BUREAU OF RECLAMATION

USBR 2022MED Hydrology Development: Detrending Methodology

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Reclamation

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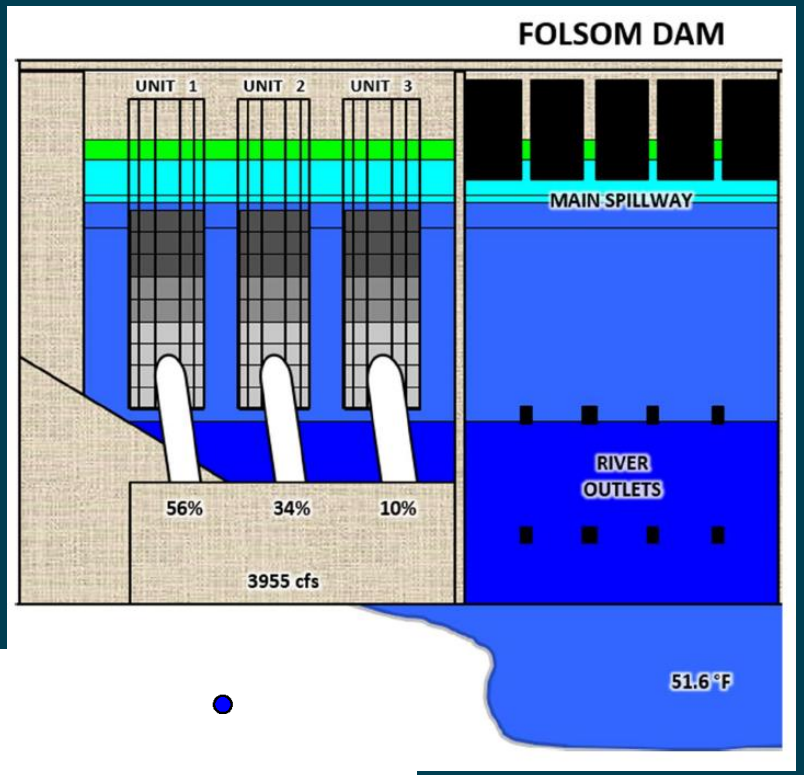
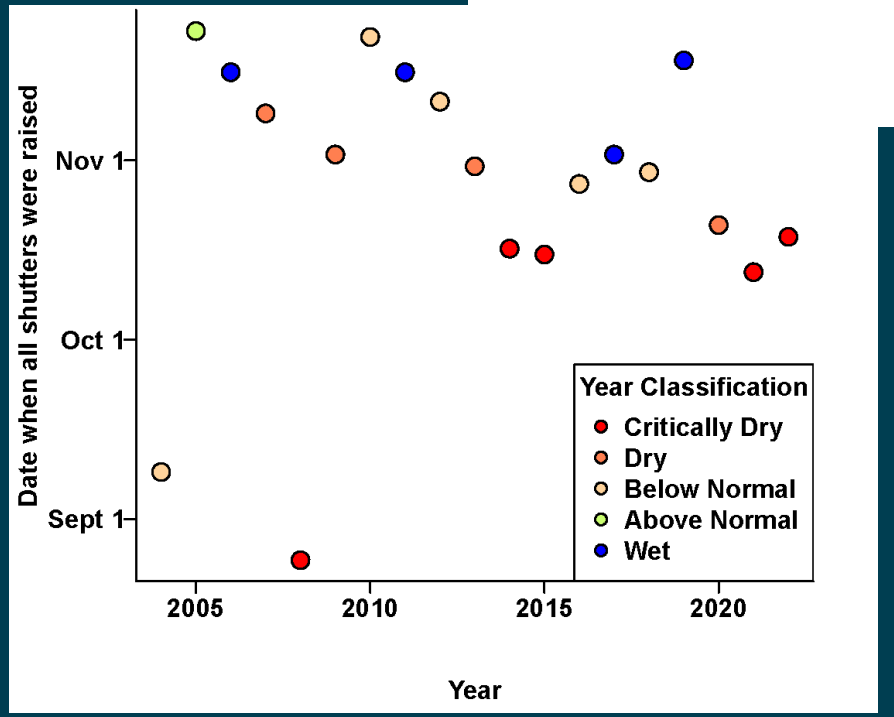
Motivation

- CVP is already experiencing climate change
- Primary versus secondary water management affects
  - California climate is characterized by interannual variability
  - Secondary trends can be more clear
- Potential for fundamental changes to CVP/SWP operations

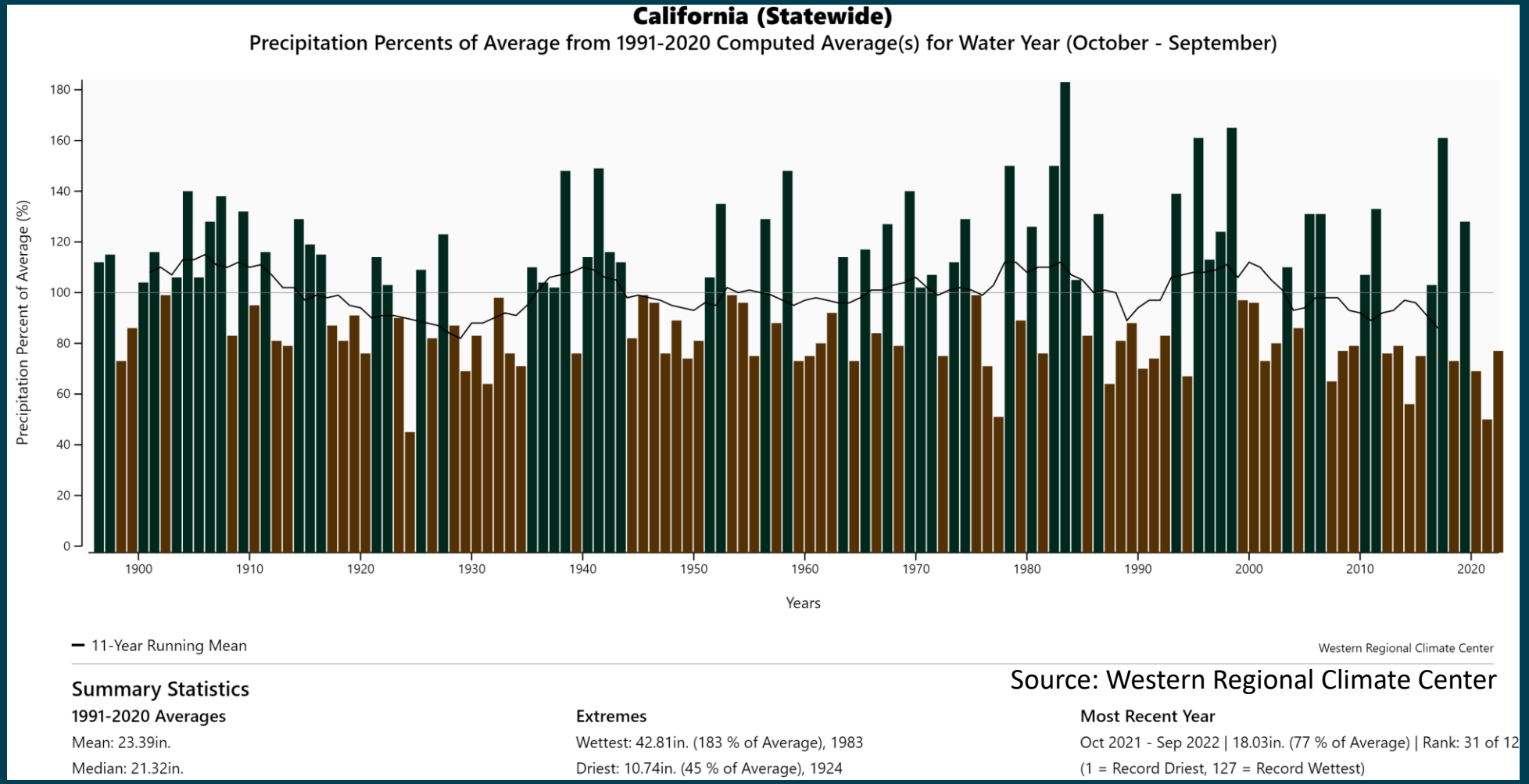
American River Group, April 2024



Reclamation, 2024

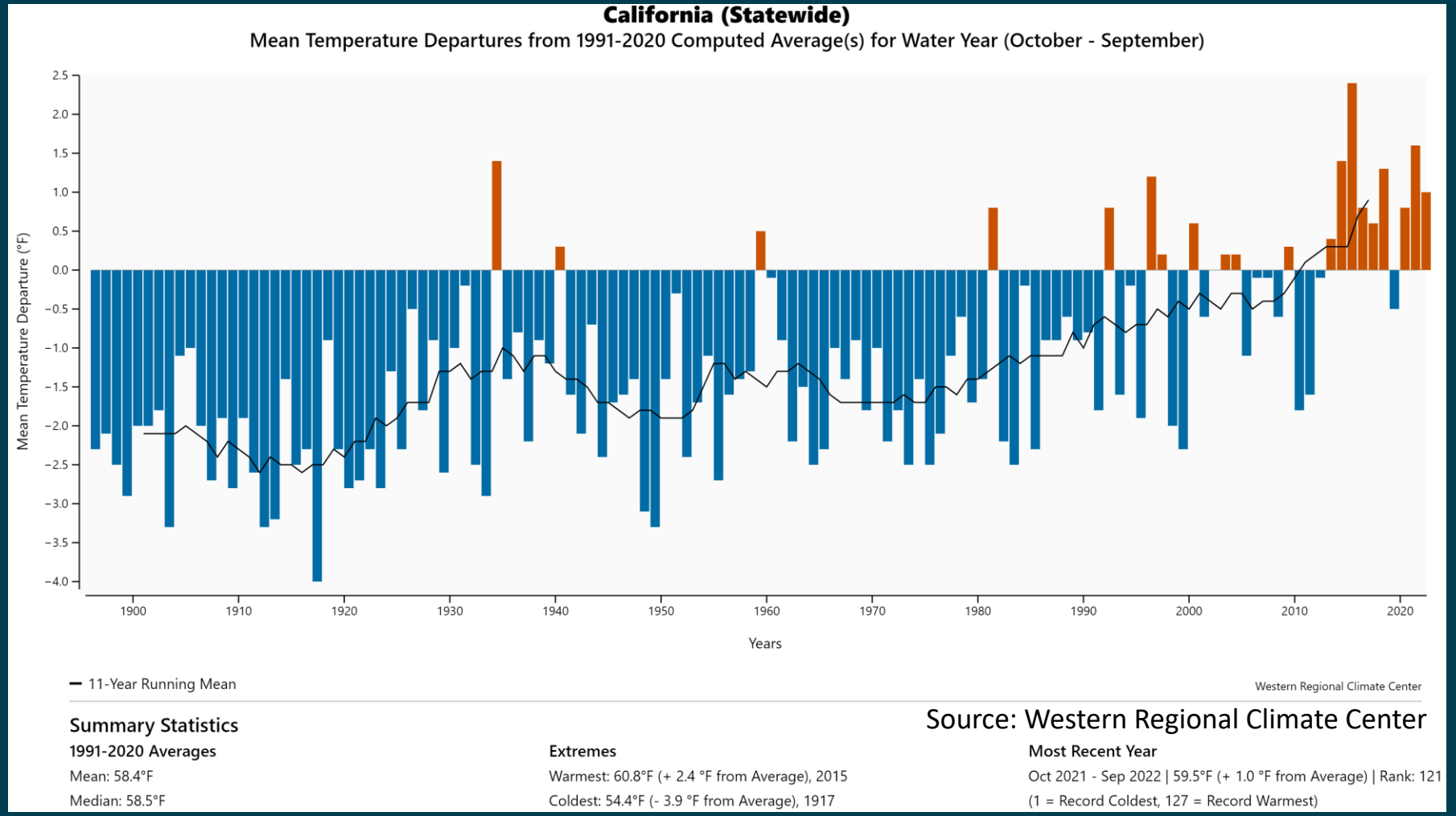


Precipitation - Percent of 1991-2020 Mean



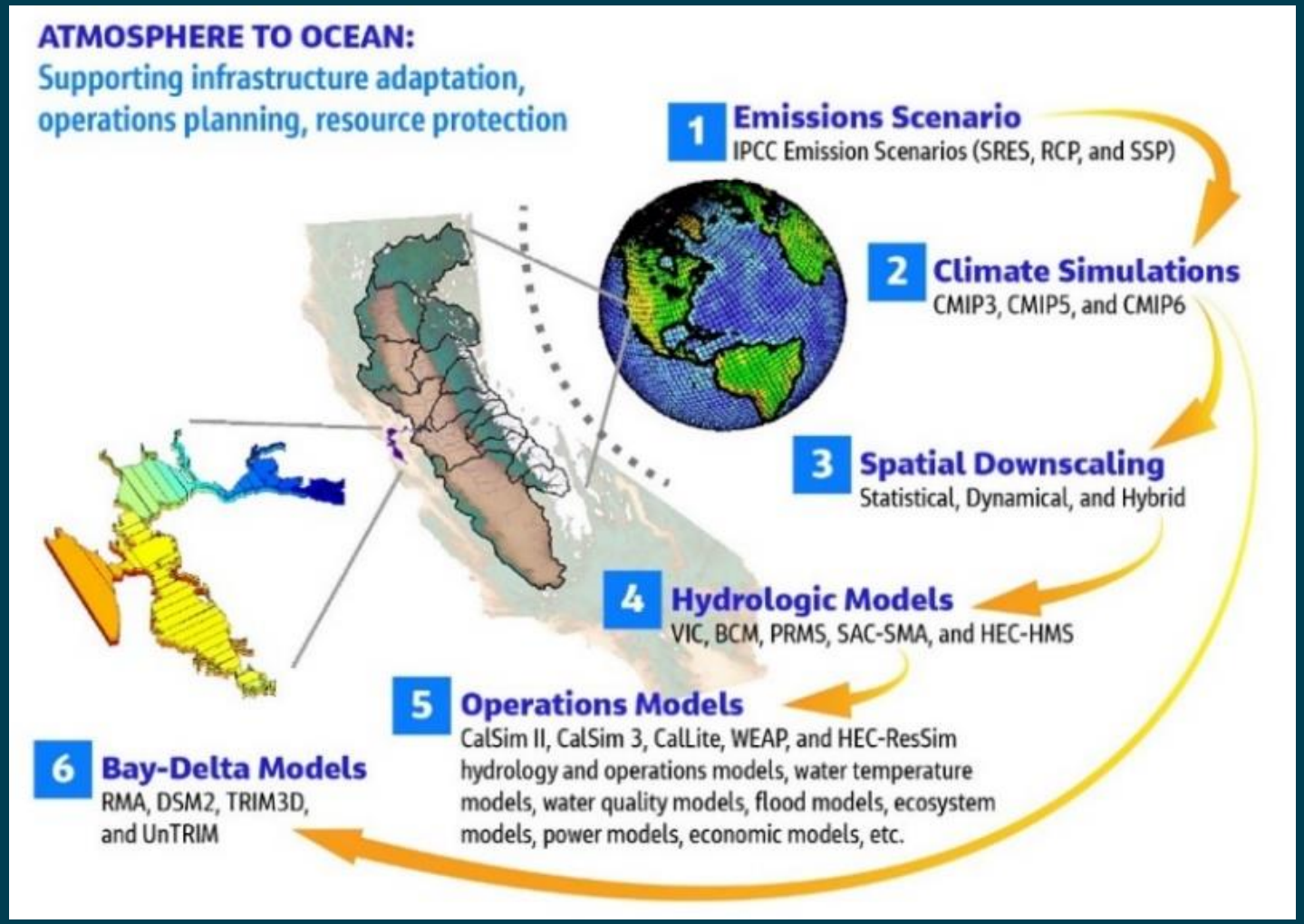
Source: Western Regional Climate Center

Mean Temperature Departures from 1991-2020 Average



Source: Western Regional Climate Center

Modeling Cascade

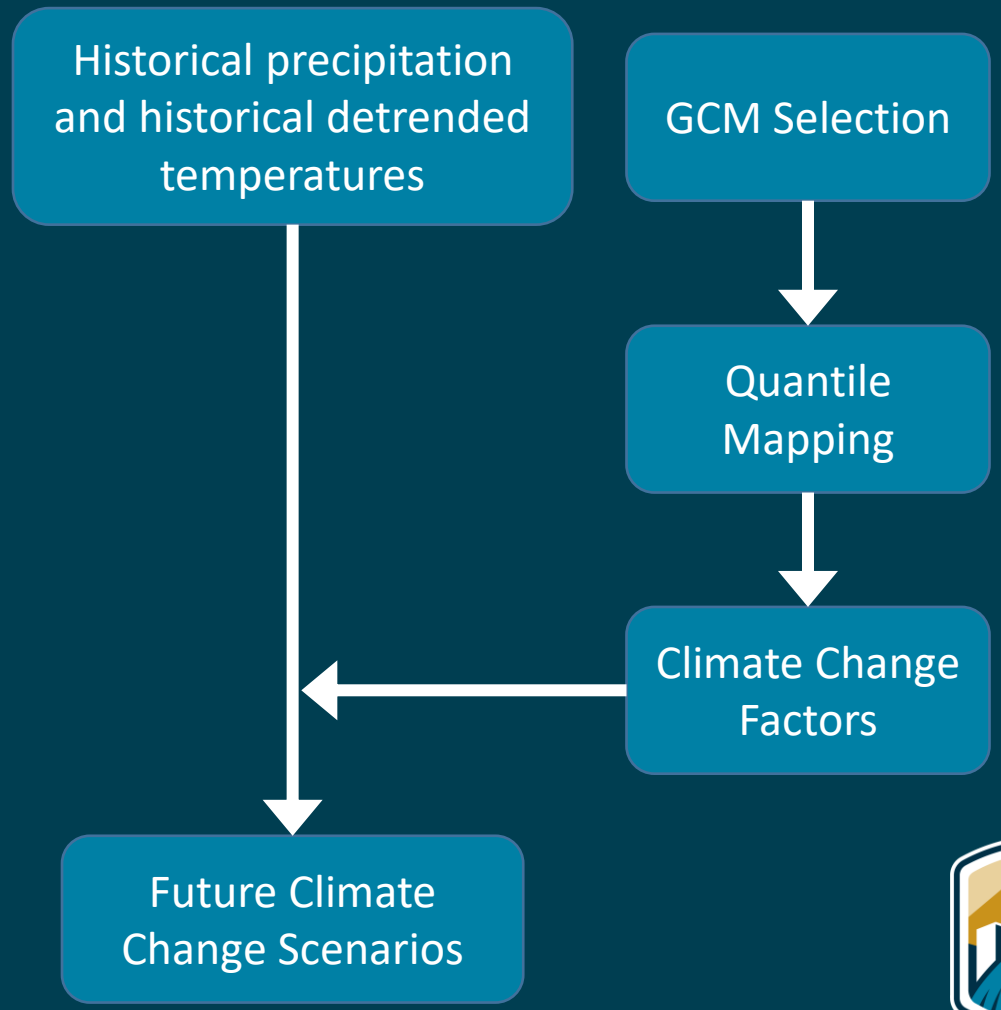


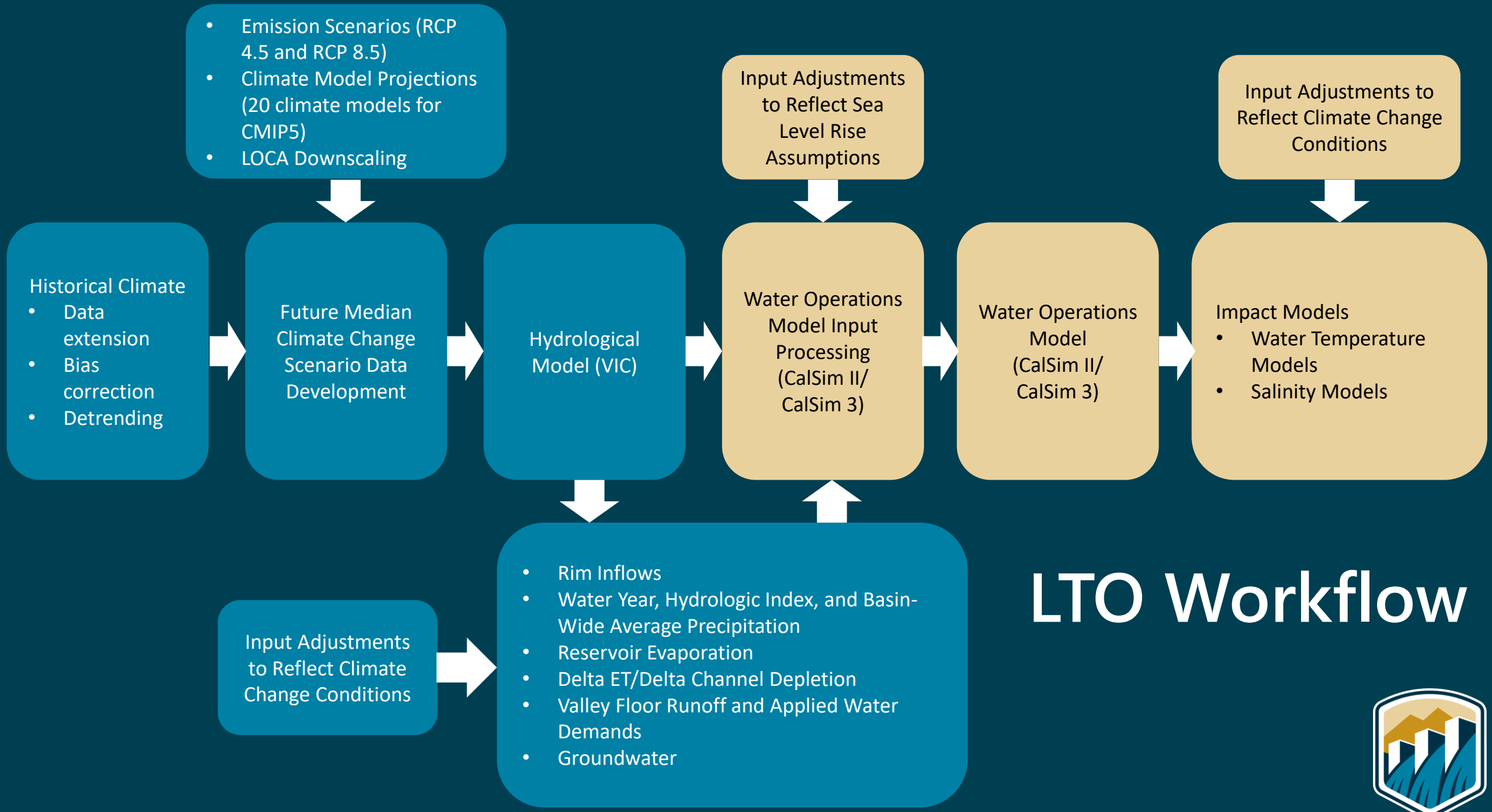
Reclamation, 2021

- Carry the best available climate information through the modeling workflow
- Sequential models at differing scales
- Climate and process uncertainty

Reclamation LTO Workflow

- Centers on the CalSim 3 operations model
  - Models regulatory, environmental, and contractual constraints on the CVP/SWP system
  - Groundwater, sea level, and surface hydrology included
- Assumes fixed constraints under a hydrologic timeseries
- Historic timeseries adjusted to represent future climate



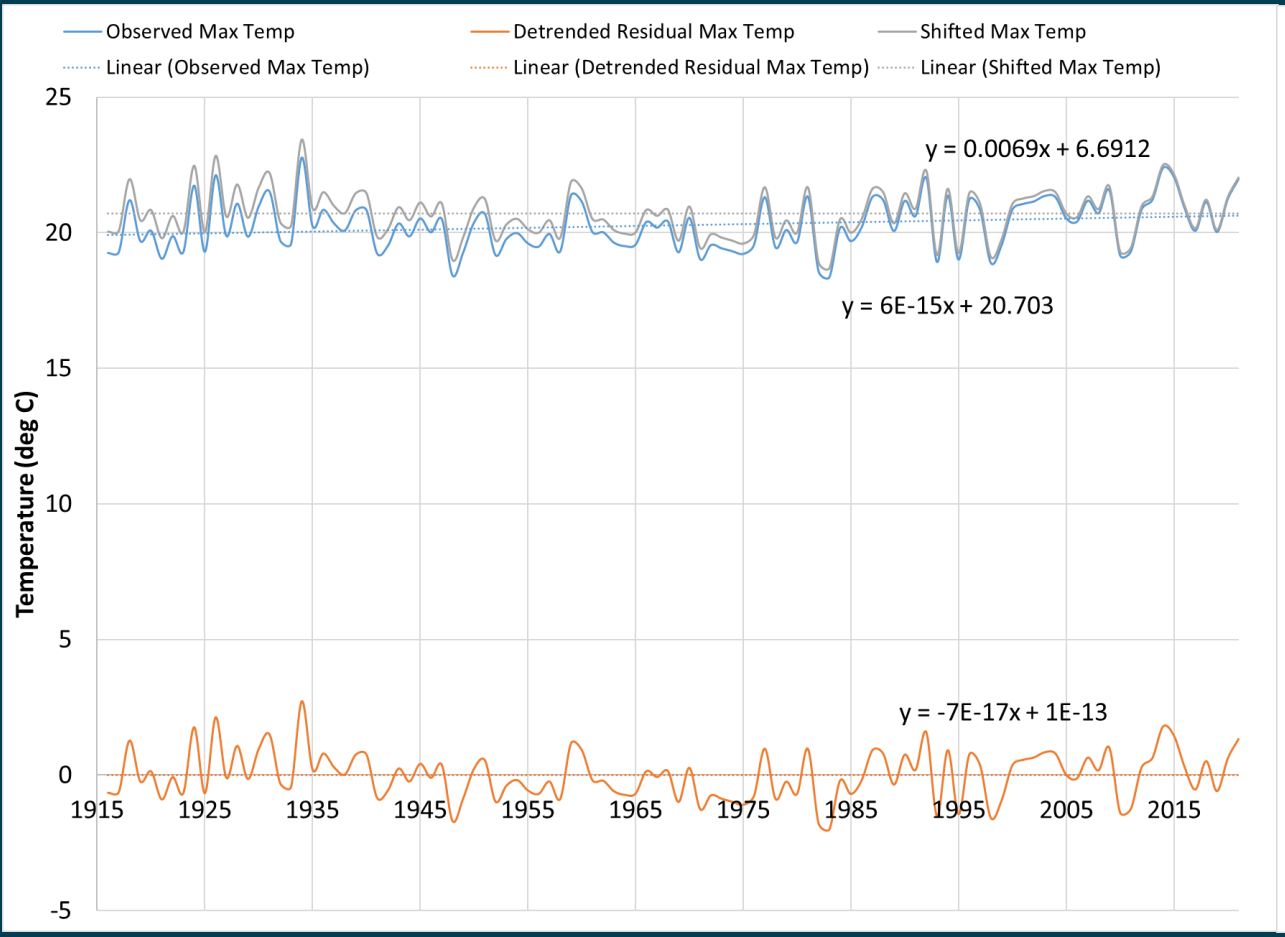


LTO Workflow

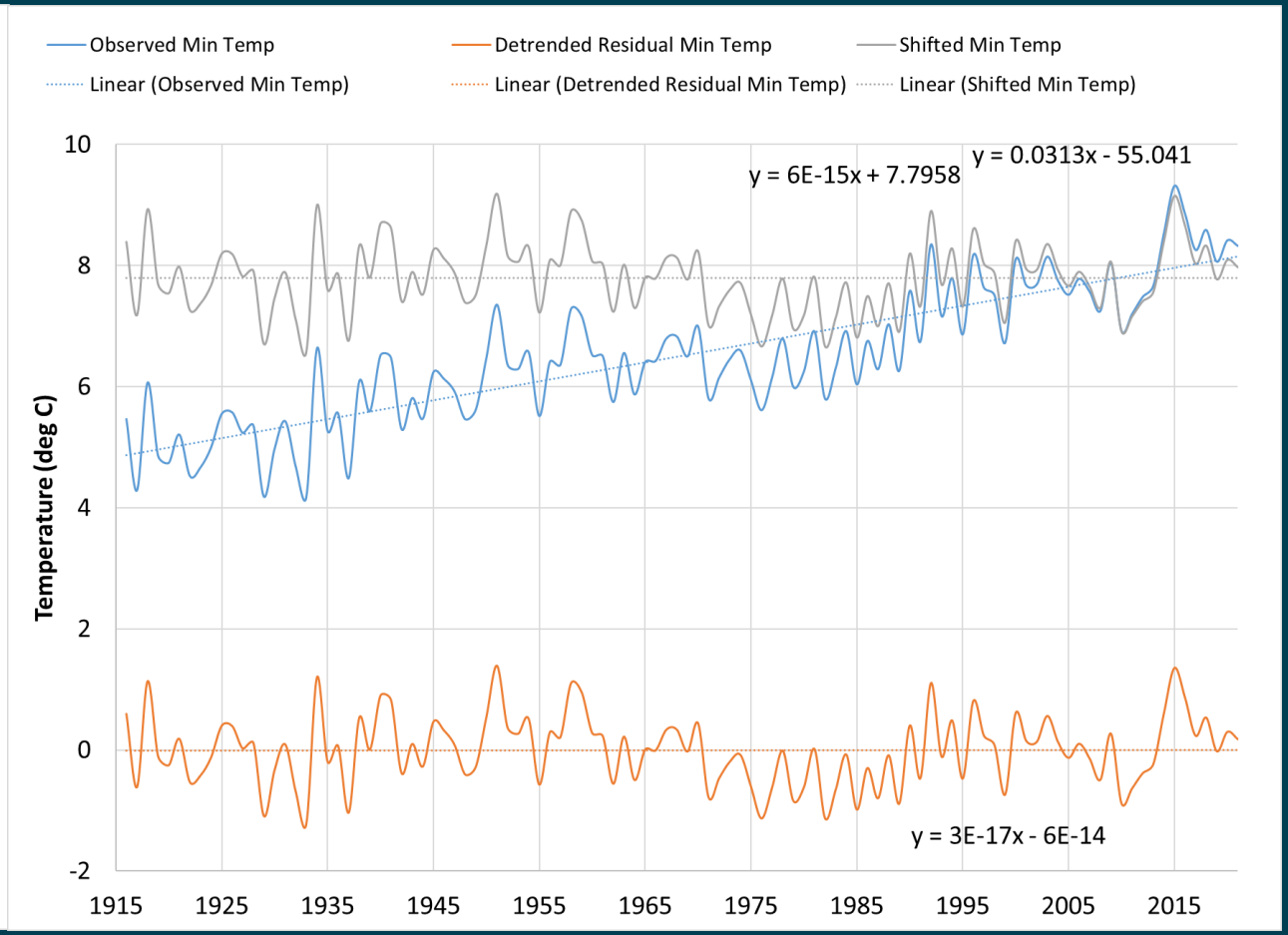
Temperature Detrending

The maximum and minimum temperatures are detrended with linear detrending method. The anchor period for temperature detrending is from 1991 to 2020.

Maximum Temperature



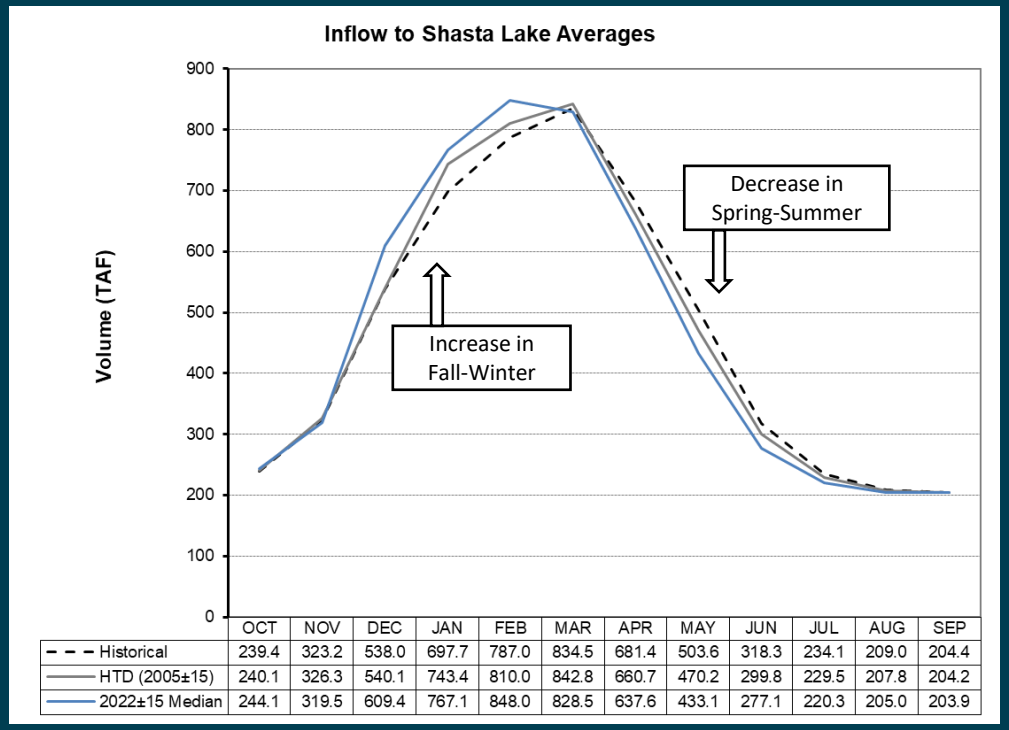
Minimum Temperature



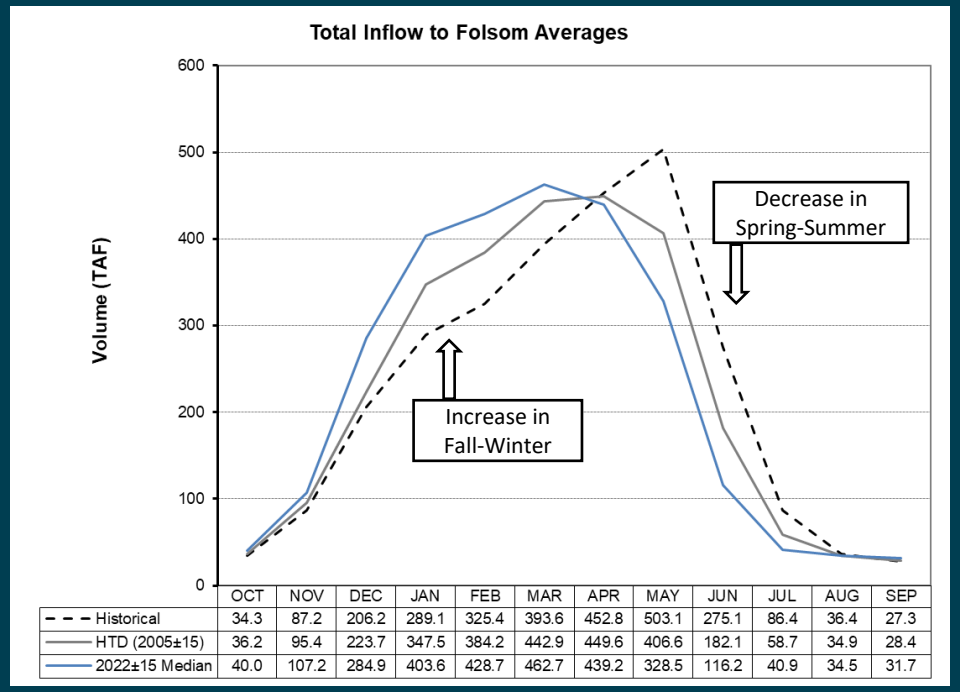
DRAFT: Subject to revisions

Climate Scenarios

- Baseline
  - 2022 Median ± 15 Years
- Climate Effects
  - Limited changes in total volumes
  - Earlier runoff, fill & spill
  - Warmer water temperatures
- Sensitivity Cases
  - Hot/Dry
    - 2022 ± 15 Years at 25th P and 75th T
  - Warm/Wet
    - 2022 ± 15 Years at 75th P and 25th T
  - 2040 Median
    - 2040 ± 15 Years at 50th P and 50th T



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Historical	239.4	323.2	538.0	697.7	787.0	834.5	681.4	503.6	318.3	234.1	209.0	204.4
HTD (2005±15)	240.1	326.3	540.1	743.4	810.0	842.8	660.7	470.2	299.8	229.5	207.8	204.2
2022±15 Median	244.1	319.5	609.4	767.1	848.0	828.5	637.6	433.1	277.1	220.3	205.0	203.9



	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Historical	34.3	87.2	206.2	289.1	325.4	393.6	452.8	503.1	275.1	86.4	36.4	27.3
HTD (2005±15)	36.2	95.4	223.7	347.5	384.2	442.9	449.6	406.6	182.1	58.7	34.9	28.4
2022±15 Median	40.0	107.2	284.9	403.6	428.7	462.7	439.2	328.5	116.2	40.9	34.5	31.7

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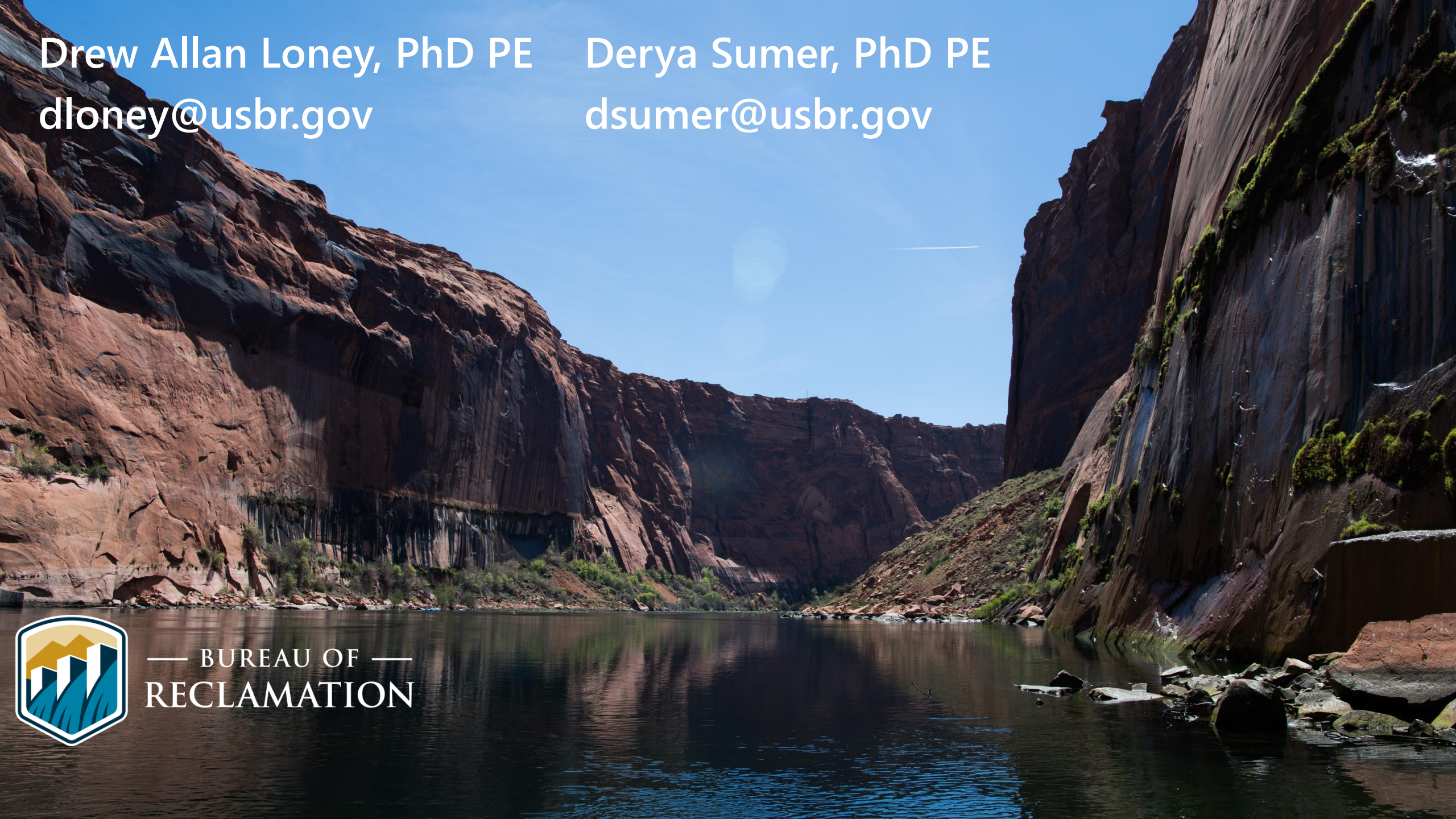

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Development of Detrended Historical Monthly Temperature Time Series

Following steps are used for detrending Tmax and DTR, separately. And Tmin is estimated as Tmax-DTR:

1. Calculate monthly averages from daily data over the historical period.
2. Compute linear trend for each month (e.g., January, February …, December) (time series for each month).
3. Remove the month-specific trend from the daily data. This results in a sequence of daily residuals.
4. Calculate monthly climatologies for 1991-2020 (i.e., the mean of all January values, the mean of all February values, and so on, from the values computed in Step 1).
5. Add the daily residuals calculated in Step 3 to the monthly climatology calculated in Step 4.

2022±15 Median Climate Change Scenario

- Changes in temperatures and precipitation are projected from 2006 onwards using climate models under different emission scenarios
- Adjusts for climate change around projected 2022
  - Statistics are developed from the period 2008 through 2037
  - Uses climate model information for 2022 conditions
  - Detrending and climate informed
- Modifies the historical meteorology for the entire period of record (1921 to 2021)