Watershed Modeling in CASCaDE: Projecting Hydrologic Changes and Management Challenges

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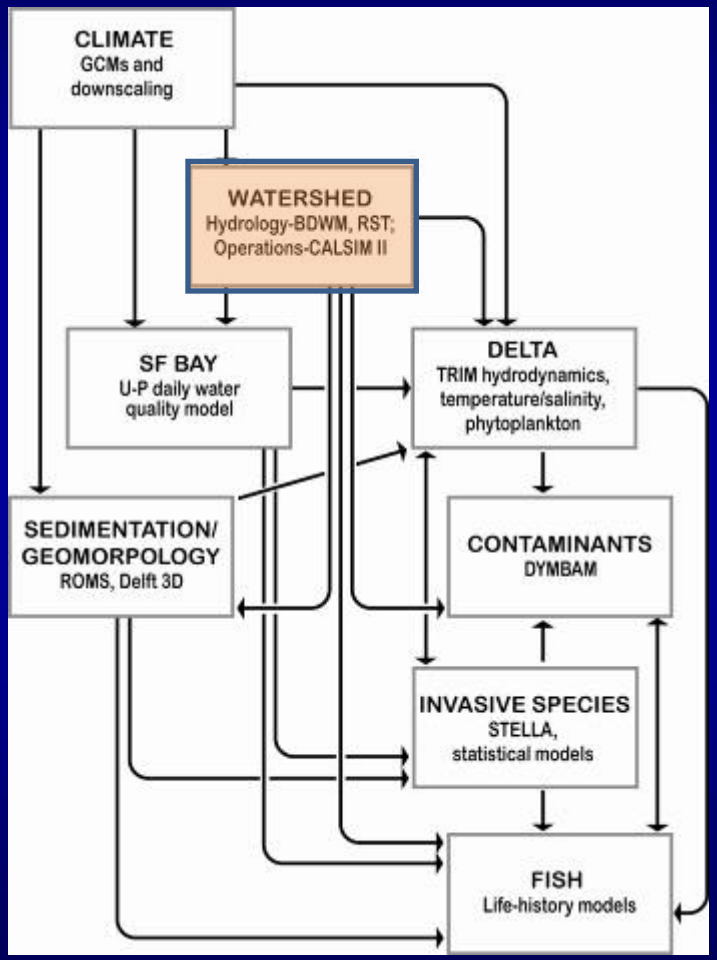
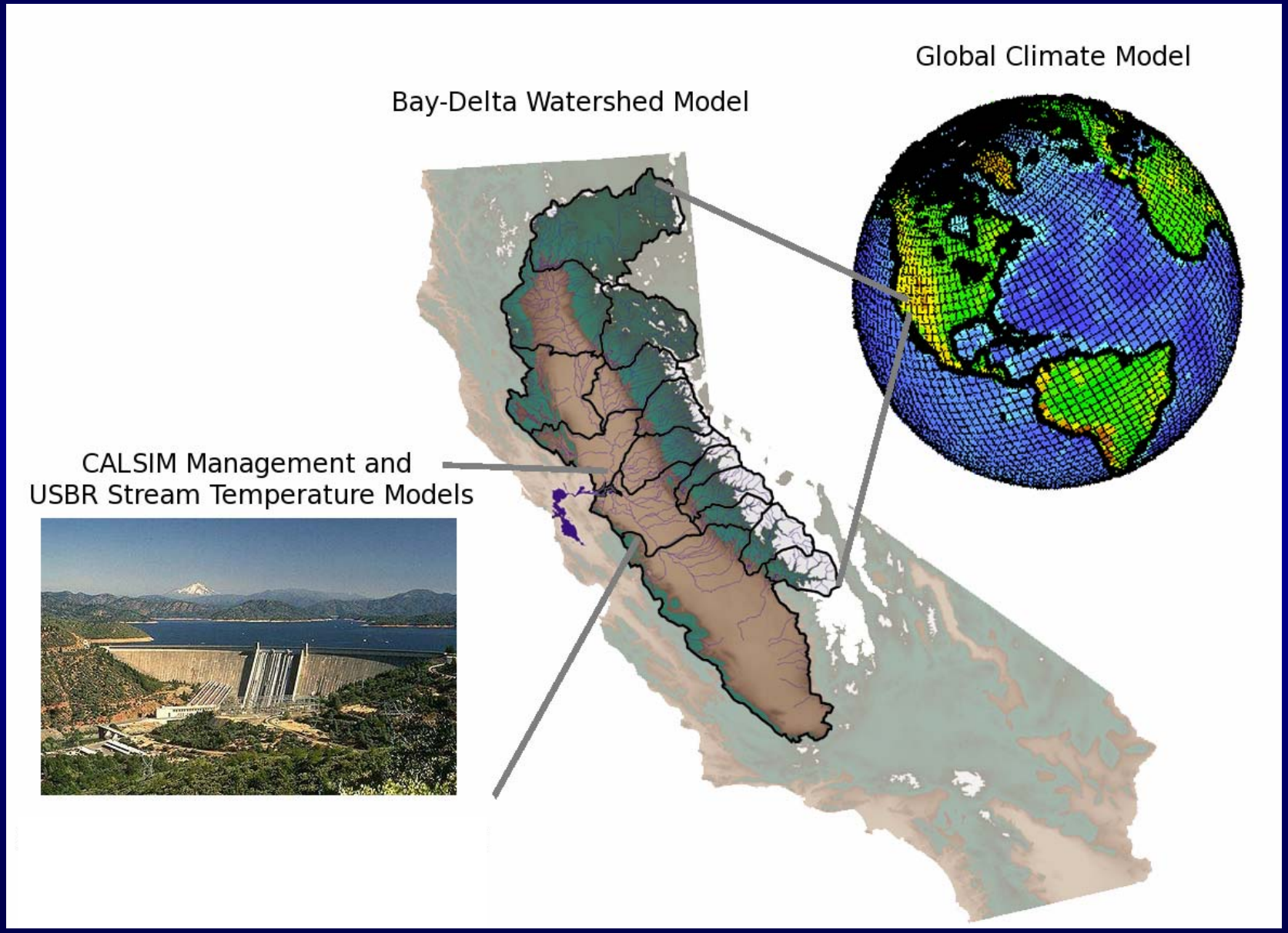


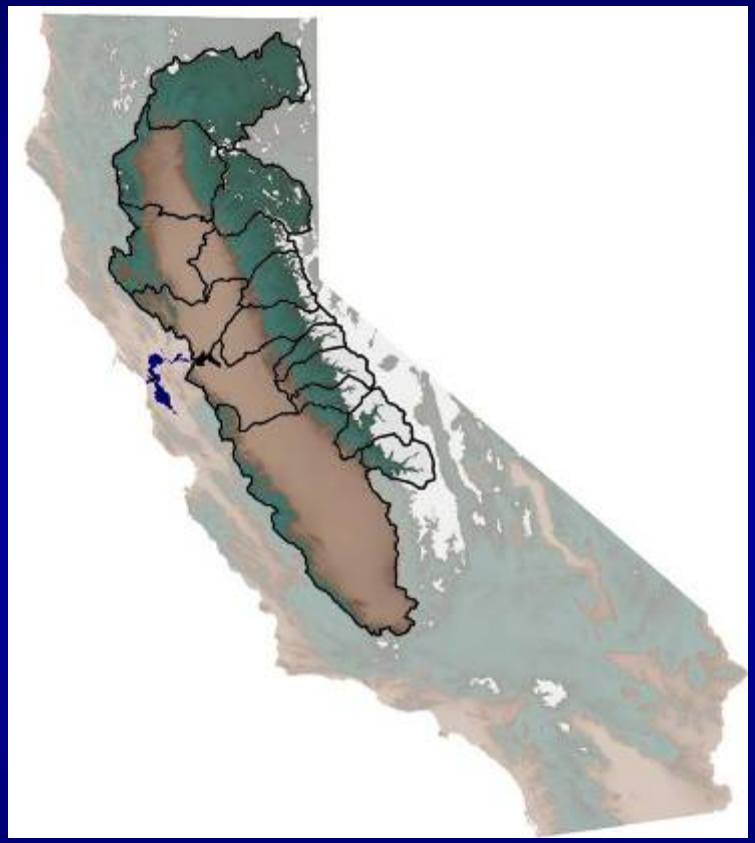
- Mike Dettinger et al. have provided daily downscaled GCM output for four scenarios
- My task is to translate these into managed flows and stream temperatures at locations throughout the Bay-Delta watershed
- This entails a novel application of a hydrology model (BDWM) and CALSIM-II, a management optimization model.
- Following is an overview of the modeling approach and results for one of the four scenarios

Model Hierarchy for CASCaDE Watershed Modeling

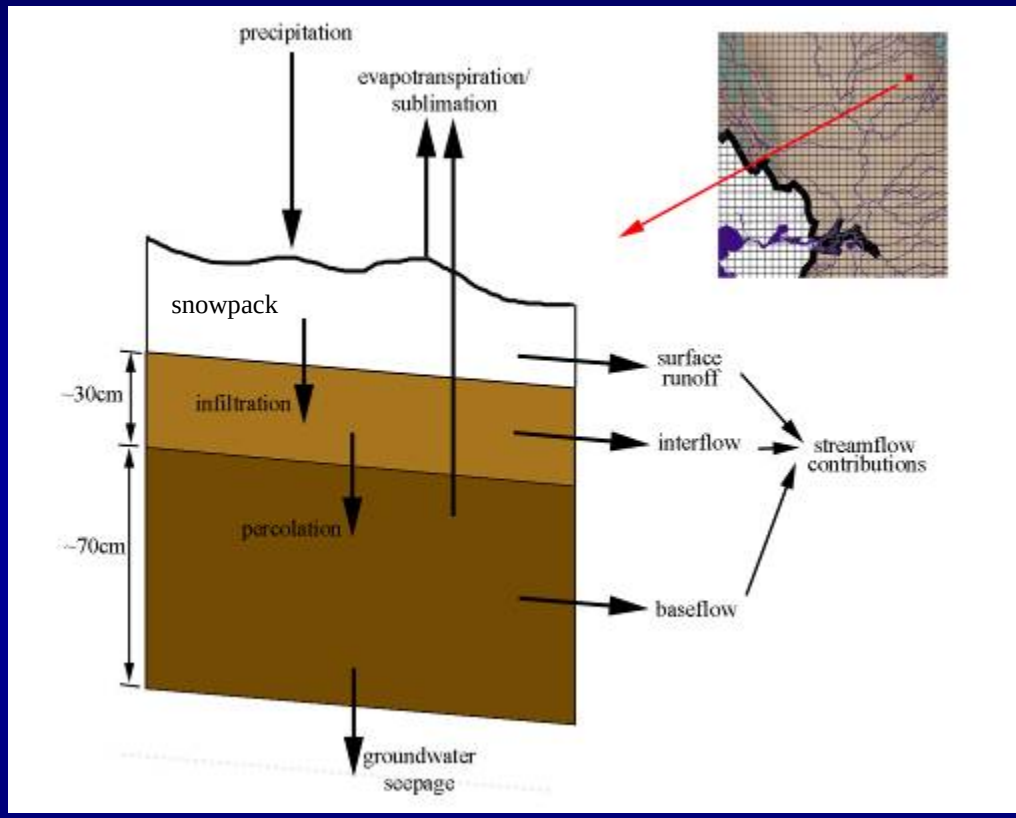


The Bay-Delta Watershed Model (BDWM) covers the entire watershed and simulates daily variability over climate-change time scales.

Model Domain and Routing Basins



Sample Grid Cell

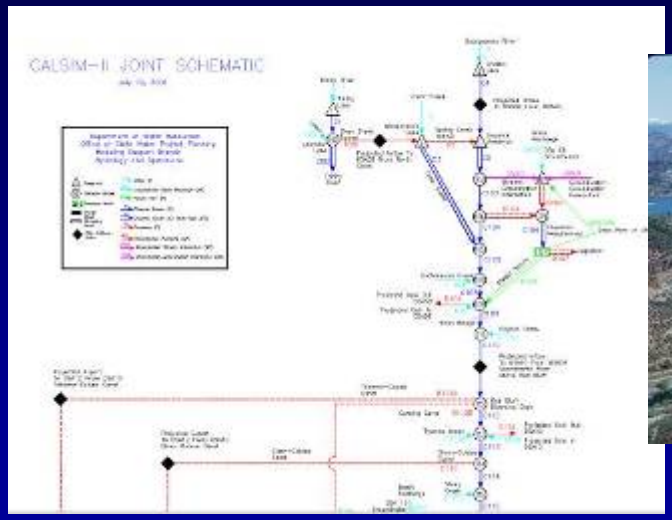


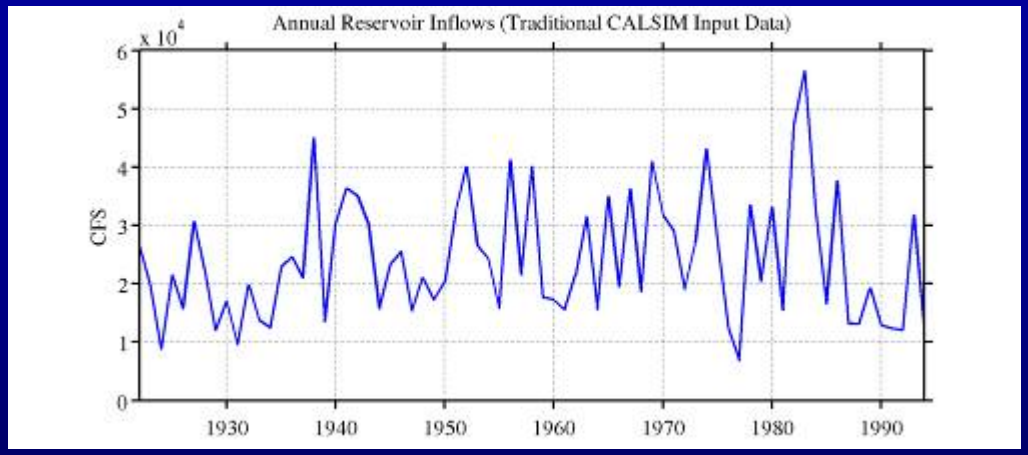
Features

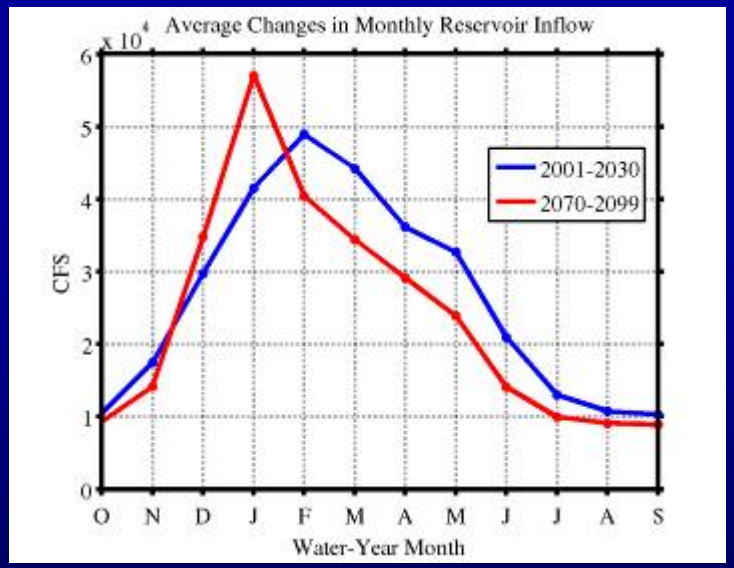
- 4 km resolution
- Daily time step
- Simulates snowpack, streamflow, etc.
- Routes streamflow to points of interest
- Capable of ensemble, multi-decade simulations

Model developed with Kosta Georgakakos, Hydrologic Research Center, Del Mar, CA

CALSIM-II is the CA Department of Resources' freshwater management model.

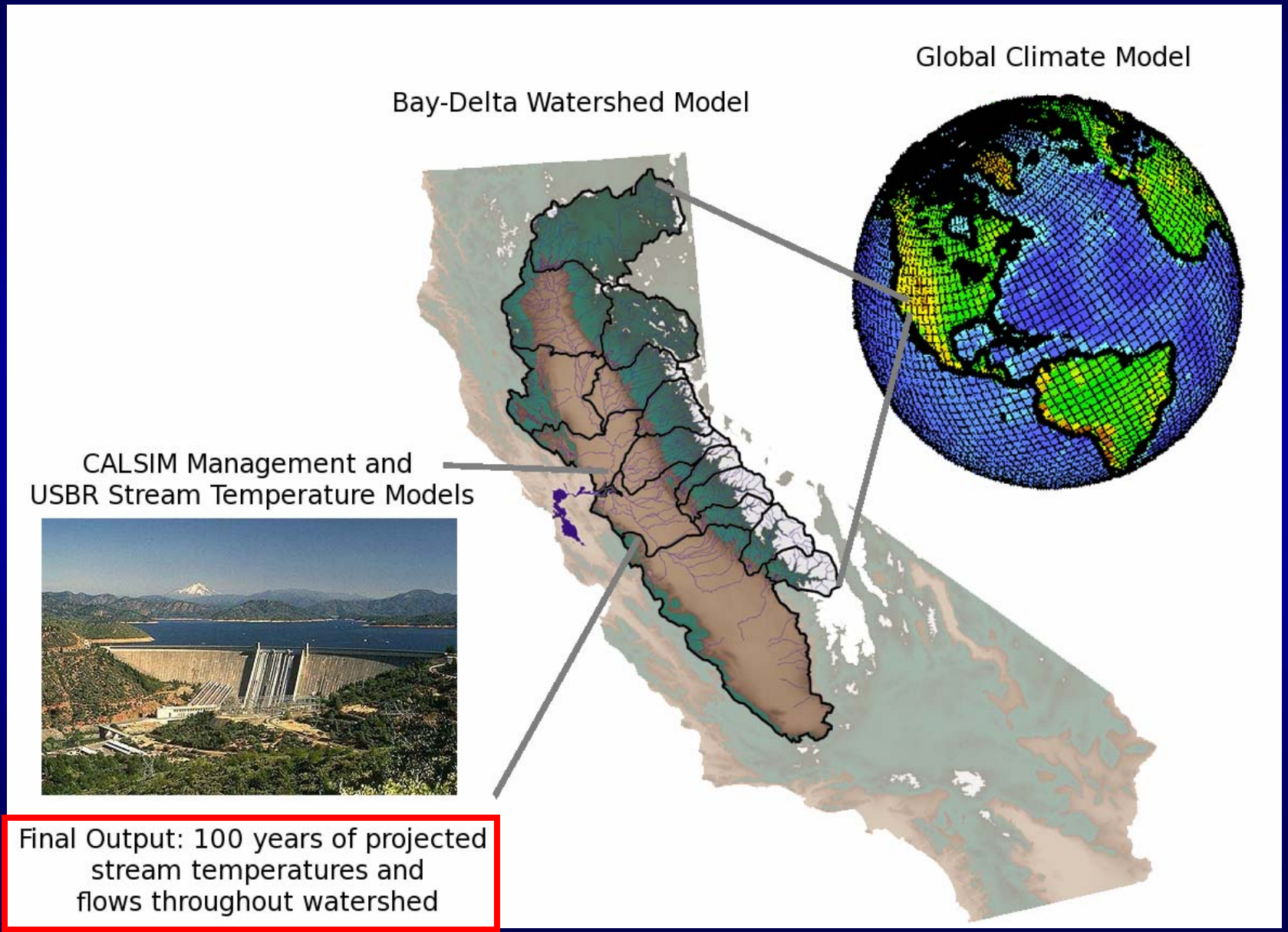


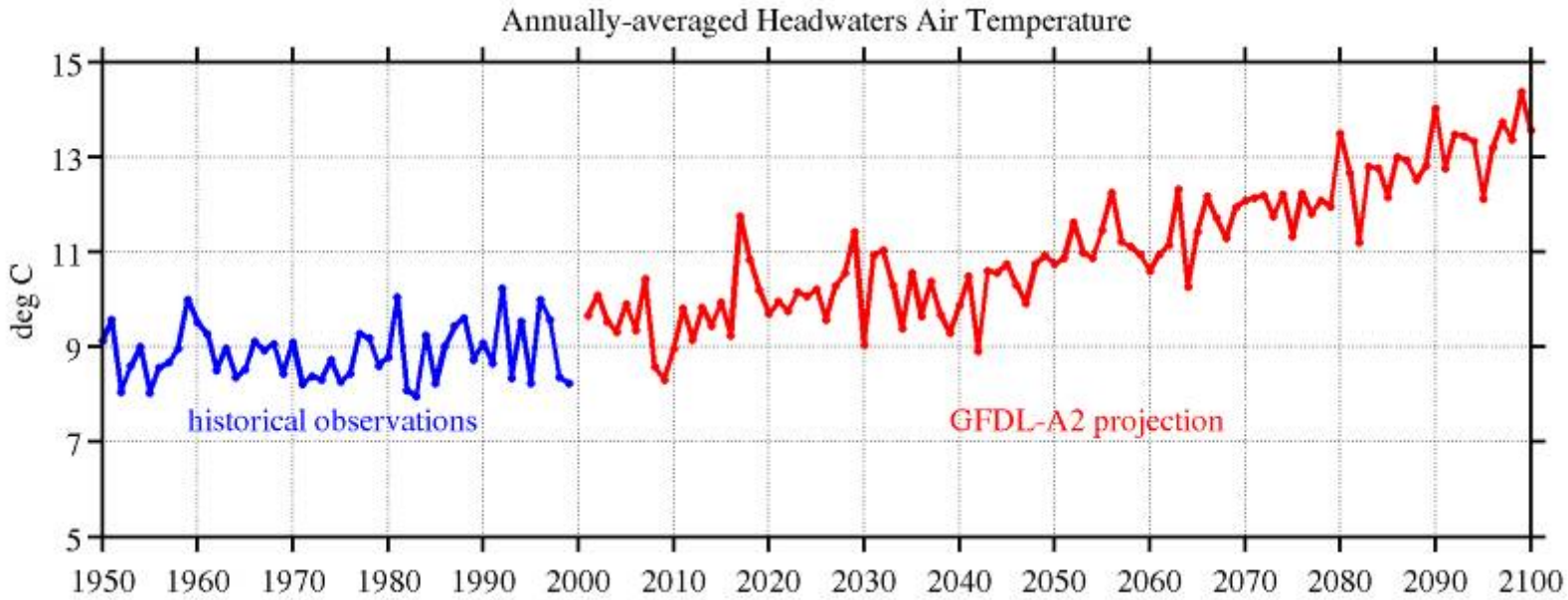


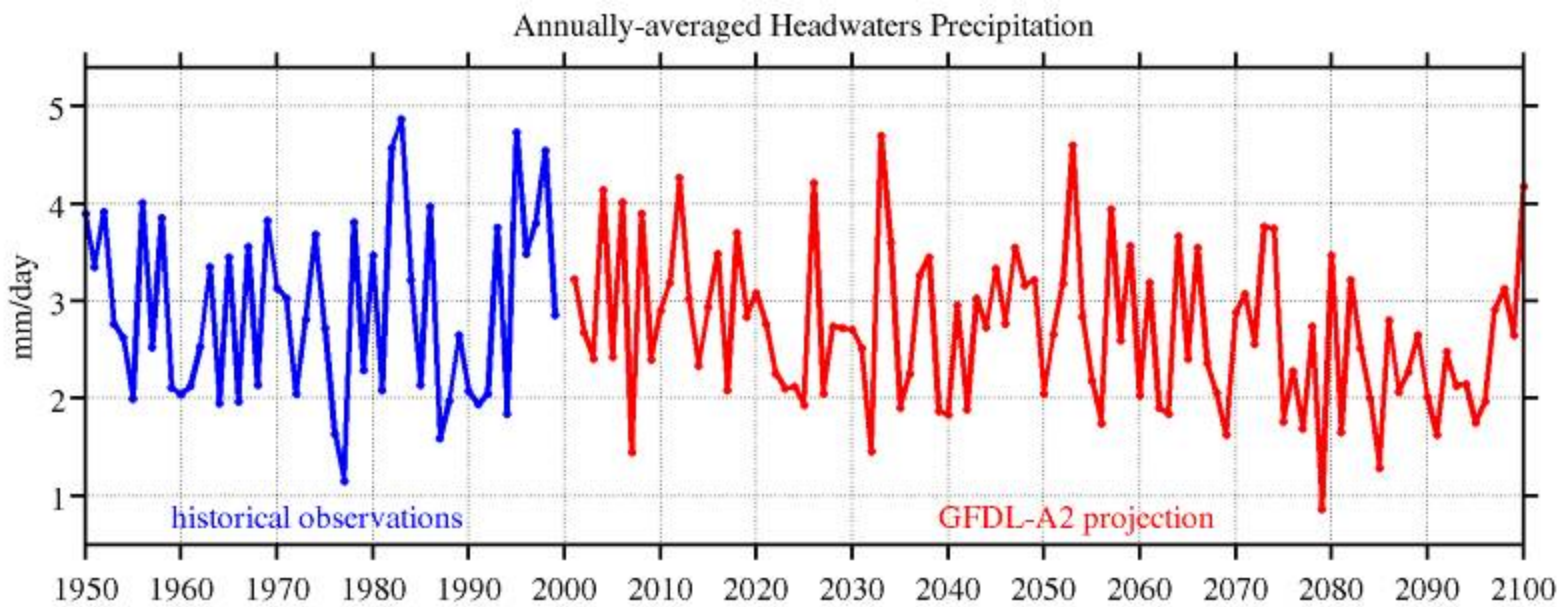


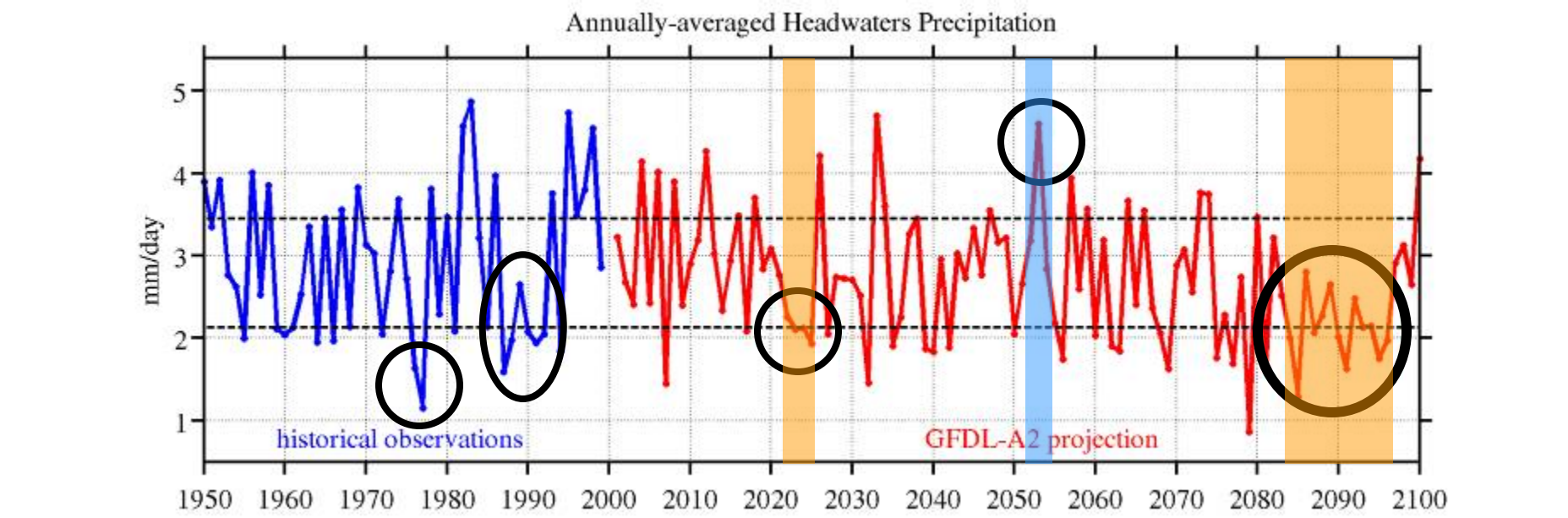
For this study, CALSIM-II was reconfigured to accept inflows *directly* from the BDWM hydrology model, allowing a representation of both projected long-term changes *and* projected interannual-to-interdecadal climate variability.

Model Hierarchy for CASCaDE Watershed Modeling



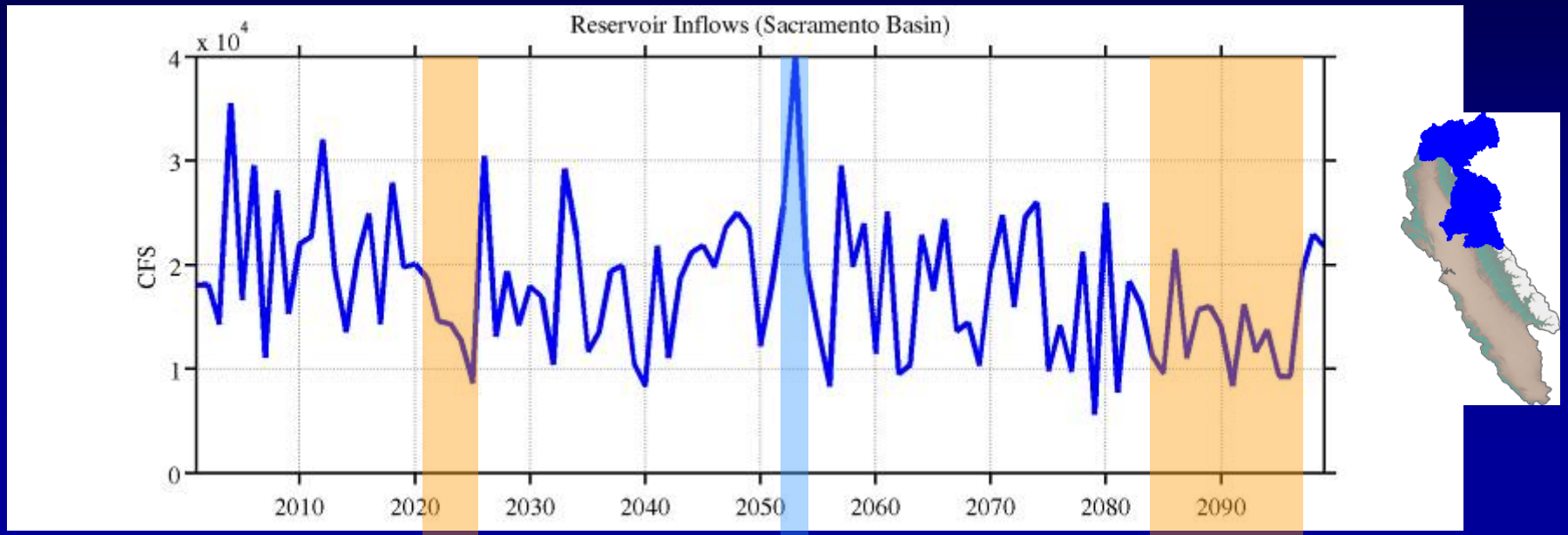

Annually-averaged Headwaters Air Temperature
deg C
15
13
11
9
7
5
historical observations
GFDL-A2 projection
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100

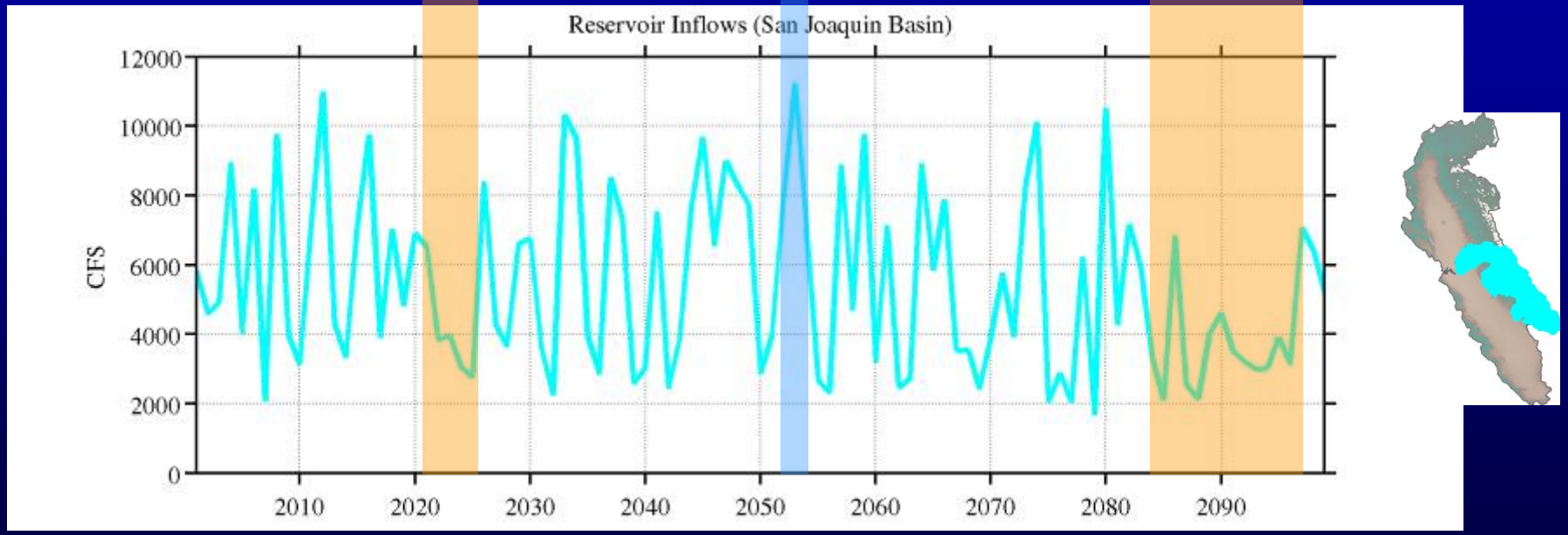

Annually-averaged Headwaters Precipitation
mm/day
5
4
3
2
1
historical observations
GFDL-A2 projection
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100



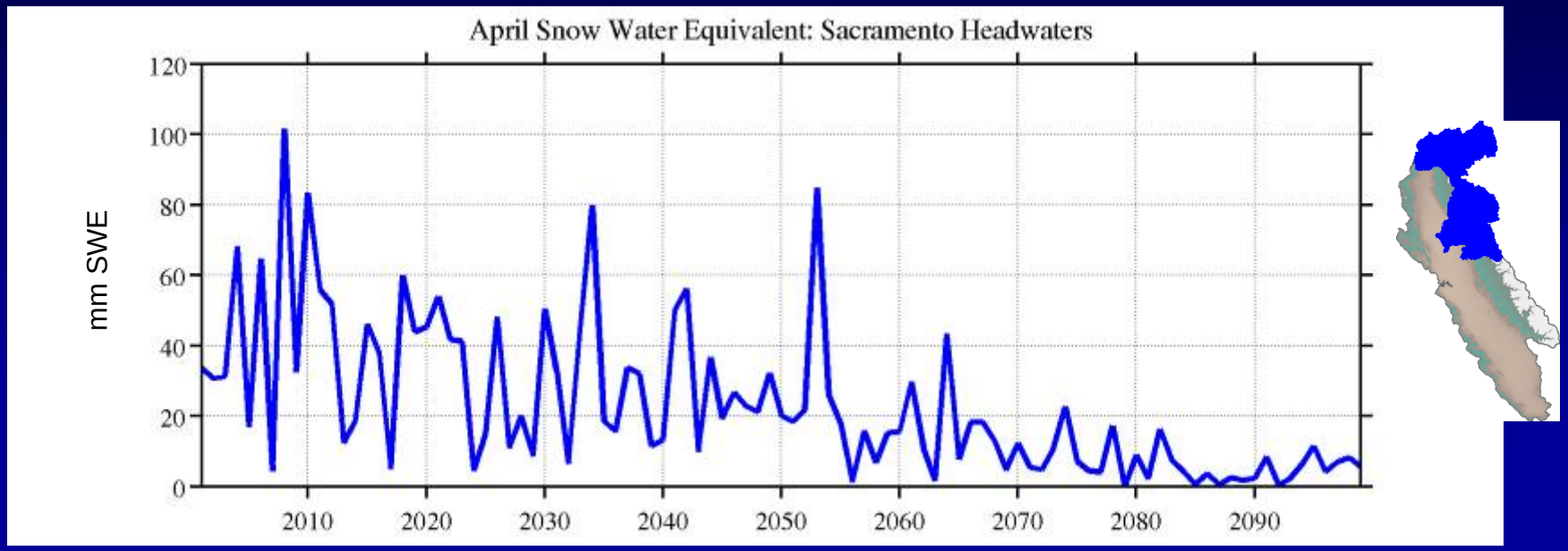
NOT A PREDICTION!

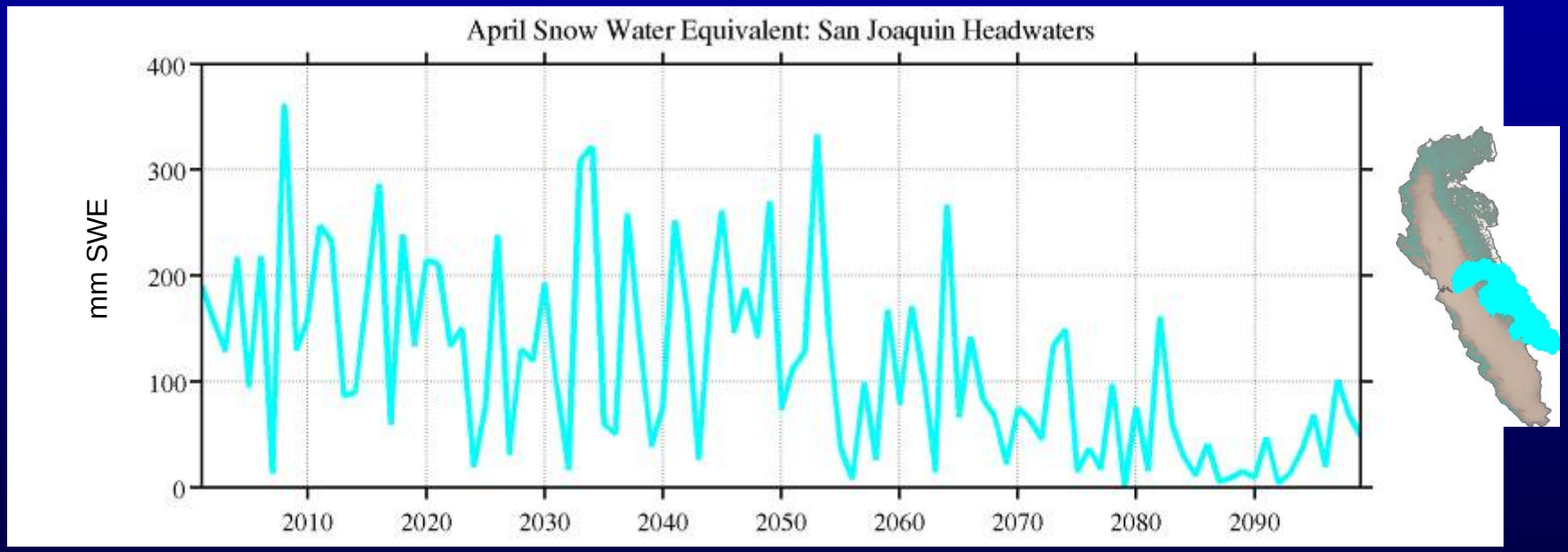
Interannual precipitation variability drives reservoir inflow variability.



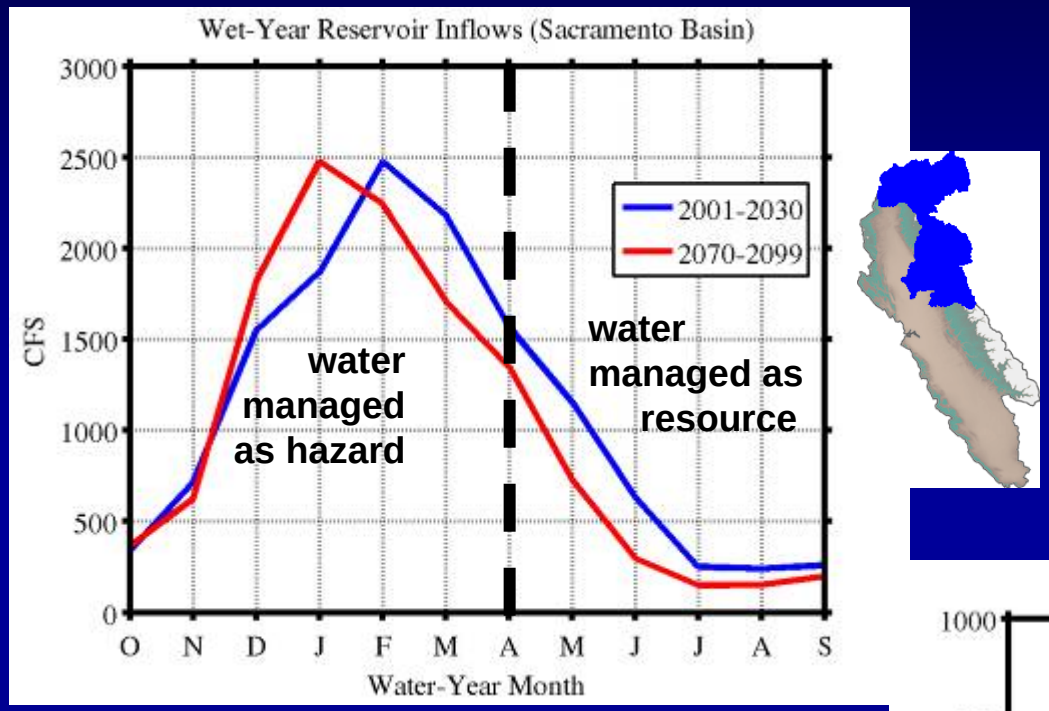


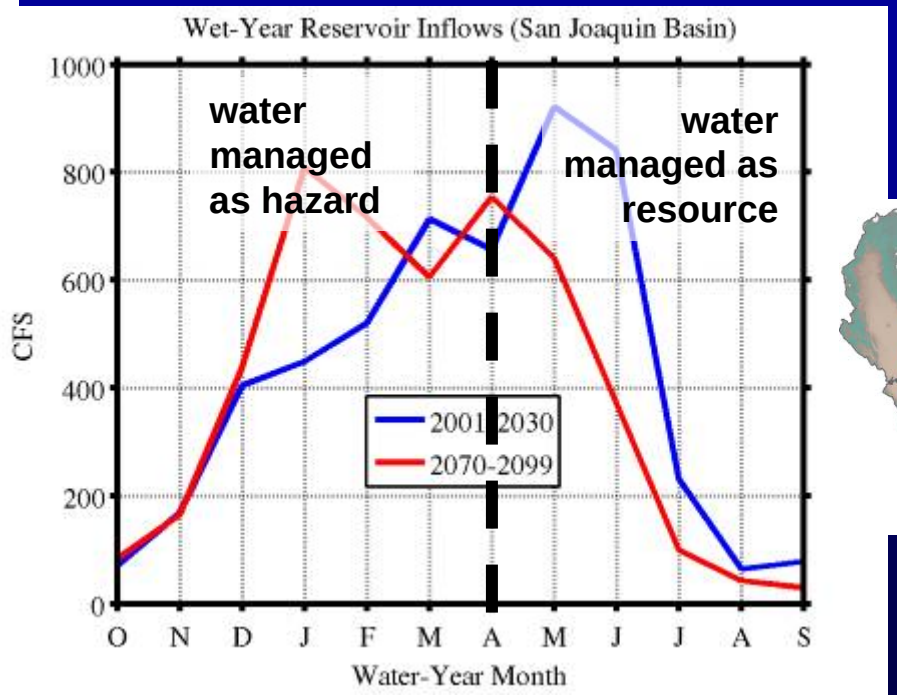
The long-term warming drives a decline of snowpacks.



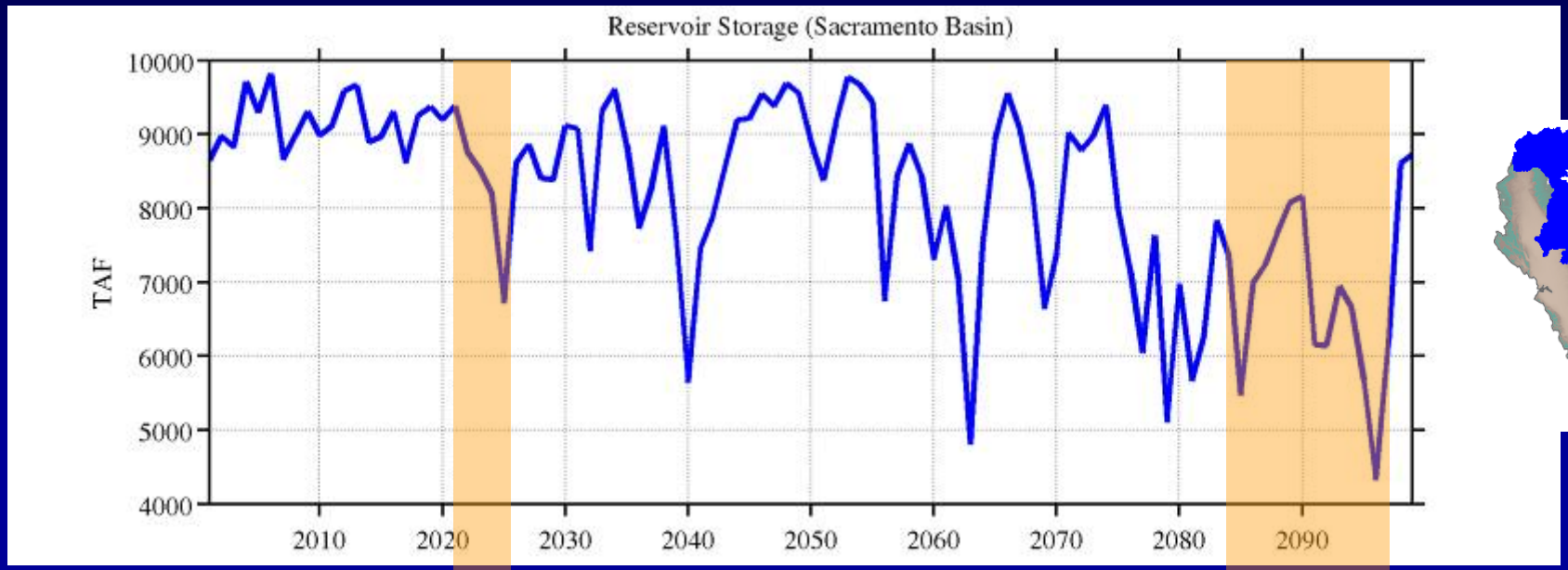


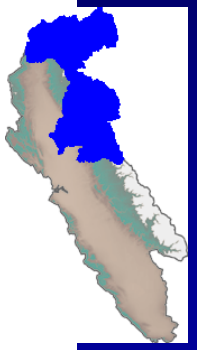
Reduces snowpack leads to earlier runoff, resulting in more water being managed as a hazard.

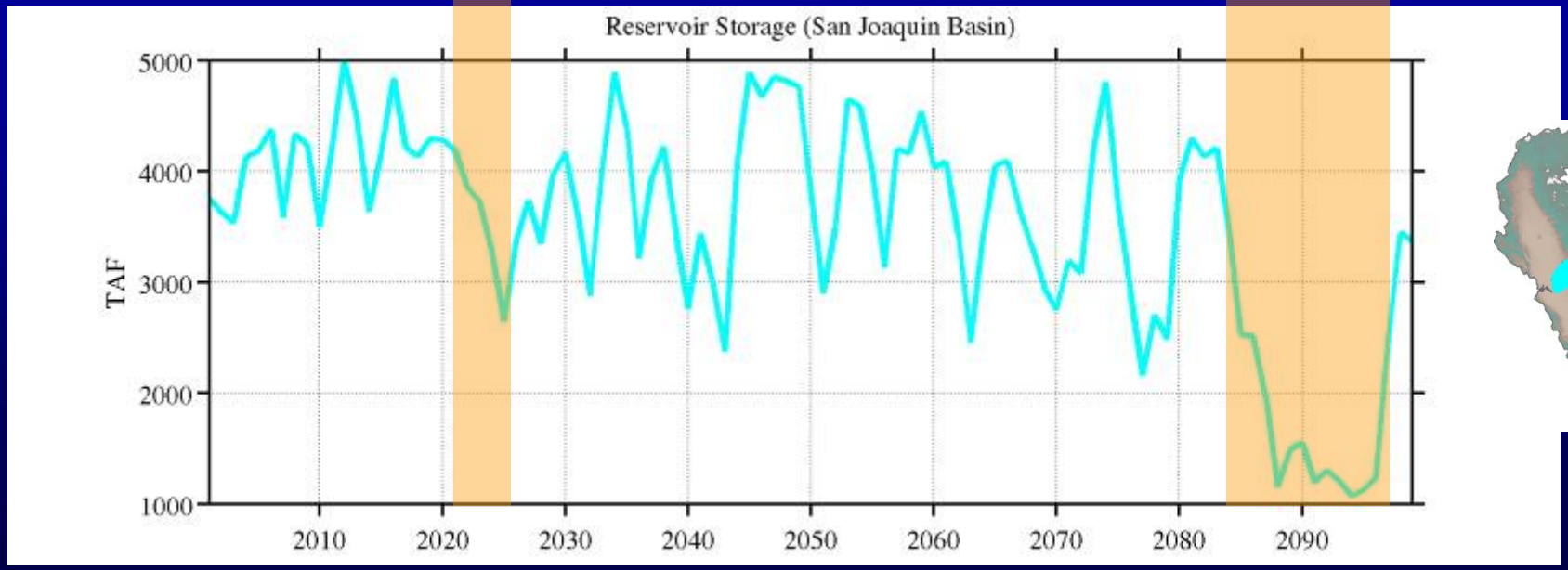




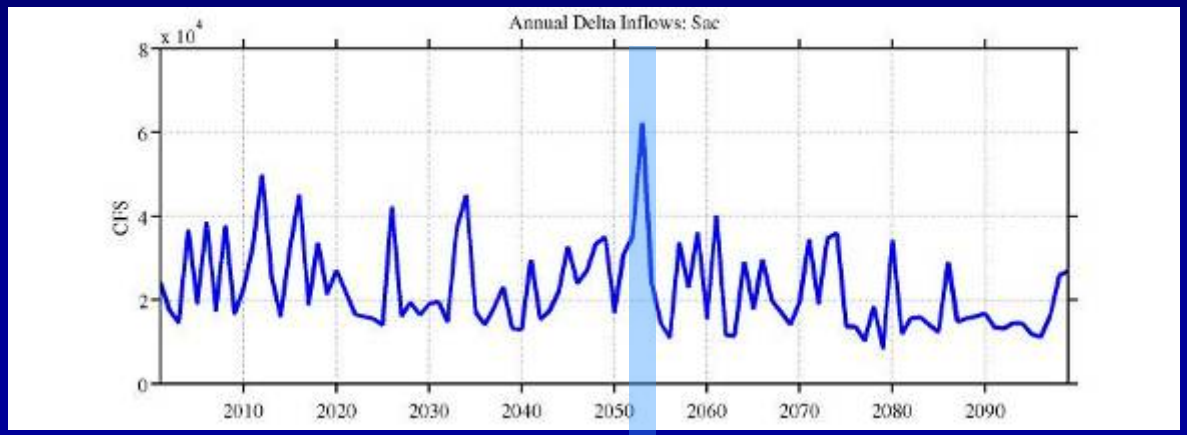
The combination of interannual inflow variability and within-year timing shifts results in emptier reservoirs.

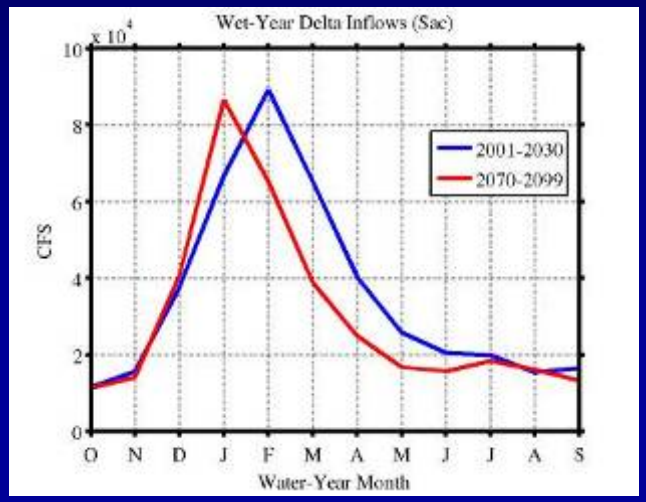


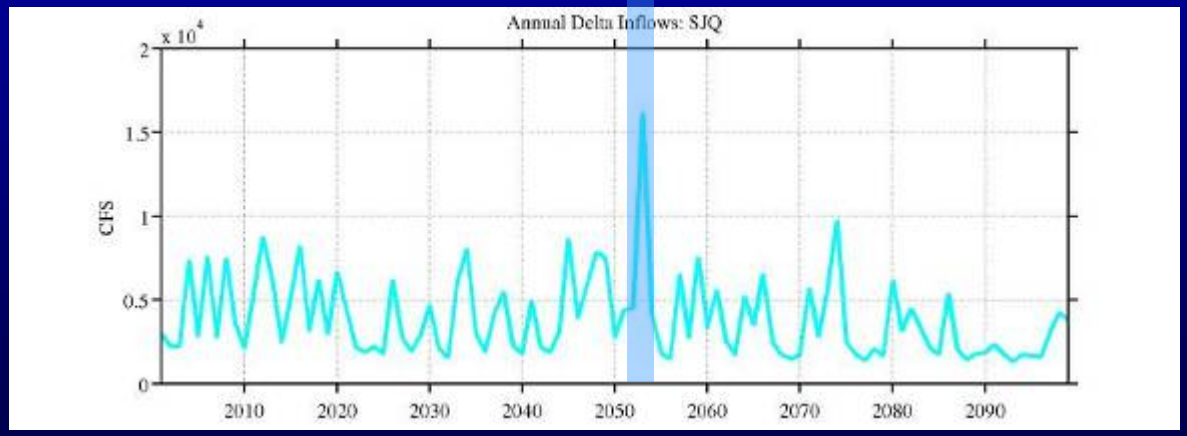


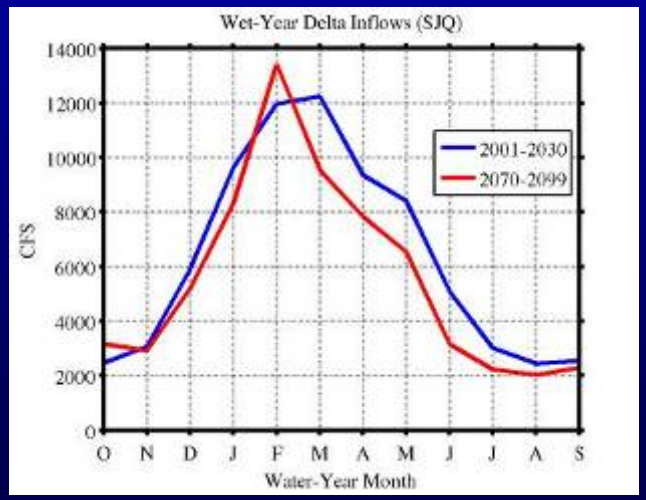


Ultimately, both the magnitude and timing of Delta inflow are affected.









Conclusions

- This approach allows the CALSIM-II operations model to be driven by 100 years of hydrology corresponding directly to the climate scenarios.
- Incorporating climate variability and change provides a dramatically different picture than climate change alone.
- Drought impacts on water supplies are amplified by the runoff timing shift associated with reduced snowpack.
- Stream temperatures were not emphasized here but were also produced for each scenario using the USBR stream temperature model.
- All data are available at http://cascade.wr.usgs.gov

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