

# ARE WE LIVING THE FUTURE?

WHAT ARE THE ALTERNATIVES TO GCM  
APPROACHES FOR WATER SUPPLY PLANNING  
IN THE FACE OF CLIMATE CHANGE?

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**Colorado River District**

*Protecting Western Colorado Water Since 1937*

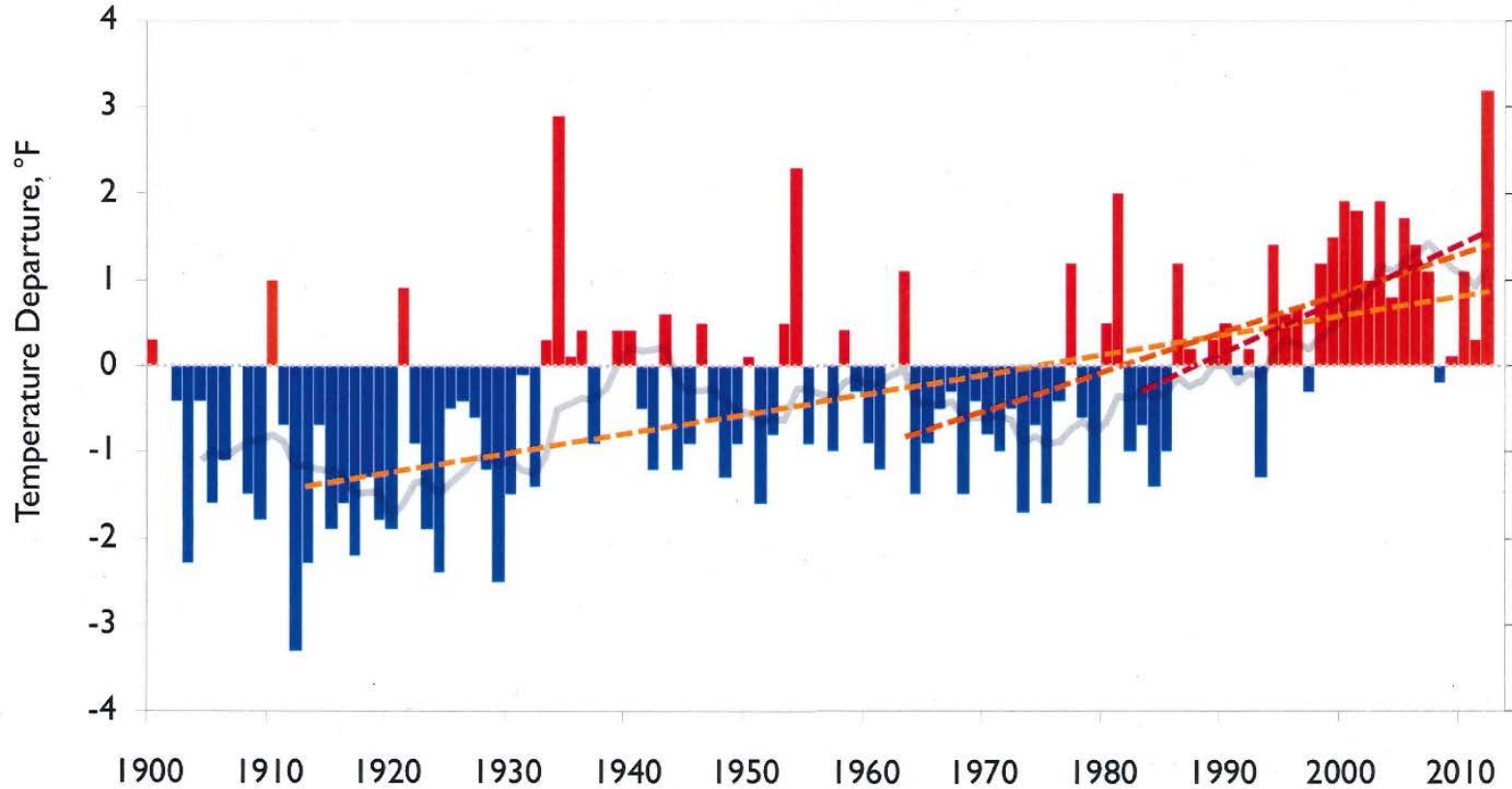
# Sources

- 1. CWCB Report “Climate Change in Colorado,” Aug. 2014**
- 2. USBR Colorado River Natural Flow Data Base**
- 3. Assessment of Climate Change in the Southwest US  
“Present Weather and Climate: Evolving Conditions”  
- Coordinating lead author Martin P. Hoerling**
- 4. “Medieval Drought in the Upper Colorado River Basin”  
- Meko, Woodhouse, Baisan, Knight, Lukas, Hughes and Salazar - May 2007**
- 5. Modeling by Hydros, Inc. using CRSS for CRWCD, CWCB & UCRC  
Oct. 2013-14**
- 6. Interim Guidelines FEIS Appendix N - Analysis of Hydrologic  
Variability, USDOl - Nov. 2007**

# What we know - or have some confidence in?

- 1. Colorado (and the SW US) have warmed significantly over the past 30 yrs.**
- 2. No long term trends in average annual precip for Colorado, even considering the dry period since 2000**
- 3. Timing of snowmelt and Spring peak runoff is 1-4 weeks earlier than the past 30 yrs.**
- 4. The PDSI shows trend toward more severe soil-moisture drought conditions over the past 30 yrs.**
- 5. Tree ring records show multiple droughts more severe than any in the observed record**
- 6. All climate models show future warming, no precip trend**

## Colorado has warmed significantly, 2° F over the past 30 years



Observed

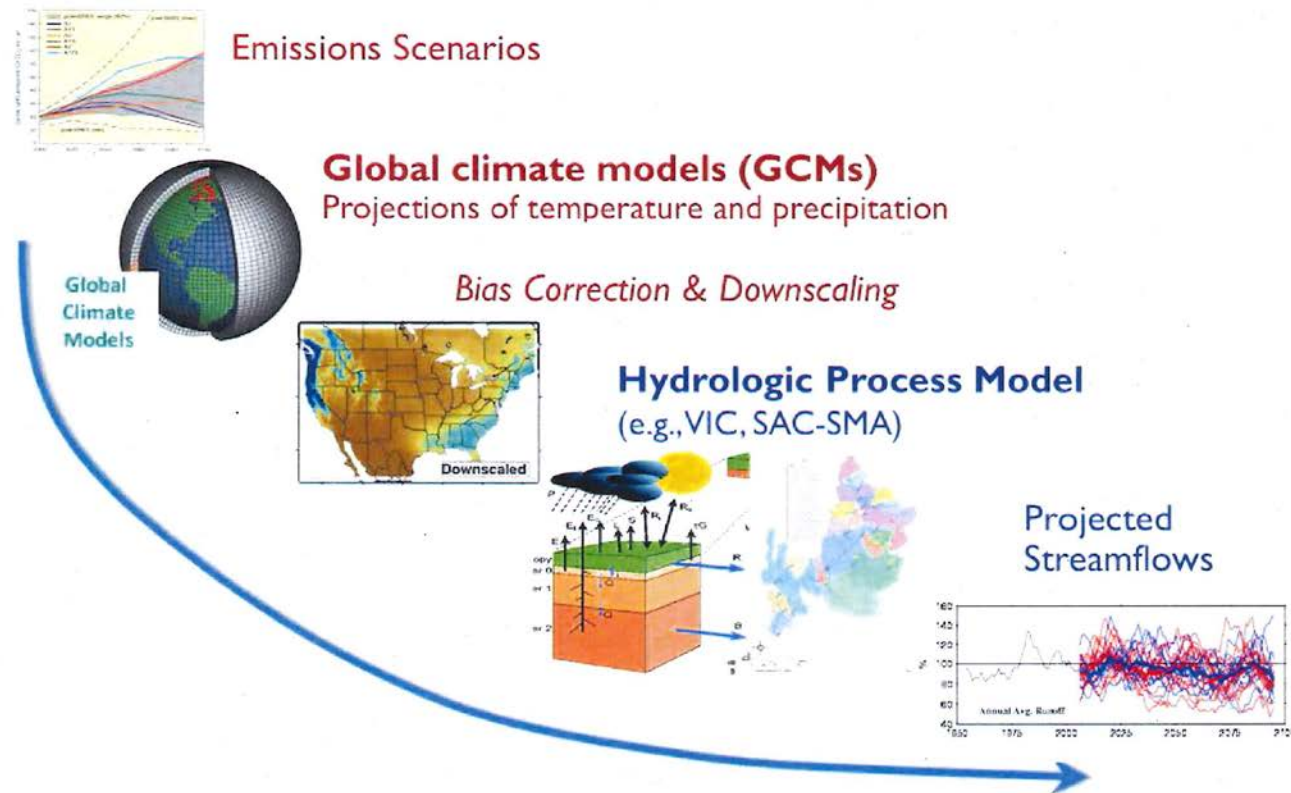
Figure ES-1 & 2-8



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## General approach for projecting basin-scale changes to hydrology (as used in Basin Study and others)



# Complications for Colorado River Water Planning

1. Climate change hydrology change shows increased variability
2. CMIP-3 vs CMIP-5 ??? Some folks are banking on CMIP-5 being wetter
3. Impacts of temperature increases on future demands
4. The Colorado River is a regional resource – what happens on the Platte, Rio Grande and Sacramento-San Joaquin impacts the Colorado
5. CRSP storage is currently < half full, compact obligations will matter in the future!
6. Uncertainty rules the roost!

# Some Basic Hydrology for Lees Ferry

**1906-2014 MEAN NATURAL FLOW - 14.82 MAF/YR**

**2000-2014 MNF - 12.33 MAF/YR (83% OF 1906-2014)**

**1988-2014 MNF - 13.19 MAF/YR (89% OF 1906 -2014)**

**1953-2014 MNF - 13.90 MAF/YR (94% OF 1906 -2014)**

**AMO NEGATIVE – 16.23 MAF/YR (89% OF 1906 -2014)**

**AMO POSITIVE - 13.20 MAF/YR (110% OF 1906-2014)**

**1118-1178 (MEKO, ET AL) – 13.44 MAF/YR (90%)**

**1622-1671 (MEKO, ET AL) – 13.74 MAF/YR (93%)**

**THE BASIN STUDY (USBR) CC HYDROLOGY USED A 9%  
REDUCTION AT LEES FERRY -13.67 MAF/YR IN 2050 USING  
CMIP-3, NO CMIP-5 FLOWS AVAILABLE**

# Findings From Chapter 5

## Colorado River at Lees Ferry

**PRECIPITATION CHANGE 2001-2010 v 1901-2000 -4%**

**TEMPERATURE CHANGE 2001-2010 v 1901-2000 +0.7C**

**STREAMFLOW CHANGE 2001-2010 v 1901-2000 -16%**

**“THE MOST SEVERE AND SUSTAINED PALEODROUGHTS OCCURRED DURING THE MCA FROM 900-1350, WERE ASSOCIATED WITH HIGH TEMPERATURES IN THE SOUTHWEST, AND...LIKELY CAUSED BY PERSISTENTLY COOL LA NINAS”**

**“OVERALL THE 20<sup>TH</sup> CENTURY EXPERIENCED LESS DROUGHT THAN MOST OF THE PRECEDING 4 TO 20 CENTURIES”**

**NOTE: SIMILAR TRENDS FOR THE SACRAMENTO, RIO GRANDE & HUMBOLT RIVERS**



# Planning Suggestions

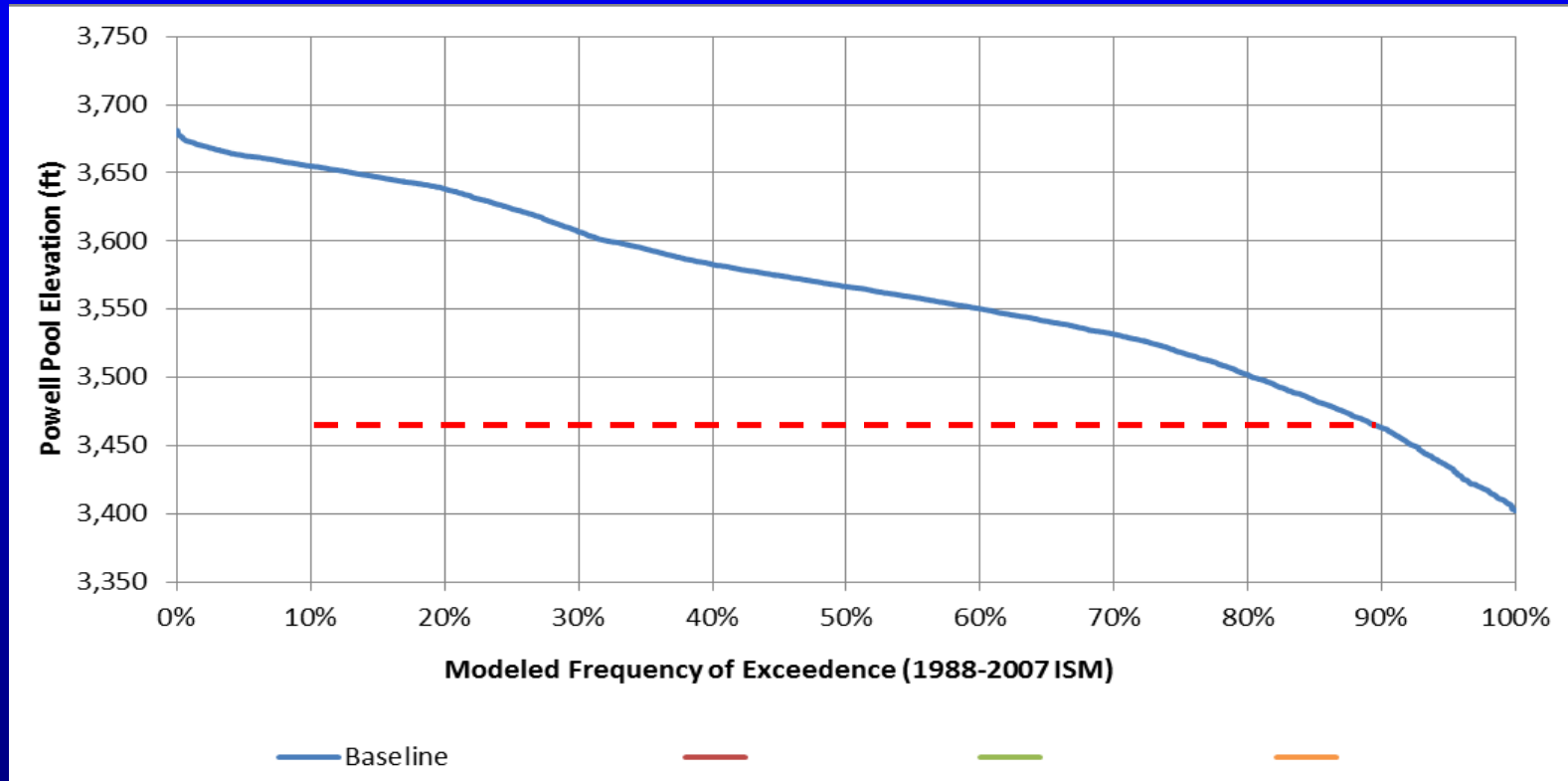
**ASSUME THE HYDROLOGY WE'VE  
EXPERIENCED SINCE 1988 CONTINUES ON INTO  
THE FUTURE**

**ASSUME THE 21<sup>ST</sup> CENTURY LOOKS LIKE THE  
12<sup>TH</sup> CENTURY (1100-1199)**

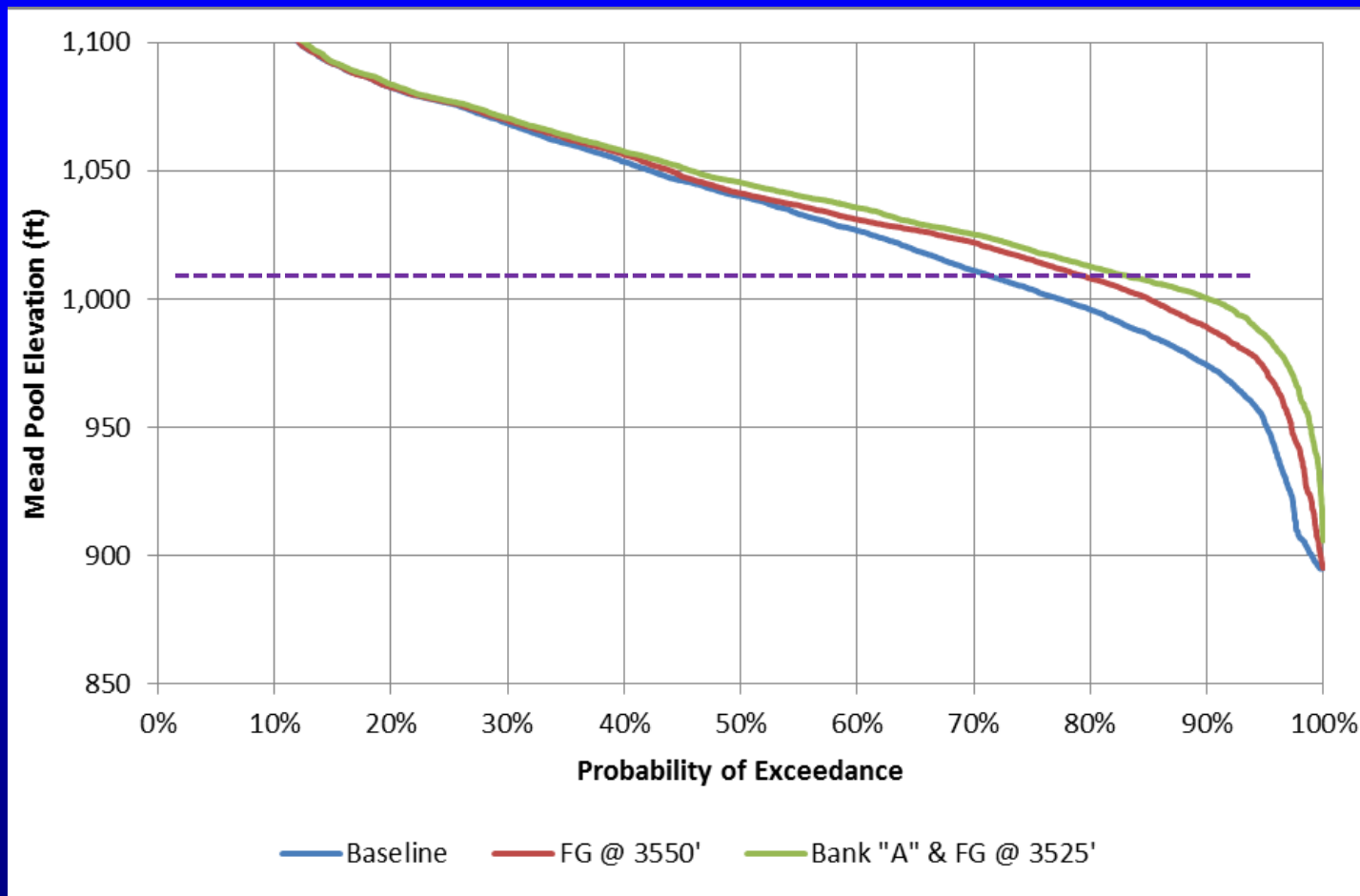
**NOTE – THE RESULTS ARE NOT PRETTY!**

# Baseline Run: Powell Pool Elevation

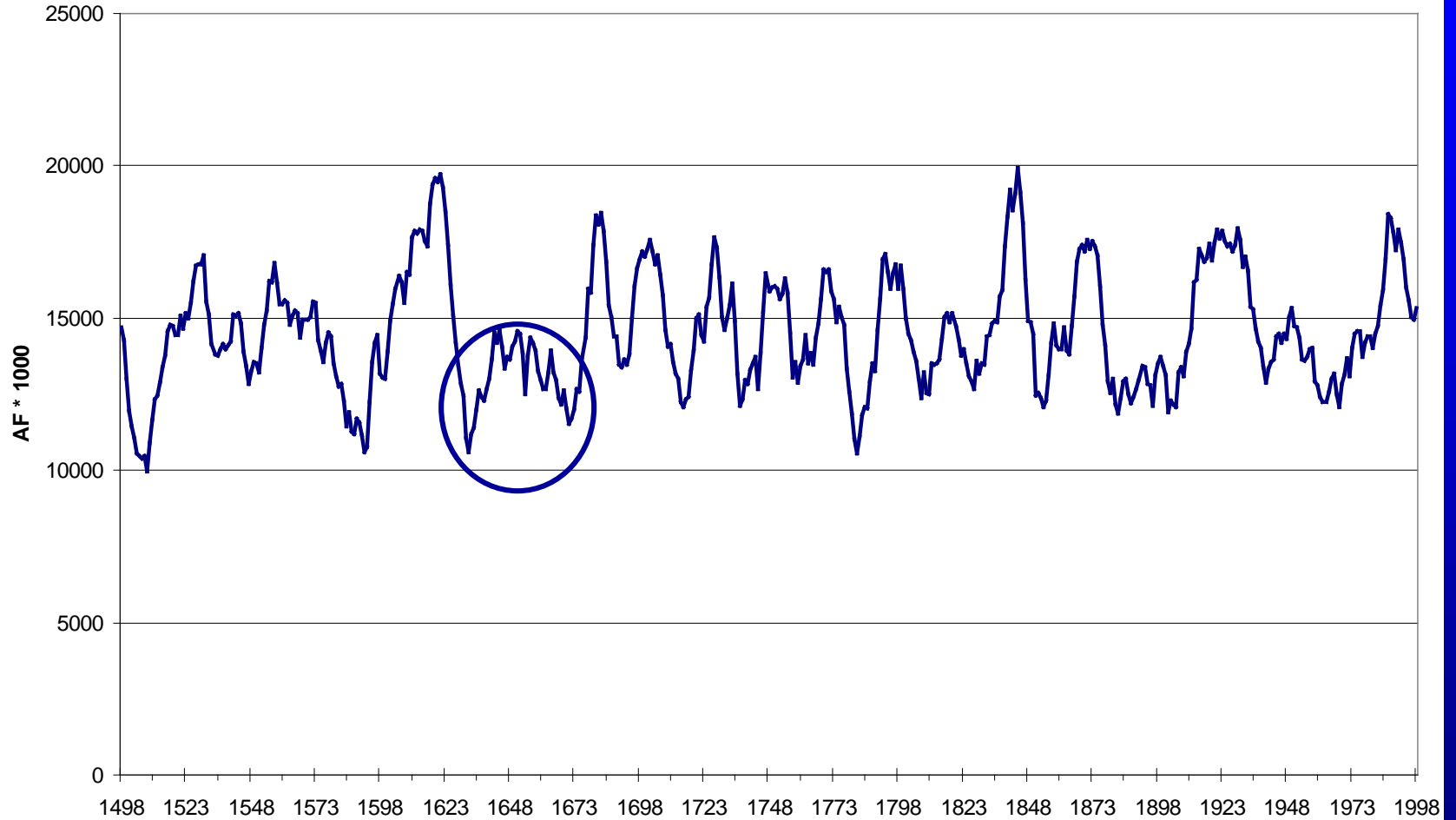
- In our “continuing drought” runs, Powell is below power pool almost 20% of the time
- Powell drops below 3490 in 19 of 20 traces, and as early as 2018.

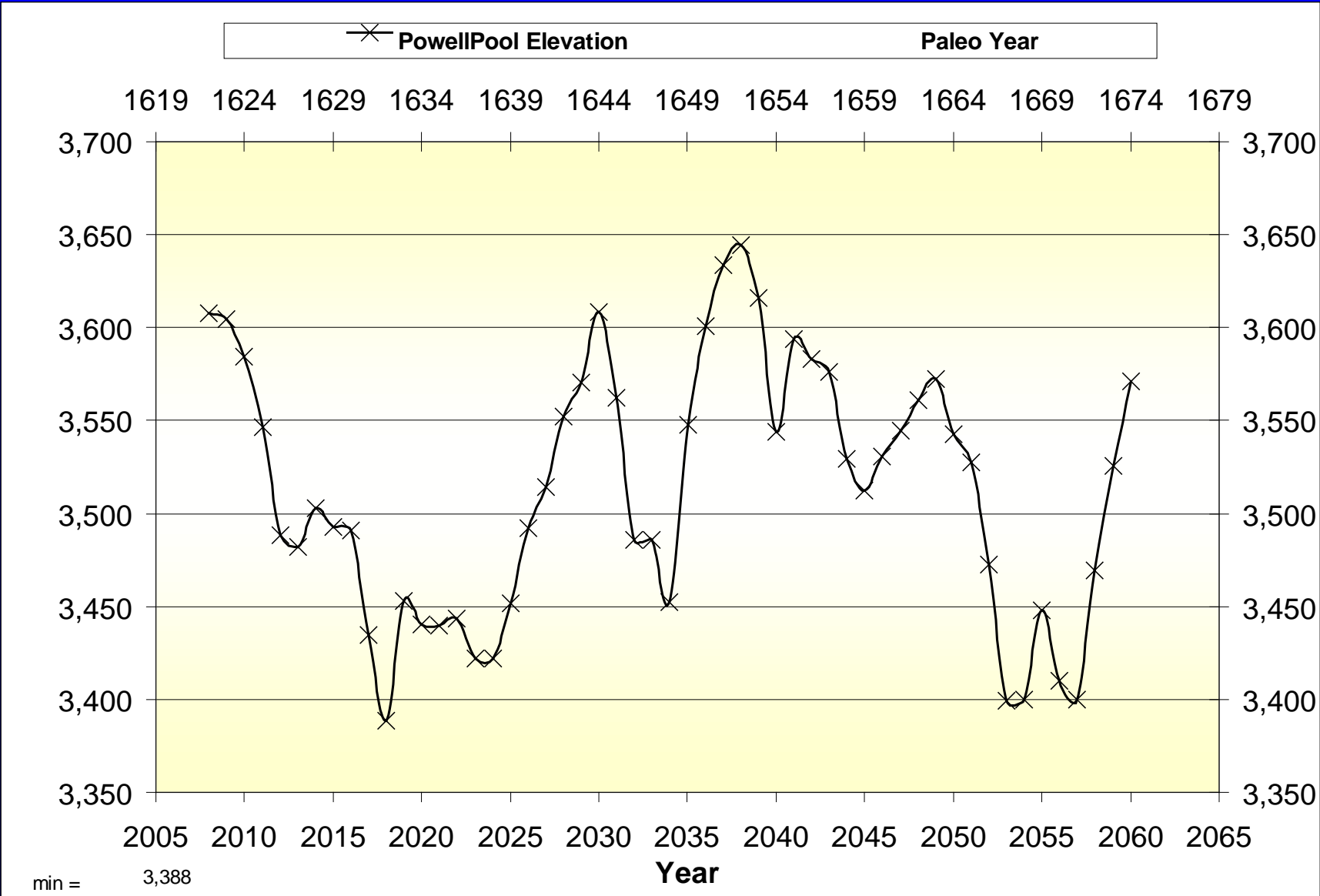


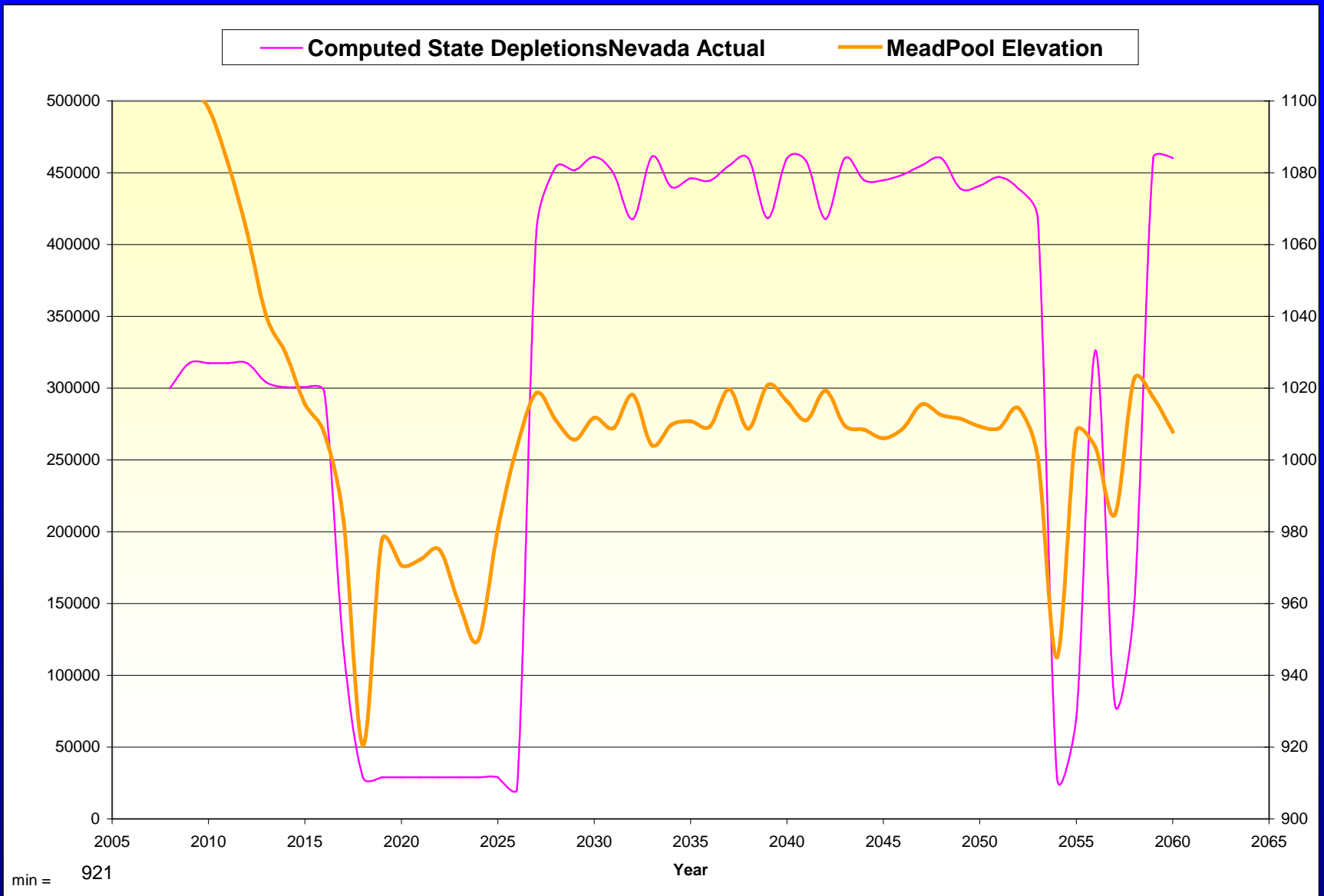
# Demand Mgmt PLUS FG Re-Op: Mead PE

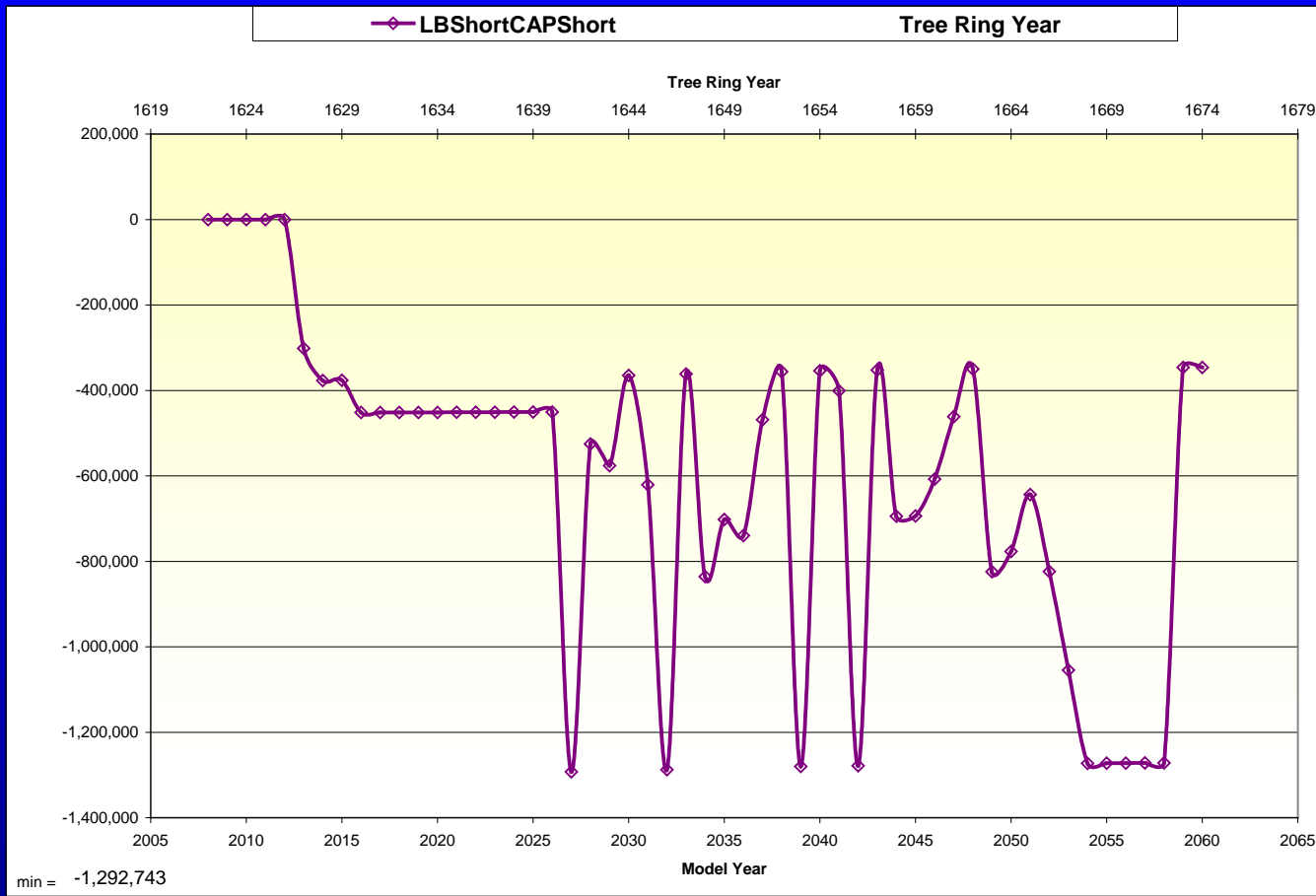


**Paleo Reconstruction - LEES "B"**  
**10 YEAR MOVING AVERAGE**









# Concluding Remarks

We have confidence that regional temperatures will continue to increase; we have less confidence with our projections for future precipitation

GCM generated streamflow projections show considerable variability - more severe droughts - some really big years 9% drop in mean under CMIP-3, probably wetter under CMIP-5

If the conditions we've experienced over the last 15-25 years continue into the future, **without action, we're in big trouble!**

We should be planning for a continuation of current conditions and conditions similar to the 1100s.

**Bottom line: we need to be prepared to reduce basin-wide consumptive uses in the Upper Basin during dry periods and all years in the Lower Basin**