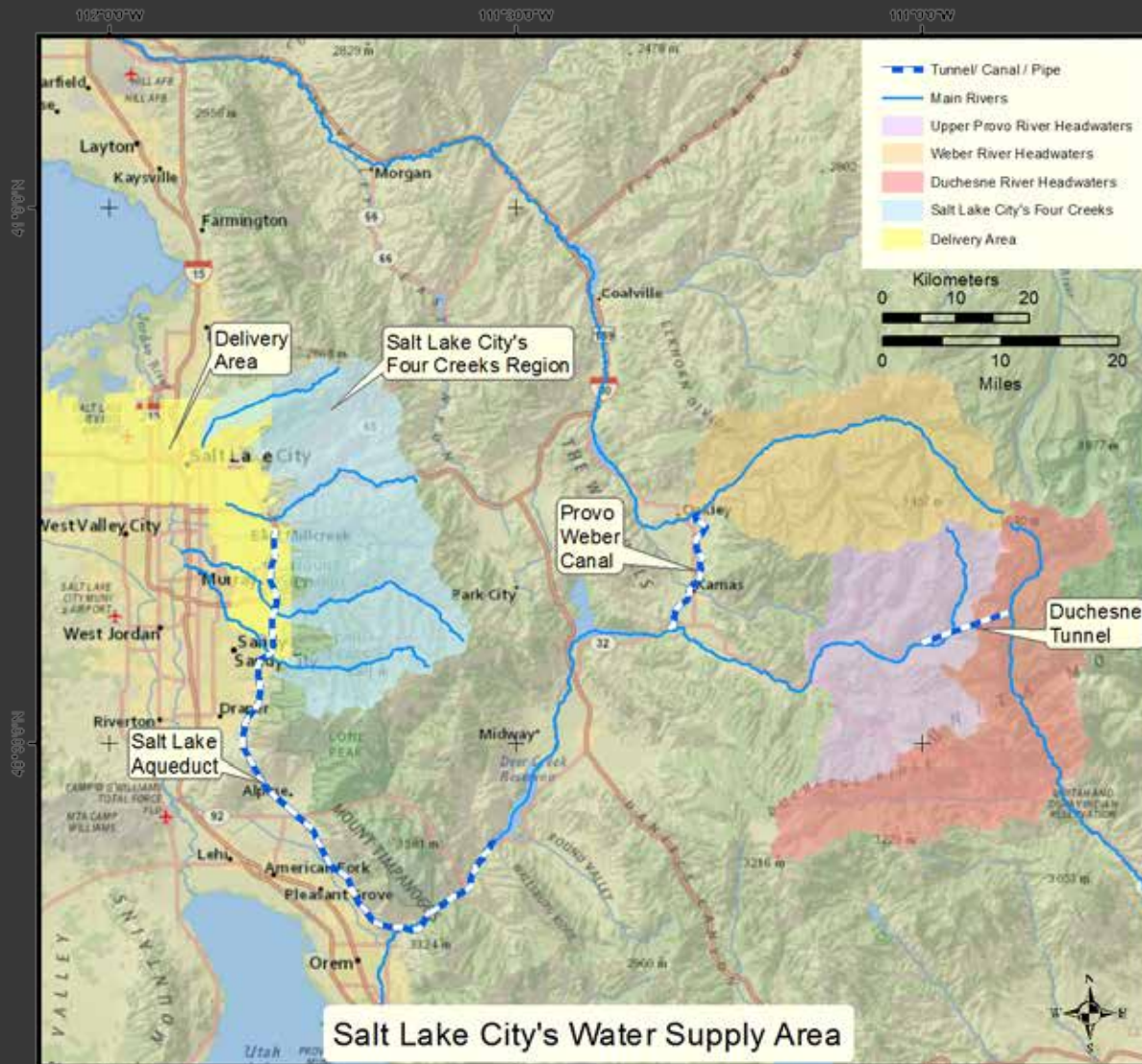


# Study Objectives

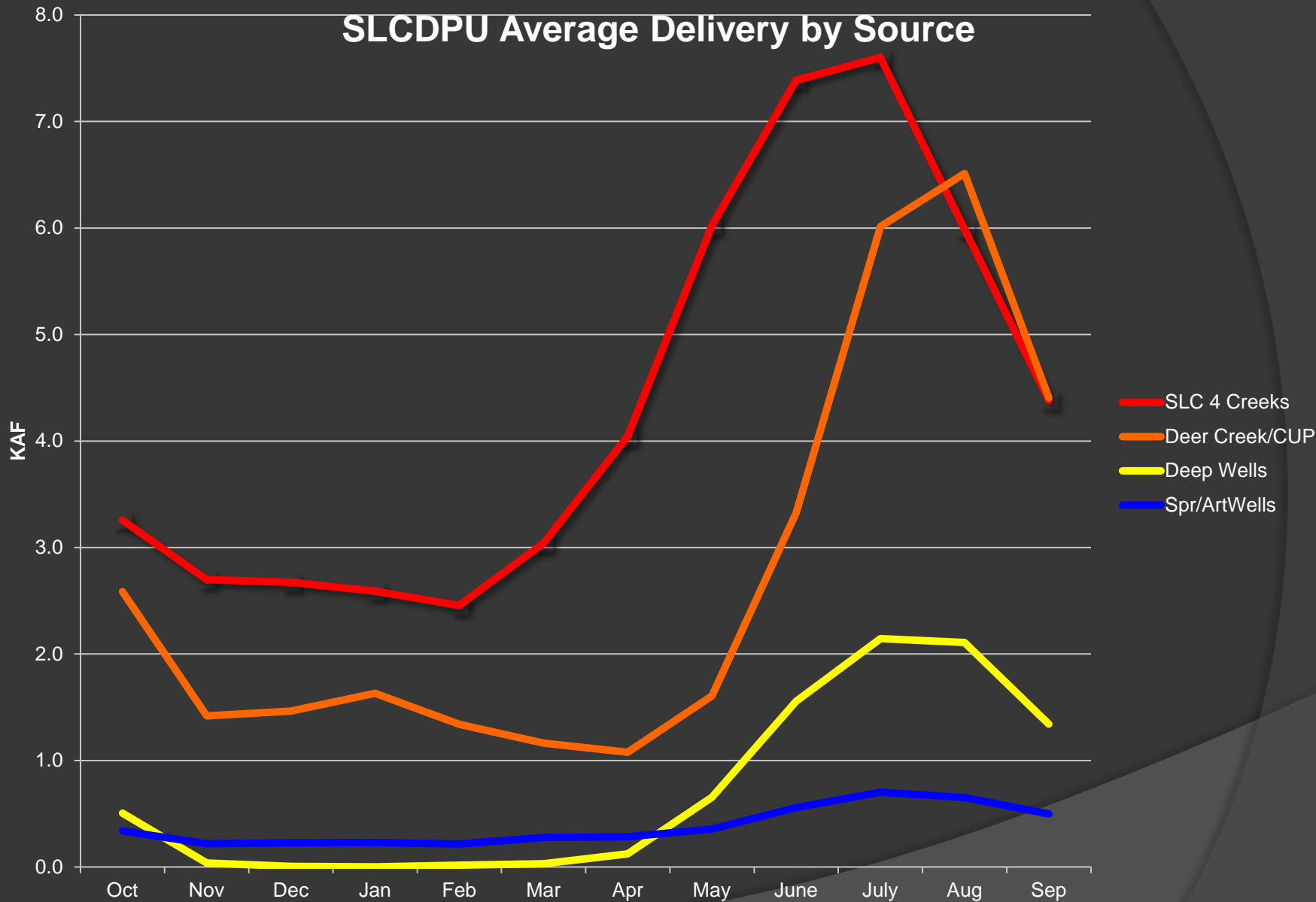
- ž Better understanding of what our water vulnerabilities will be
- ž Begin regional and utility specific climate sensitivity and vulnerability analyses
- ž Partner with research community looking at water - Western Water Assessment, Colorado Basin River Forecast Center, U of U, Umass



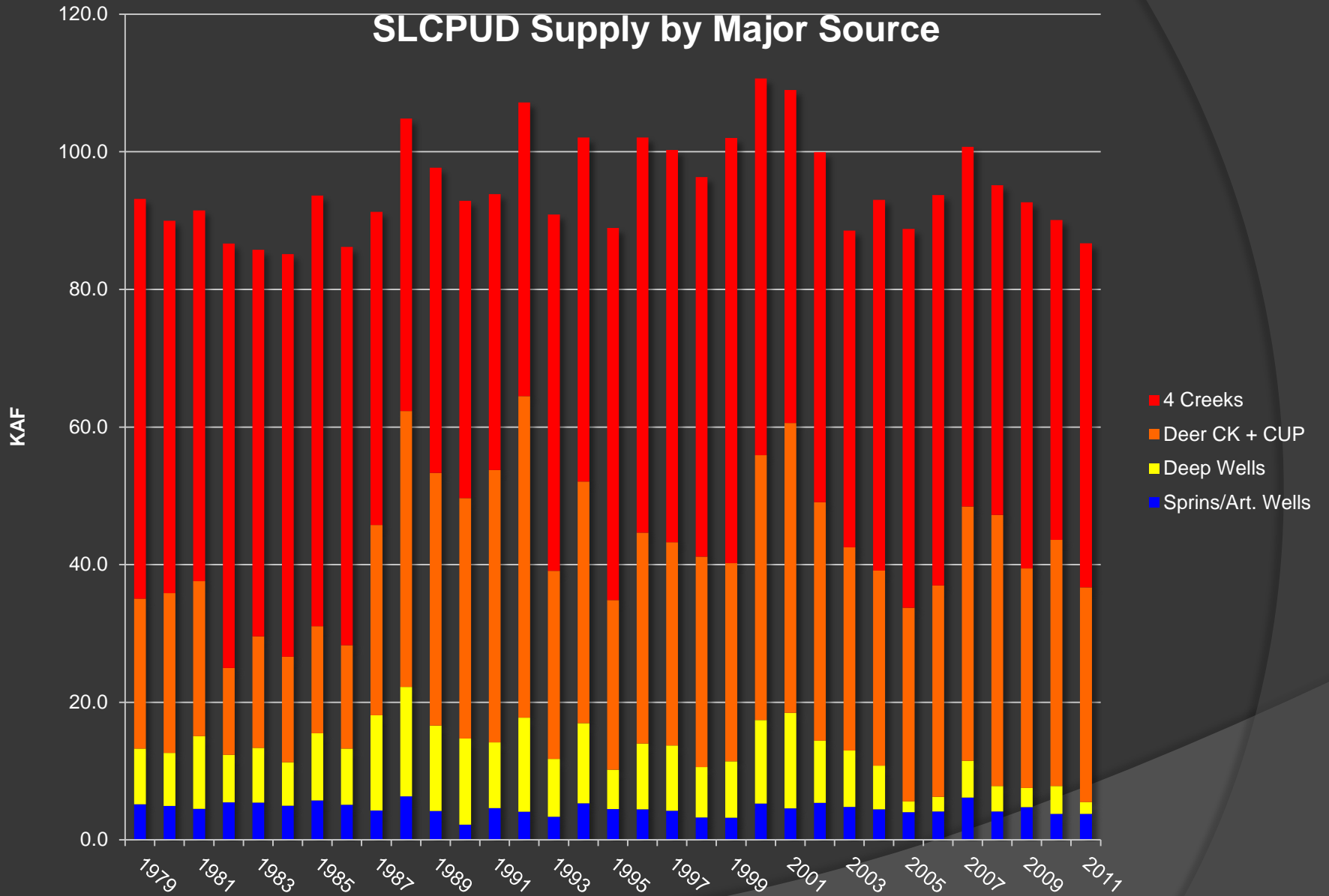
# Six Creeks Water Resources



# SLCDPU Average Delivery by Source

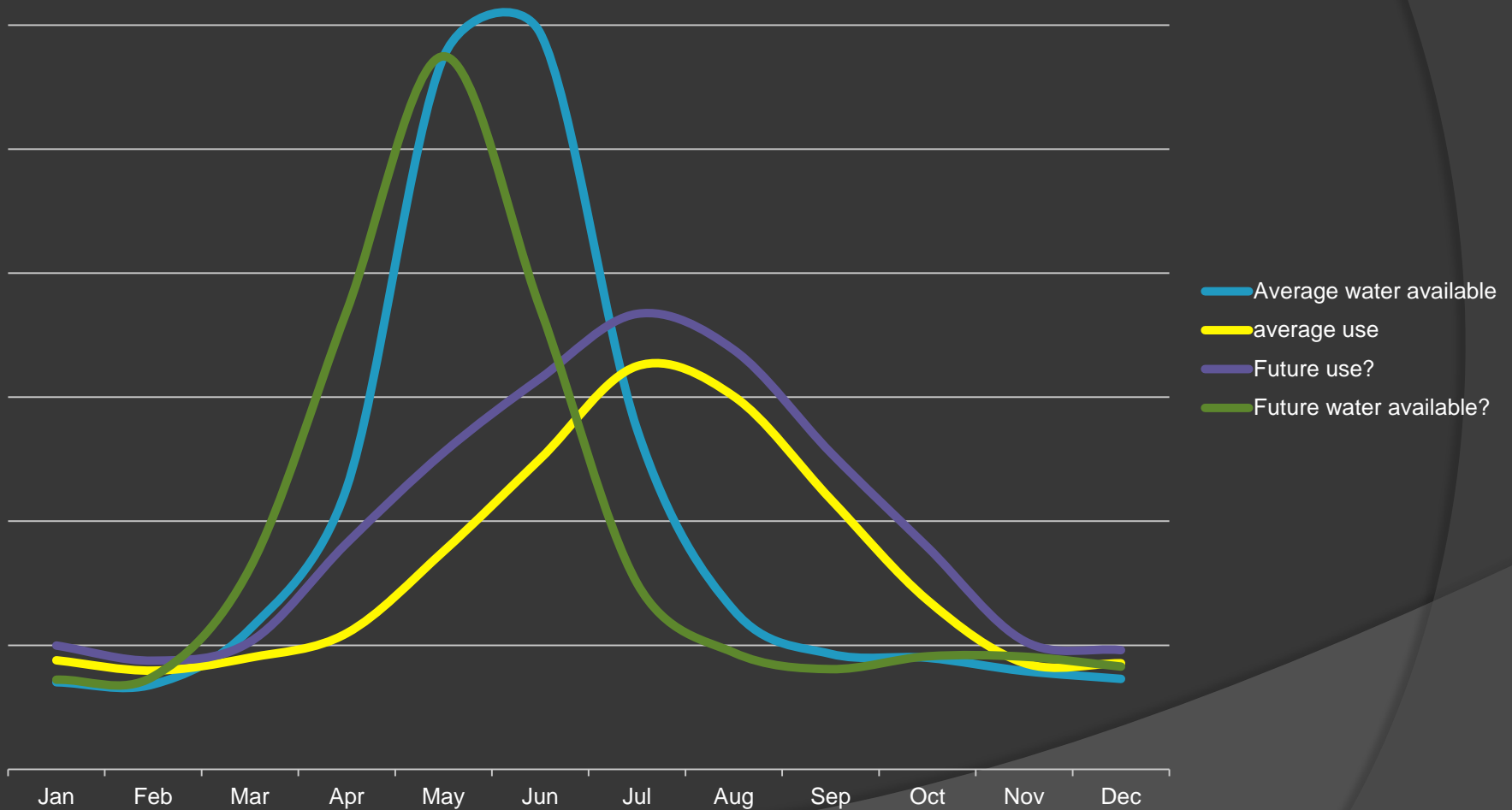


# SLCPUD Supply by Major Source





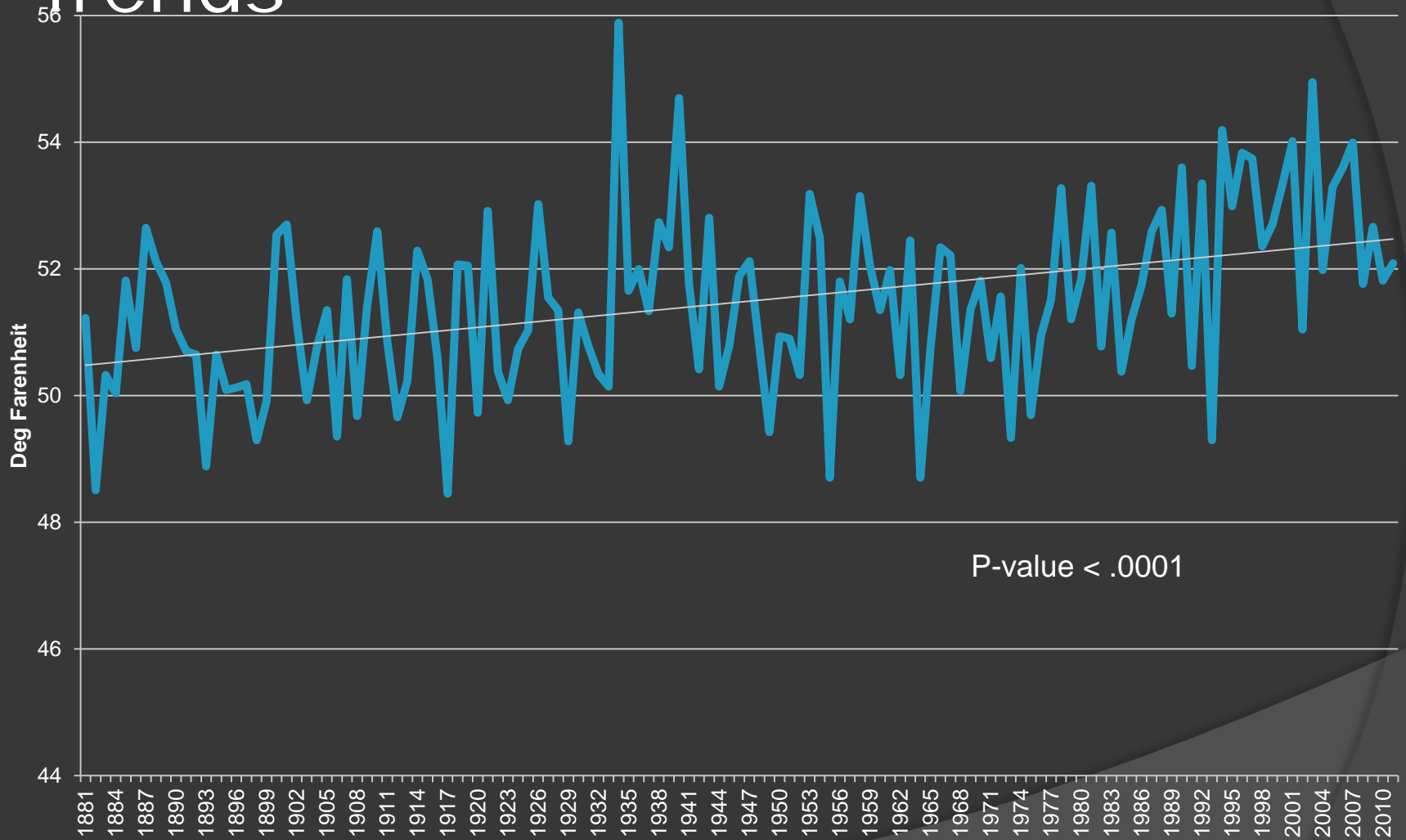
# Supply and Demand



# Scope of Analysis

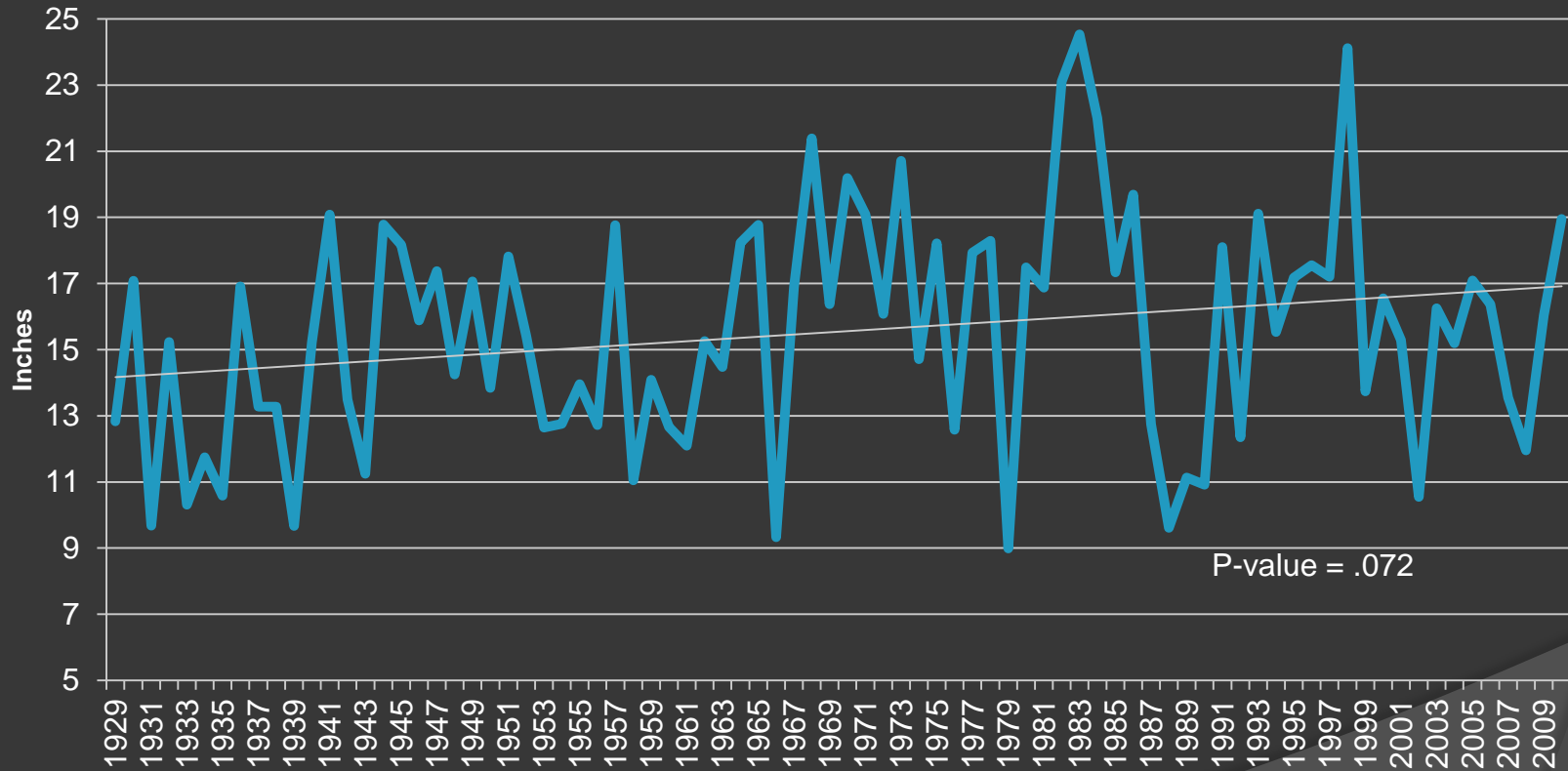
- ž Climate models and observed trends
- ž Watersheds runoff sensitivity to temperature and precipitation changes (Hydro Model)
- ž Scenario development
- ž Planning model development (U of U UMass)
- ž Past and future water demand??
- ž Iterate

# Observed Local Temperature Trends

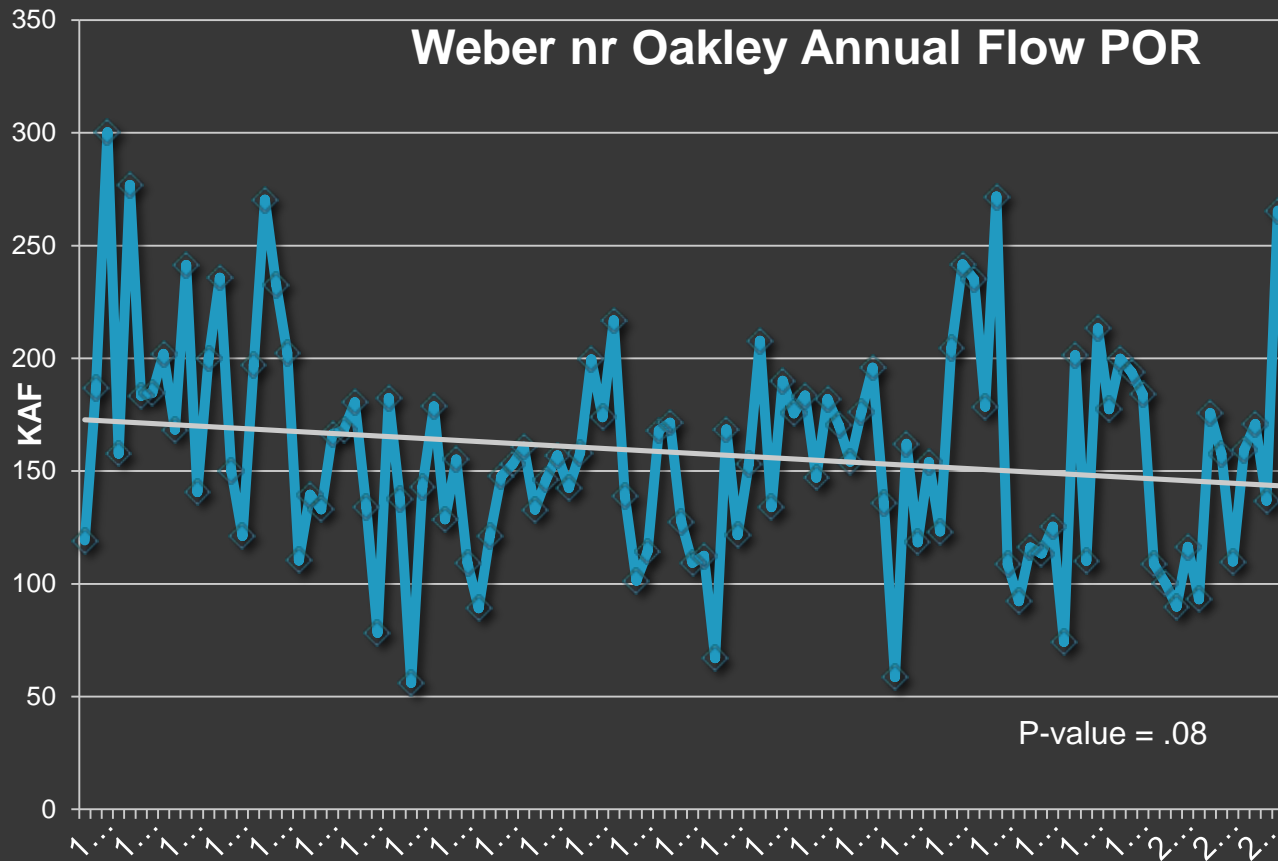


# Observed Local Precipitation Trends

## SLC Annual Precipitation



# Observed Trends in Water Flow



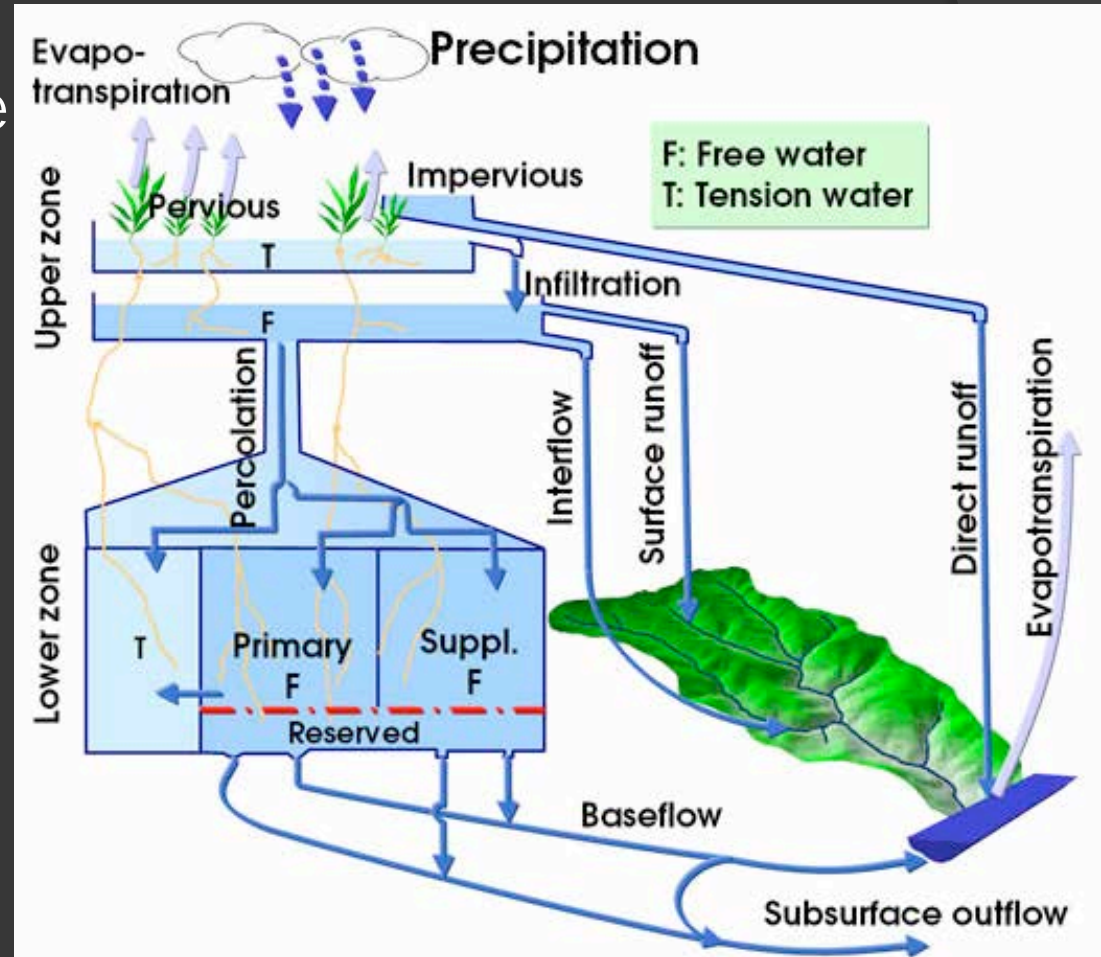


# Runoff Sensitivity/ CBRFC Watershed Models

RFCs use a snow model and a rainfall-runoff model:

Snow Model: SNOW-17  
Temperature Index Snow model

- SNOW-17: Temperature index model for simulating snowpack accumulation and melt
- Sacramento Soil Moisture Accounting Model: Conceptual hydrologic model used to generate runoff



# Big Cottonwood Creek

## Calibration Example:

For monthly flows:

Average Observed 72.3cfs

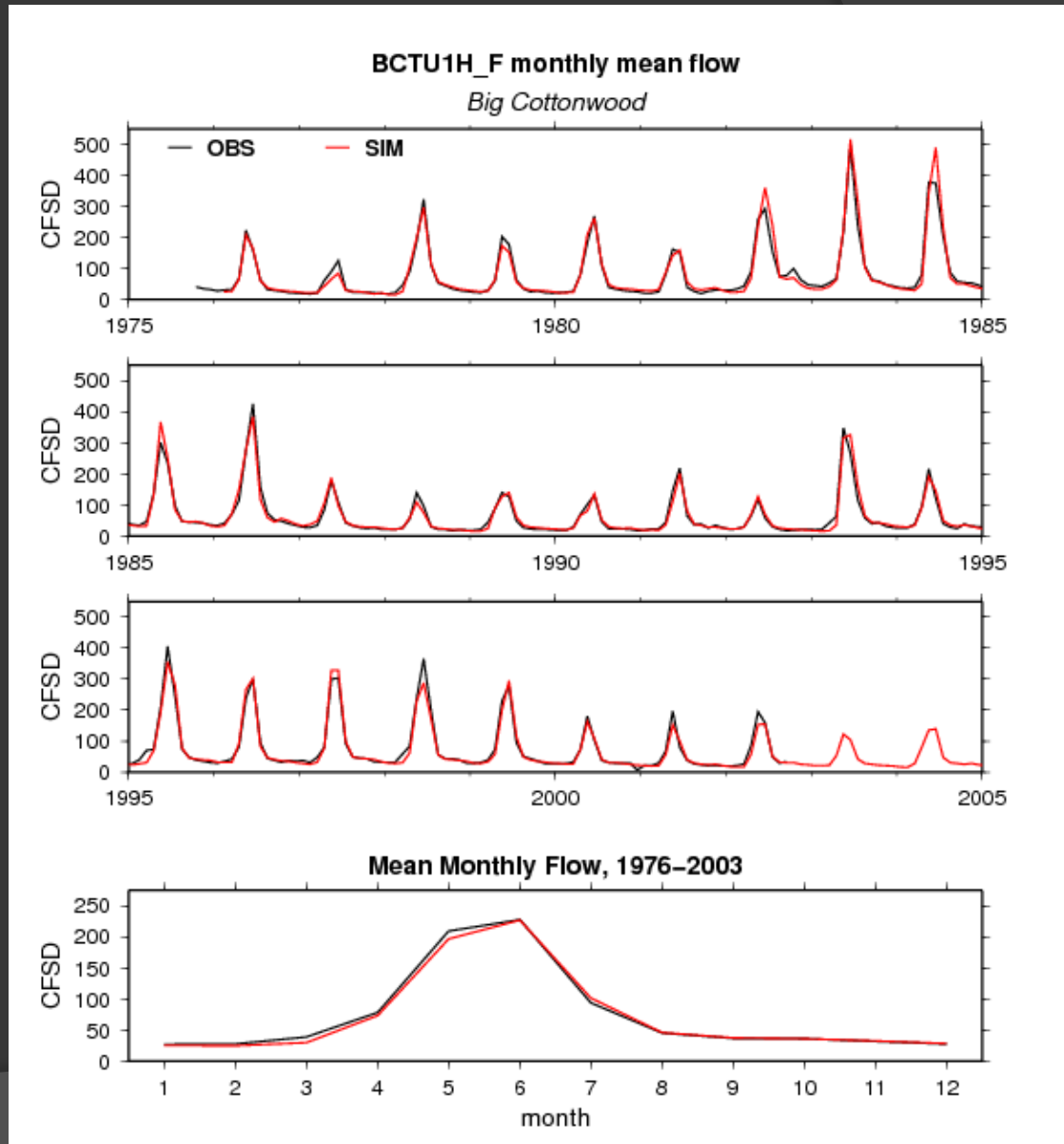
Average Simulated 70.0cfs

RMSE = 19.96

RMSE/Obs mean = .28

$R^2 = 0.97$

Other watersheds are similar

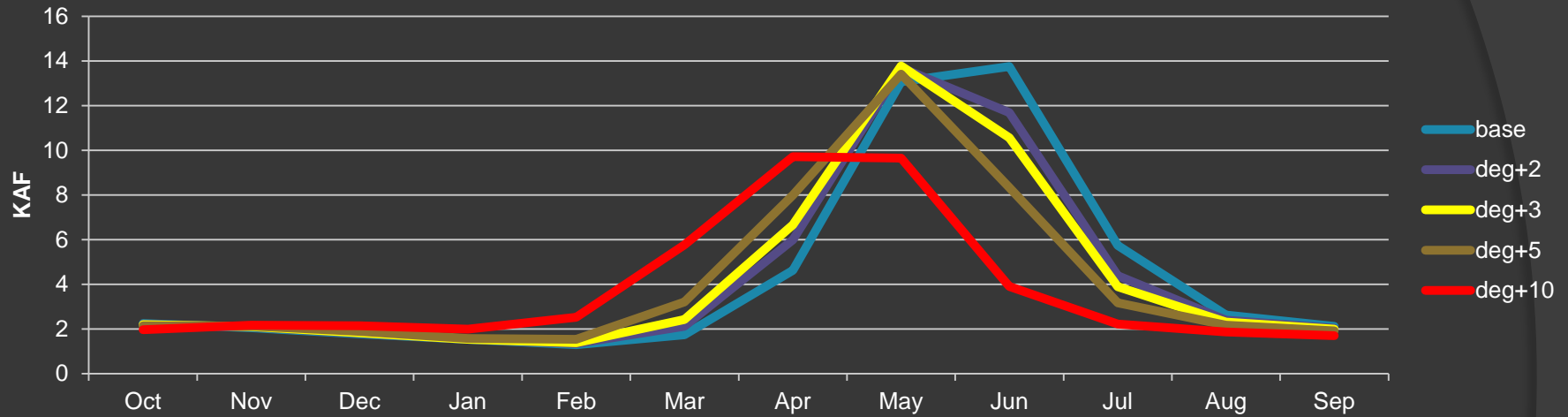


# Temperature and Precipitation Sensitivity

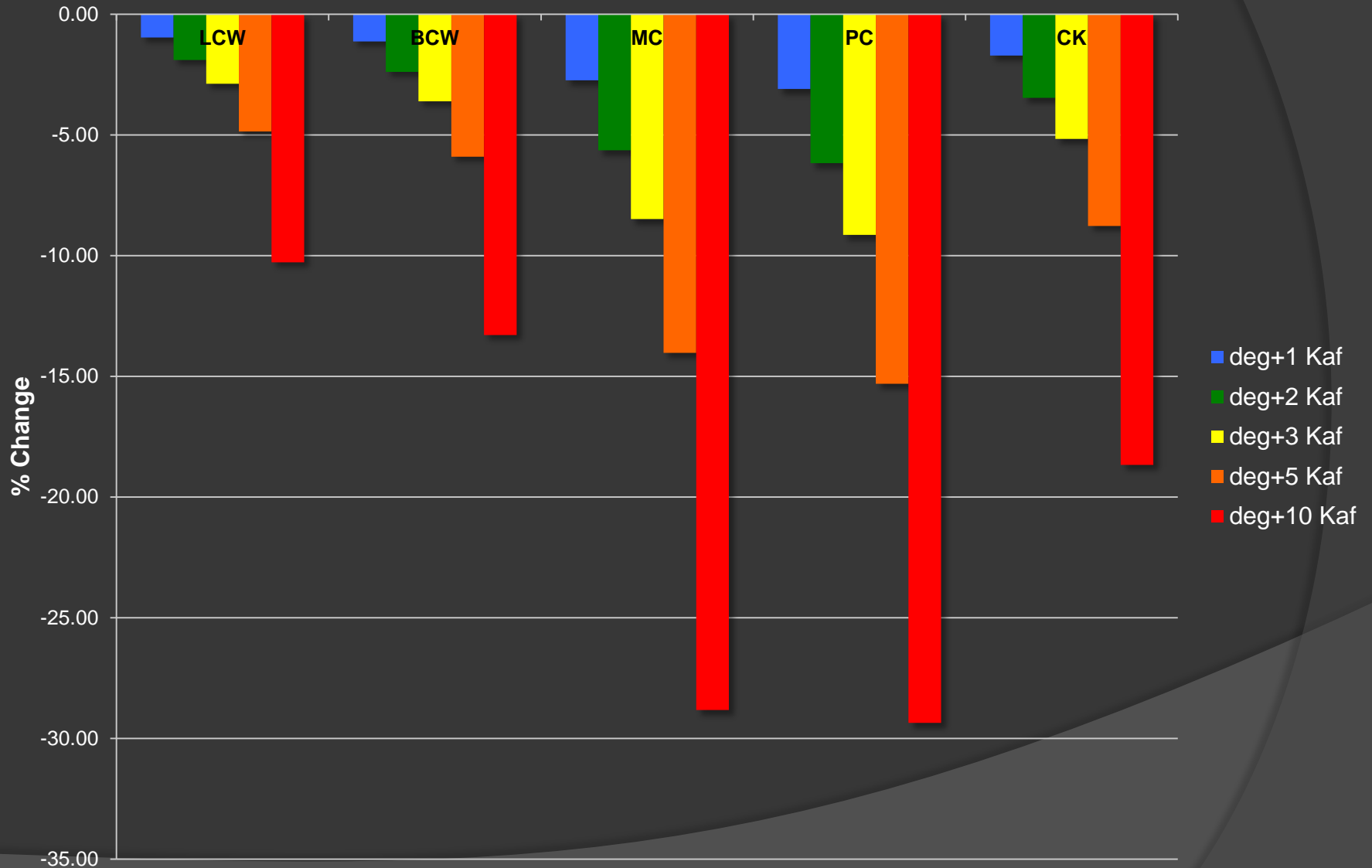
- ž CBRFC Hydrology model forced with numerous Temp and Precip. changes
- ž Changes uniformly distributed over season
- ž Calibration Period WY 1981-2010
- ž Run for All SLC watershed Creeks and Provo, Weber, Duchesne

# Big Cottonwood Creek

## Simulated Average Flow with Temperature Forcings

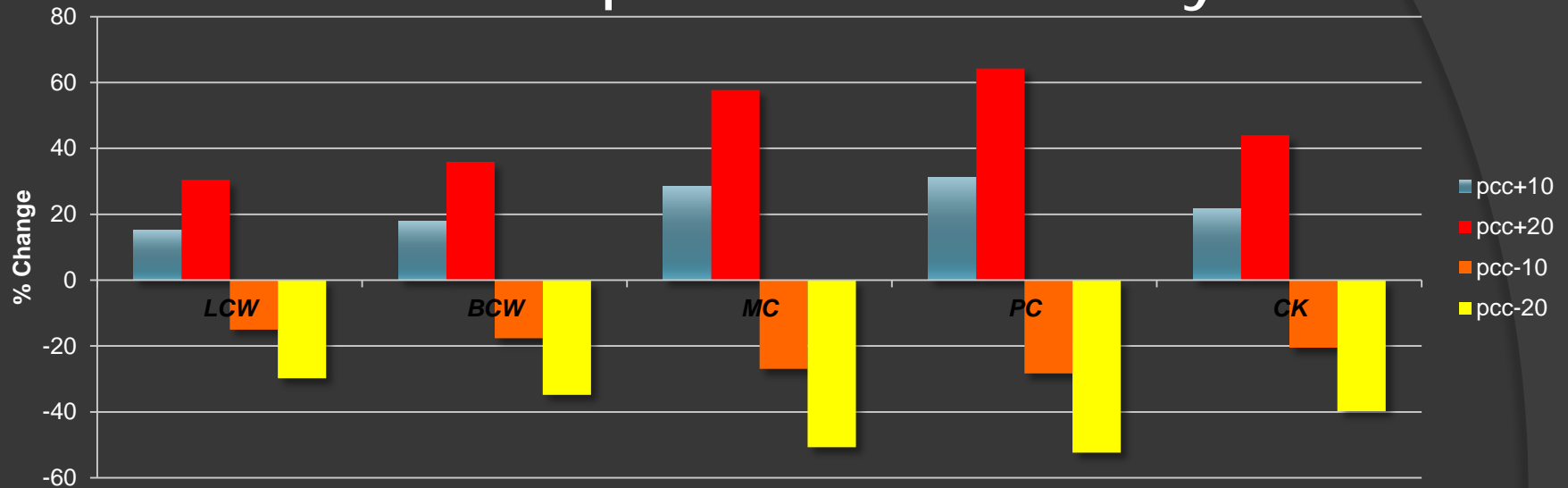


# Five Creeks Temperature Forcings



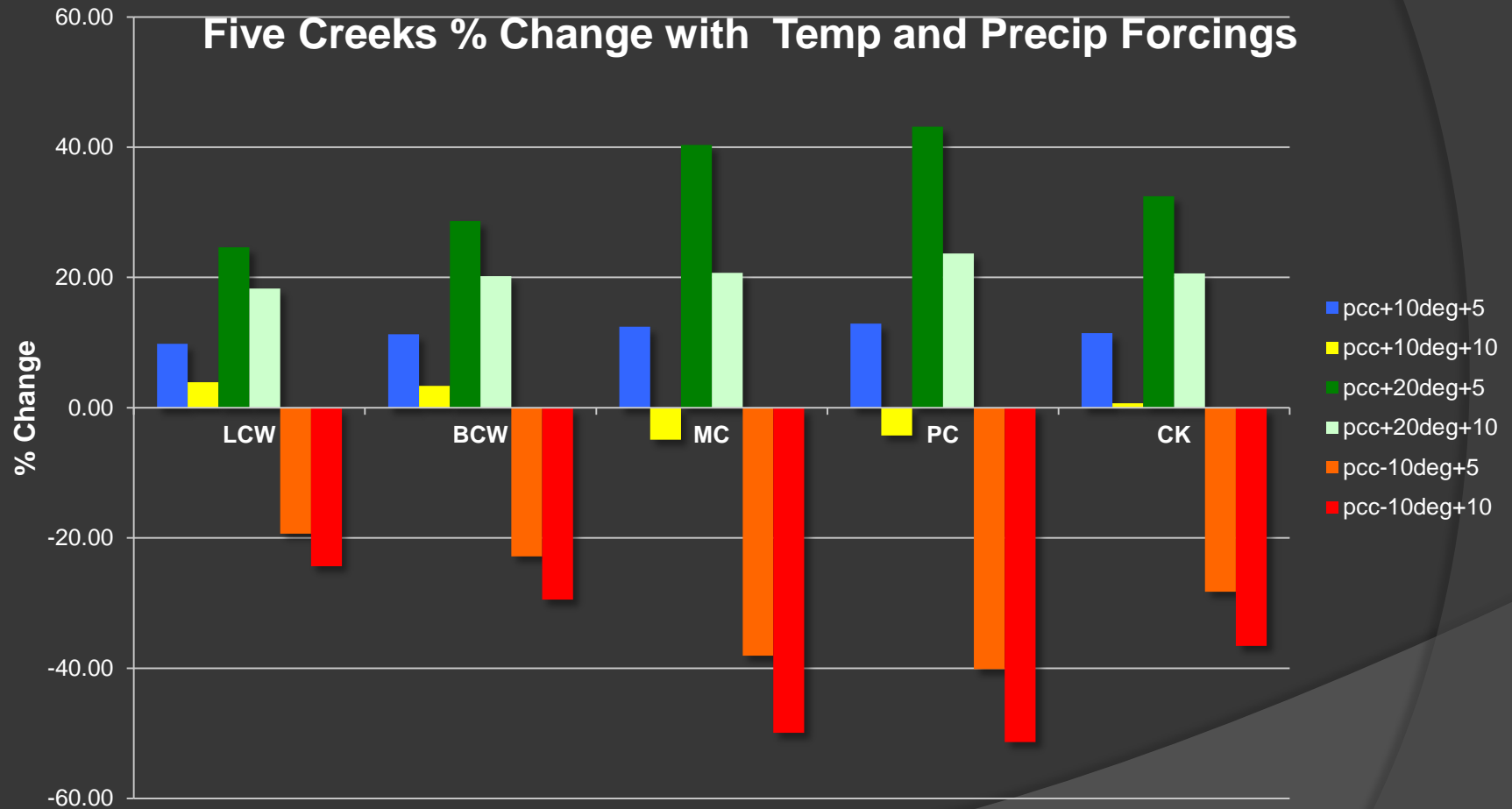


# Five Creeks Precipitation Summary



- Annual average % change
- Higher elevation/runoff efficiency less sensitive

# Combined Temperature and Precipitation Forcings

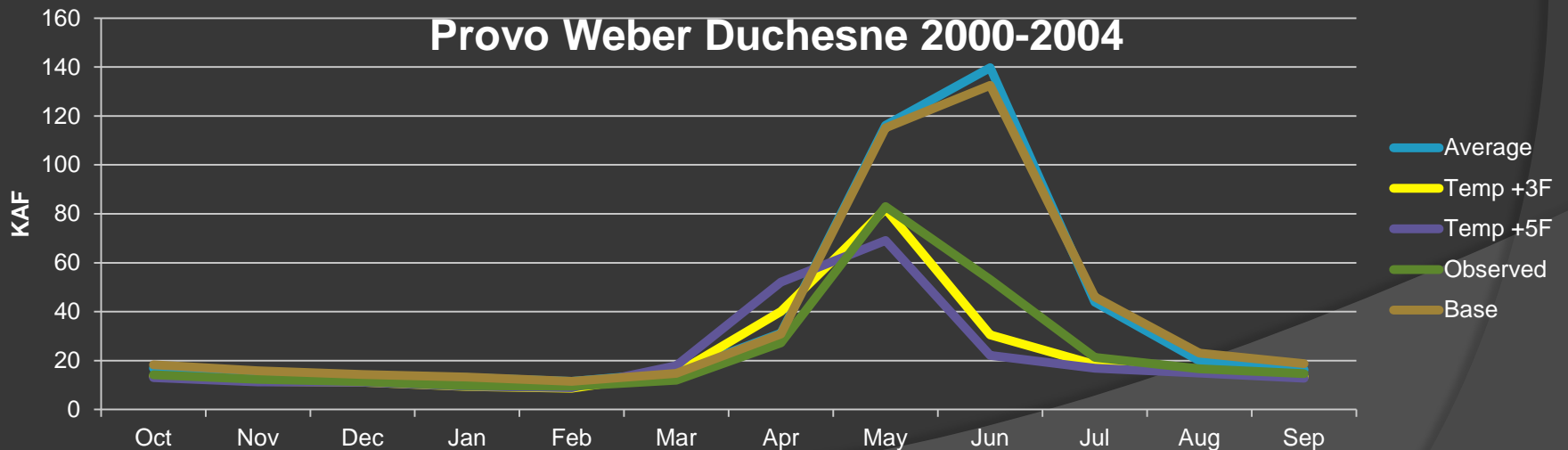
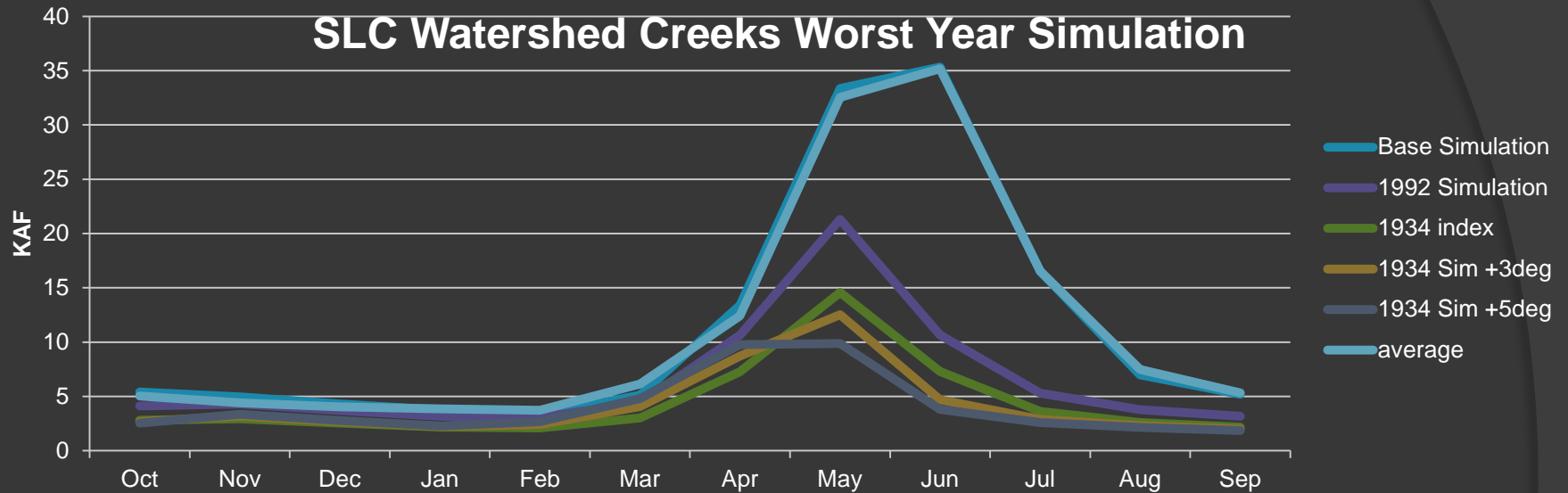


# Sensitivity Scenario Testing

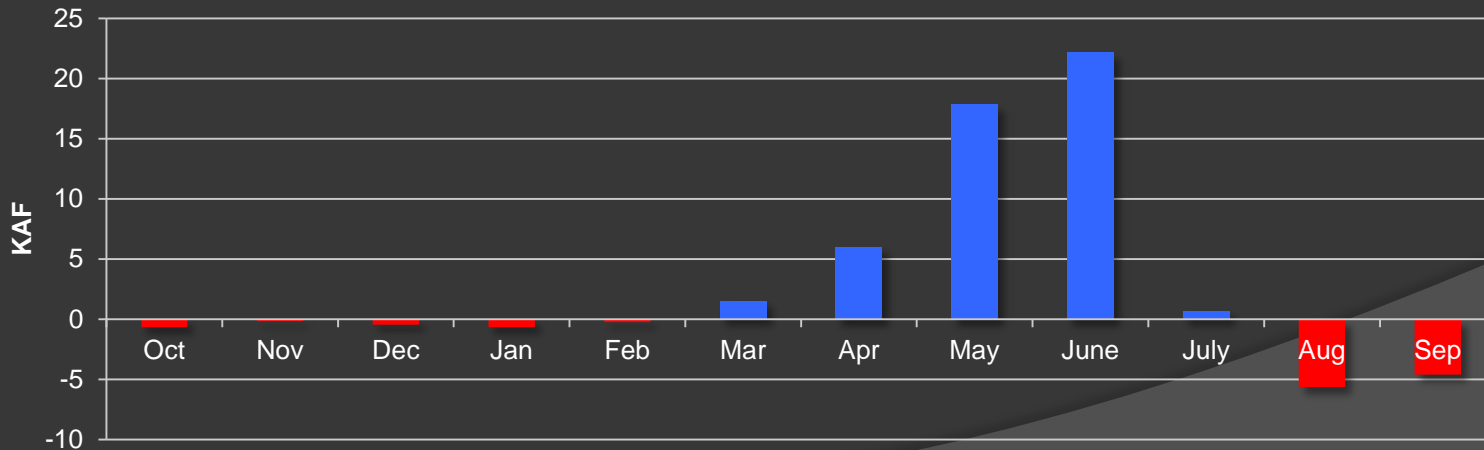
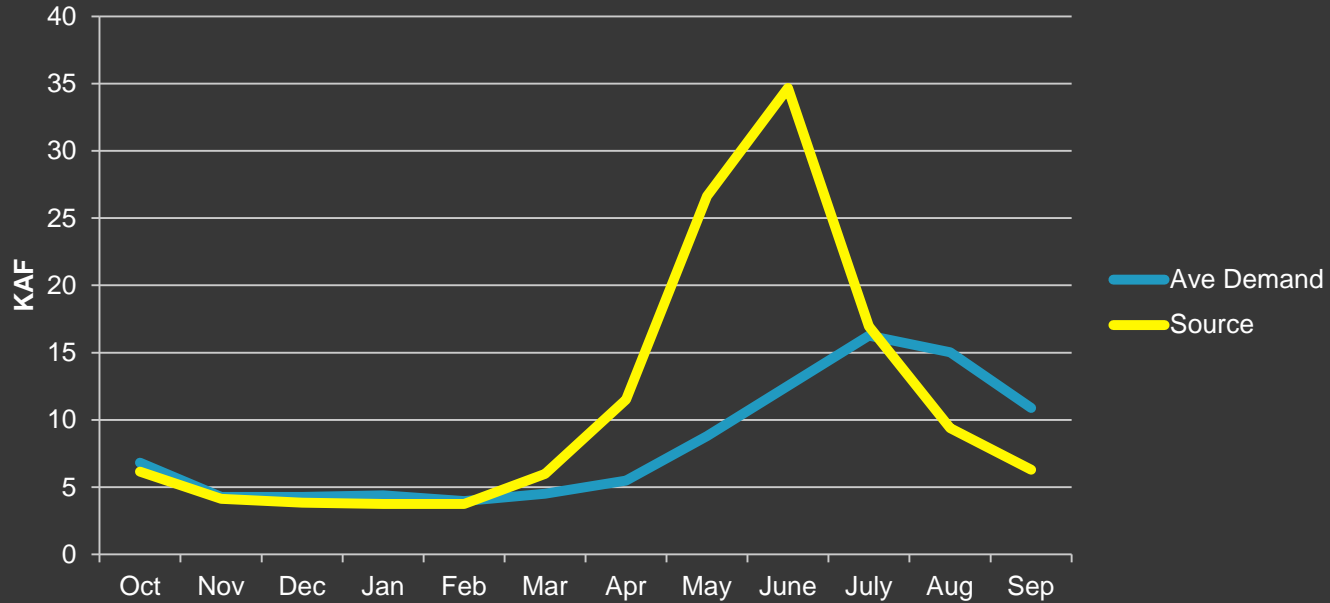
## ž Four Scenarios Selected

- 1934 flows on watershed creeks with 2000-2004 flows on Provo/Weber/Duchesene with increased temperature
- Paleo drought from tree-ring proxy
- Deer Creek/CUP loss
- Early runoff/reduced snowpack from watershed creeks coupled with increased demands

# Worst Year/Years/Paleo Drought Scenario

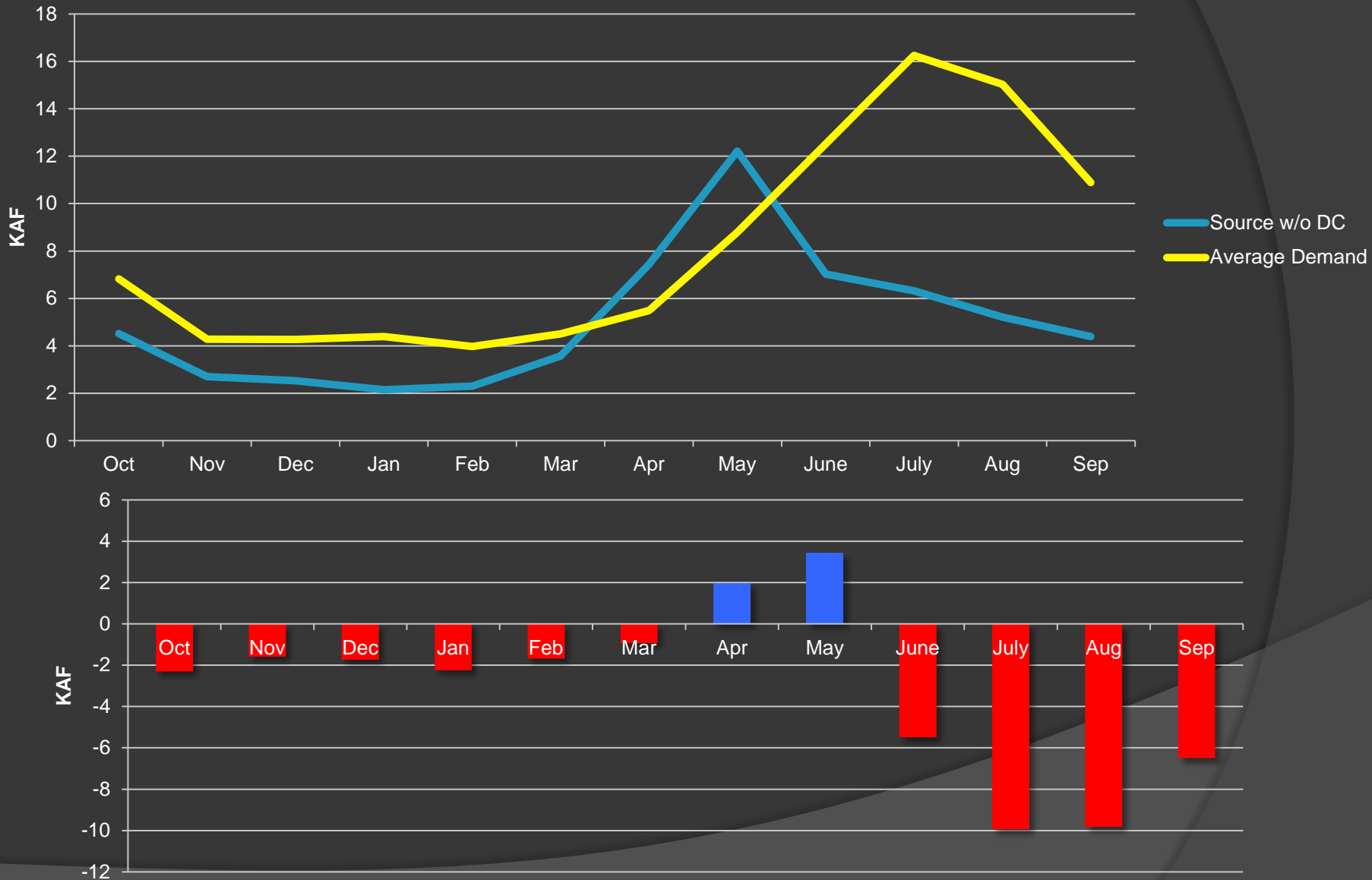


# Deer Creek Loss: Average Year

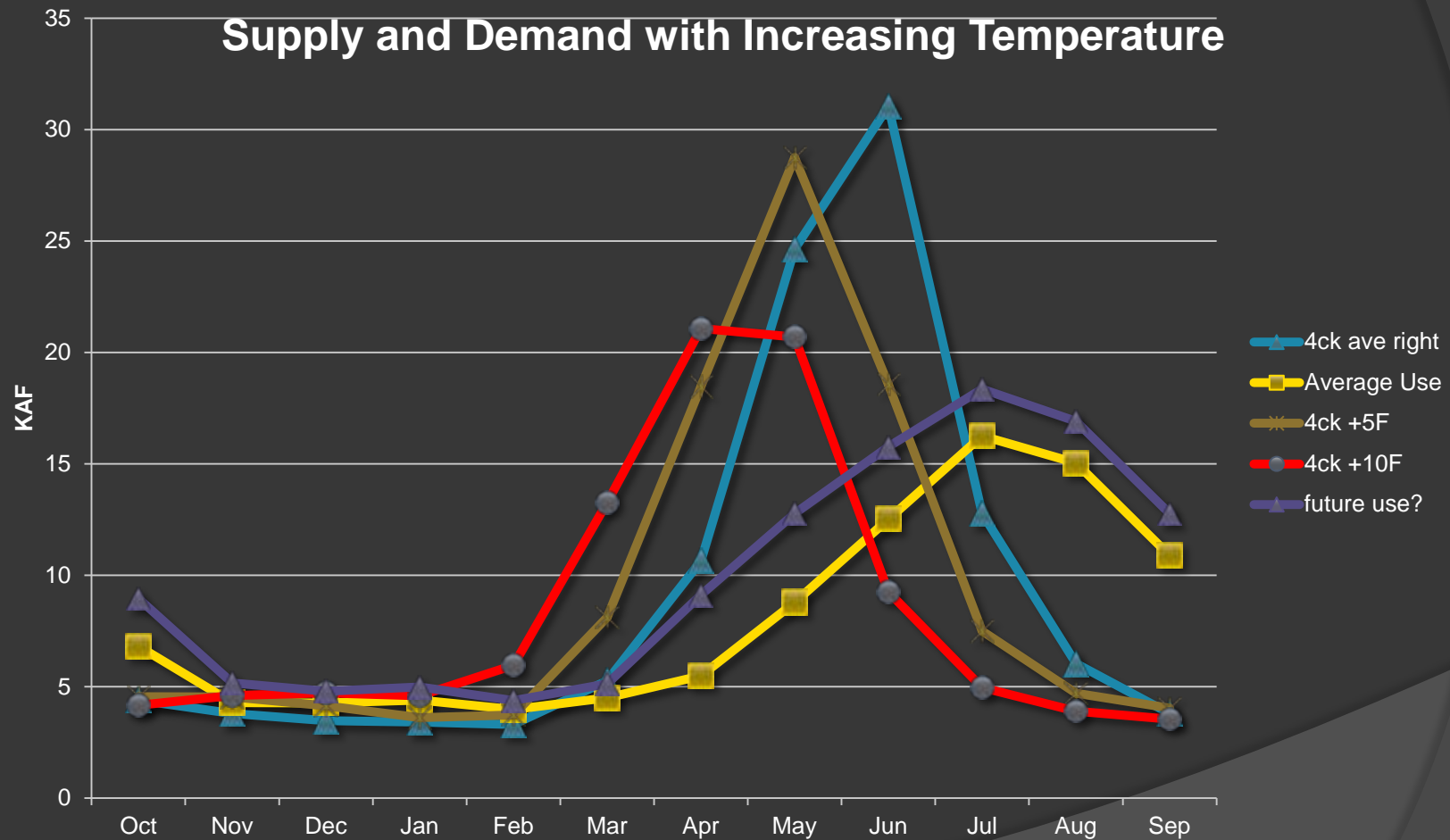




# Deer Creek/CUP Loss: Worst Year



# Early Runoff/ Expanded Demand Scenario



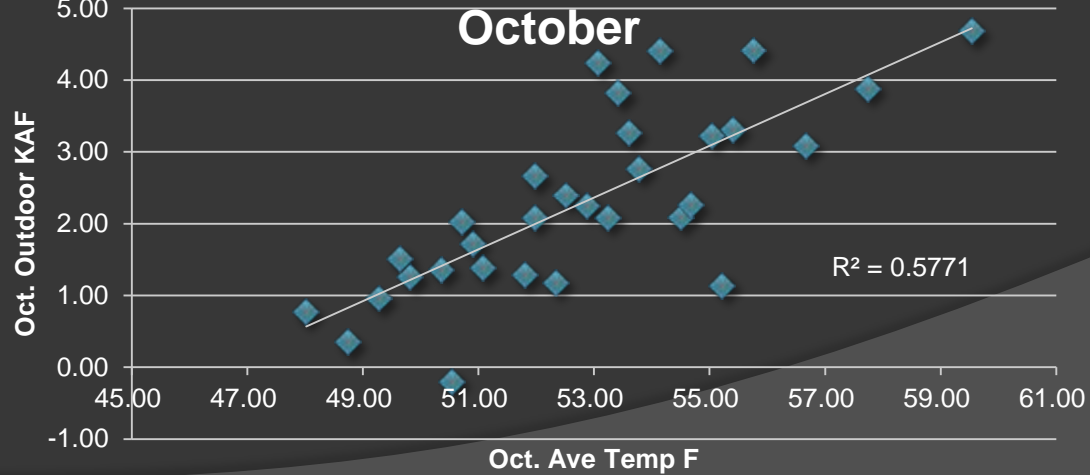
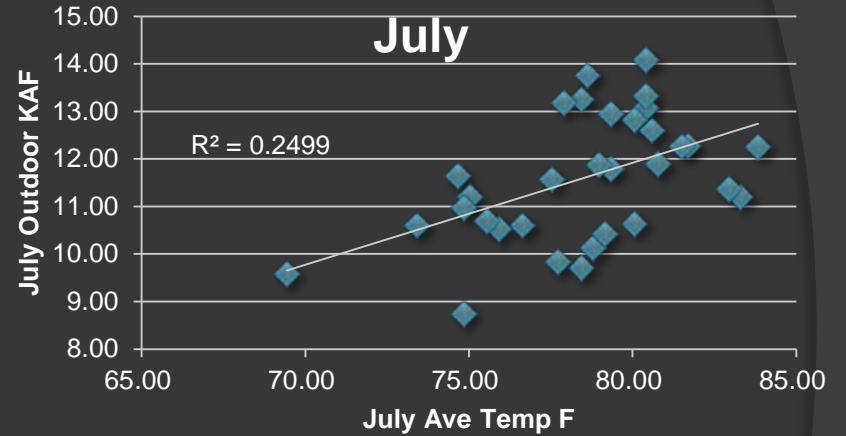
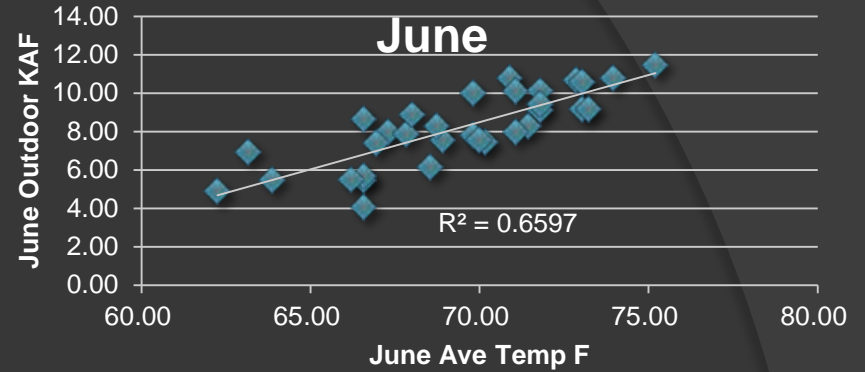
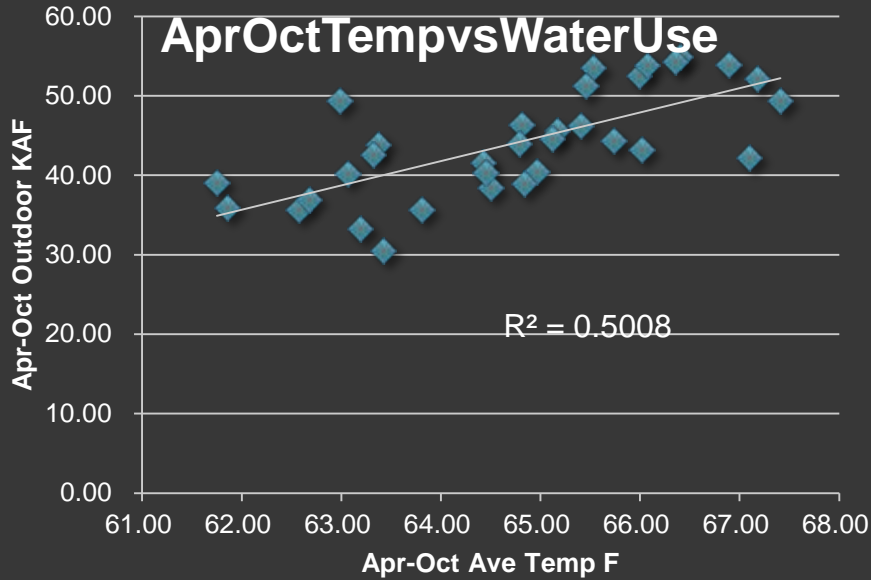
# Sensitivity Study Conclusions (so far)

- ž Salt Lake City's surface water sources show significant sensitivities as temperature gets warmer in terms of volume and runoff timing
- ž Earlier runoff timing could present challenges in meeting late summer demands in dry years
- ž Current normal year operations without Deer Creek, would be difficult, but dry year and warmer climate scenarios would be extremely challenging.

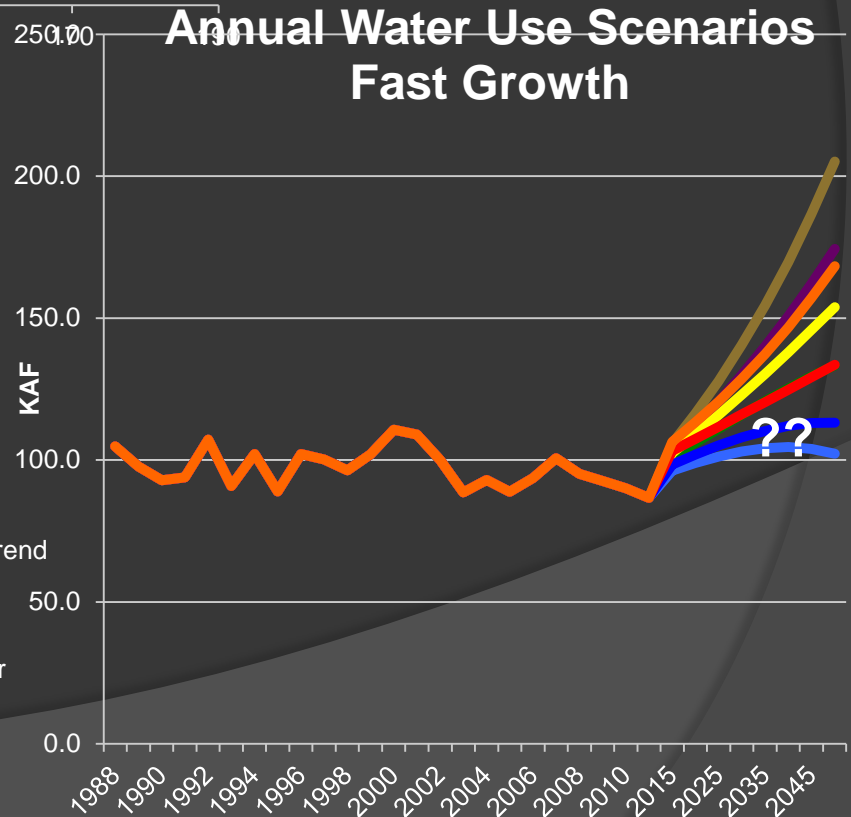
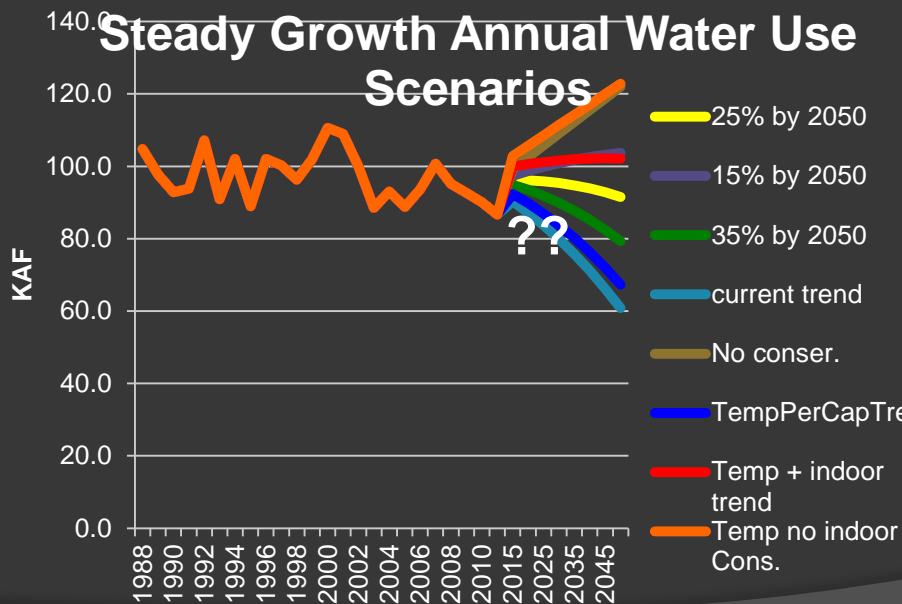
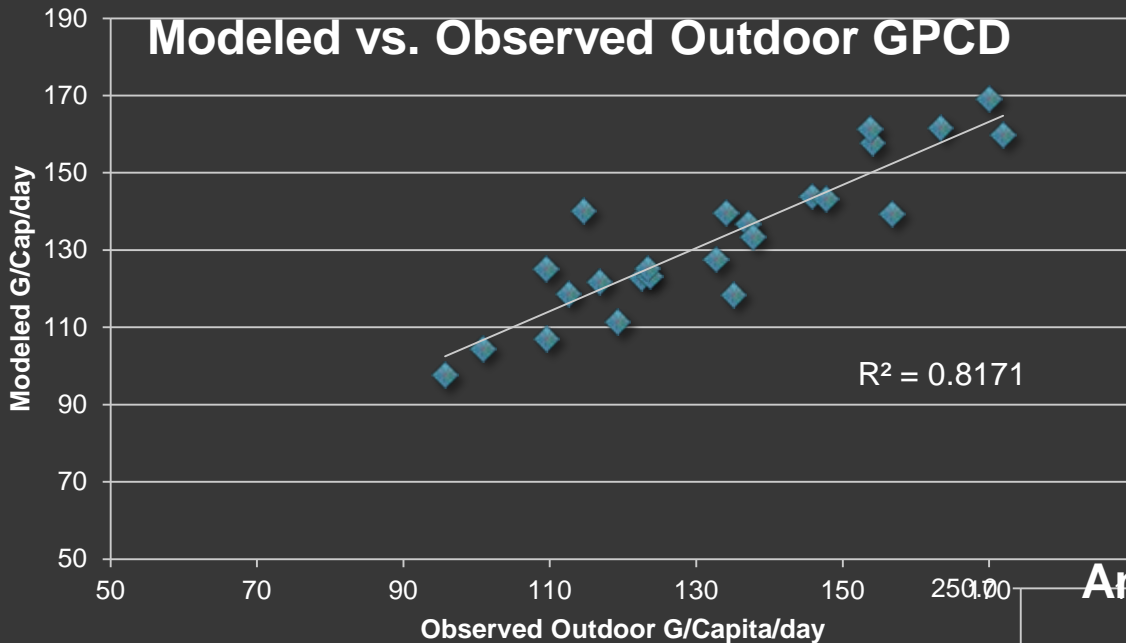
# Future Water Demand

- ž This study is just beginning to review an overlay of potential changes in water demand due to climate change.
- ž Very complex issue with many variables - difficult to assess. Evapotranspiration, Temperature, Precipitation, water conservation, population, behavior, economics, etc... difficult components to evaluate.

# Future Demand?

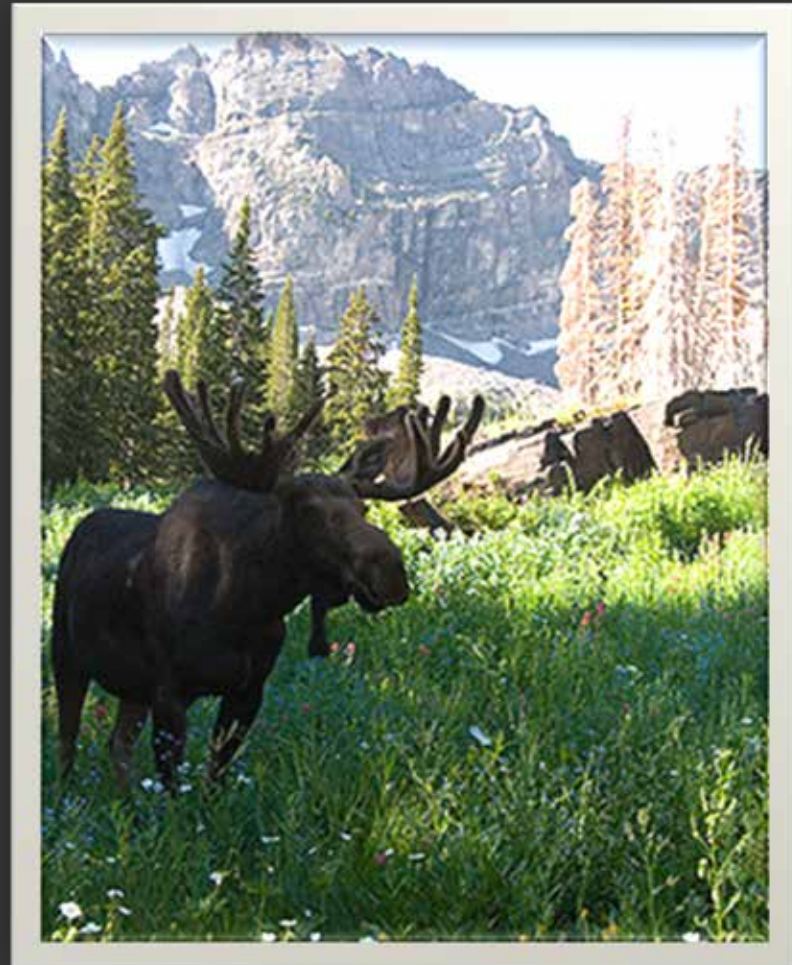






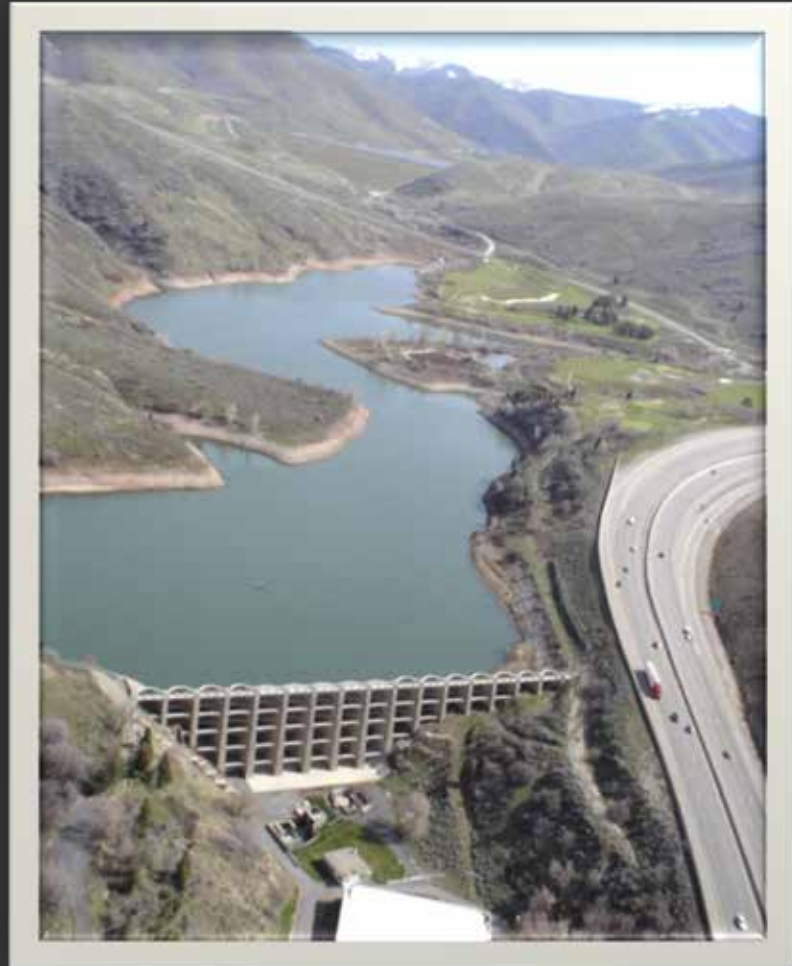
# How Can We Use this Information in Water Resource Planning?

- ž Develop scenarios and refine research
- ž “No regrets” climate adaptation strategies:
  - investment in natural capital
  - water conservation
  - land use planning
  - partnership building



# Complex Future Decisions

- ž Water Storage?
- ž Aquifer Storage and Recovery?
- ž Other Water Sources?



# Ongoing Research

- ž Systems modeling with U of U and UMass
- ž Dynamic PET integrated into CBRFC hydrology model
- ž Develop regionally specific climate models (U of U C. Strong)
- ž Select climate scenarios for hydro model runs
- ž Seasonality of demand scenarios
- ž Determine adaptive strategies best suited to improve resilience to a wide variety of scenarios

# Questions?

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<http://wwa.colorado.edu/>

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[Laura.briefer@slcgov.com](mailto:Laura.briefer@slcgov.com)

