



*Water Resource Research*

Supporting Information for

**Quantifying and Classifying Streamflow Ensembles Using a Broad Range of Metrics  
for an Evidence-Based Analysis: Colorado River Case Study**

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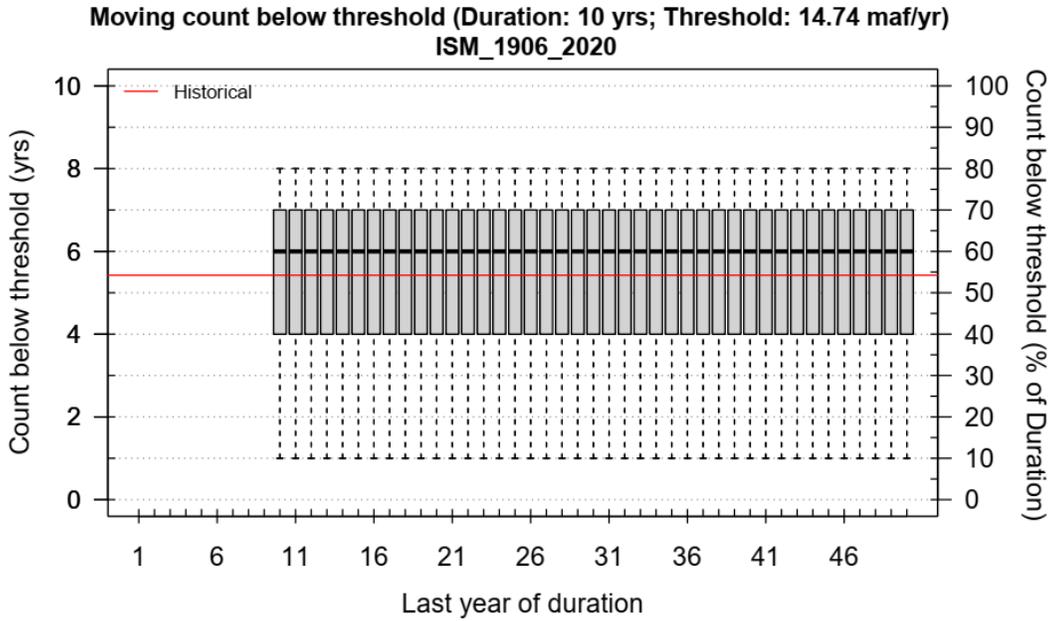
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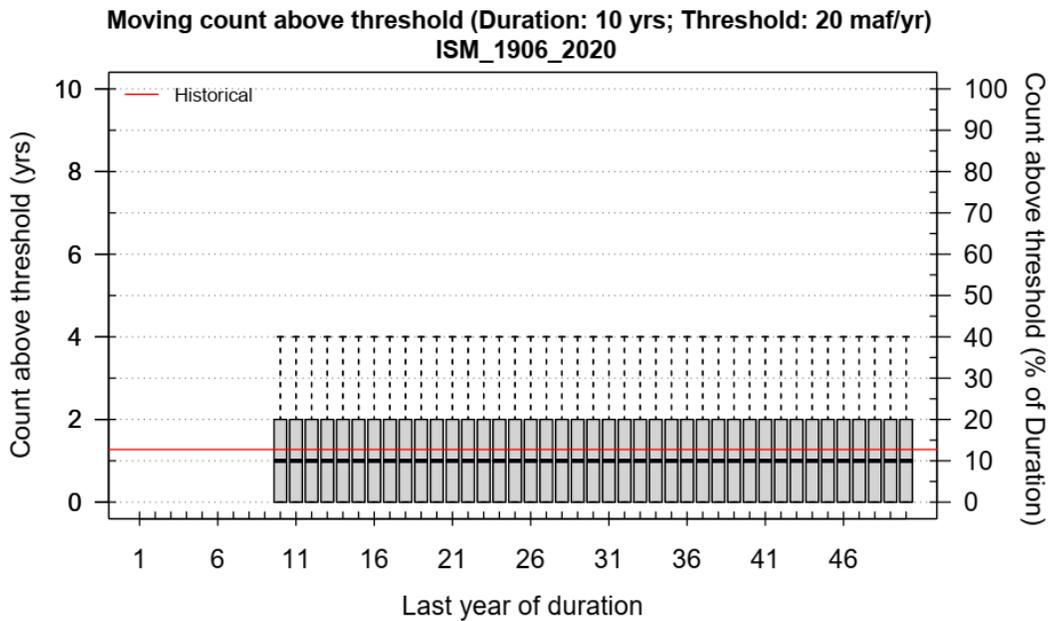
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**Introduction**

This supporting information contains figures illustrating metrics calculated for streamflow ensembles in the Colorado River Basin, as well as a summary description of each ensemble.



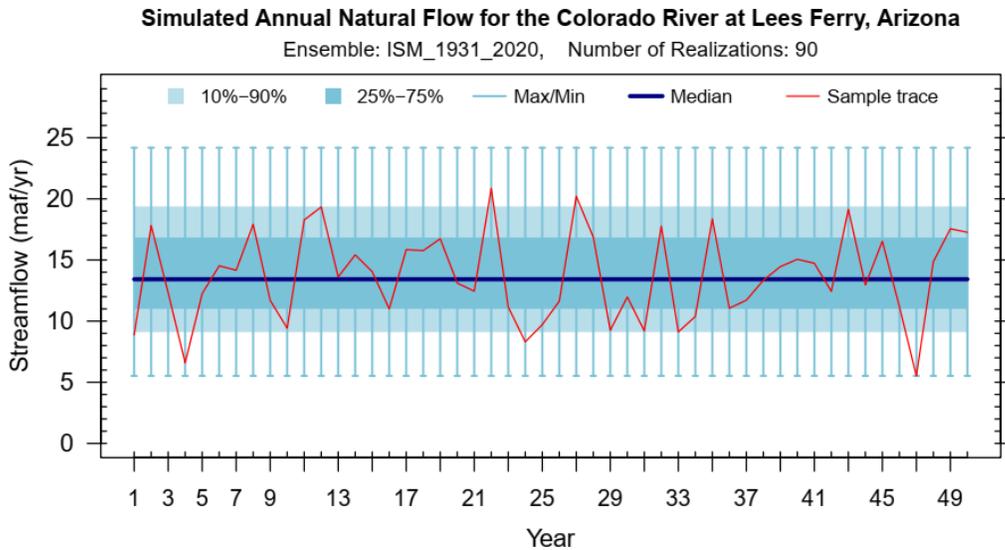
**Figure S1.** Moving count below threshold for the ISM\_1906\_2020 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



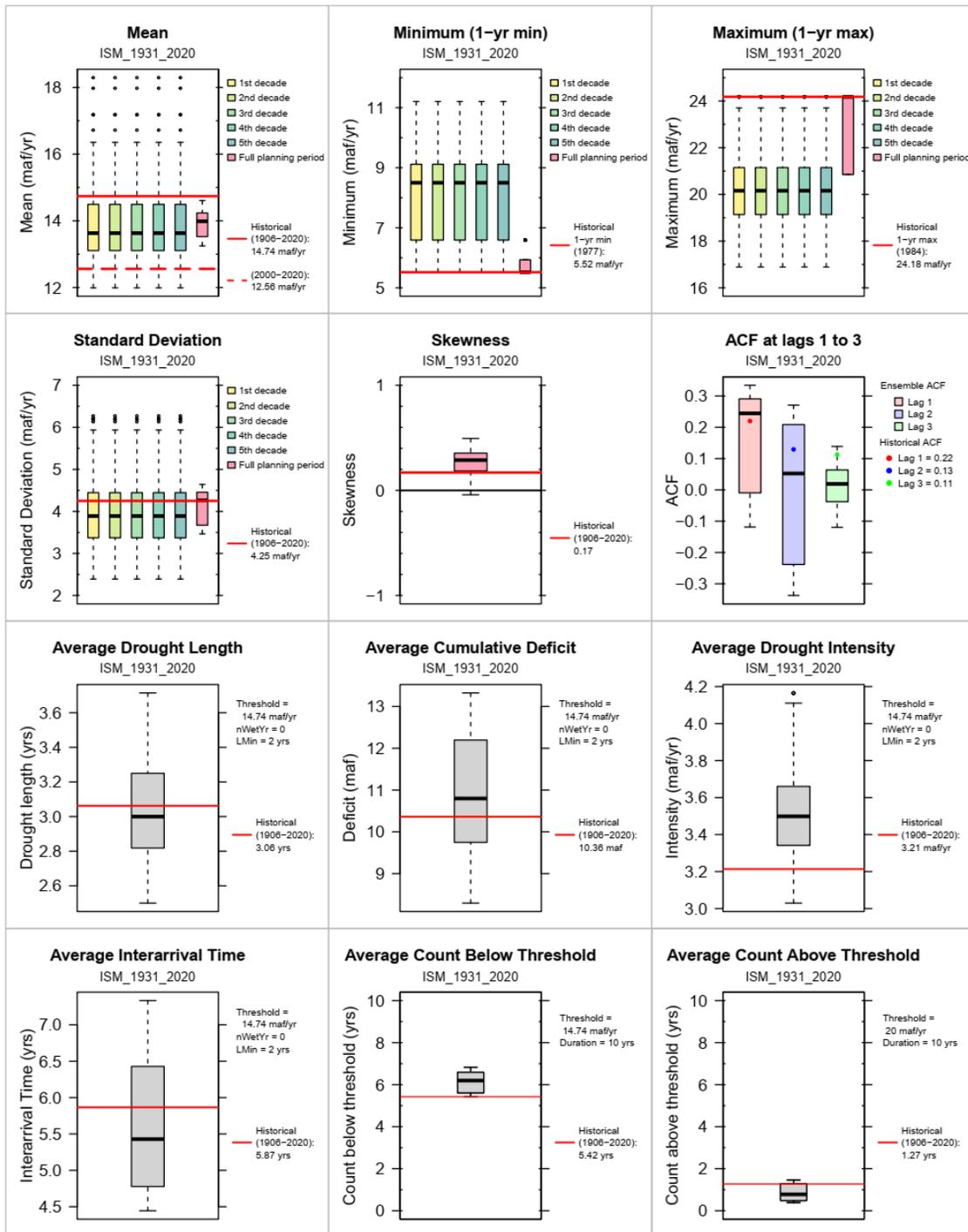
**Figure S2.** Moving count above threshold for the ISM\_1906\_2020 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.

**Text S1. ISM\_1931\_2020: Pluvial-Removed ISM Ensemble**

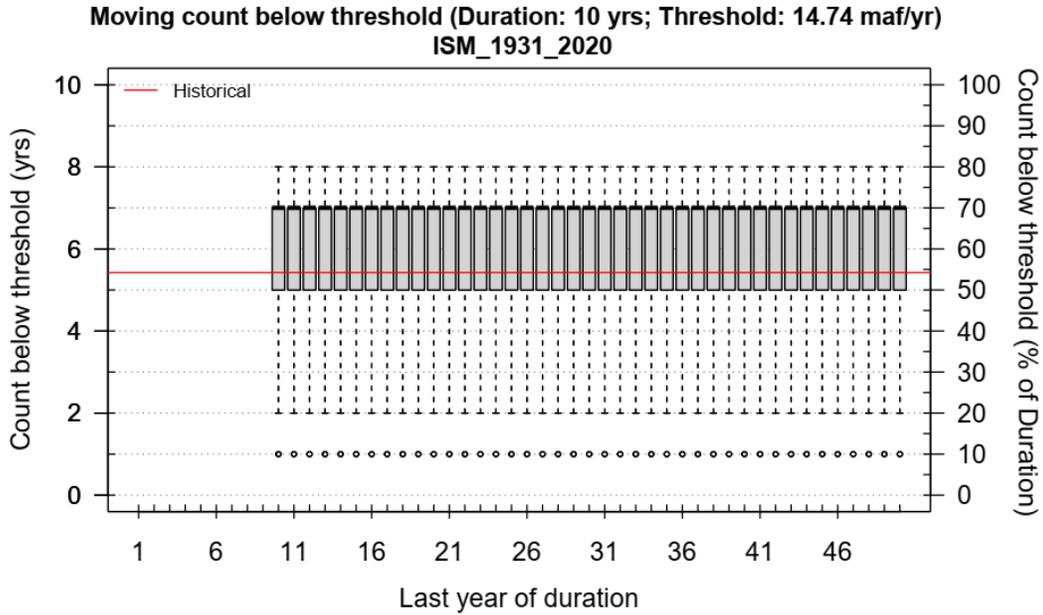
Figure S3 through Figure S9 present the metrics calculated for the Pluvial-Removed ISM ensemble, labeled as "ISM\_1931\_2020". This ensemble comprises 90 time series, generated using the Index Sequential Method (ISM) as described by Ouarda et al. (1997) and illustrated by Salehabadi et al. (2020). To generate this ensemble, ISM was applied to the post-pluvial historical natural flow from 1931 to 2020. The length of each time series of the ensemble is set by a designated planning period, taken as 50 years here.



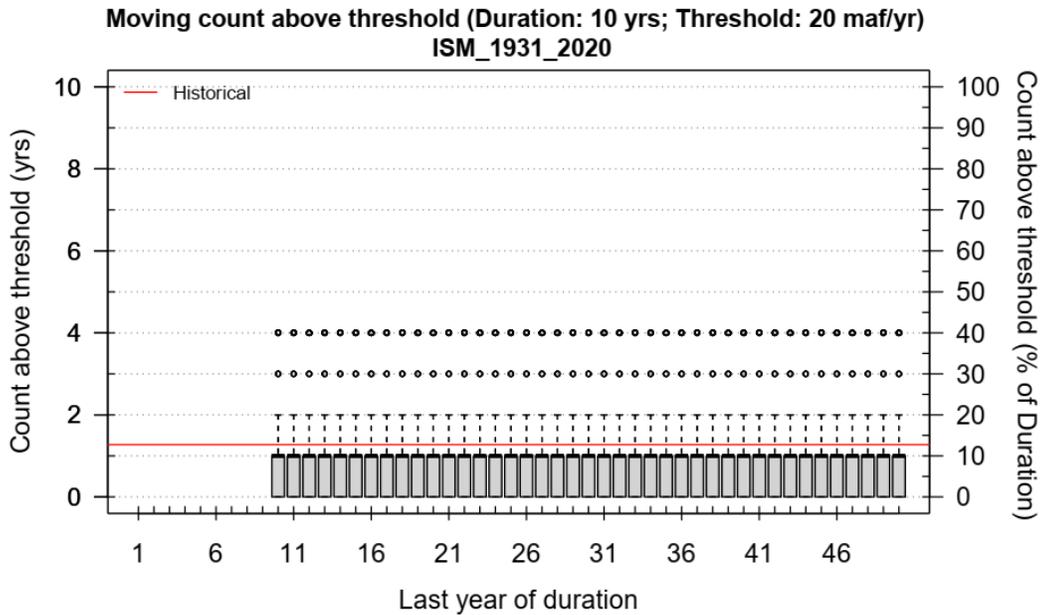
**Figure S3.** Time series of the simulated annual natural flow at Lees Ferry for the ISM\_1931\_2020 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



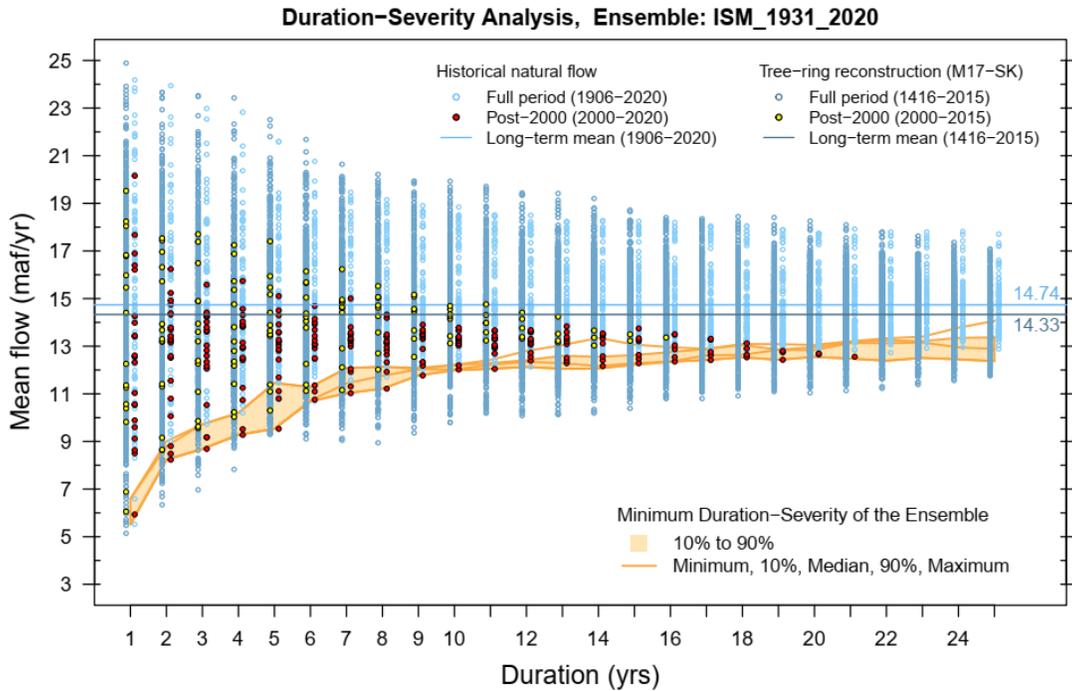
**Figure S4.** Summary metrics of simulated annual natural flow at Lees Ferry for the ISM\_1931\_2020 ensemble.



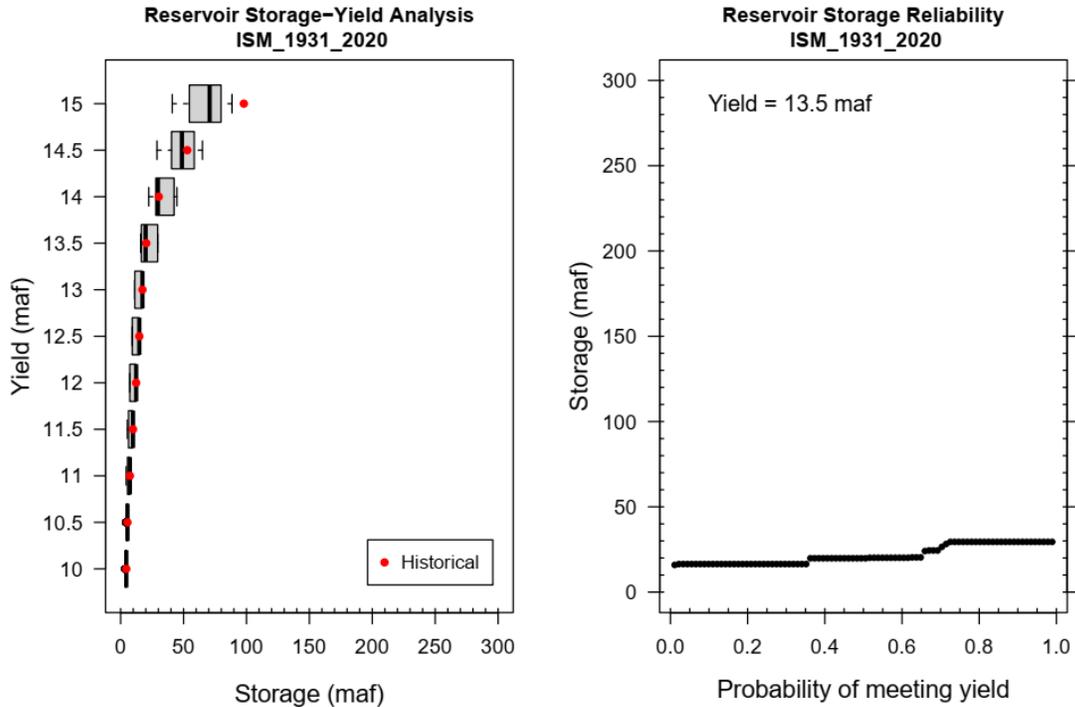
**Figure S5.** Moving count below threshold for the ISM\_1931\_2020 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



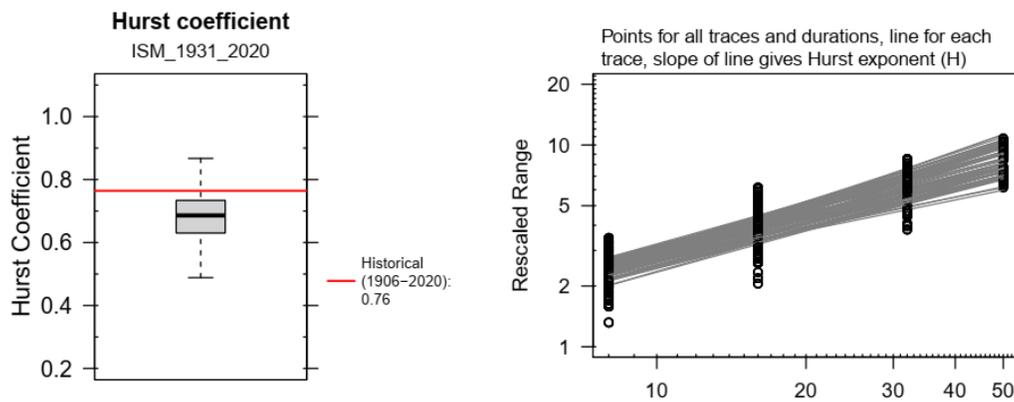
**Figure S6.** Moving count above threshold for the ISM\_1931\_2020 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S7.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the ISM\_1931\_2020 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



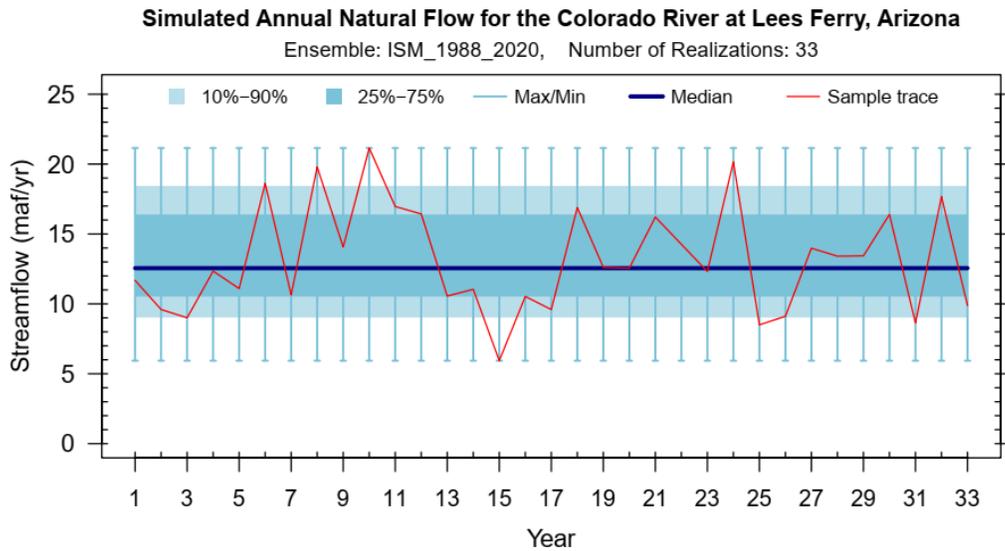
**Figure S8.** Reservoir storage-yield and reliability analysis for ISM\_1931\_2020. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



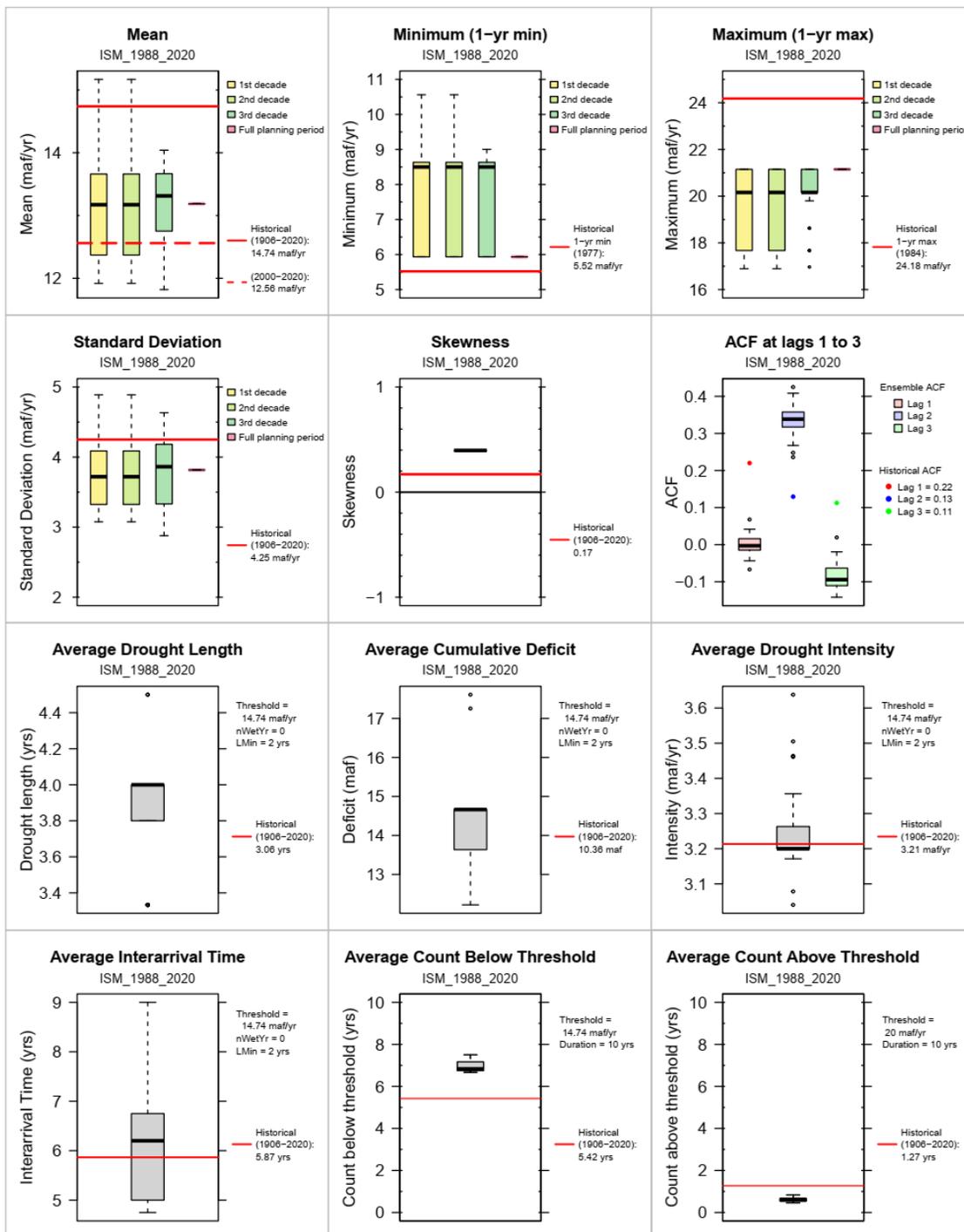
**Figure S9.** Hurst coefficient for the ISM\_1931\_2020 ensemble.

### Text S2. ISM\_1988\_2020: Stress Test ISM

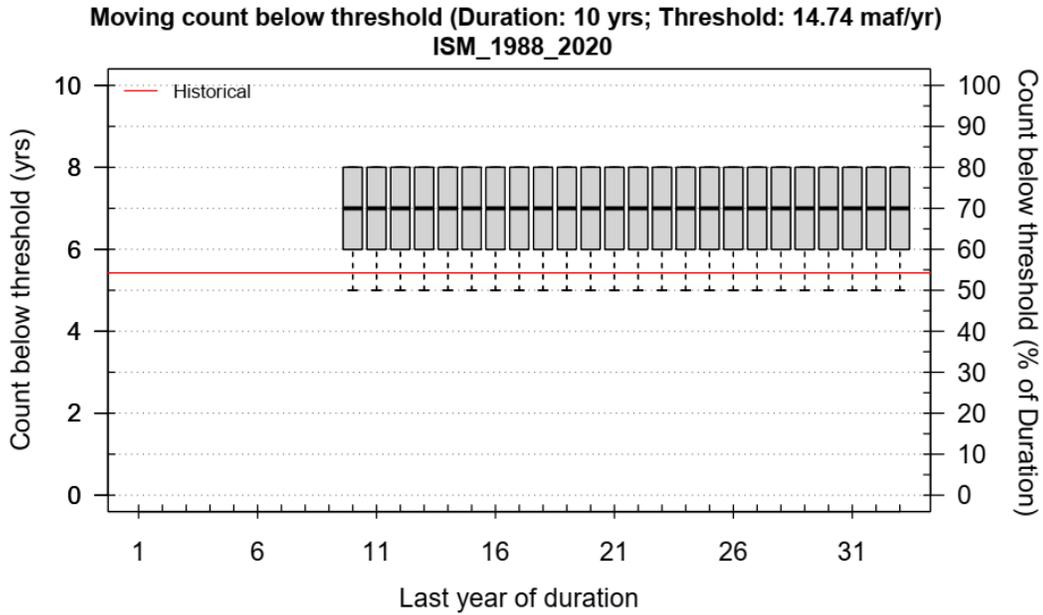
Figure S10 through Figure S16 present the metrics calculated for the Stress Test ISM ensemble, labeled as "ISM\_1988\_2020". This ensemble is generated by applying ISM to a subset of the historical natural flow record from 1988 to 2020. This ensemble comprises 33 time series, each 33 years long, and can only be used for planning periods up to 33 years.



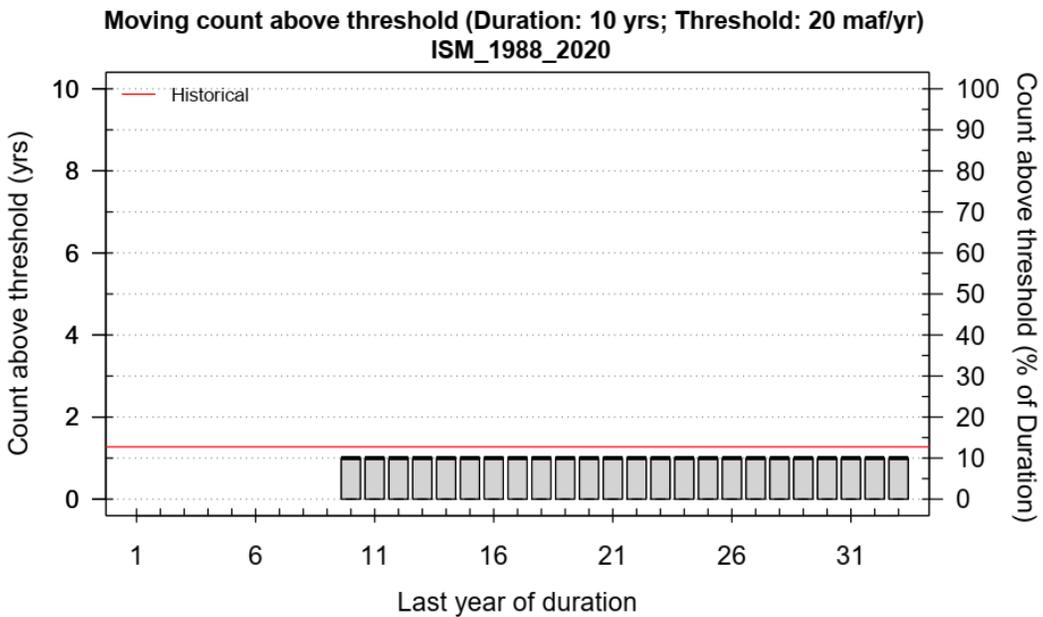
**Figure S10.** Time series of the simulated annual natural flow at Lees Ferry for the ISM\_1988\_2020 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



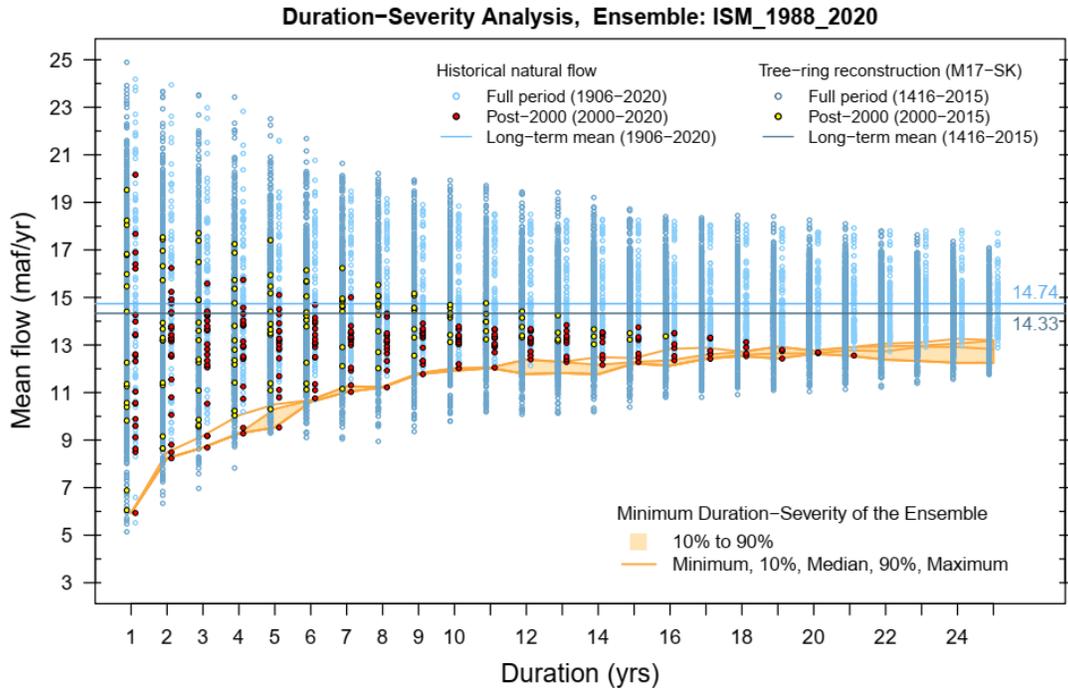
**Figure S11.** Summary metrics of simulated annual natural flow at Lees Ferry for the ISM\_1988\_2020 ensemble.



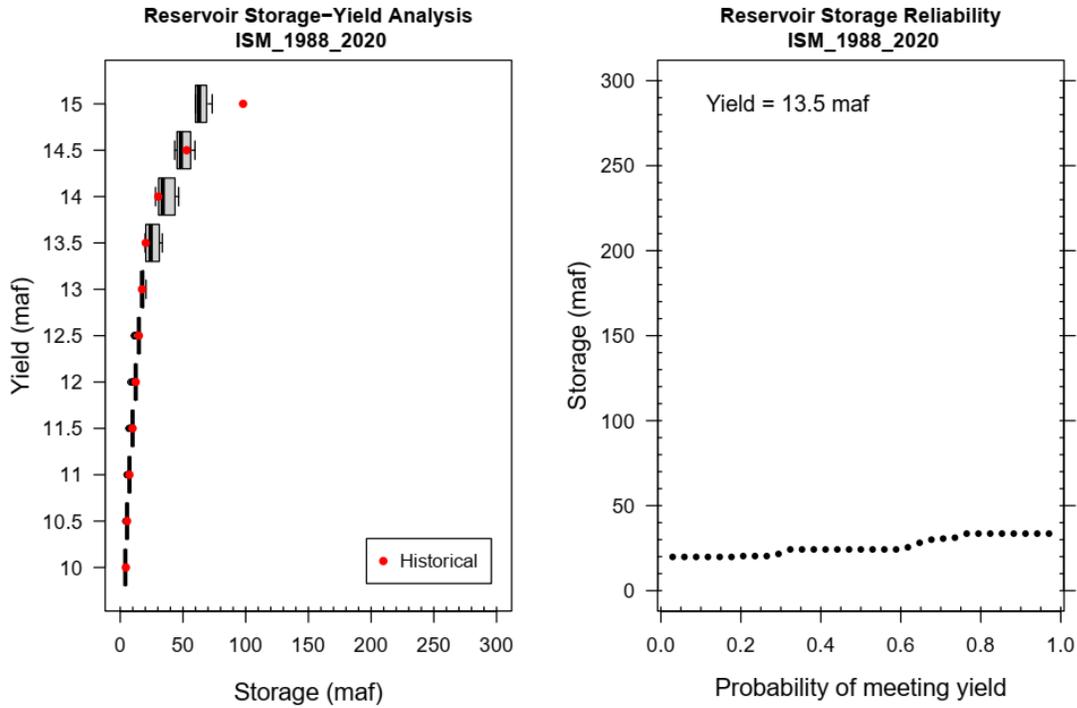
**Figure S12.** Moving count below threshold for the ISM\_1988\_2020 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



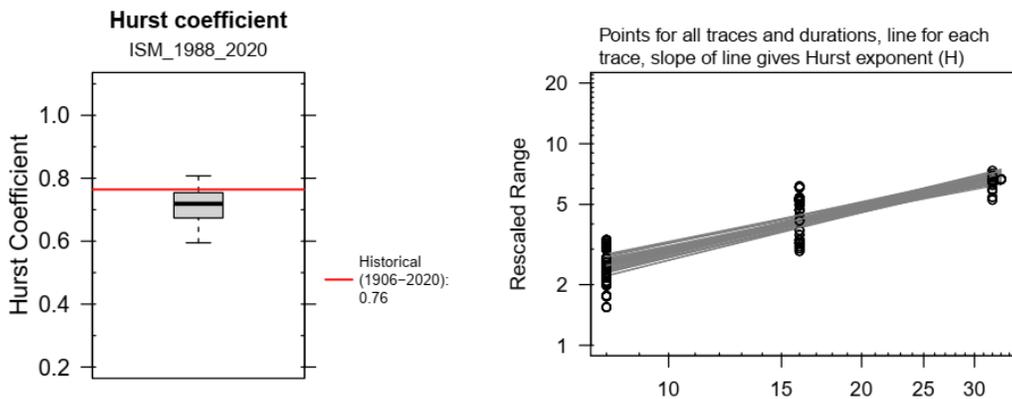
**Figure S13.** Moving count above threshold for the ISM\_1988\_2020 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S14.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the ISM\_1988\_2020 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



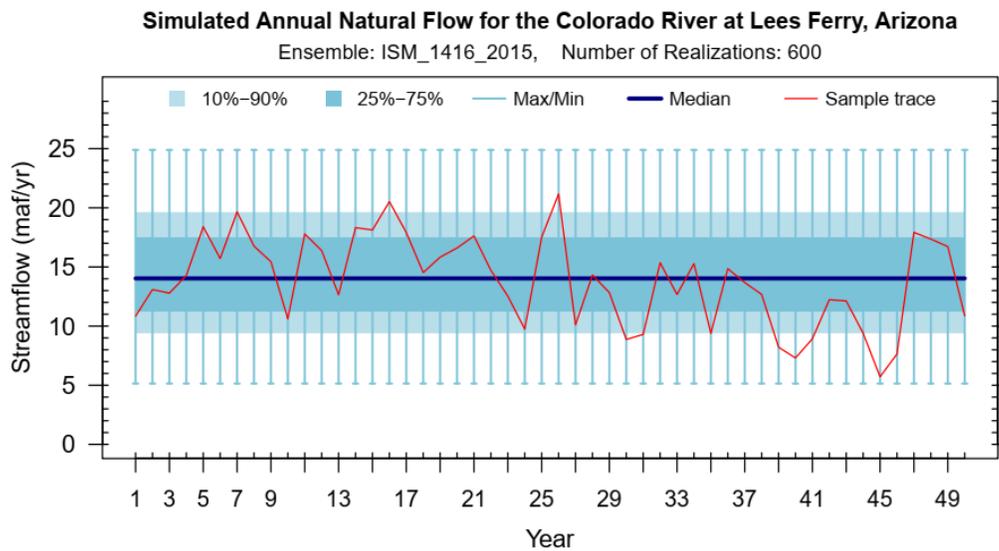
**Figure S15.** Reservoir storage-yield and reliability analysis for ISM\_1988\_2020. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



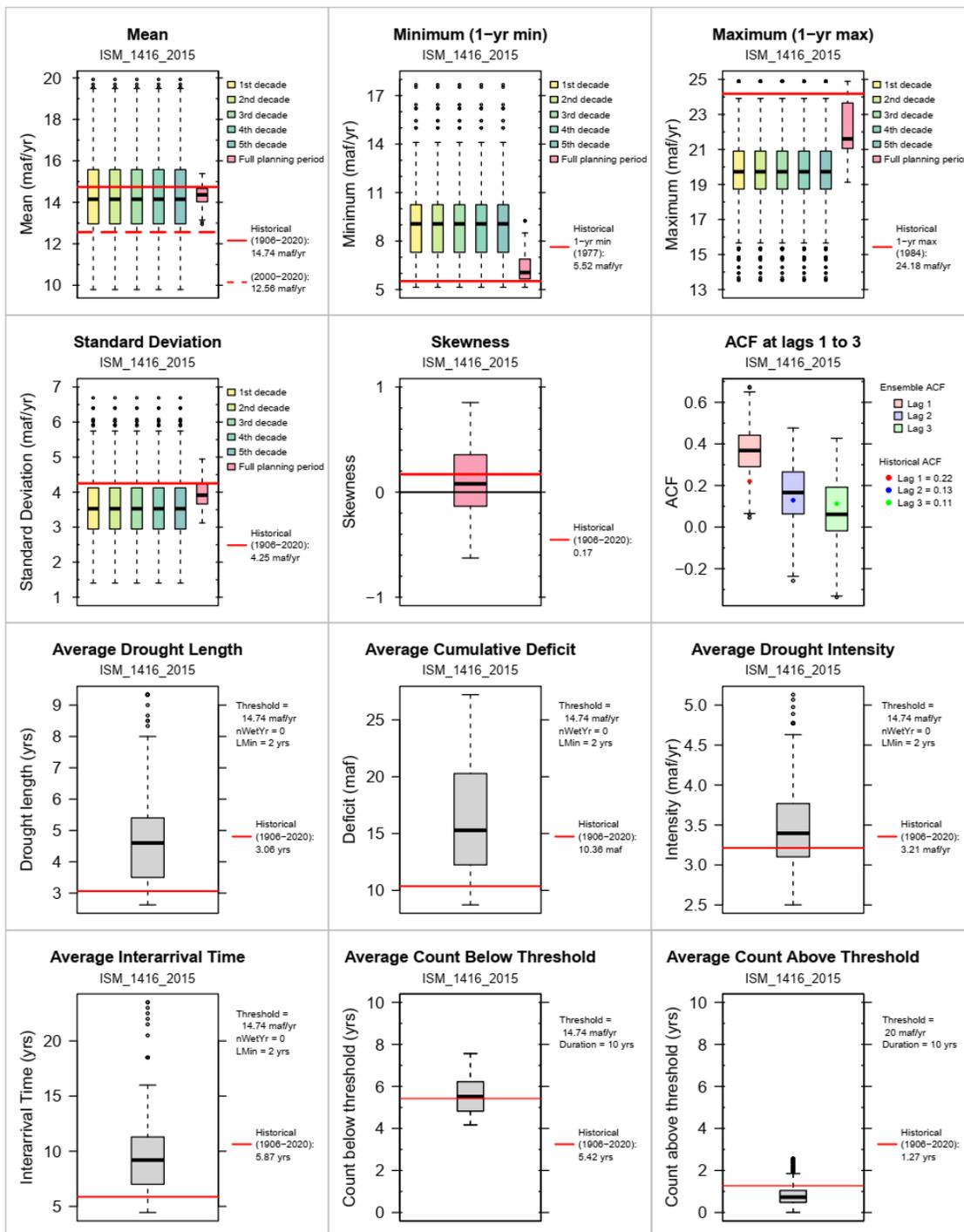
**Figure S16.** Hurst coefficient for the ISM\_1988\_2020 ensemble.

### Text S3. ISM\_1416\_2015: Paleo ISM Ensemble

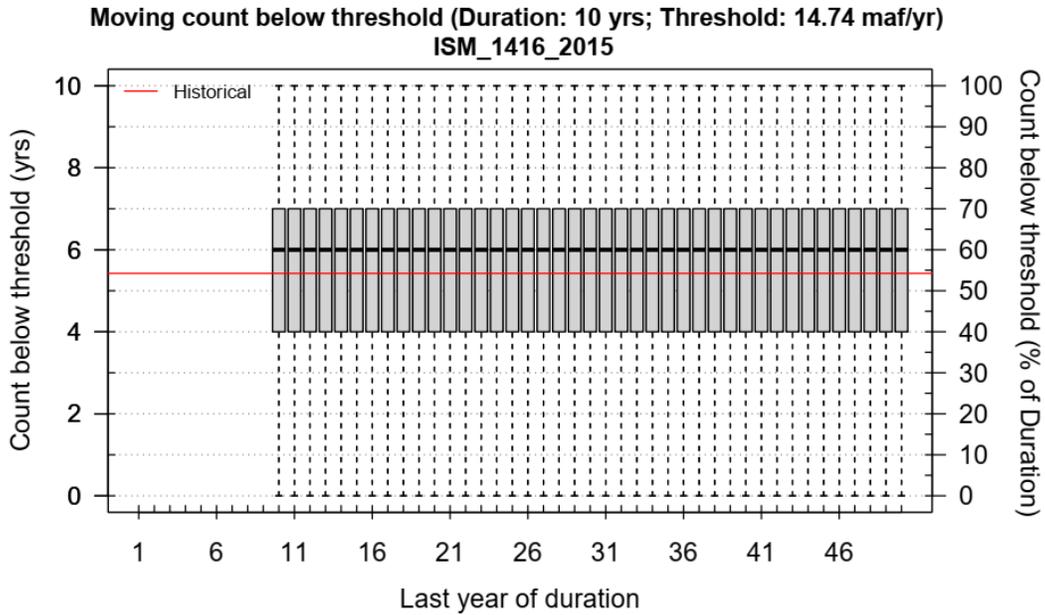
Figure S17 through Figure S23 present the metrics calculated for the Paleo ISM ensemble, labeled as "ISM\_1416\_2015". This ensemble comprises 600 time series, generated by applying ISM to the full period (1416-2015) of tree-ring-reconstructed natural flow data. The length of each time series of the ensemble is set by a designated planning period, taken as 50 years here.



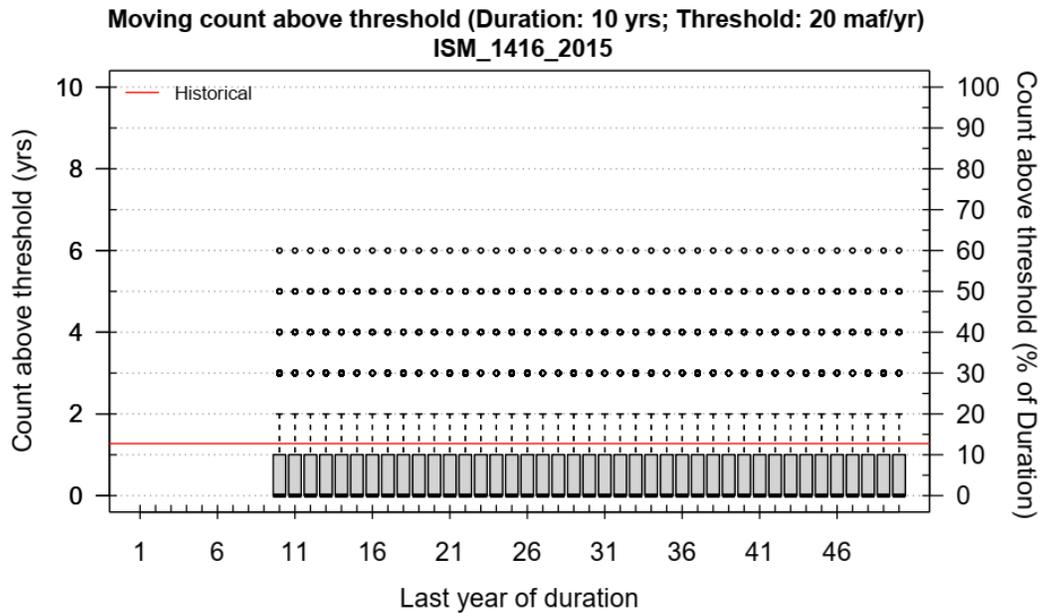
**Figure S17.** Time series of the simulated annual natural flow at Lees Ferry for the ISM\_1416\_2015 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



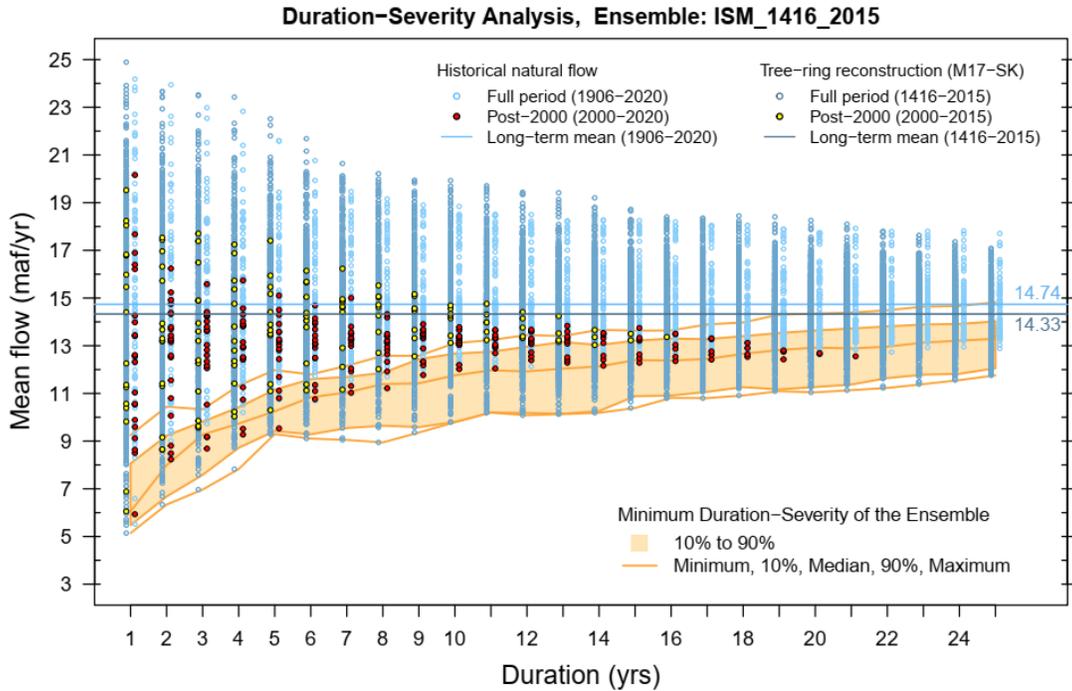
**Figure S18.** Summary metrics of simulated annual natural flow at Lees Ferry for the ISM\_1416\_2015 ensemble.



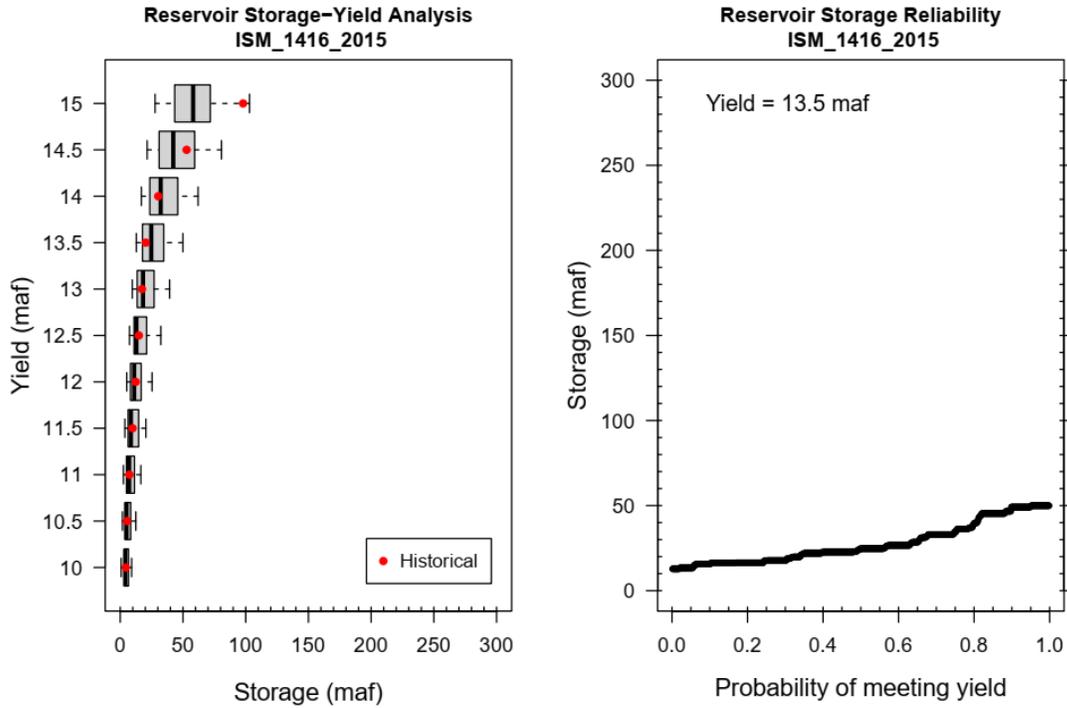
**Figure S19.** Moving count below threshold for the ISM\_1416\_2015 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



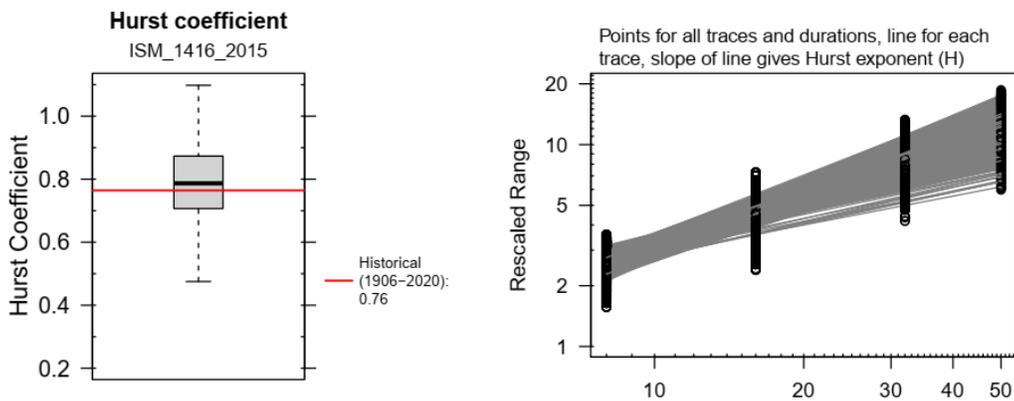
**Figure S20.** Moving count above threshold for the ISM\_1416\_2015 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S21.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the ISM\_1416\_2015 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



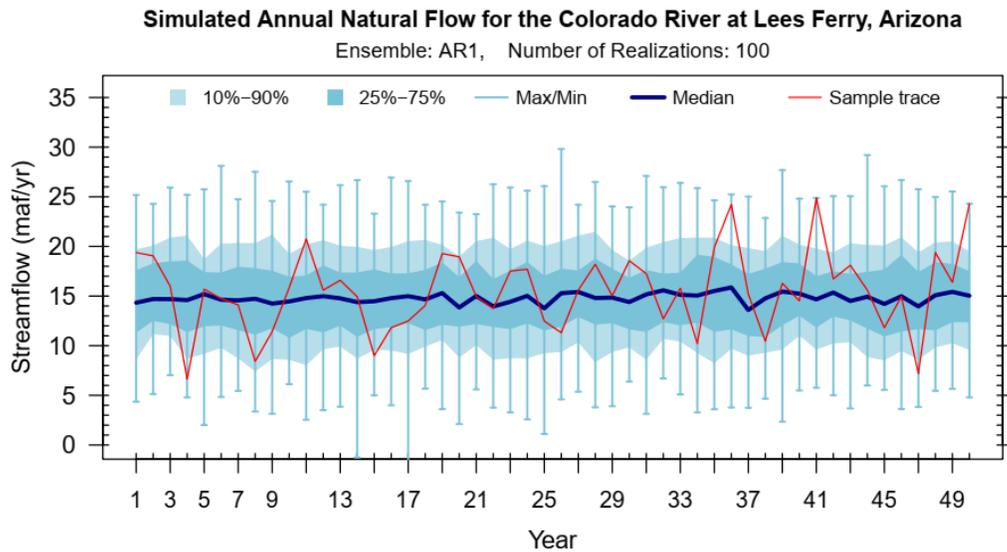
**Figure S22.** Reservoir storage-yield and reliability analysis for ISM\_1416\_2015. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



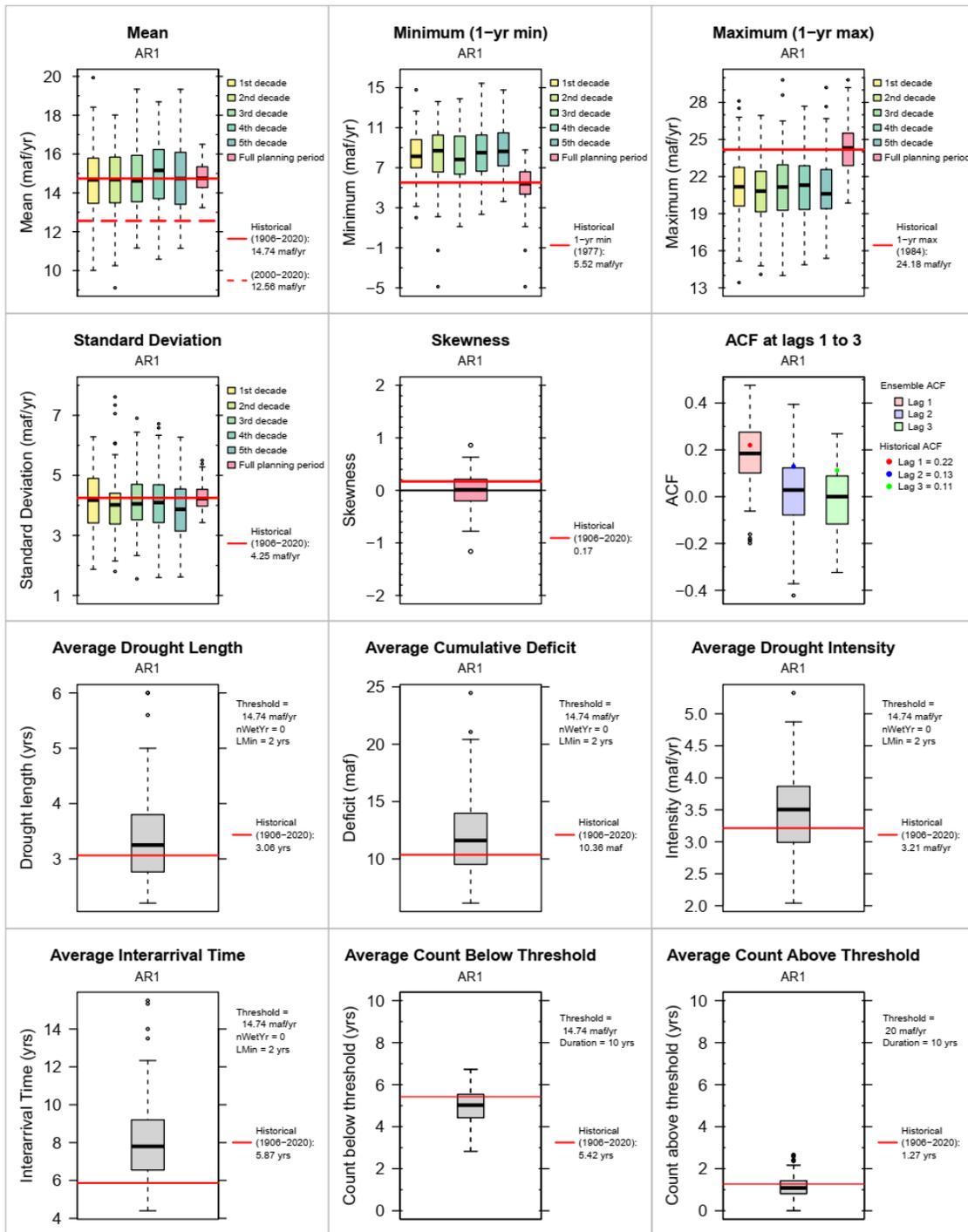
**Figure S23.** Hurst coefficient for the ISM\_1416\_2015 ensemble.

#### Text S4. AR1 Ensemble

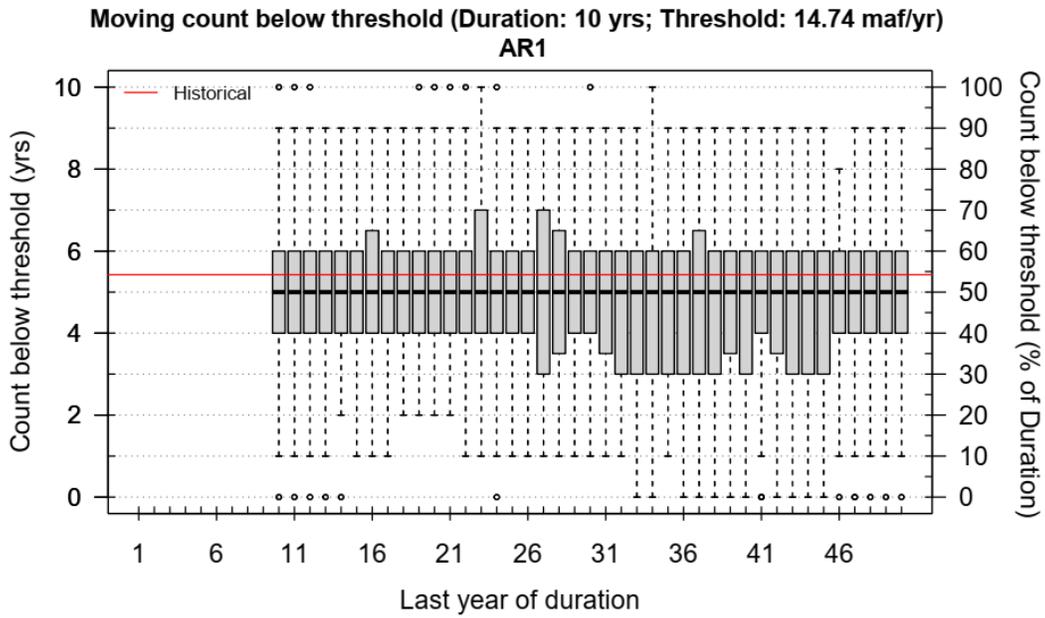
Figure S24 through Figure S30 present the metrics calculated for the AR1 ensemble. This ensemble comprises 100 time series, each 50 years long, generated using an Auto-Regressive order 1 (AR1) model with mean and variance of the full observed natural flow record.



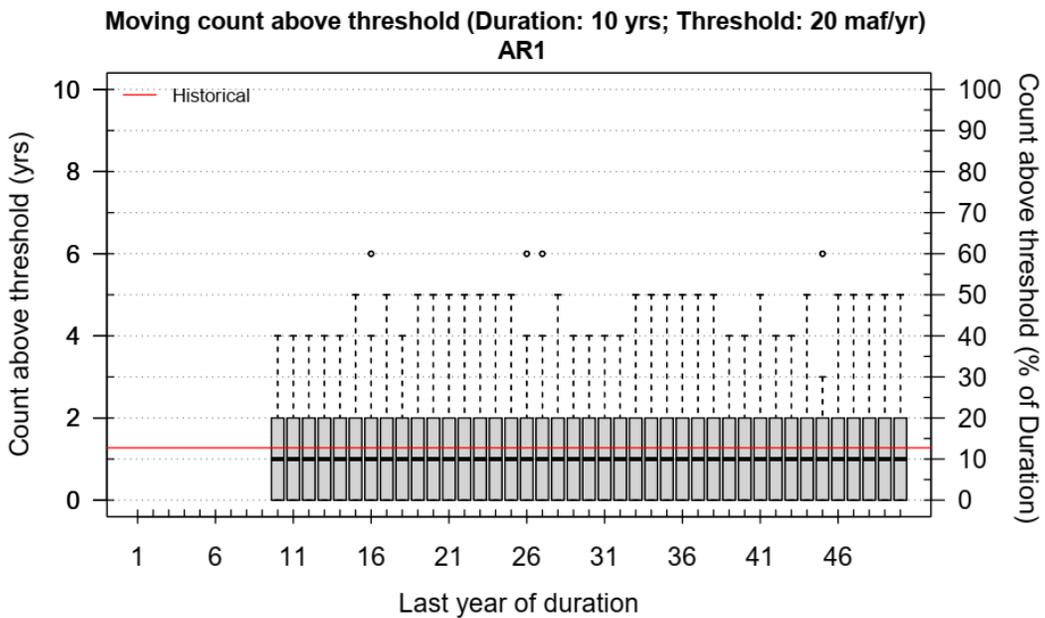
**Figure S24.** Time series of the simulated annual natural flow at Lees Ferry for the AR1 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



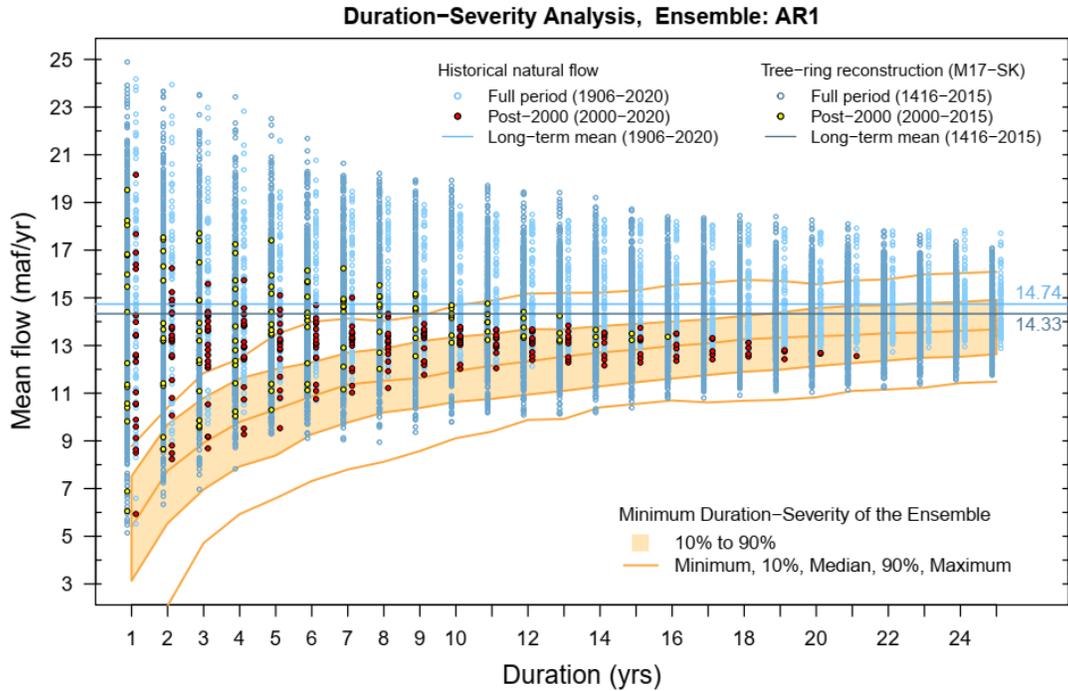
**Figure S25.** Summary metrics of simulated annual natural flow at Lees Ferry for the AR1 ensemble.



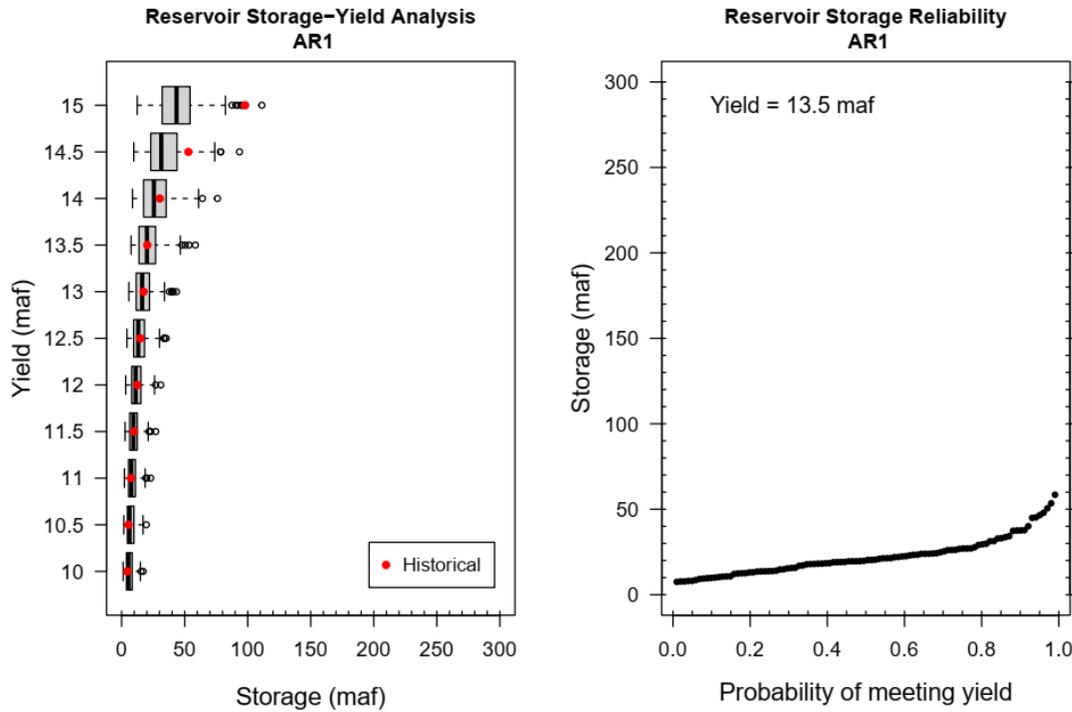
**Figure S26.** Moving count below threshold for the AR1 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



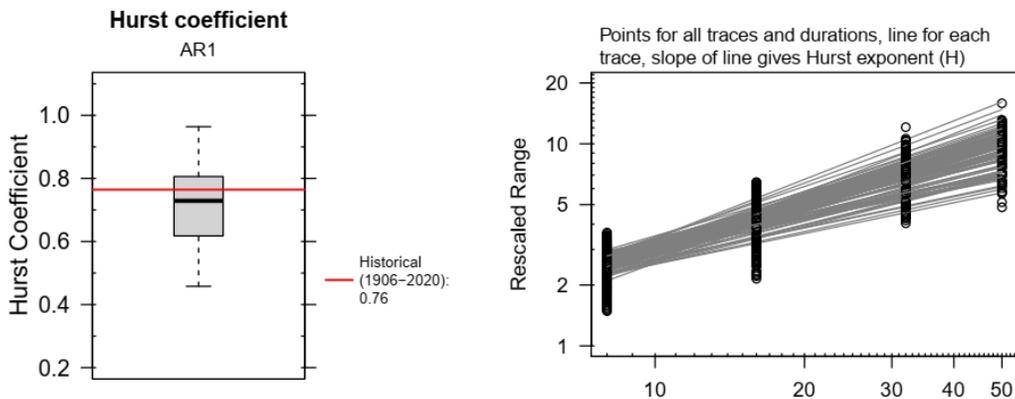
**Figure S27.** Moving count above threshold for the AR1 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S28.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the AR1 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



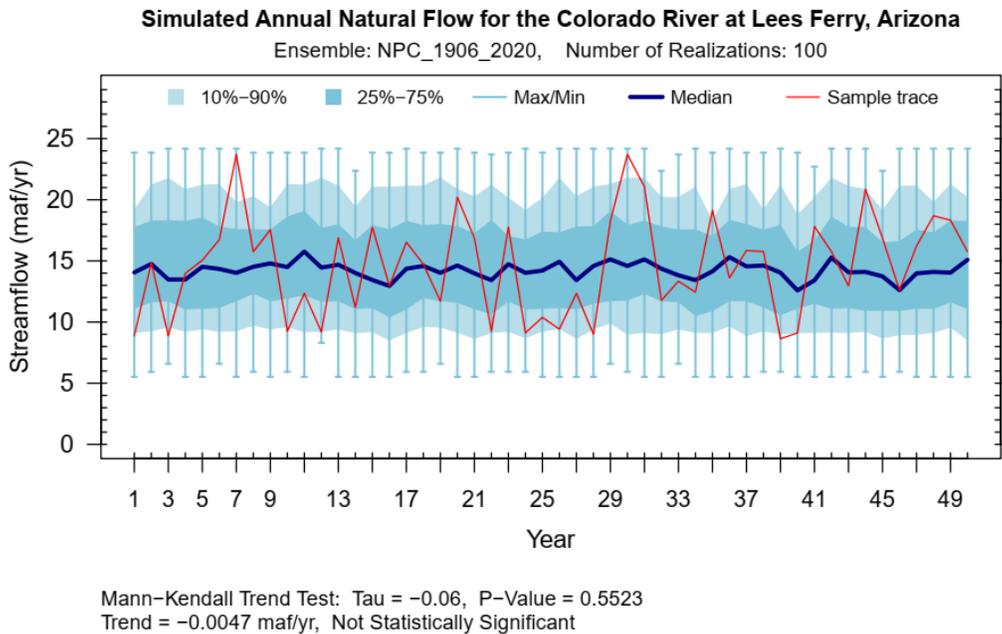
**Figure S29.** Reservoir storage-yield and reliability analysis for AR1. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



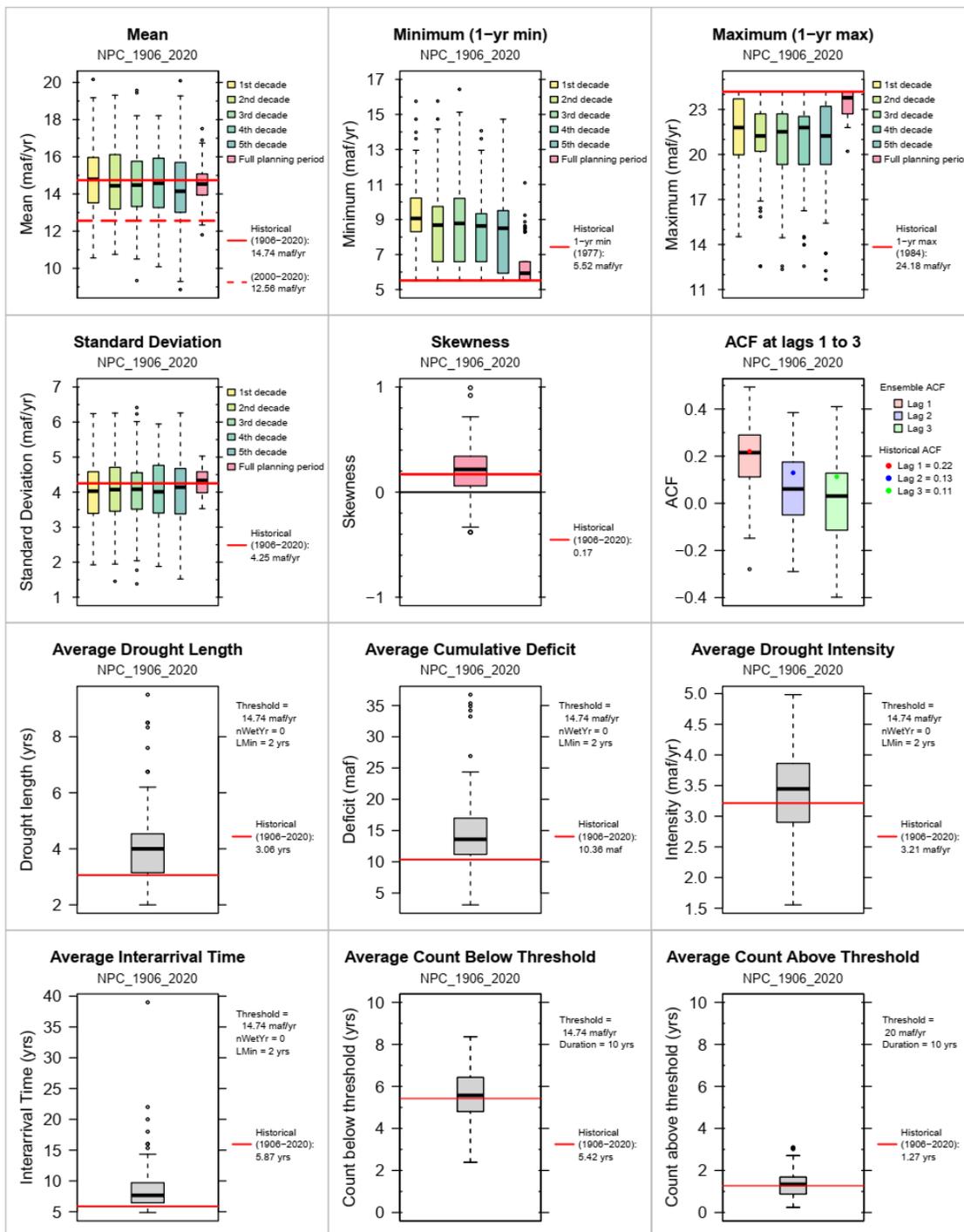
**Figure S30.** Hurst coefficient for the AR1 ensemble.

**Text S5. NPC\_1906\_2020: Full Observed Record Paleo-Conditioned Ensemble**

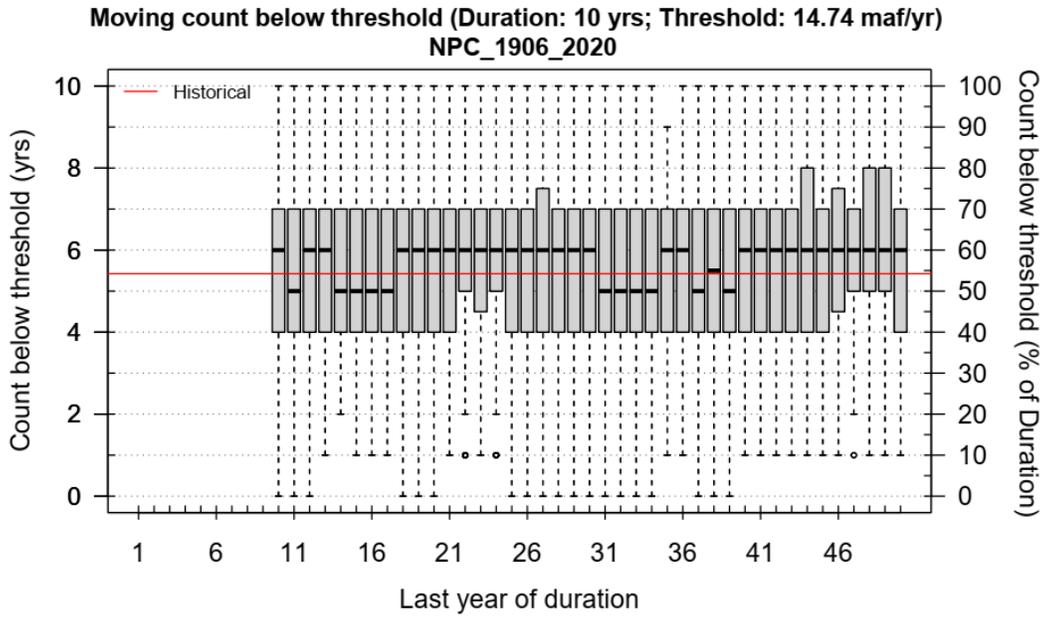
Figure S31 through Figure S37 present the metrics calculated for the Full Observed Record Paleo-Conditioned ensemble, labeled as “NPC\_1906\_2020”. This ensemble comprises 100 time series, each 50 years long, generated using the Nonparametric Paleo-Conditioned (NPC) method described by Prairie et al. (2008). NPC was applied to the full observed natural flow record from 1906 to 2020 and tree-ring reconstructed natural flows from 1416 to 2015.



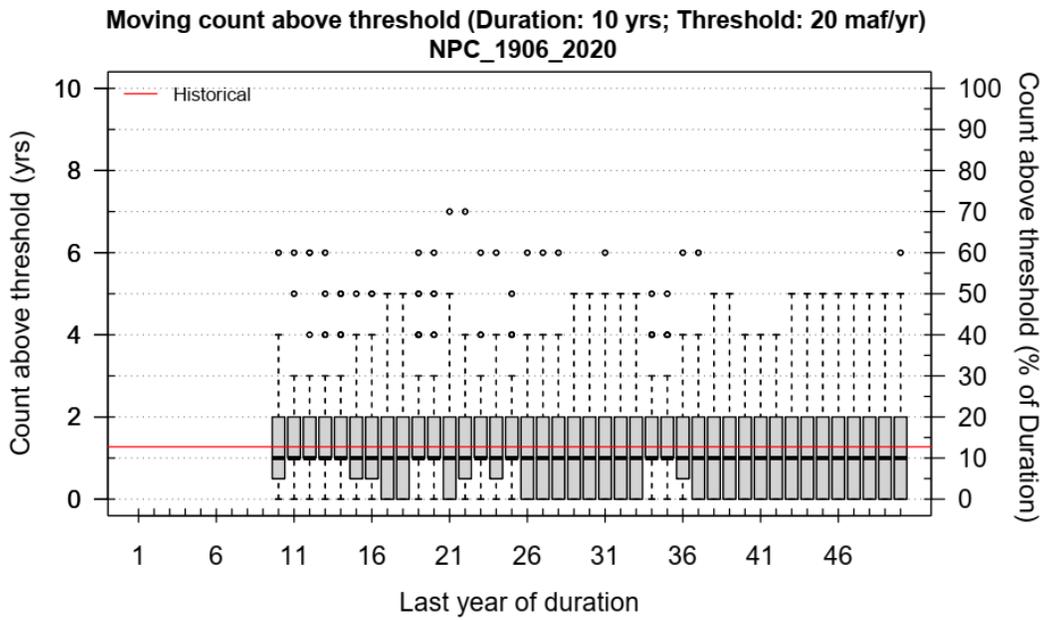
**Figure S31.** Time series of the simulated annual natural flow at Lees Ferry for the NPC\_1906\_2020 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



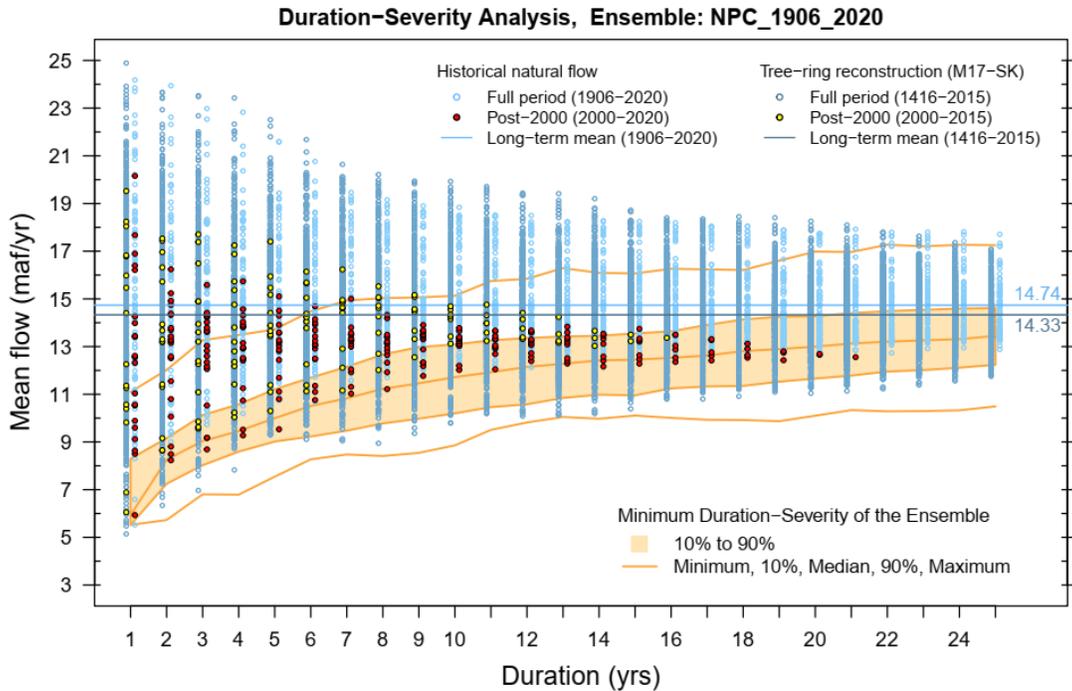
**Figure S32.** Summary metrics of simulated annual natural flow at Lees Ferry for the NPC\_1906\_2020 ensemble.



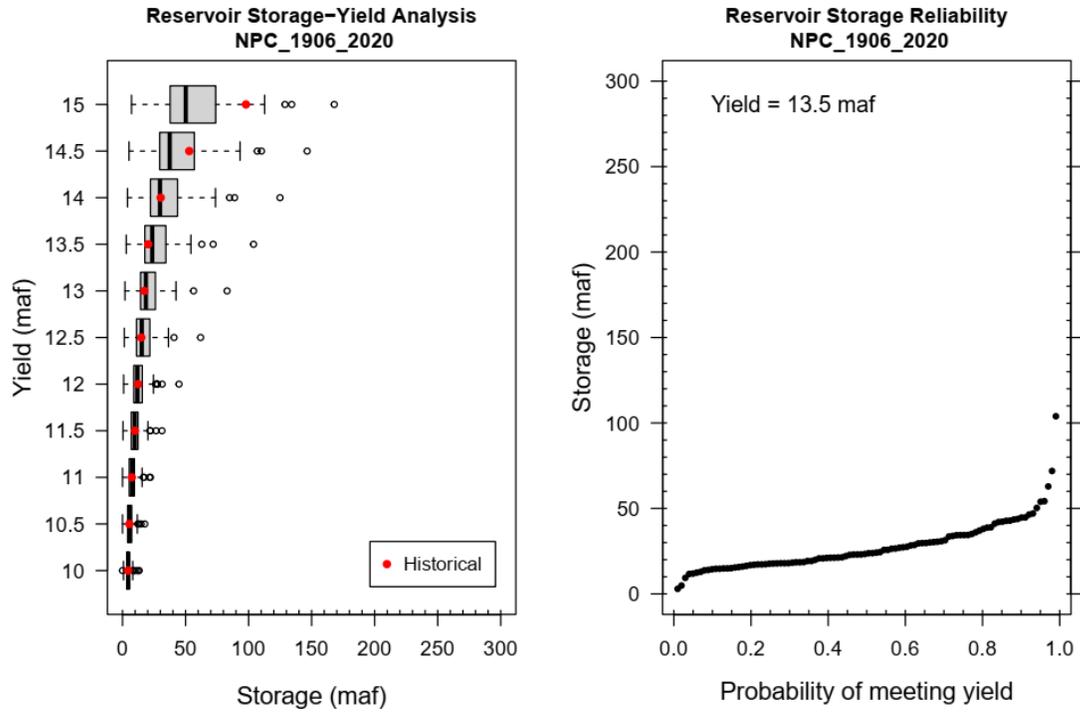
**Figure S33.** Moving count below threshold for the NPC\_1906\_2020 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



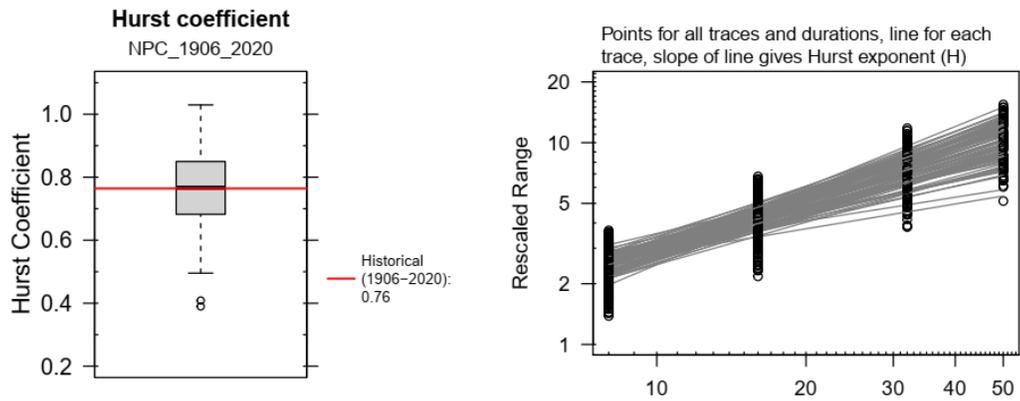
**Figure S34.** Moving count above threshold for the NPC\_1906\_2020 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S35.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the NPC\_1906\_2020 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



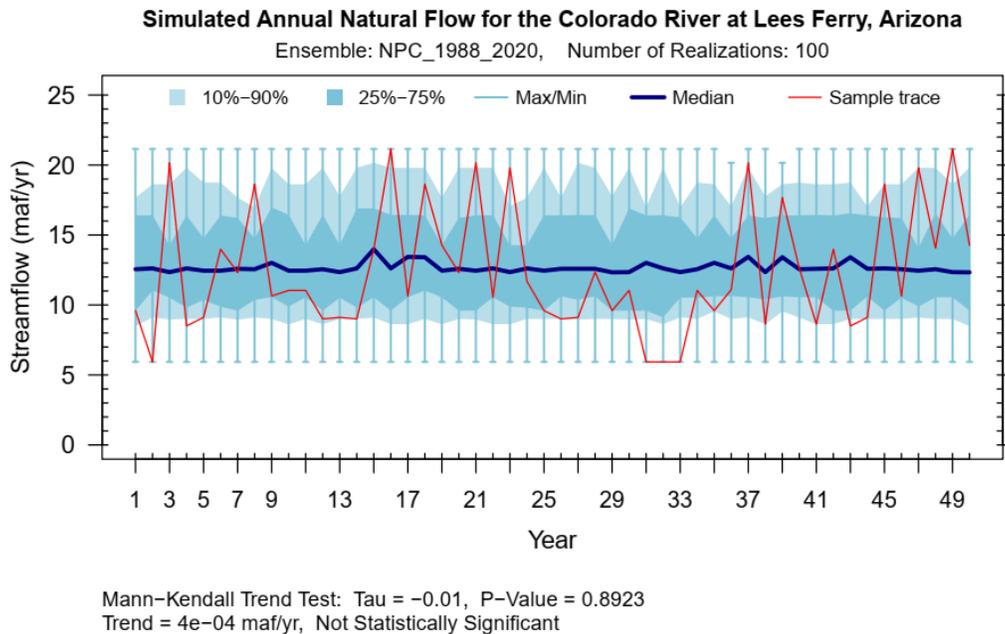
**Figure S36.** Reservoir storage-yield and reliability analysis for NPC\_1906\_2020. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



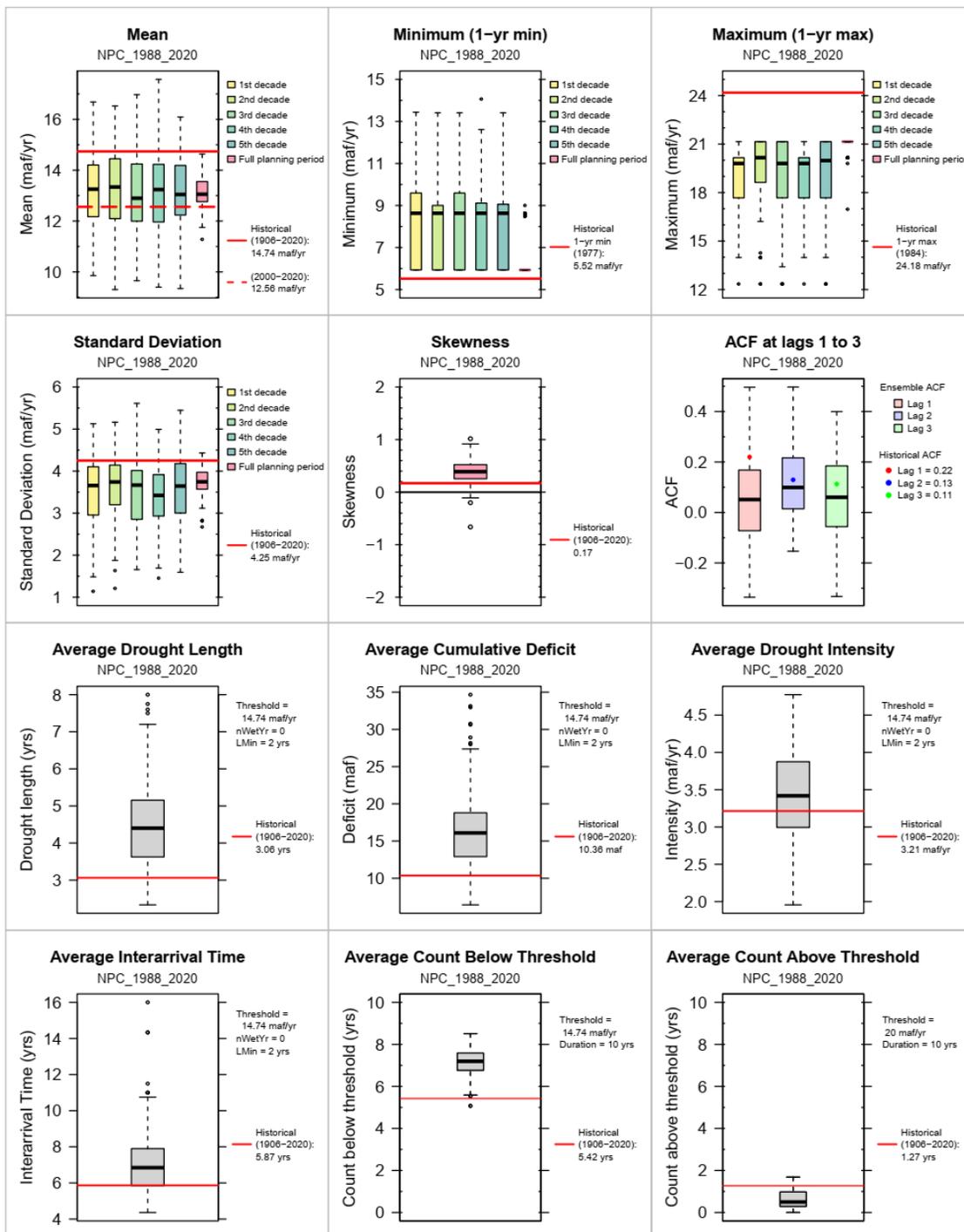
**Figure S37.** Hurst coefficient for the NPC\_1906\_2020 ensemble.

### Text S6. NPC\_1988\_2020: Stress Test Paleo-Conditioned Ensemble

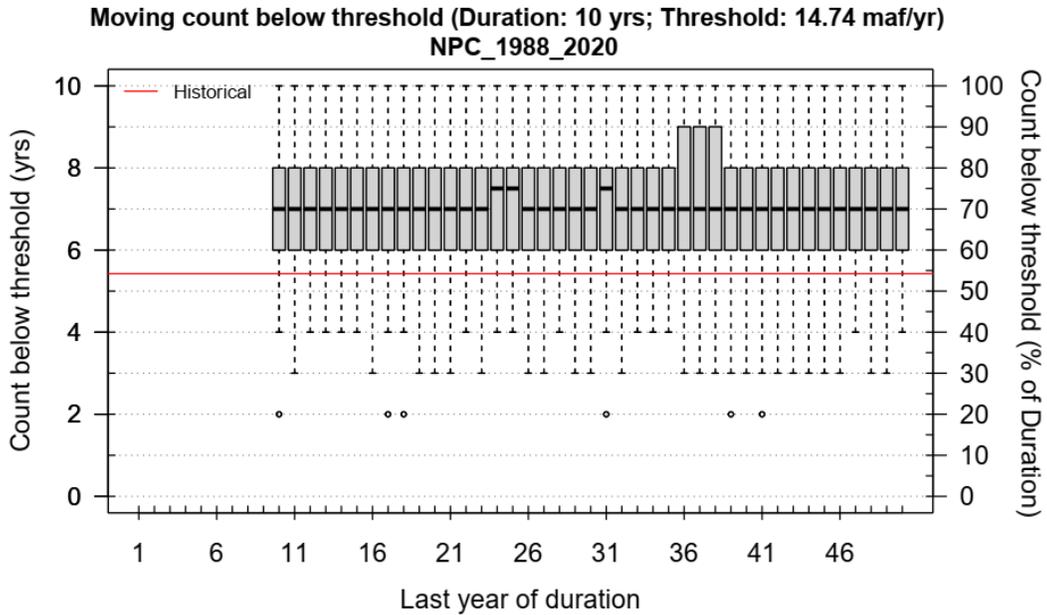
Figure S38 through Figure S44 present the metrics calculated for the Stress Test Paleo-Conditioned ensemble, labeled as "NPC\_1988\_2020". This ensemble comprises 100 time series, each 50 years long, generated using the Nonparametric Paleo-Conditioned (NPC) method described by Prairie et al. (2008). NPC was applied to a subset of the observed natural flow record from 1988 to 2020 and the full tree-ring reconstructed natural flows from 1416 to 2015.



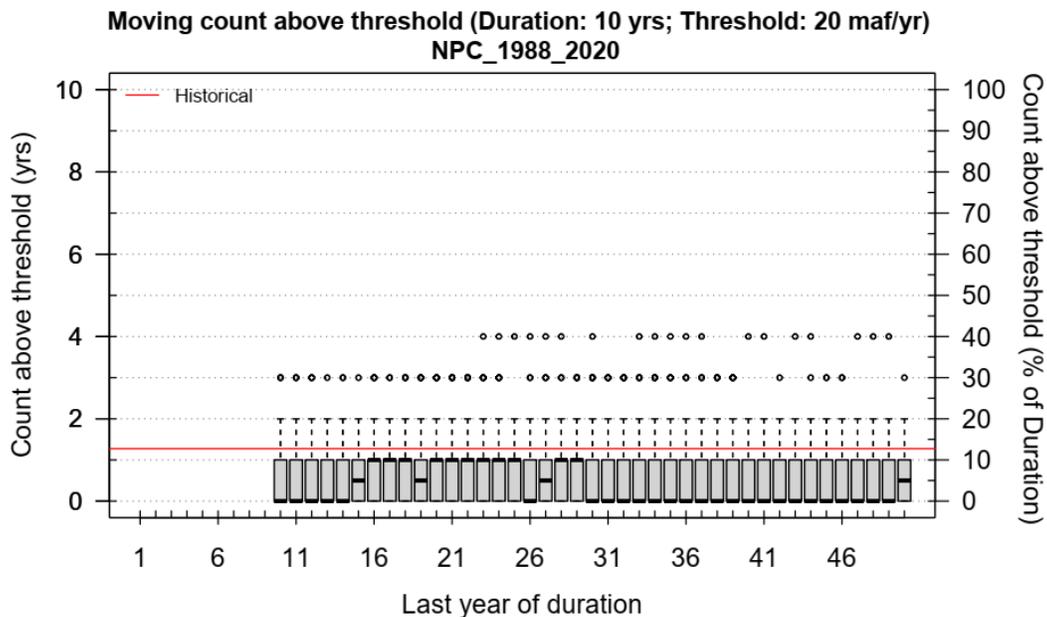
**Figure S38.** Time series of the simulated annual natural flow at Lees Ferry for the NPC\_1988\_2020 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



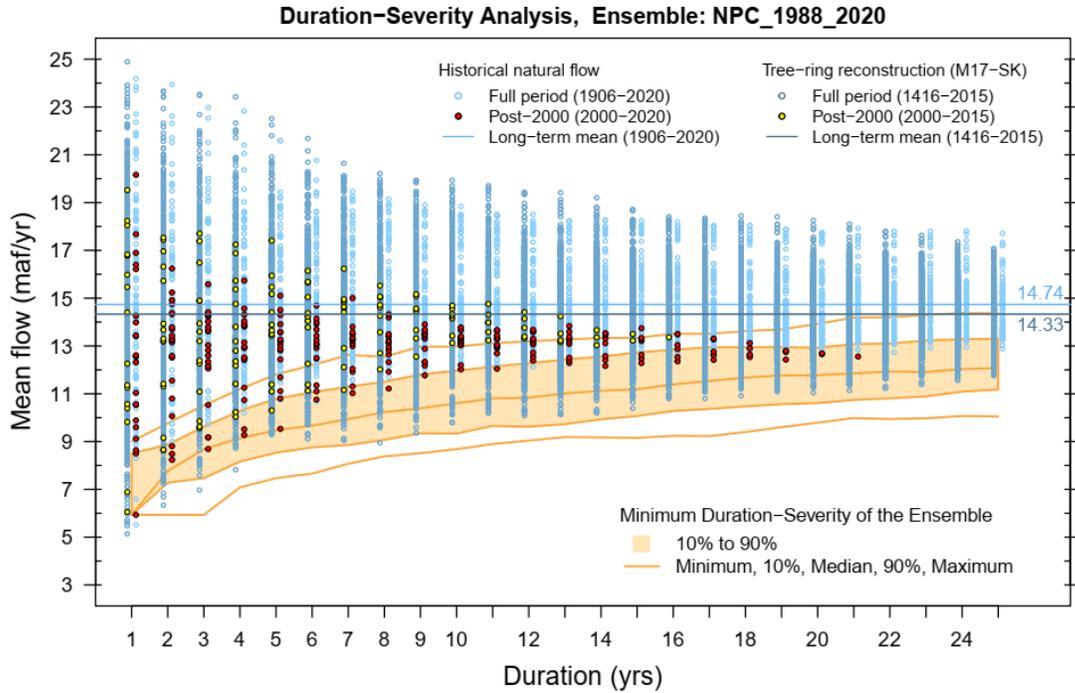
**Figure S39.** Summary metrics of simulated annual natural flow at Lees Ferry for the NPC\_1988\_2020 ensemble.



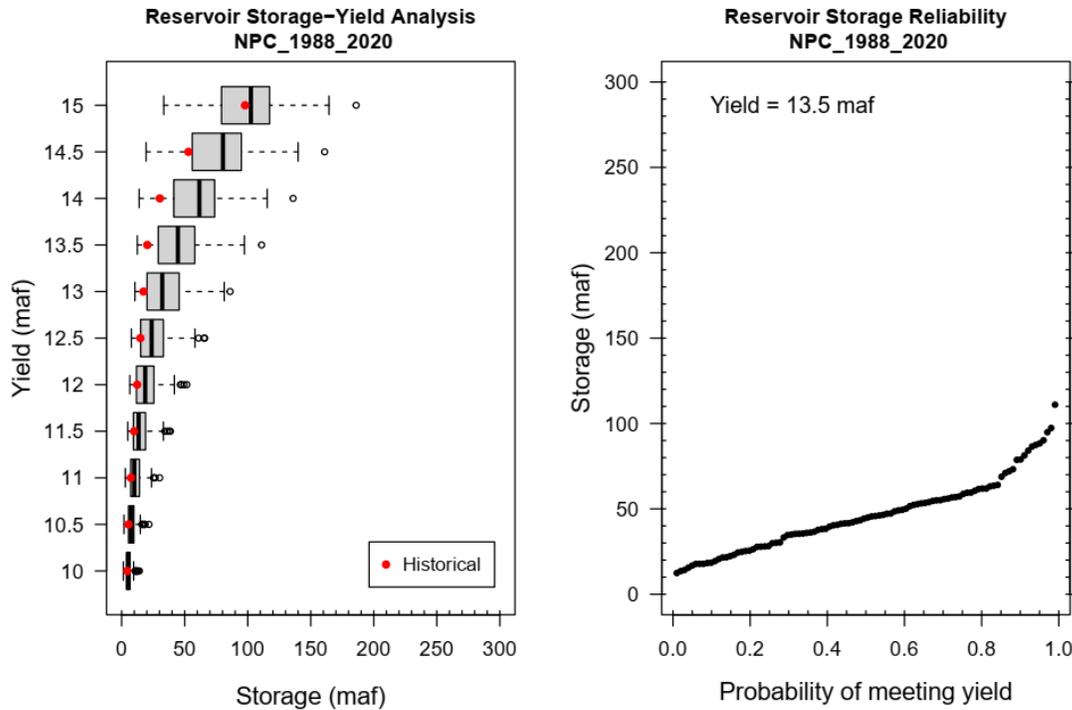
**Figure S40.** Moving count below threshold for the NPC\_1988\_2020 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



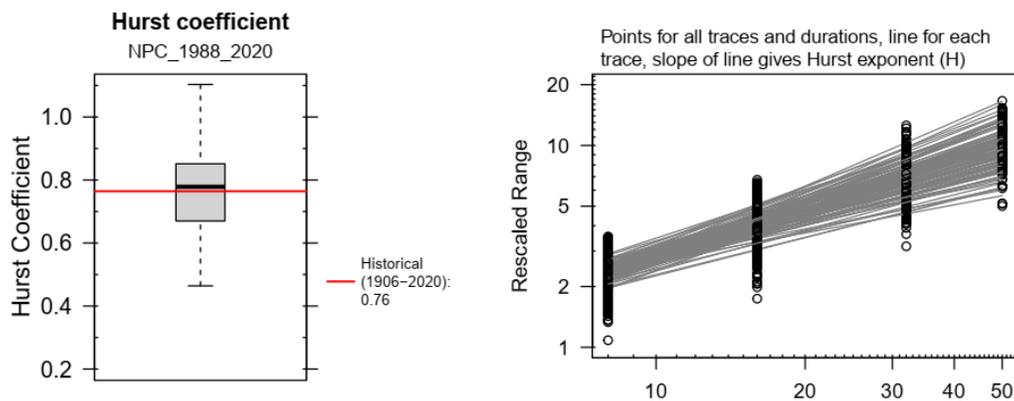
**Figure S41.** Moving count above threshold for the NPC\_1988\_2020 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S42.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the NPC\_1988\_2020 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



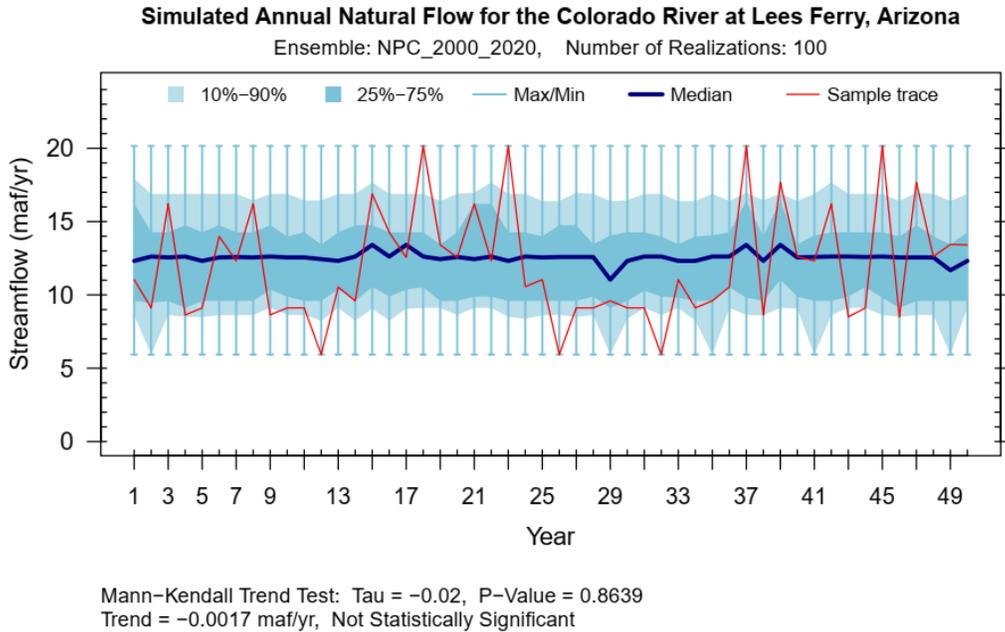
**Figure S43.** Reservoir storage-yield and reliability analysis for NPC\_1988\_2020. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



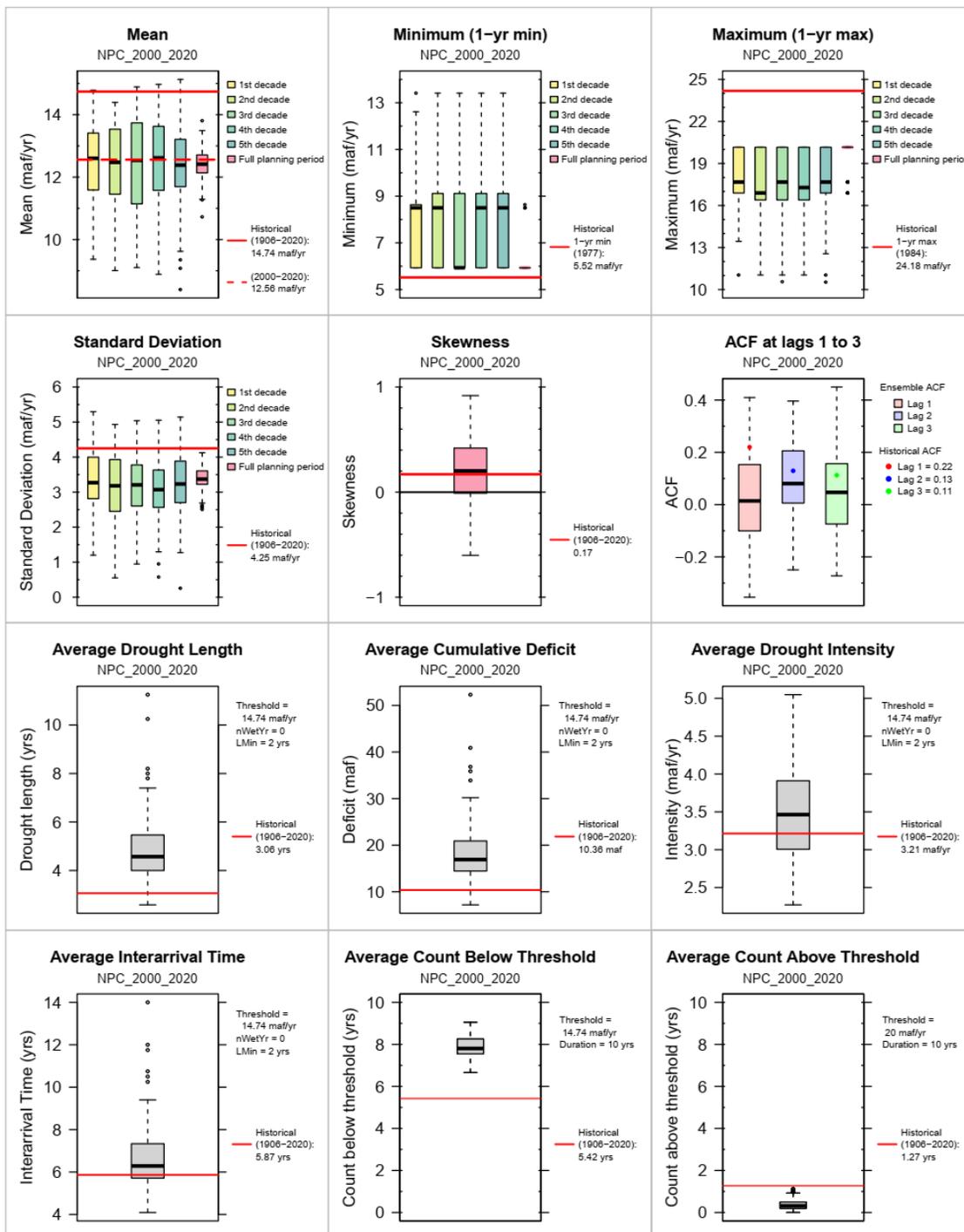
**Figure S44.** Hurst coefficient for the NPC\_1988\_2020 ensemble.

**Text S7. NPC\_2000\_2020: Millennium Drought Paleo-Conditioned Ensemble**

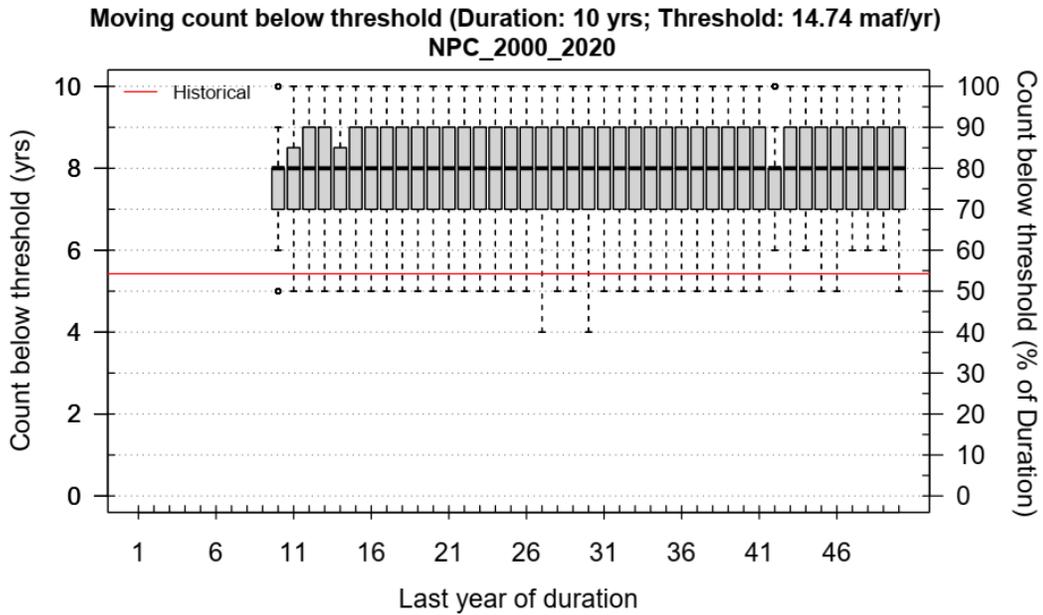
Figure S45 through Figure S51 present the metrics calculated for the Millennium Drought Paleo-Conditioned ensemble, labeled as “NPC\_2000\_2020”. This ensemble comprises 100 time series, each 50 years long, generated using the Nonparametric Paleo-Conditioned (NPC) method described by Prairie et al. (2008). NPC was applied to a subset of the observed natural flow record from 2000 to 2020 (the millennium drought period) and the full tree-ring reconstructed natural flows from 1416 to 2015.



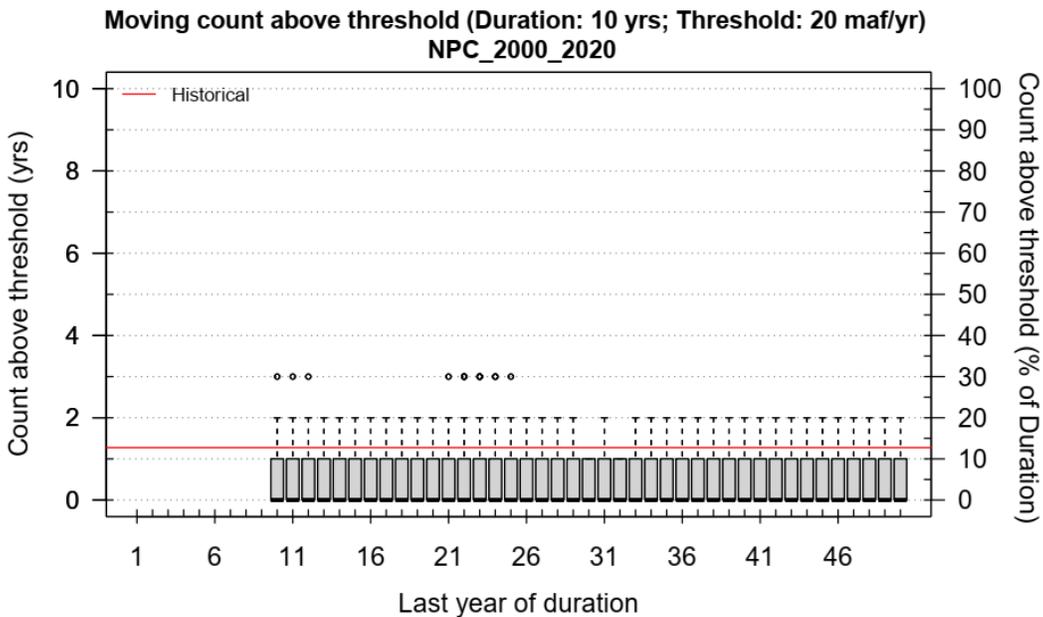
**Figure S45.** Time series of the simulated annual natural flow at Lees Ferry for the NPC\_2000\_2020 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



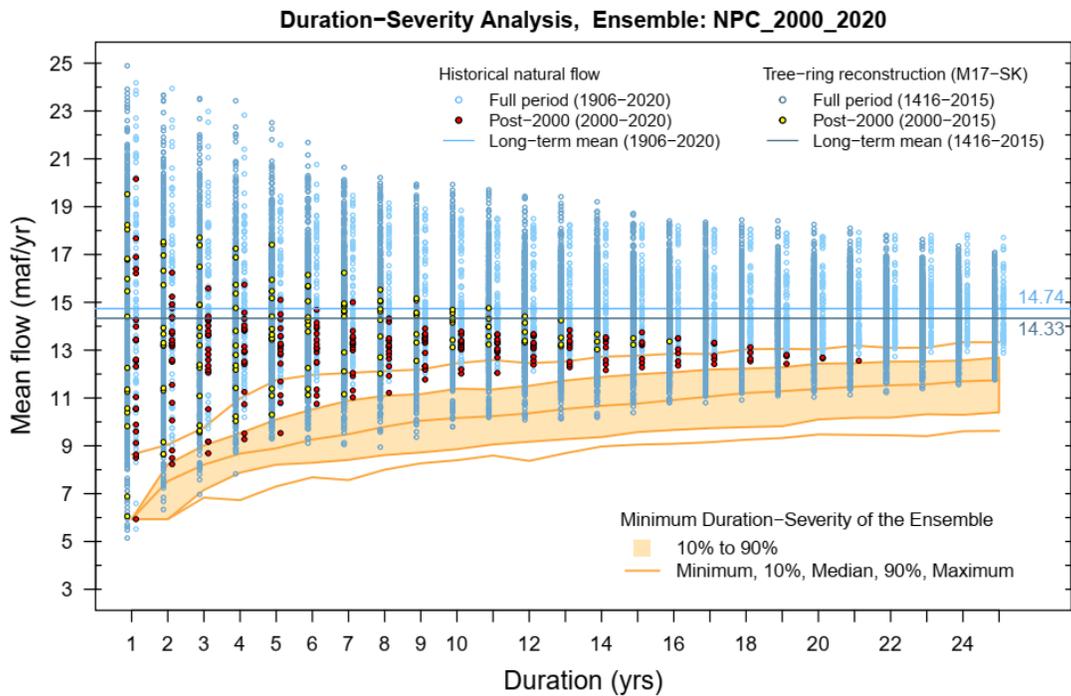
**Figure S46.** Summary metrics of simulated annual natural flow at Lees Ferry for the NPC\_2000\_2020 ensemble.



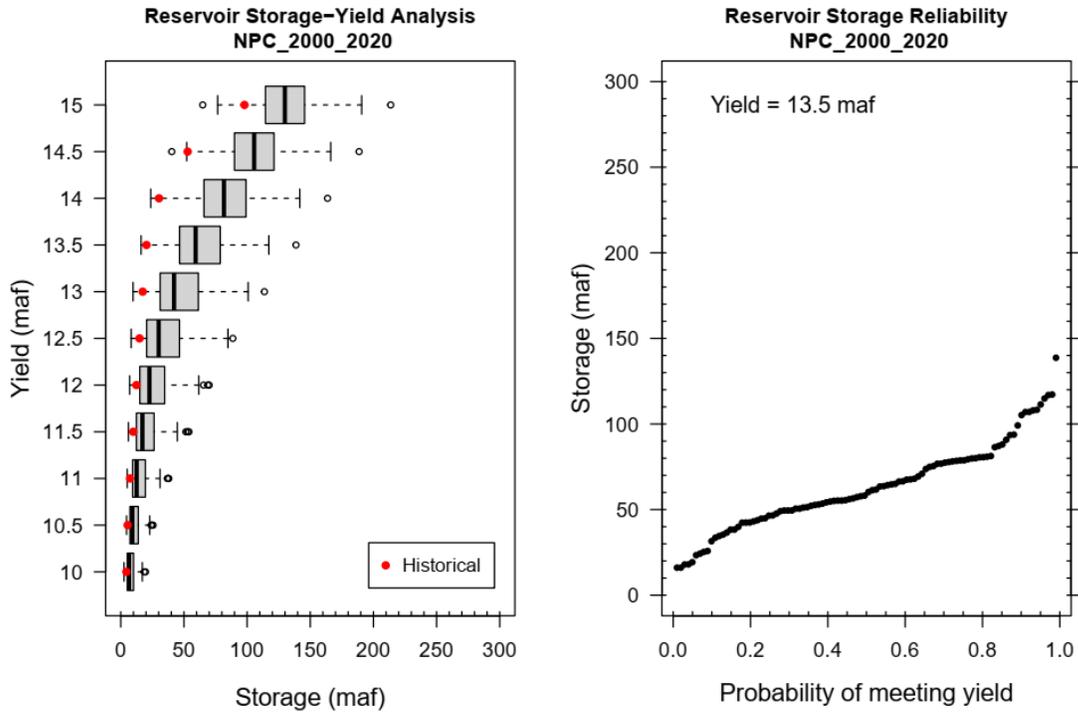
**Figure S47.** Moving count below threshold for the NPC\_2000\_2020 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



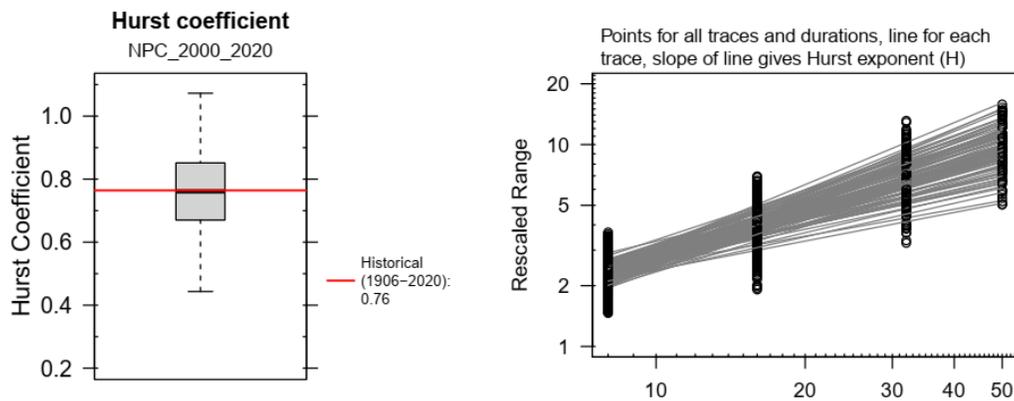
**Figure S48.** Moving count above threshold for the NPC\_2000\_2020 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S49.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the NPC\_2000\_2020 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



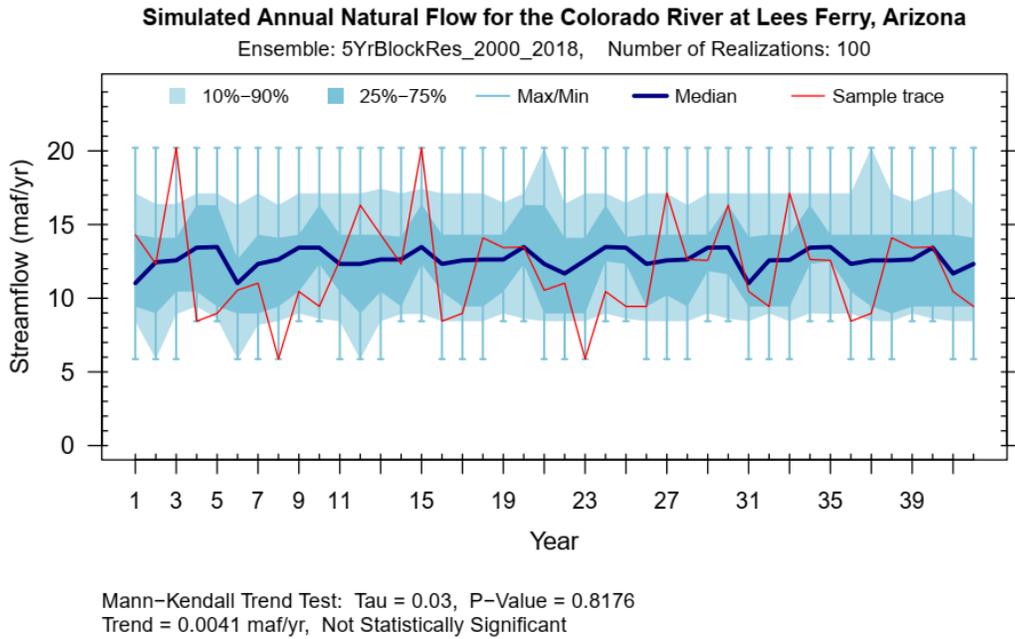
**Figure S50.** Reservoir storage-yield and reliability analysis for NPC\_2000\_2020. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



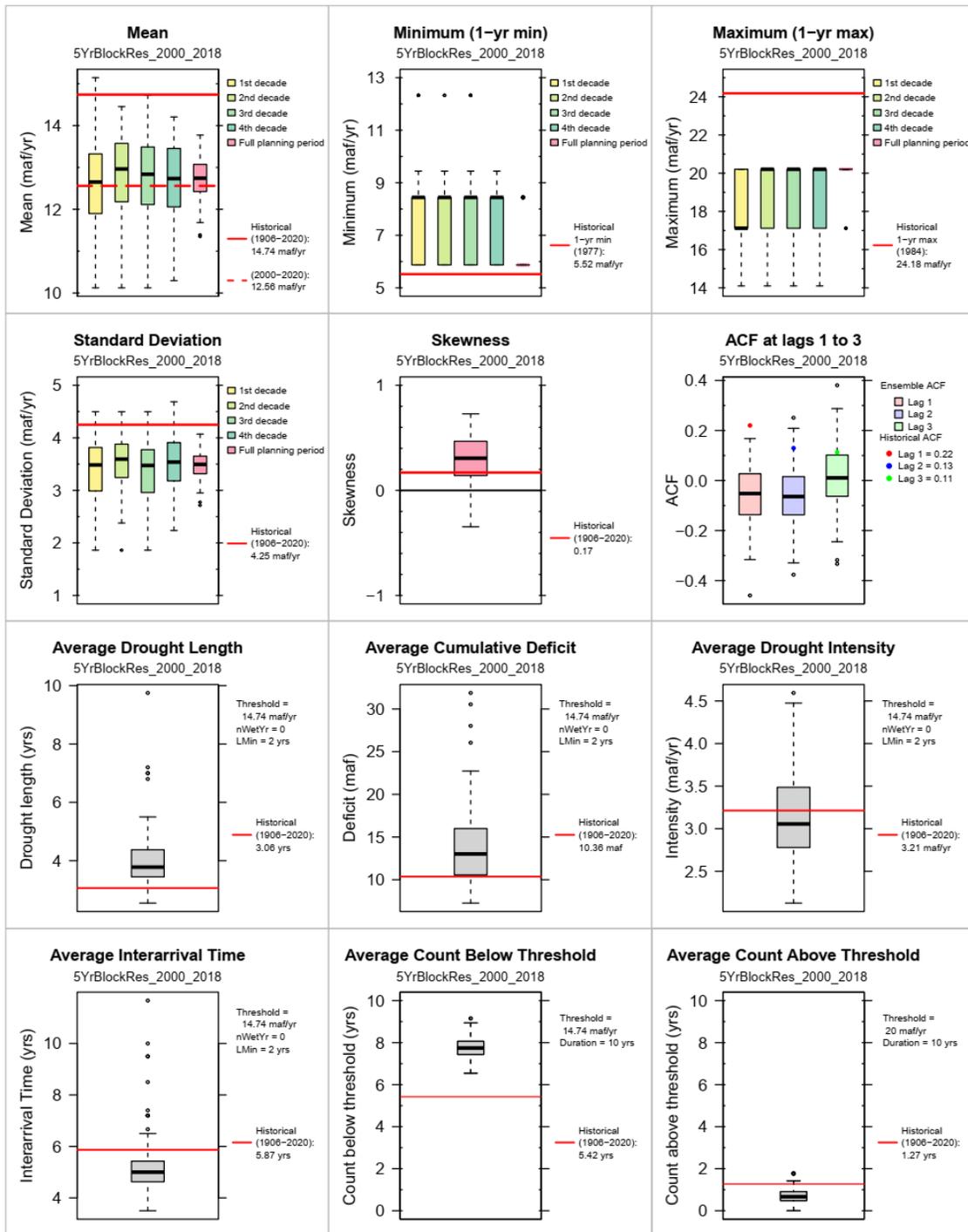
**Figure S51.** Hurst coefficient for the NPC\_2000\_2020 ensemble.

**Text S8. 5YrBlockRes\_2000\_2018: Millennium Drought 5-Year Resampled**

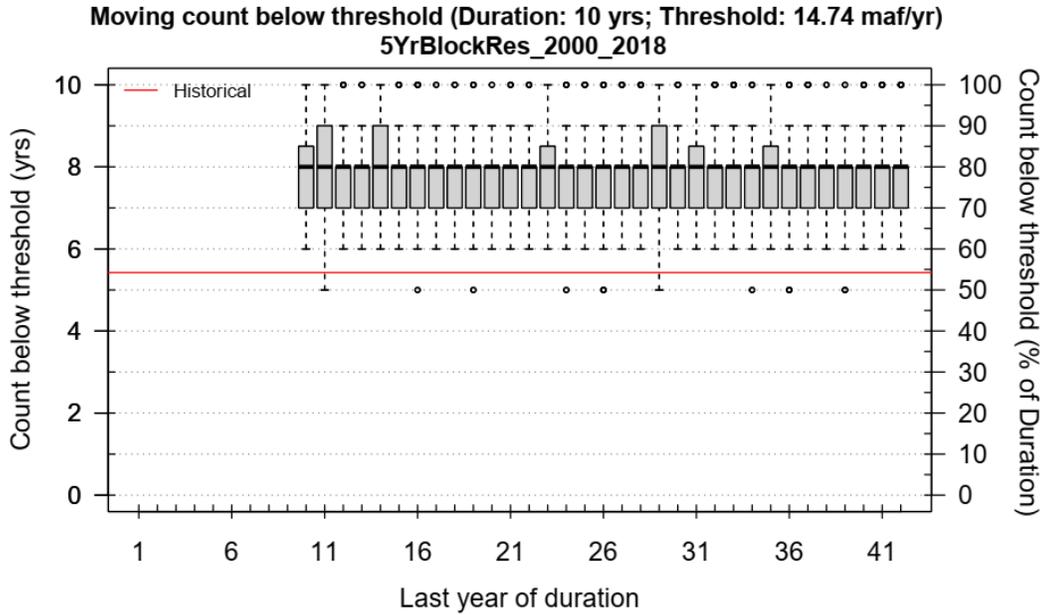
Figure S52 through Figure S58 present the metrics calculated for the Millennium Drought 5-Year Resampled ensemble, labeled as "5YrBlockRes\_2000\_2018". This ensemble comprises 100 time series, each 42 years long, generated by Salehabadi et al. (2022) through a 5-year drought scenario resampling method.



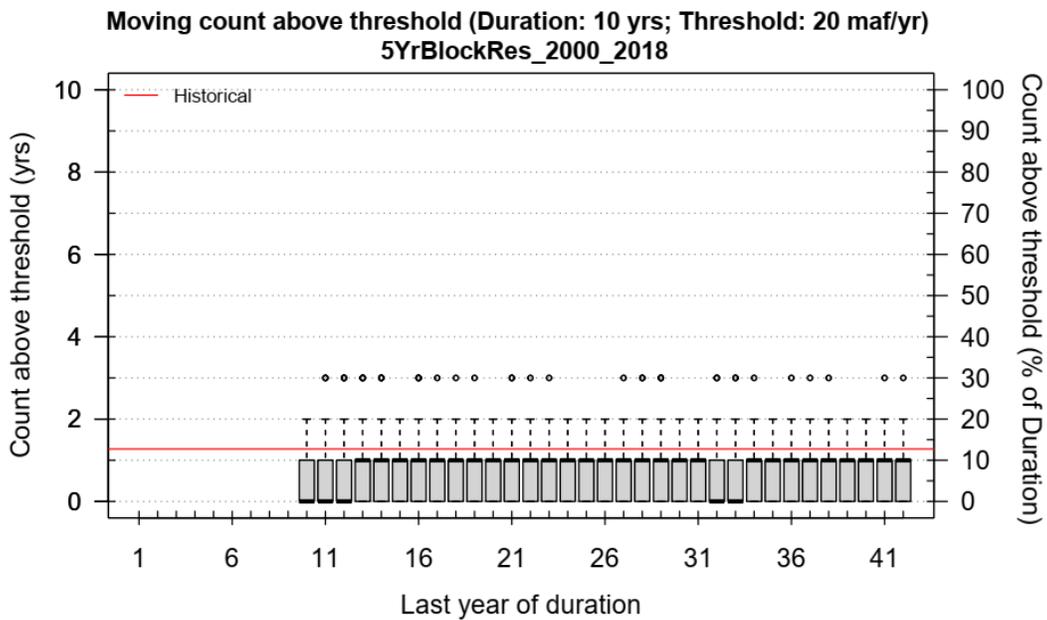
**Figure S52.** Time series of the simulated annual natural flow at Lees Ferry for the 5YrBlockRes\_2000\_2018 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



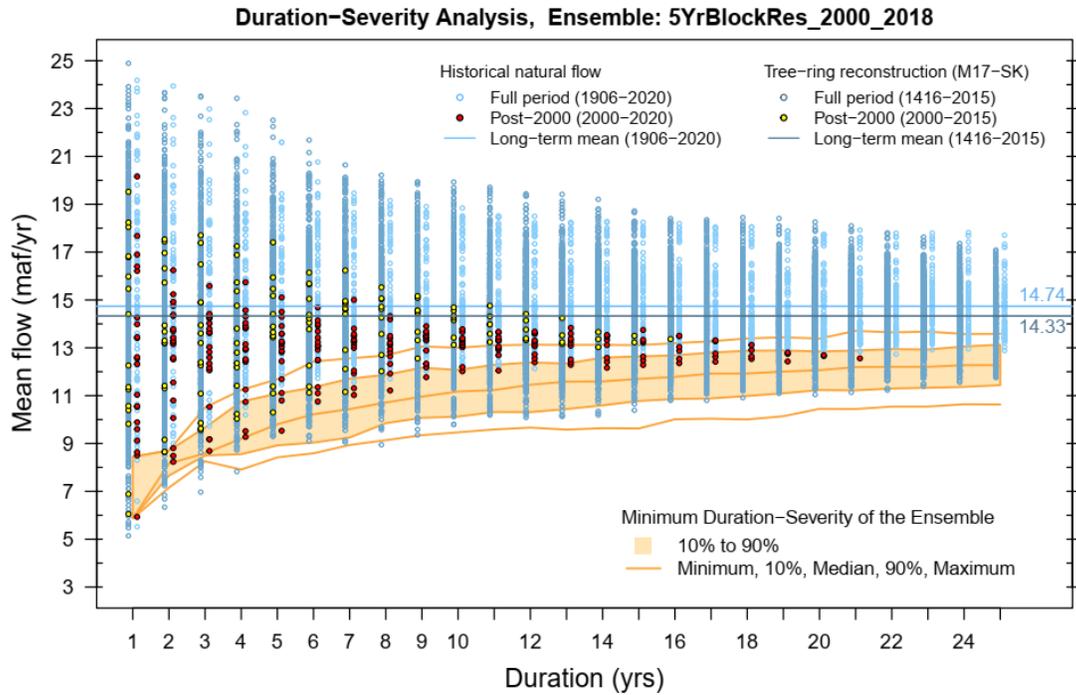
**Figure S53.** Summary metrics of simulated annual natural flow at Lees Ferry for the 5YrBlockRes\_2000\_2018 ensemble.



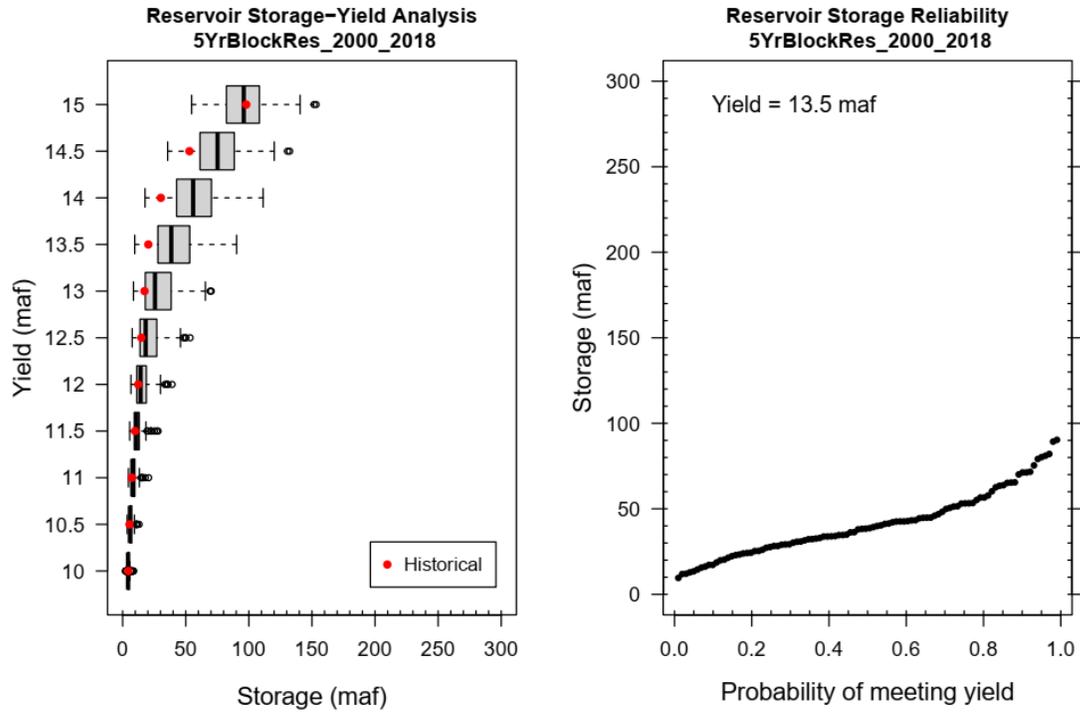
**Figure S54.** Moving count below threshold for the 5YrBlockRes\_2000\_2018 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



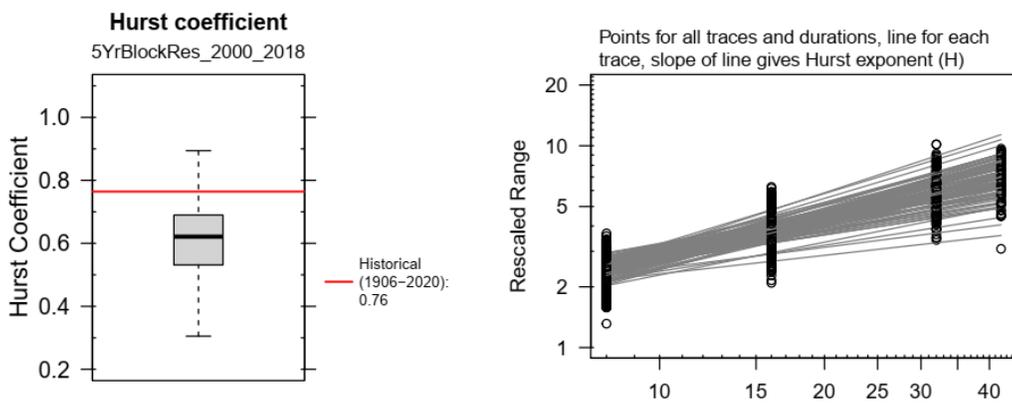
**Figure S55.** Moving count above threshold for the 5YrBlockRes\_2000\_2018 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S56.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the 5YrBlockRes\_2000\_2018 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



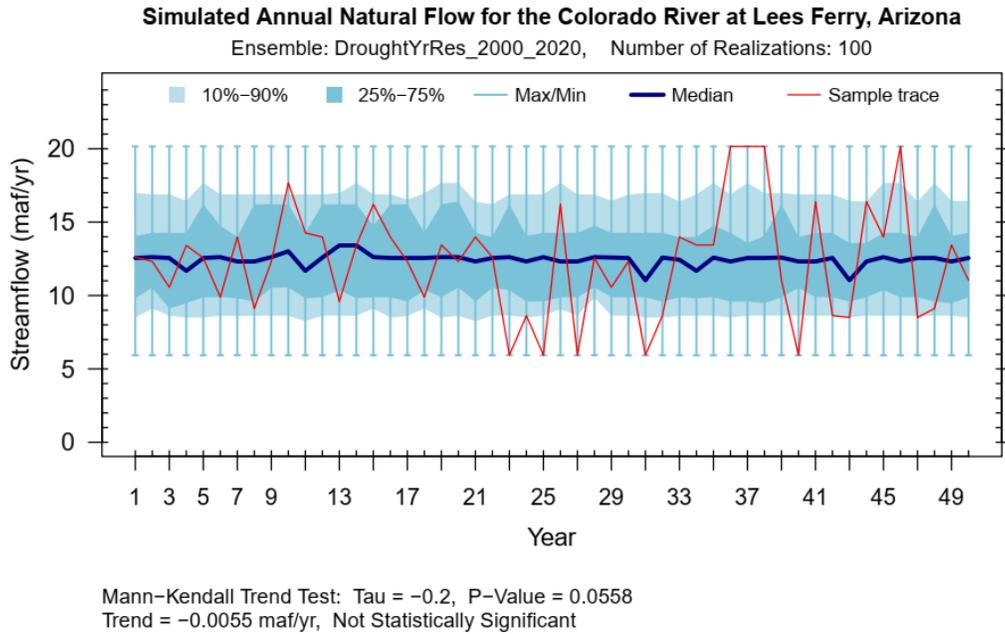
**Figure S57.** Reservoir storage-yield and reliability analysis for 5YrBlockRes\_2000\_2018. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



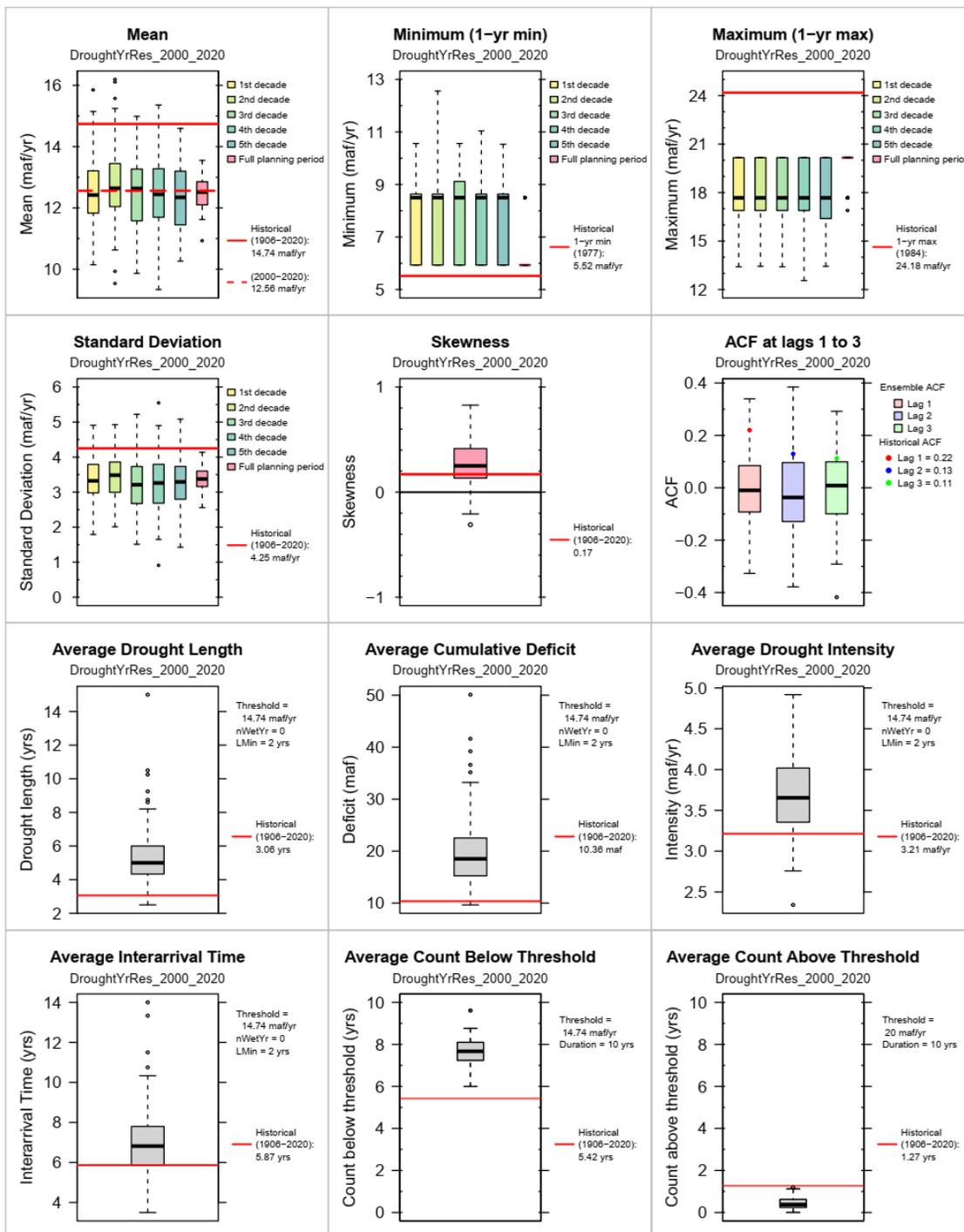
**Figure S58.** Hurst coefficient for the 5YrBlockRes\_2000\_2018 ensemble.

### Text S9. DroughtYrRes\_2000\_2020: Millennium Drought Year Resampled

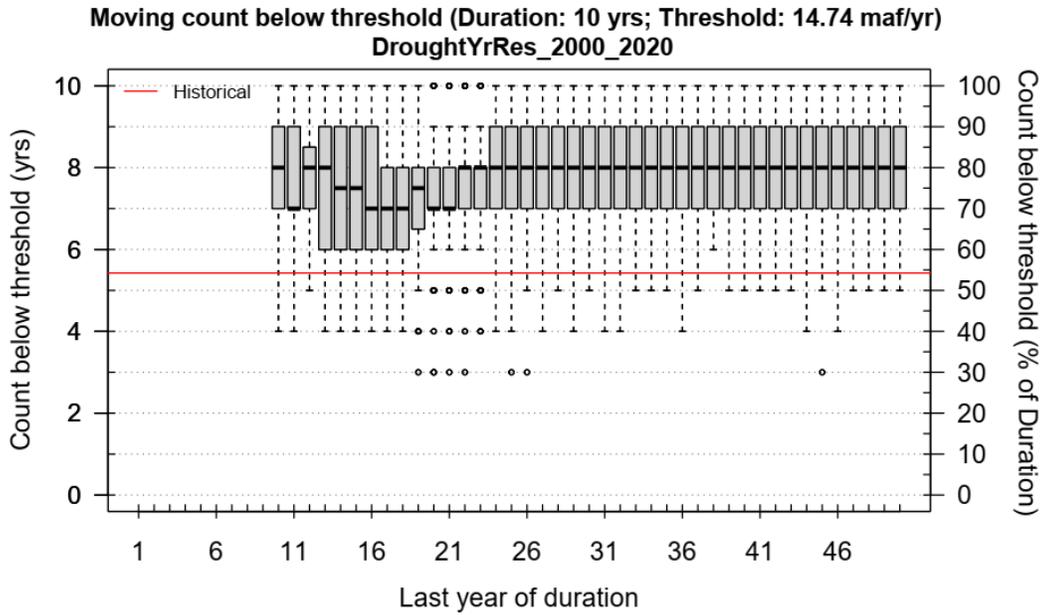
Figure S59 through Figure S65 present the metrics calculated for the Millennium Drought Year Resampled ensemble, labeled as "DroughtYrRes\_2000\_2020". This ensemble comprises 100 time series, each 50 years long, generated using the drought scenario resampling method described by Salehabadi et al. (2022).



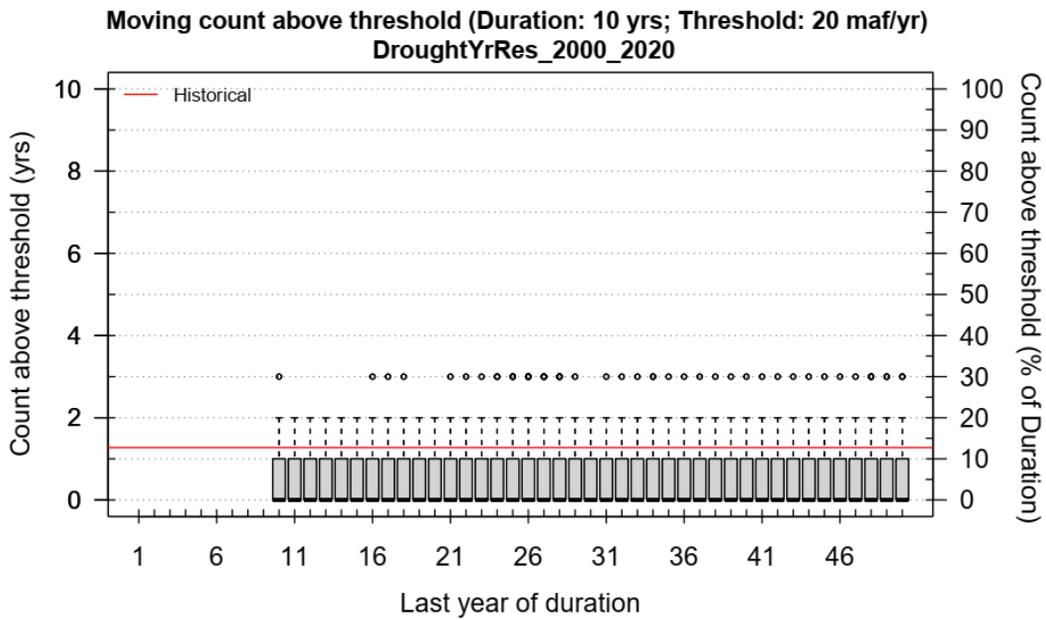
**Figure S59.** Time series of the simulated annual natural flow at Lees Ferry for the DroughtYrRes\_2000\_2020 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



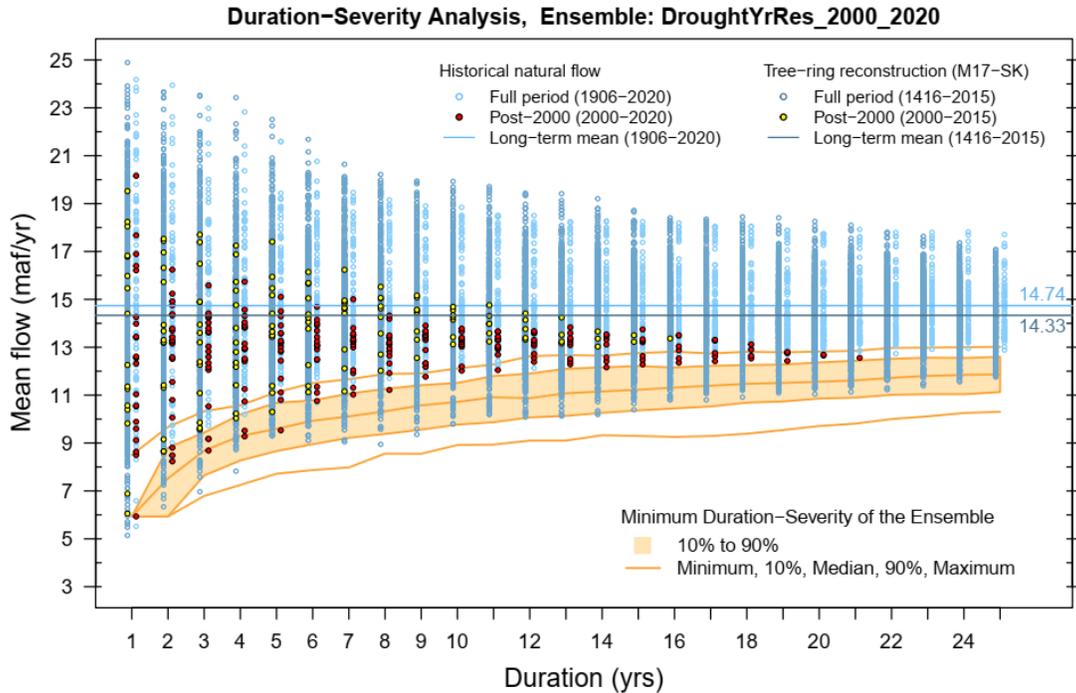
**Figure S60.** Summary metrics of simulated annual natural flow at Lees Ferry for the DroughtYrRes\_2000\_2020 ensemble.



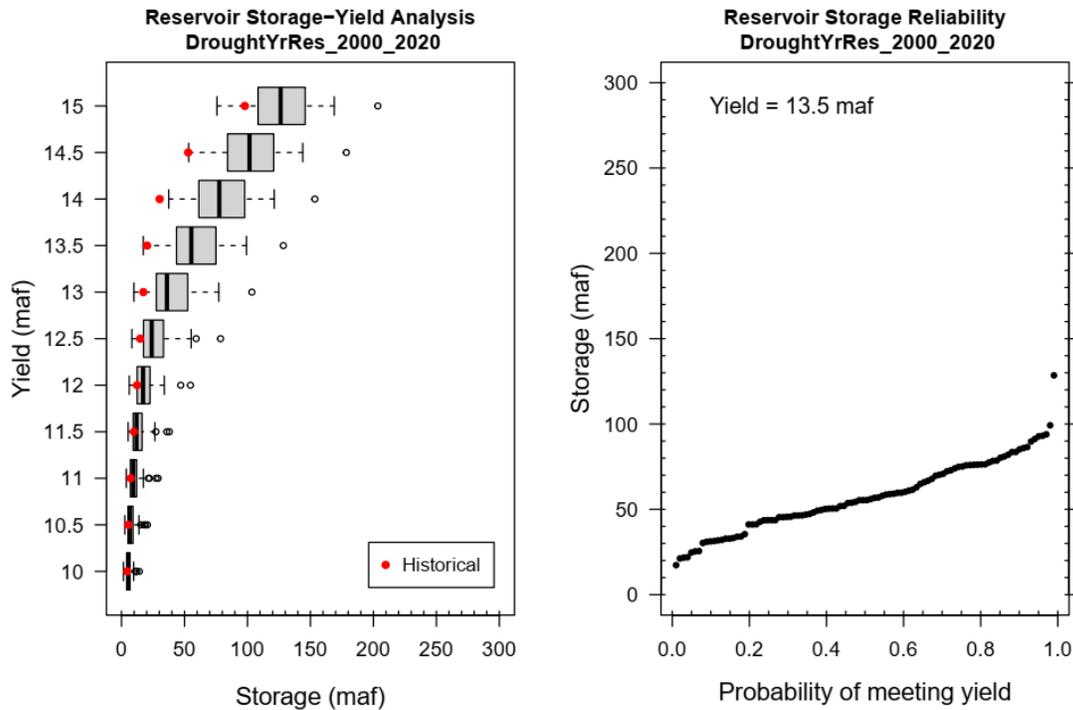
**Figure S61.** Moving count below threshold for the DroughtYrRes\_2000\_2020 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



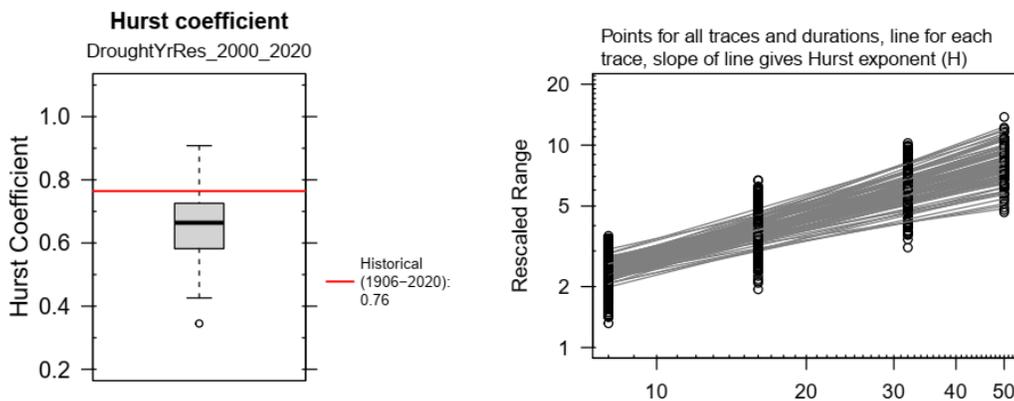
**Figure S62.** Moving count above threshold for the DroughtYrRes\_2000\_2020 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S63.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the DroughtYrRes\_2000\_2020 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



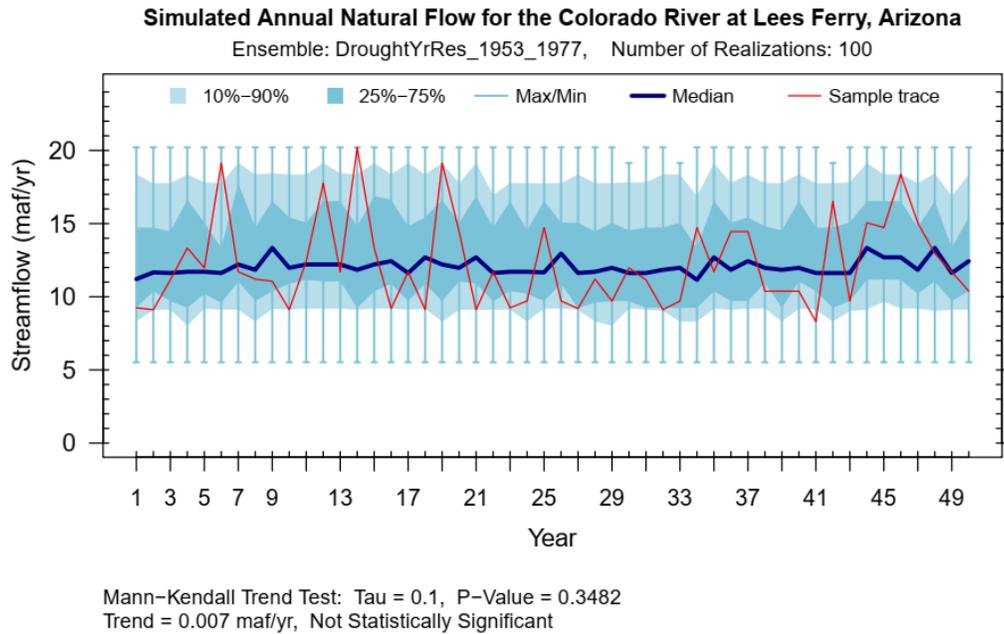
**Figure S64.** Reservoir storage-yield and reliability analysis for DroughtYrRes\_2000\_2020. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



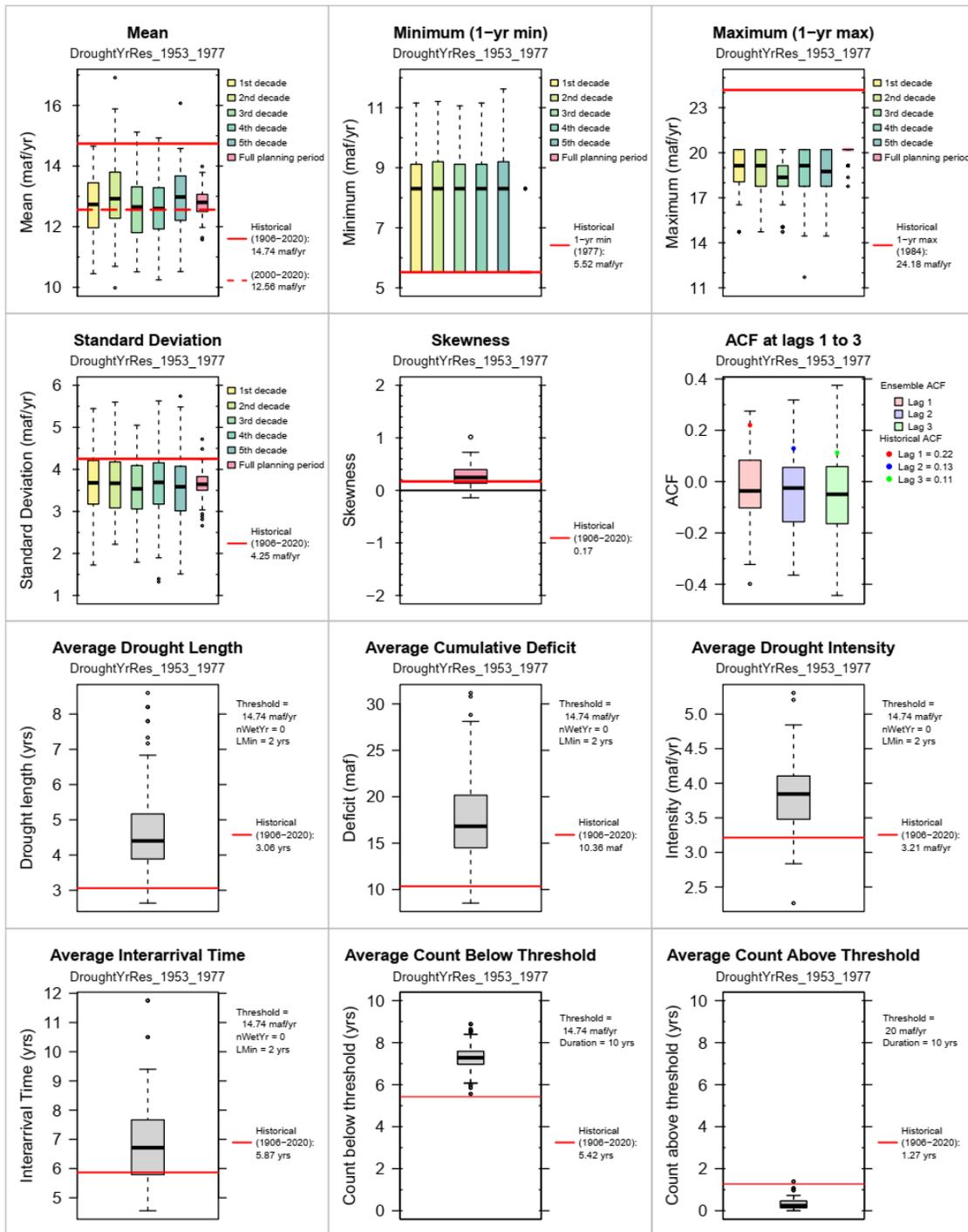
**Figure S65.** Hurst coefficient for the DroughtYrRes\_2000\_2020 ensemble.

**Text S10. DroughtYrRes\_1953\_1977: Mid-20<sup>th</sup>-Century Drought Year Resampled**

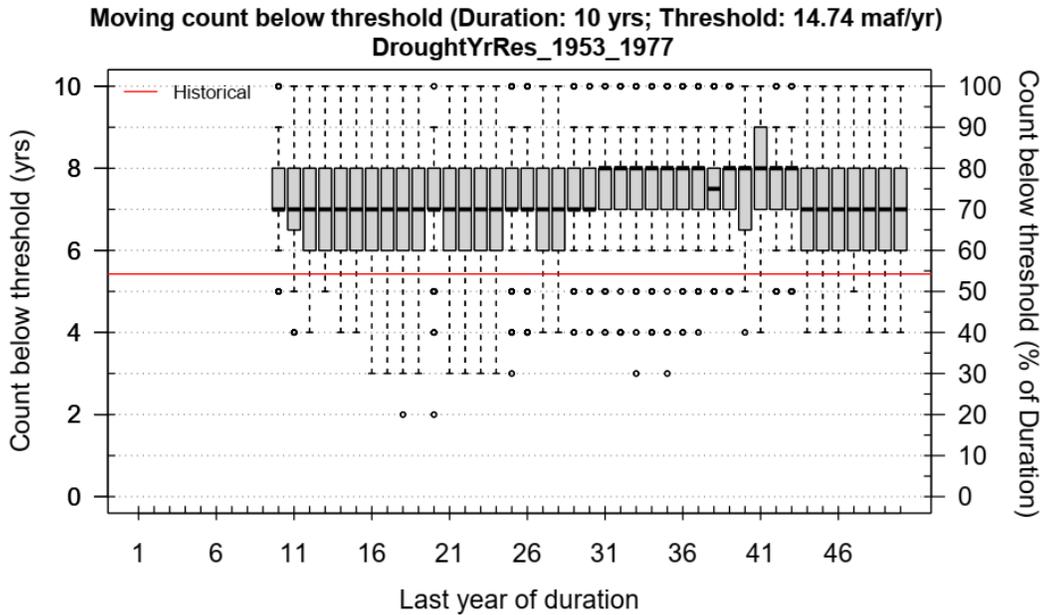
Figure S66 through Figure S72 present the metrics calculated for the Mid-20th-Century Drought Year Resampled ensemble, labeled as "DroughtYrRes\_1953\_1977". This ensemble comprises 100 time series, each 50 years long, generated using the drought scenario resampling method described by Salehabadi et al. (2022).



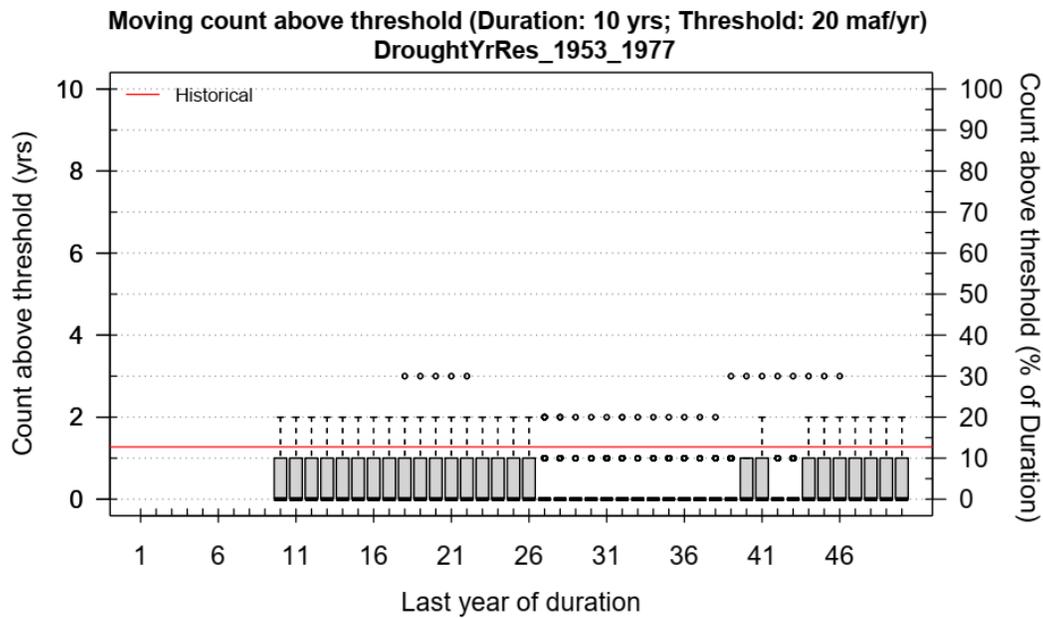
**Figure S66.** Time series of the simulated annual natural flow at Lees Ferry for the DroughtYrRes\_1953\_1977 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



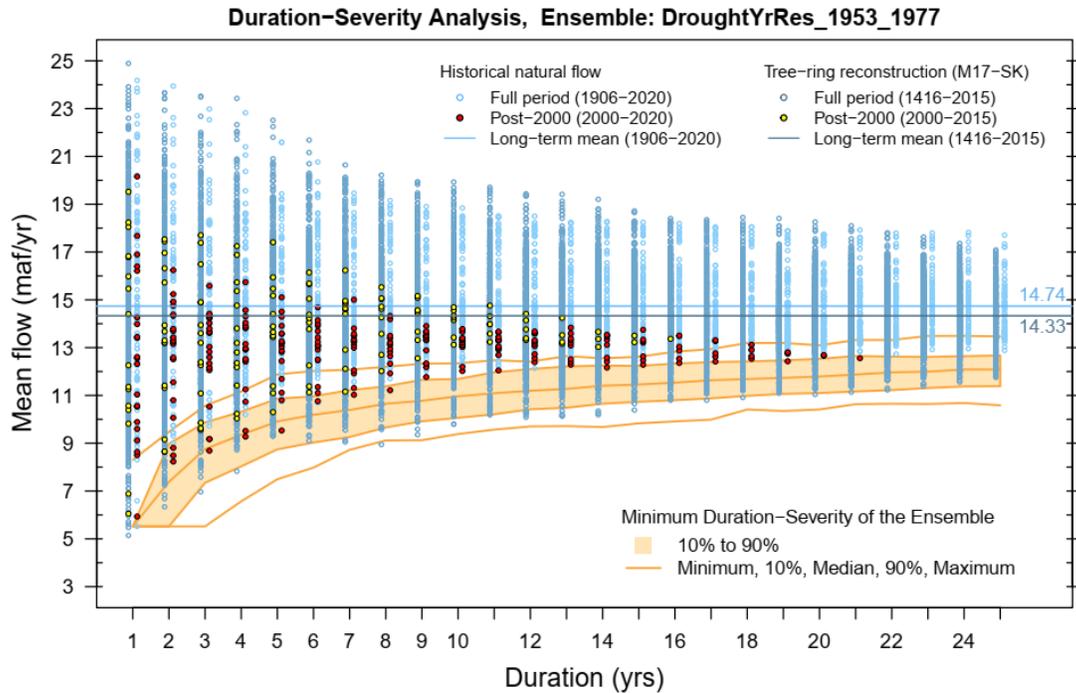
**Figure S67.** Summary metrics of simulated annual natural flow at Lees Ferry for the DroughtYrRes\_1953\_1977 ensemble.



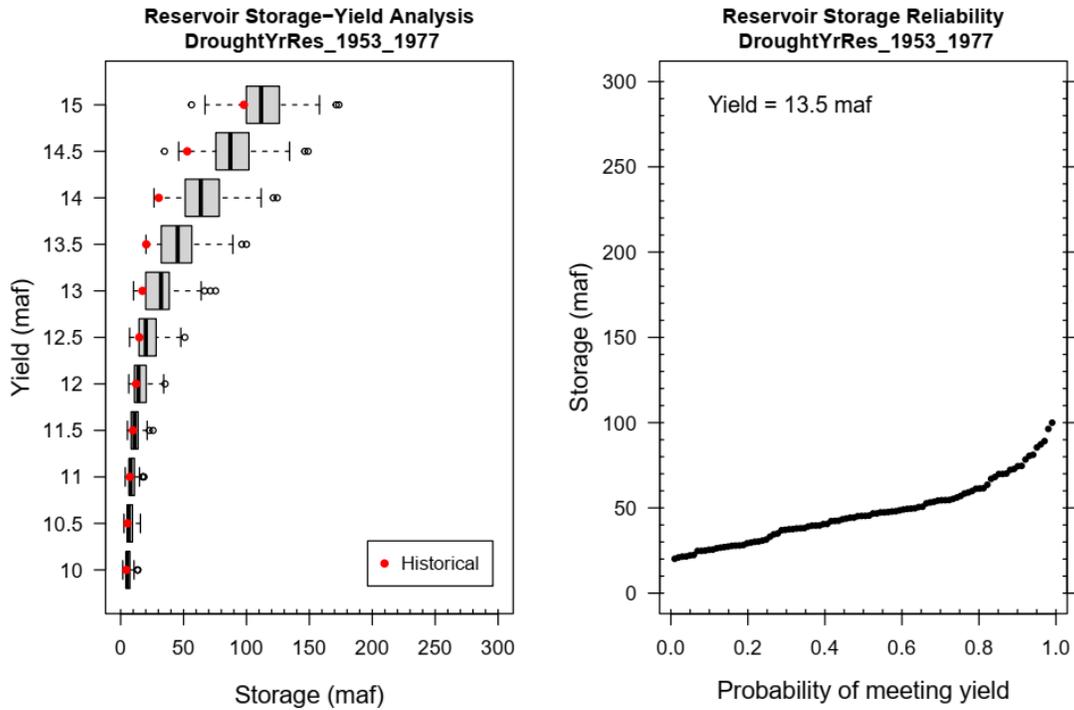
**Figure S68.** Moving count below threshold for the DroughtYrRes\_1953\_1977 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



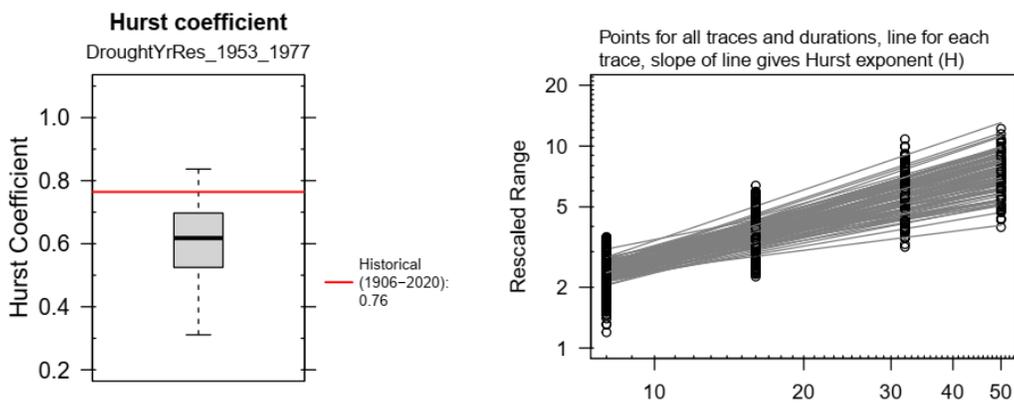
**Figure S69.** Moving count above threshold for the DroughtYrRes\_1953\_1977 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S70.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the DroughtYrRes\_1953\_1977 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



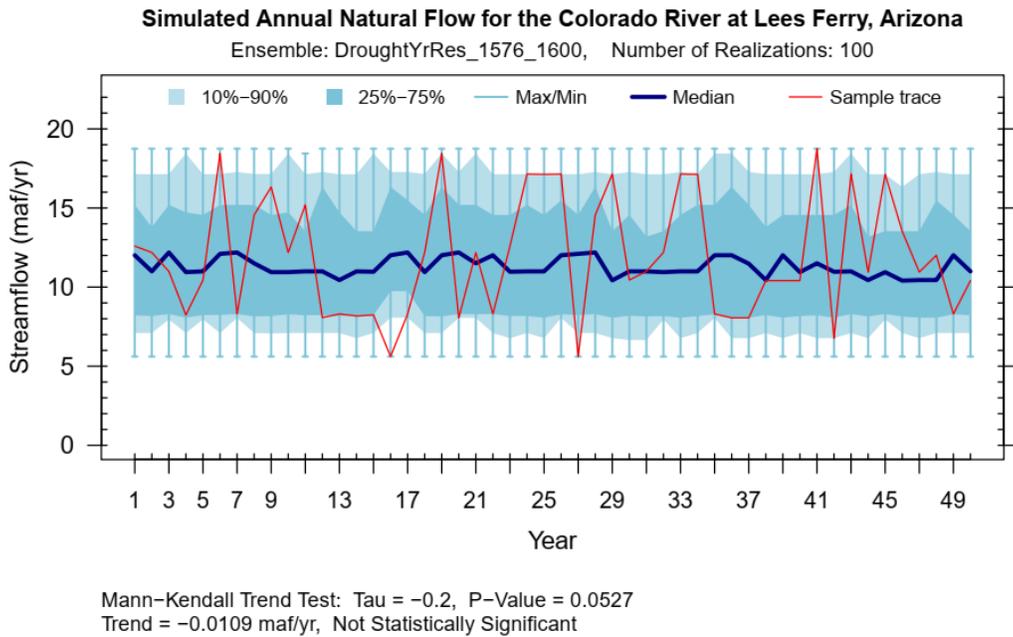
**Figure S71.** Reservoir storage-yield and reliability analysis for DroughtYrRes\_1953\_1977. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



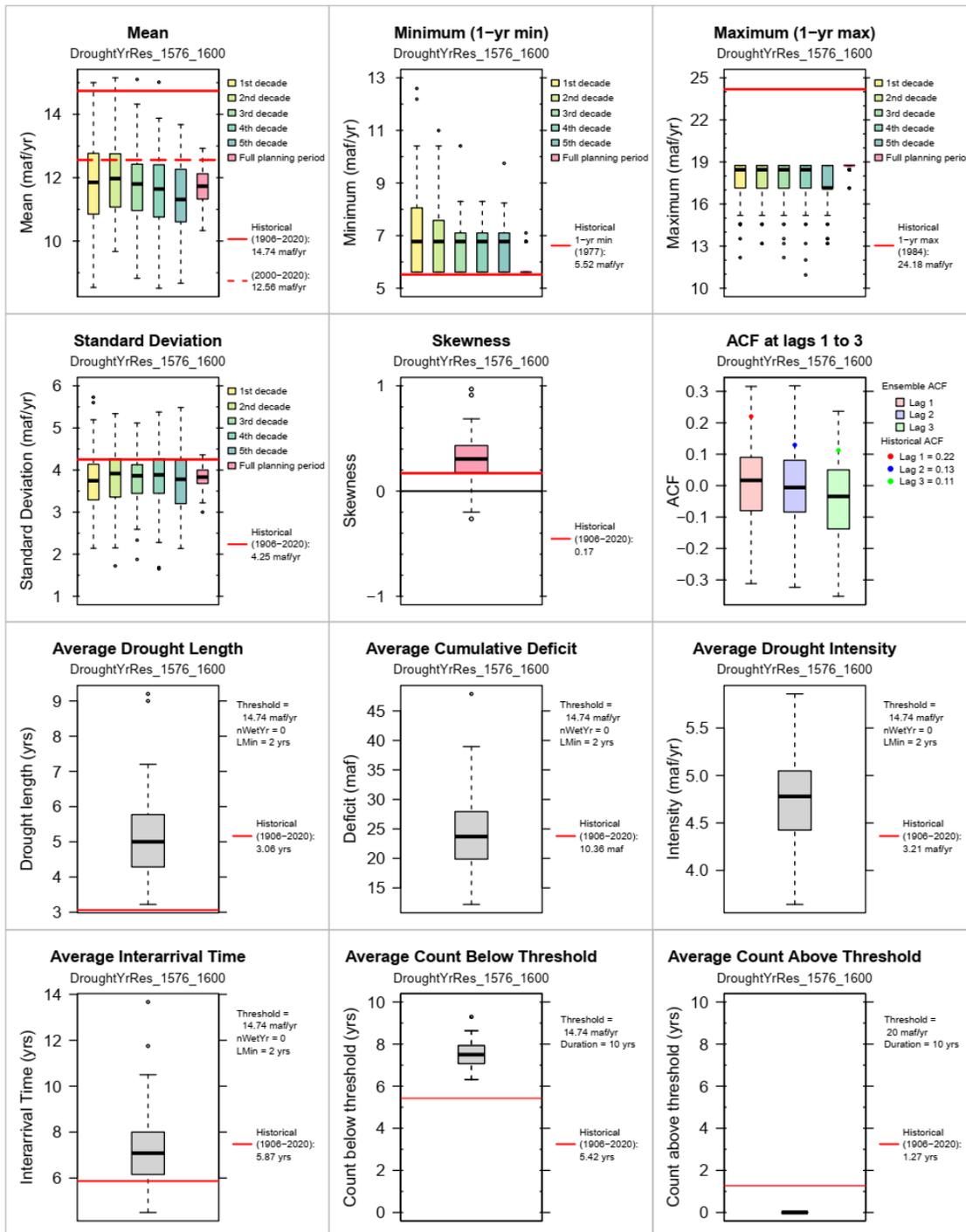
**Figure S72.** Hurst coefficient for the DroughtYrRes\_1953\_1977 ensemble.

**Text S11. DroughtYrRes\_1576\_1600: Paleo Drought Year Resampled**

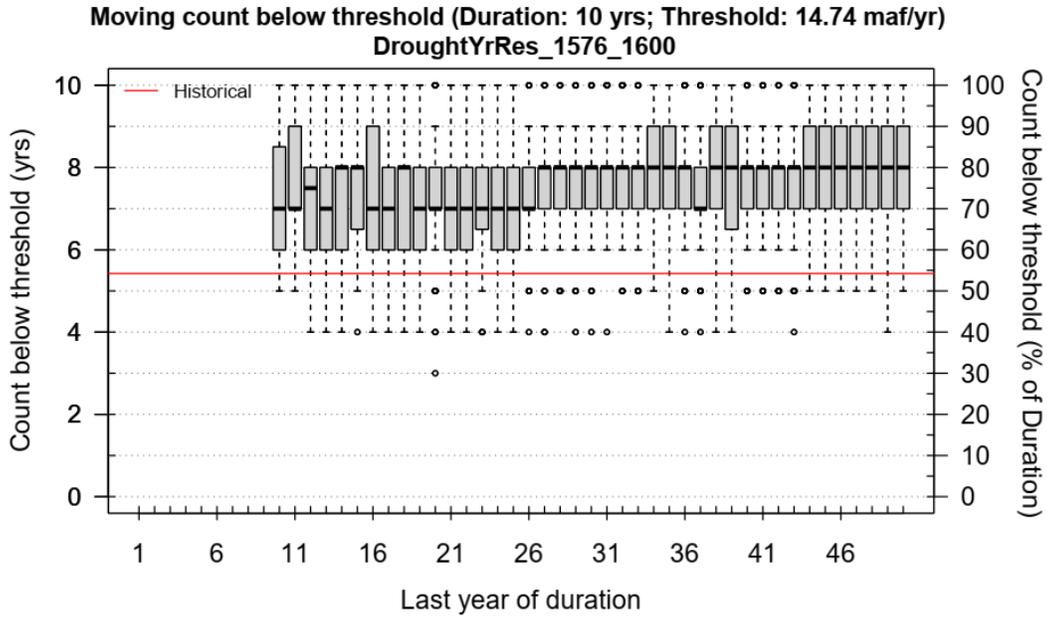
Figure S73 through Figure S79 present the metrics calculated for Paleo Drought Year Resampled ensemble, labeled as "DroughtYrRes\_1576\_1600". This ensemble comprises 100 time series each 50 years long, generated using the drought scenario resampling method described by Salehabadi et al. (2022).



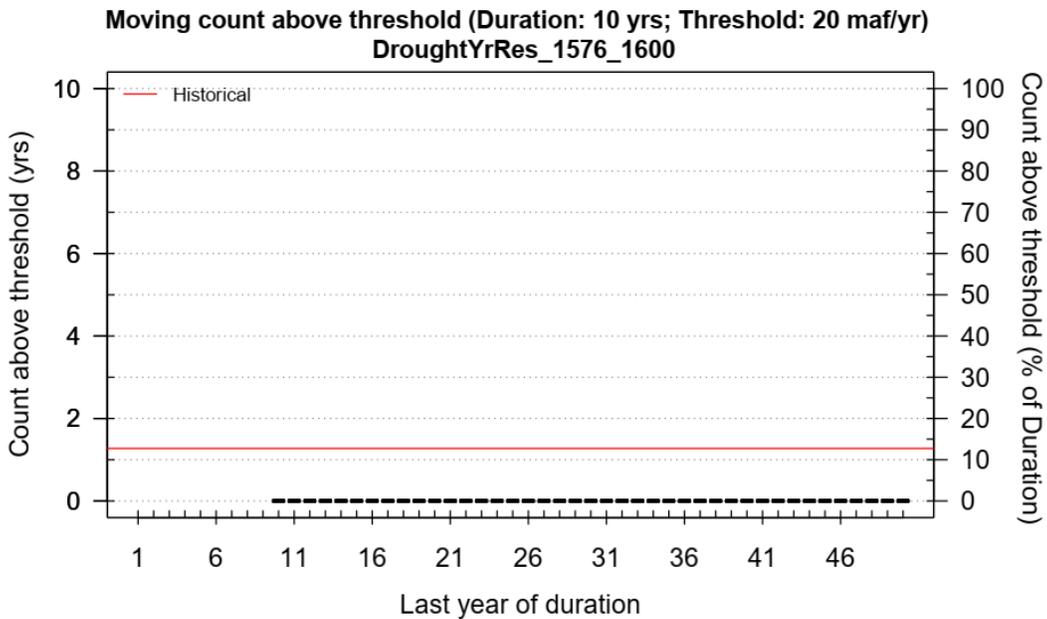
**Figure S73.** Time series of the simulated annual natural flow at Lees Ferry for the DroughtYrRes\_1576\_1600 ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



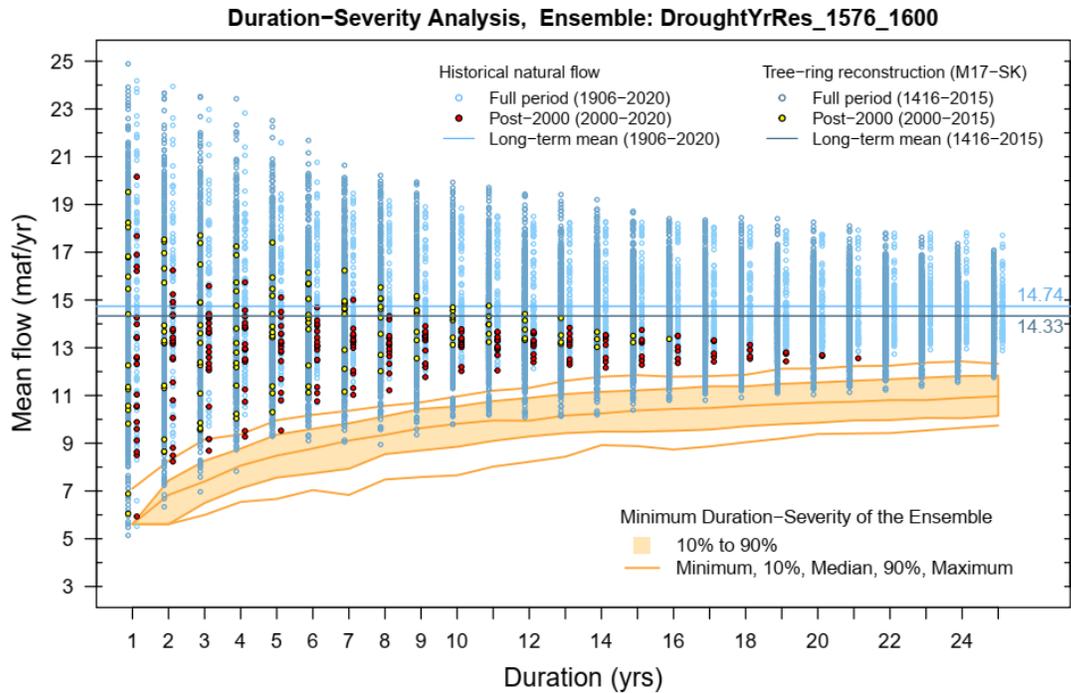
**Figure S74.** Summary metrics of simulated annual natural flow at Lees Ferry for the DroughtYrRes\_1576\_1600 ensemble.



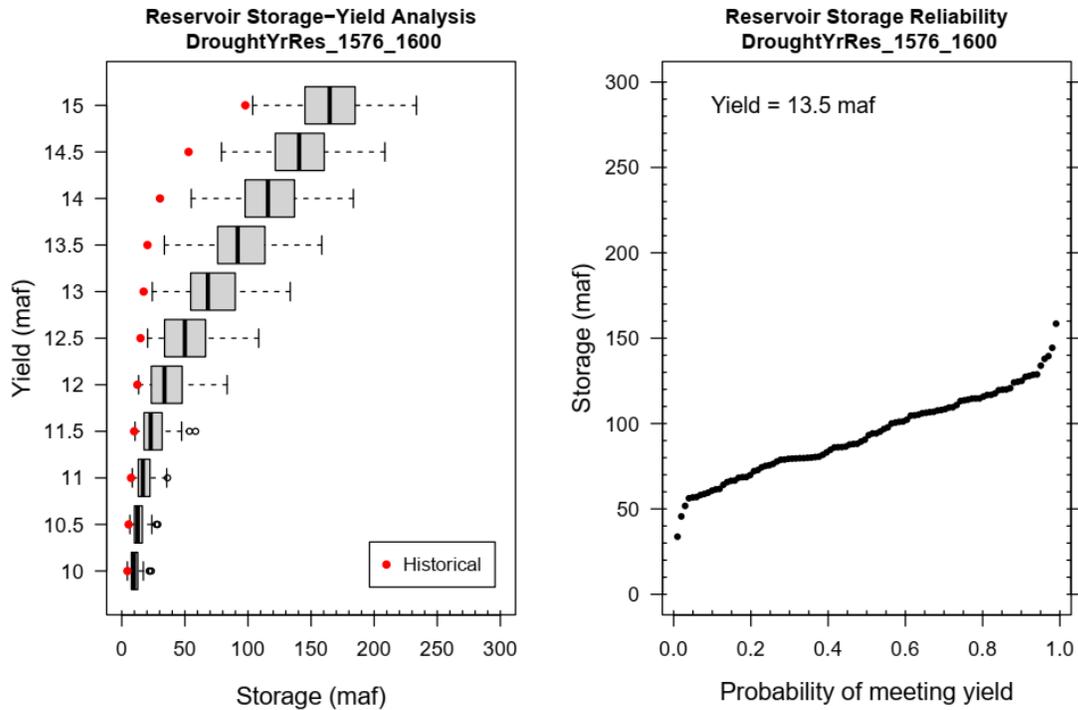
**Figure S75.** Moving count below threshold for the DroughtYrRes\_1576\_1600 ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



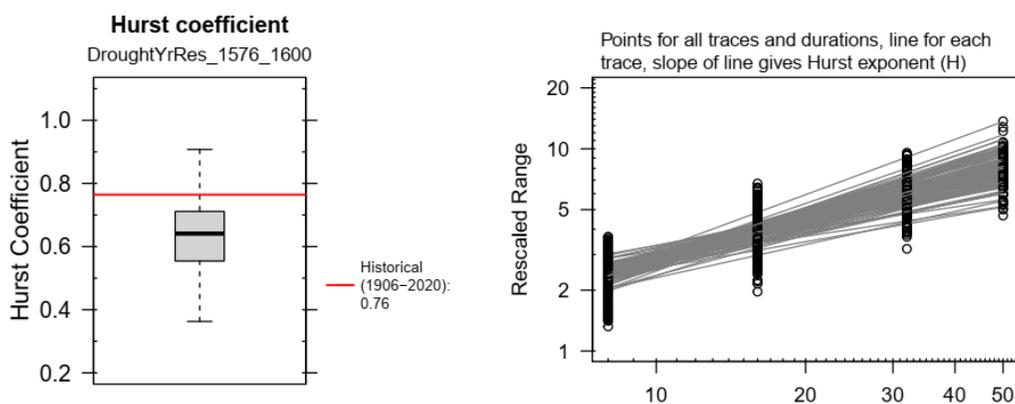
**Figure S76.** Moving count above threshold for the DroughtYrRes\_1576\_1600 ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S77.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the DroughtYrRes\_1576\_1600 ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



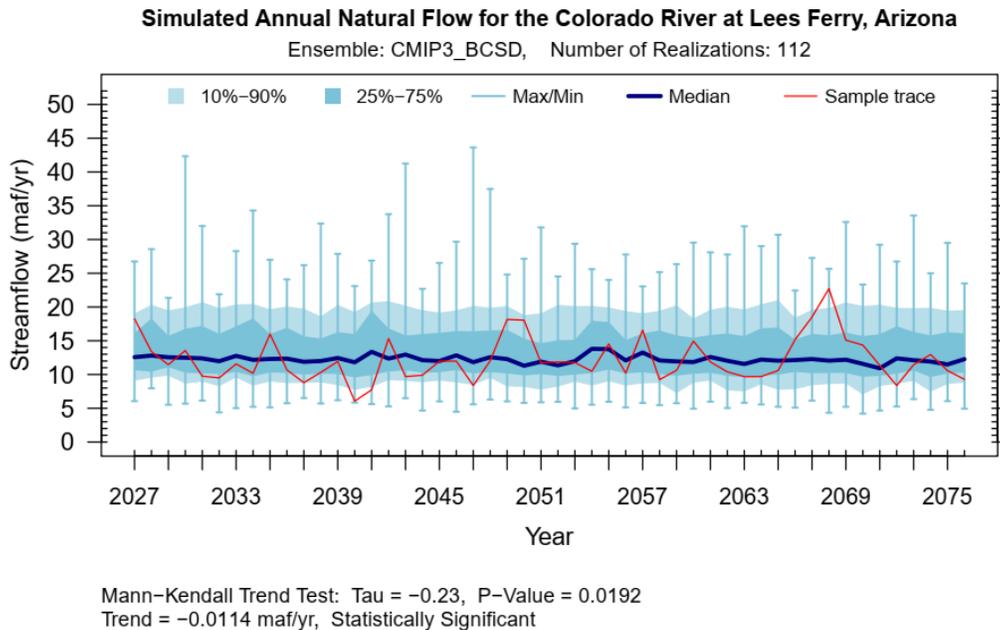
**Figure S78.** Reservoir storage-yield and reliability analysis for DroughtYrRes\_1576\_1600. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



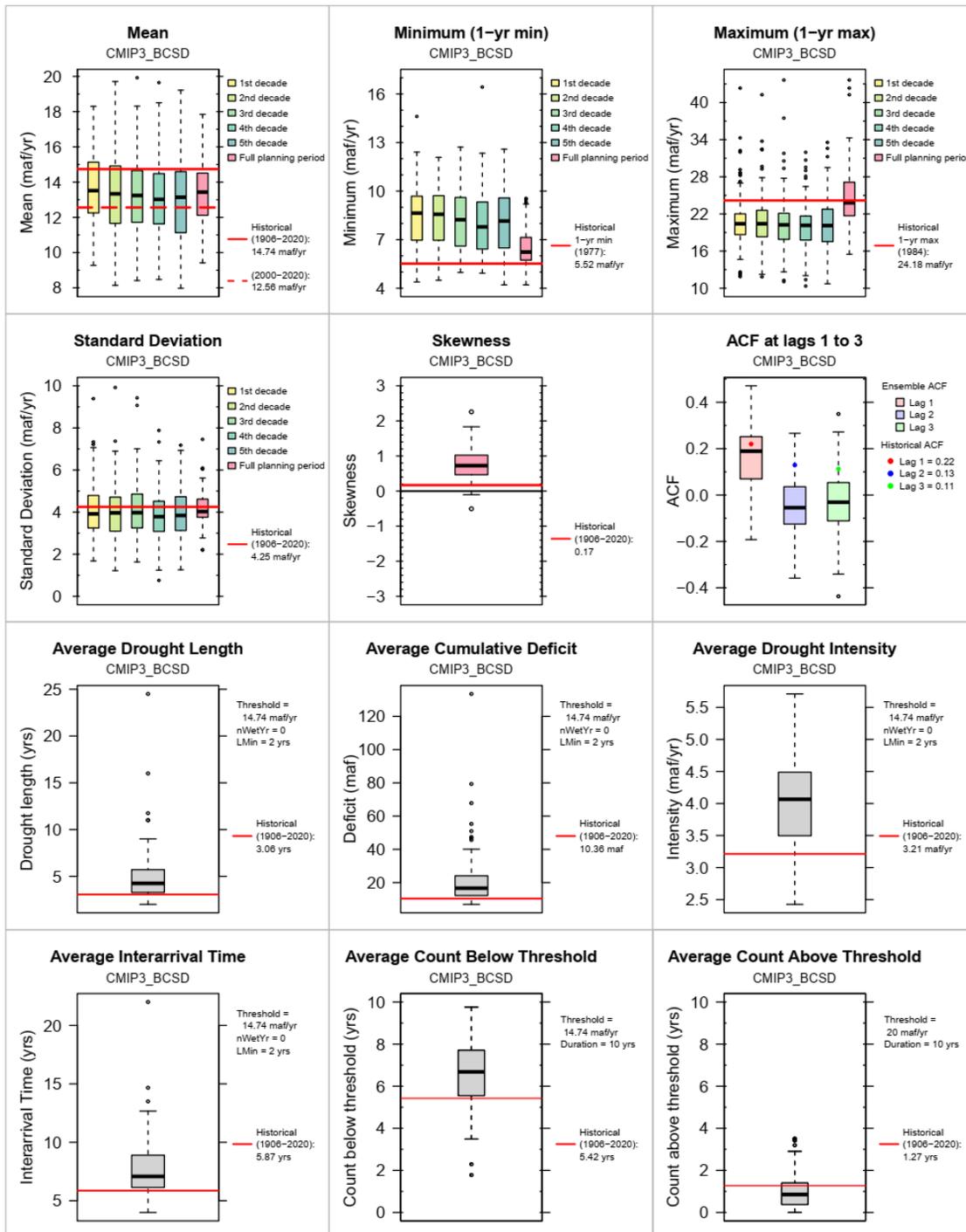
**Figure S79.** Hurst coefficient for the DroughtYrRes\_1576\_1600 ensemble.

### Text S12. CMIP3\_BCSD Ensemble

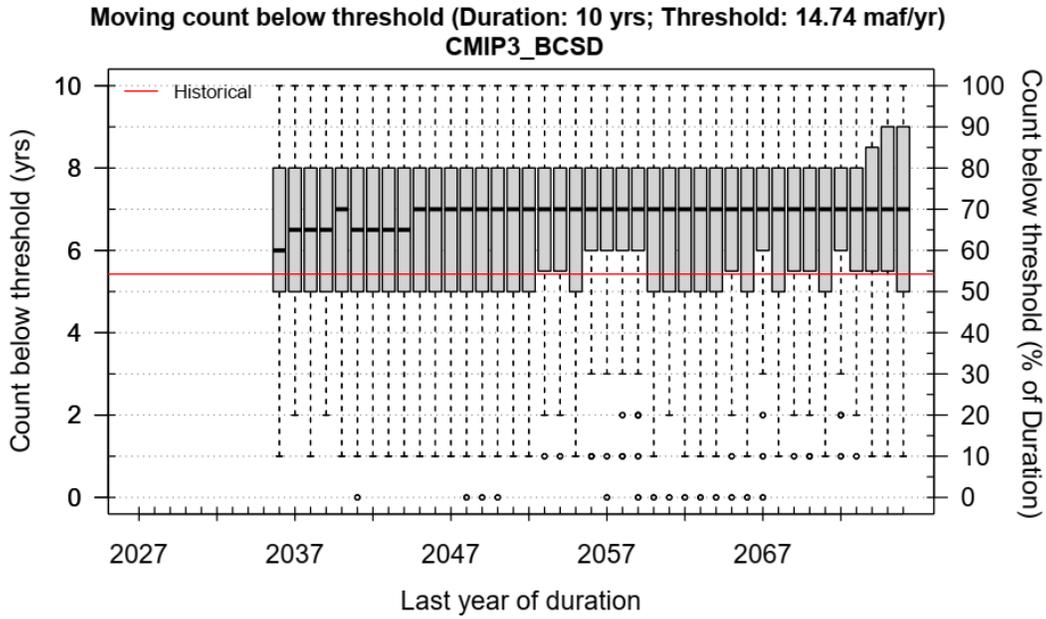
Figure S80 through Figure S86 present the metrics calculated for BCSD CMIP3 hydrology projections from USBR (2011), labeled as "CMIP3\_BCSD". This ensemble comprises 112 time series, projected by USBR (2011) using CMIP3 climate model simulations, the Bias Correction and Spatial Downscaling (BCSD) method, and Variable Infiltration Capacity (VIC) hydrology model.



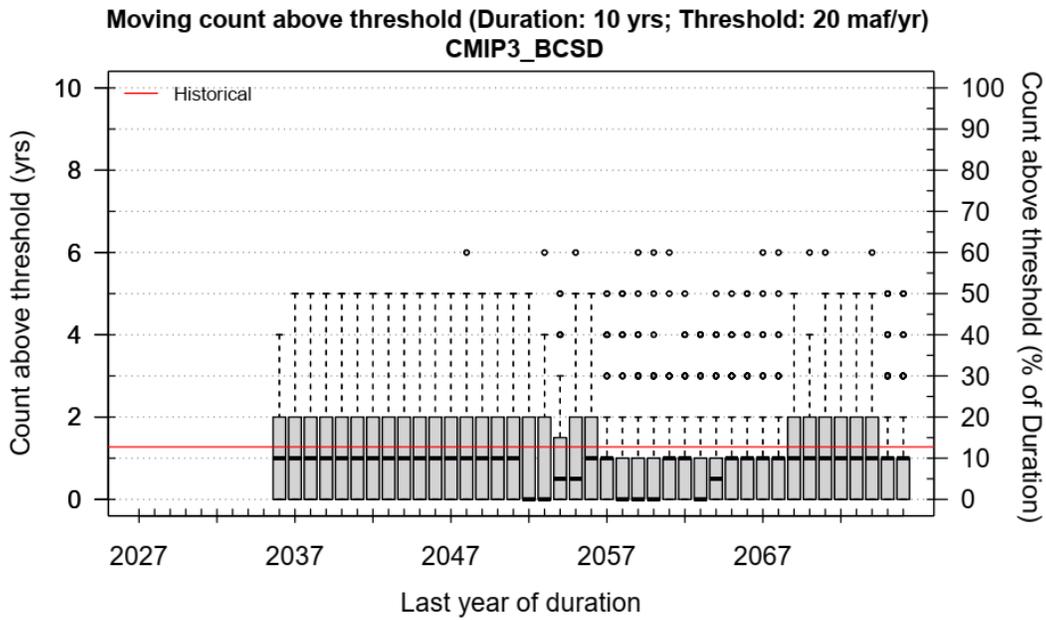
**Figure S80.** Time series of the simulated annual natural flow at Lees Ferry for the CMIP3\_BCSD ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



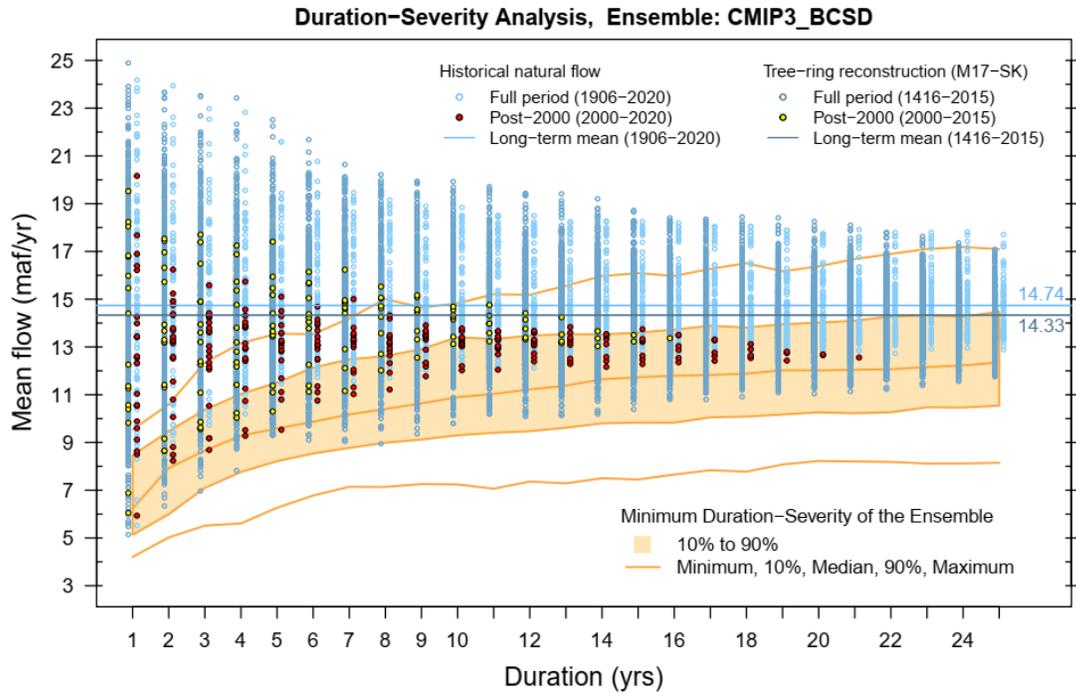
**Figure S81.** Summary metrics of simulated annual natural flow at Lees Ferry for the CMIP3\_BCSO ensemble.



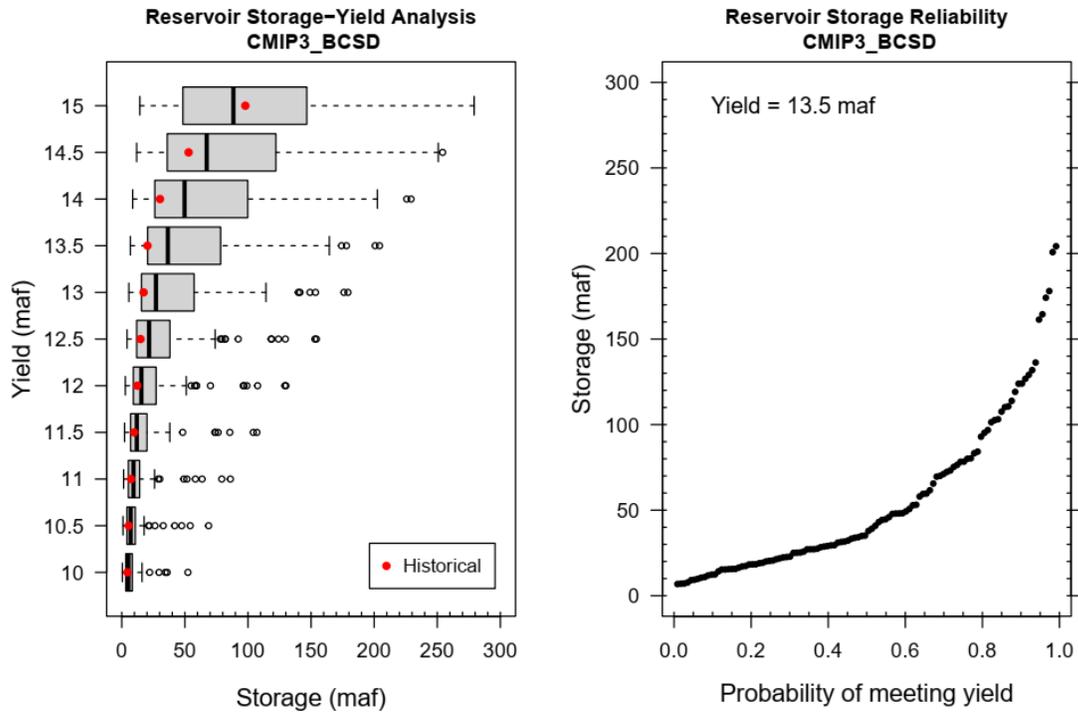
**Figure S82.** Moving count below threshold for the CMIP3\_BCSD ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



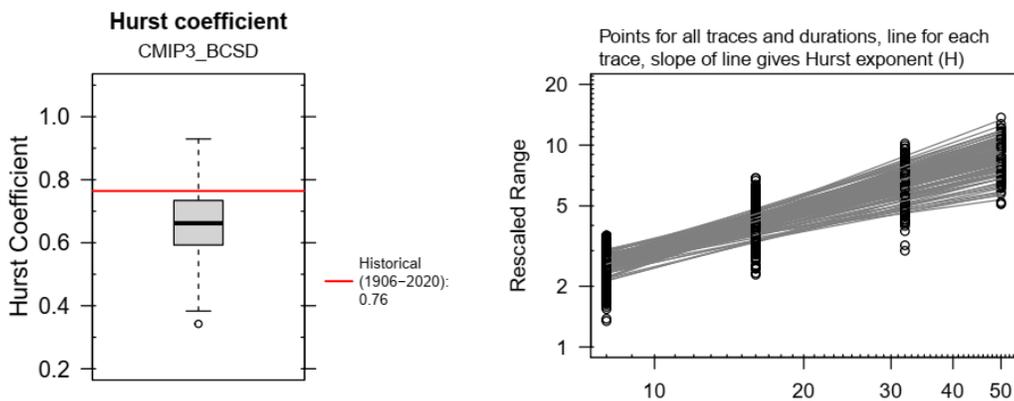
**Figure S83.** Moving count above threshold for the CMIP3\_BCSD ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S84.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the CMIP3\_BCSD ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



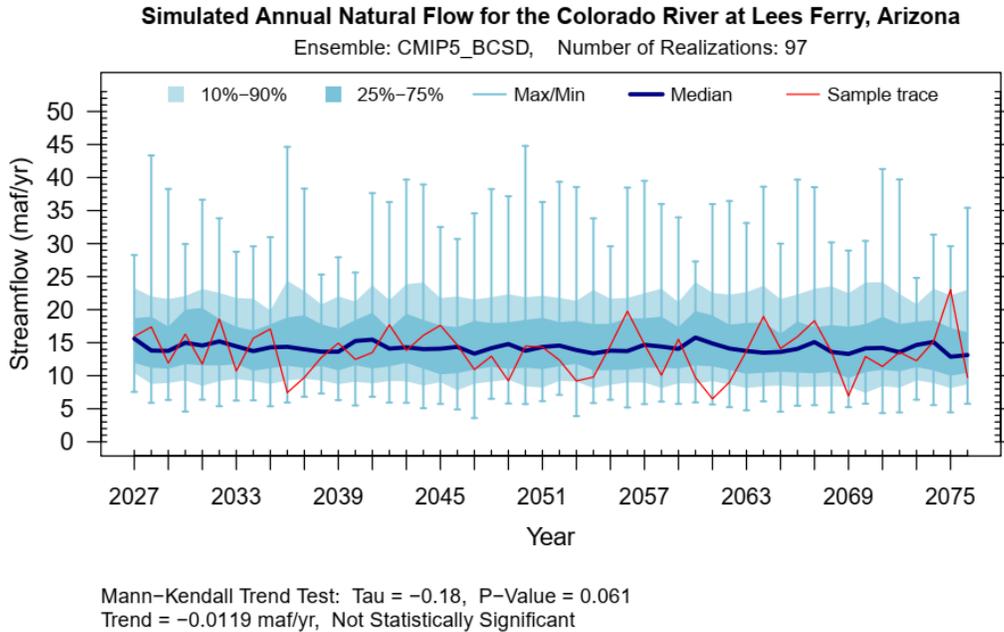
**Figure S85.** Reservoir storage-yield and reliability analysis for CMIP3\_BCSD. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



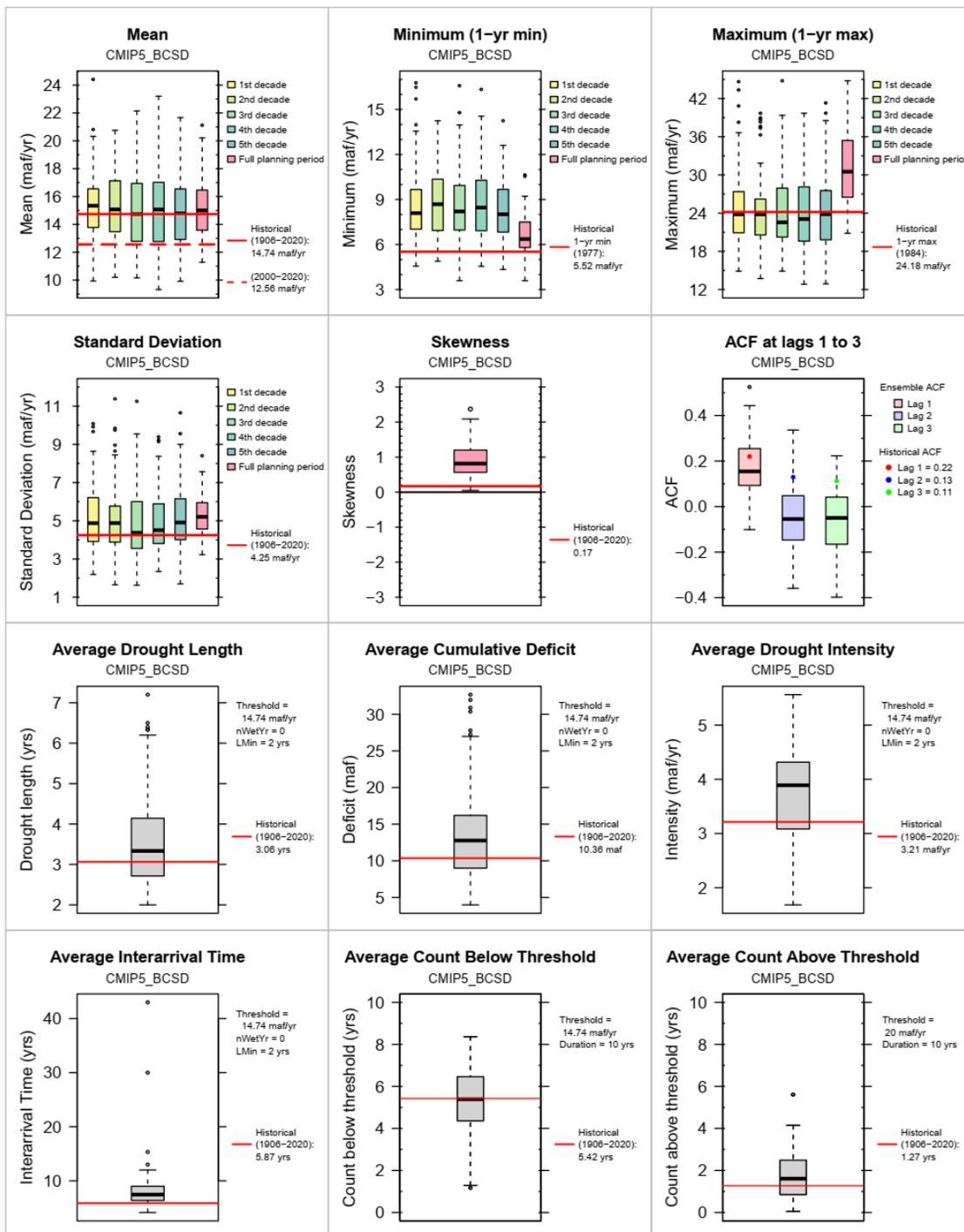
**Figure S86.** Hurst coefficient for the CMIP3\_BCSD ensemble.

**Text S13. CMIP5\_BCSD Ensemble**

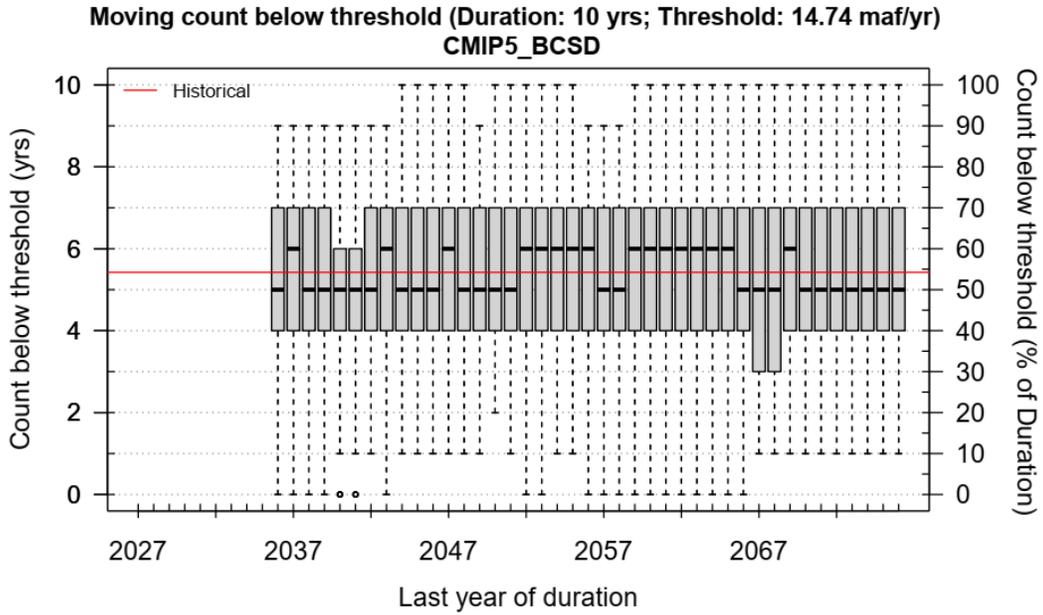
Figure S87 through Figure S93 present the metrics calculated for BCSD CMIP5 hydrology projections from USBR (2014), labeled as "CMIP5\_BCSD". This ensemble comprises 97 time series, projected by USBR (2014) using CMIP5 climate model simulations, the Bias Correction and Spatial Downscaling (BCSD) method, and Variable Infiltration Capacity (VIC) hydrology model.



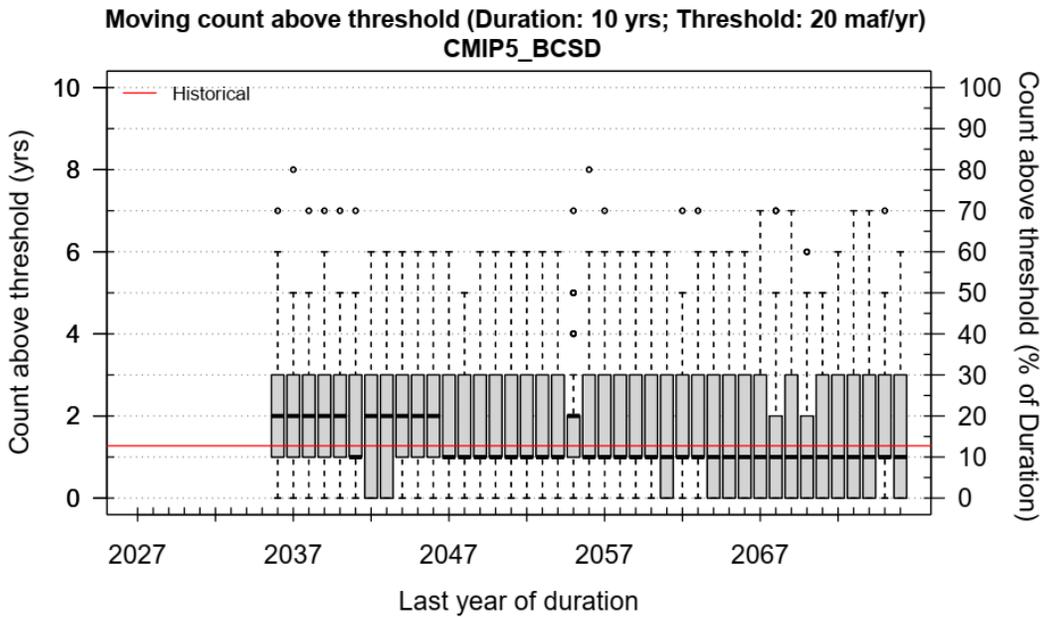
**Figure S87.** Time series of the simulated annual natural flow at Lees Ferry for the CMIP5\_BCSD ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



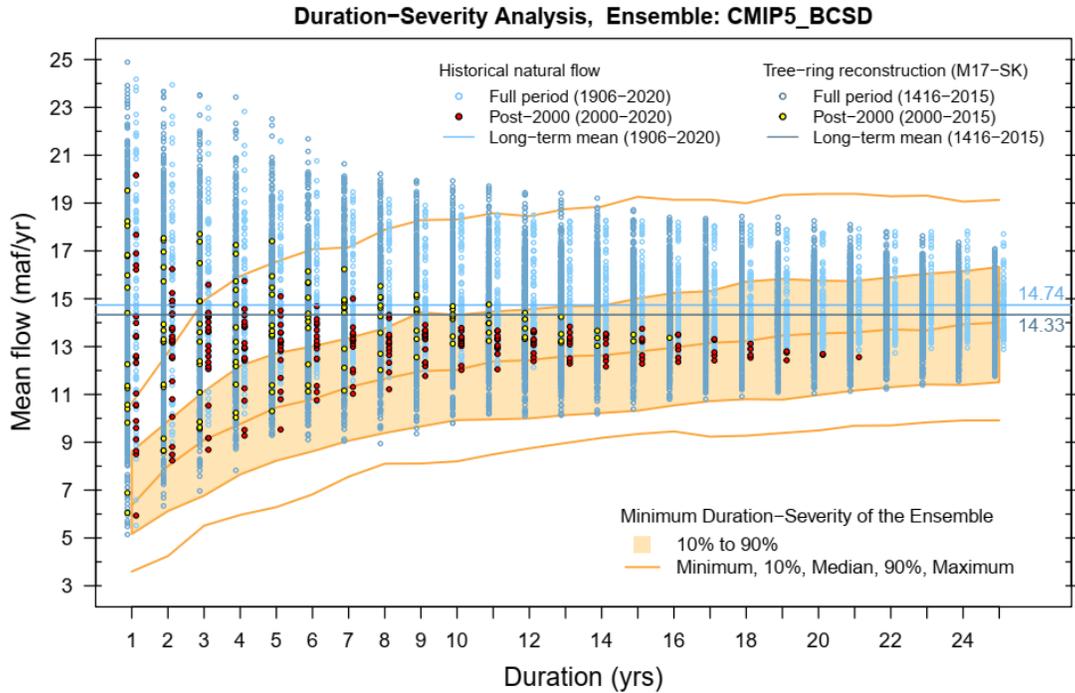
**Figure S88.** Summary metrics of simulated annual natural flow at Lees Ferry for the CMIP5\_BCSO ensemble.



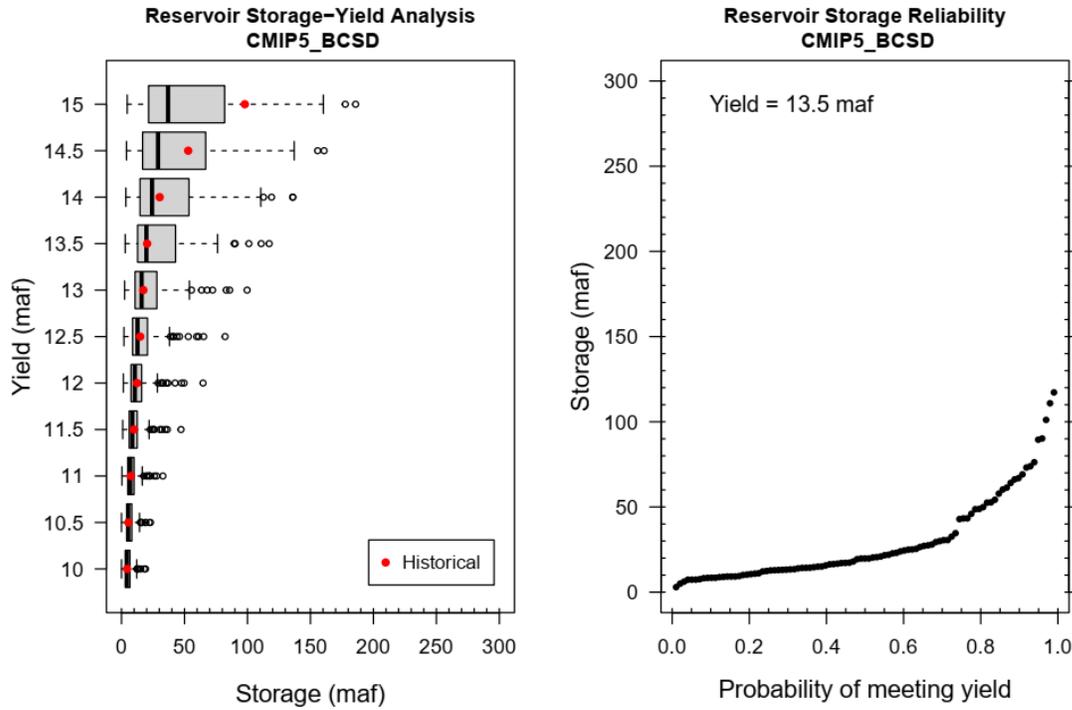
**Figure S89.** Moving count below threshold for the CMIP5\_BCSD ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



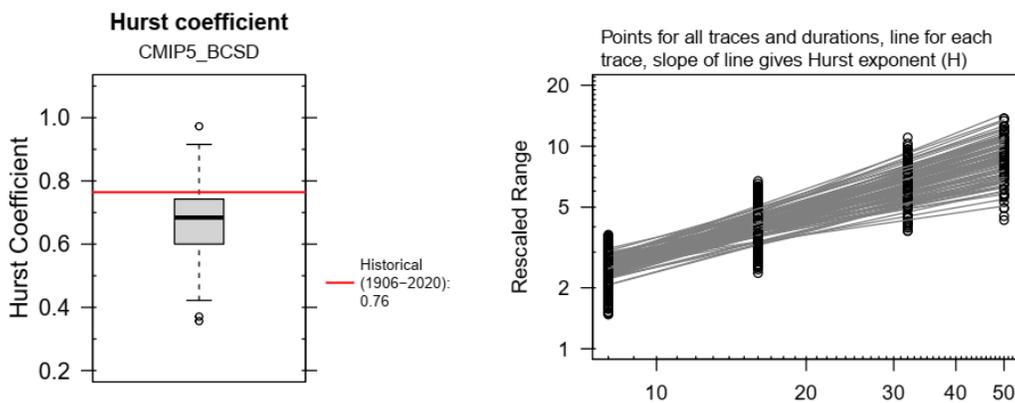
**Figure S90.** Moving count above threshold for the CMIP5\_BCSD ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S91.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the CMIP5\_BCSD ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



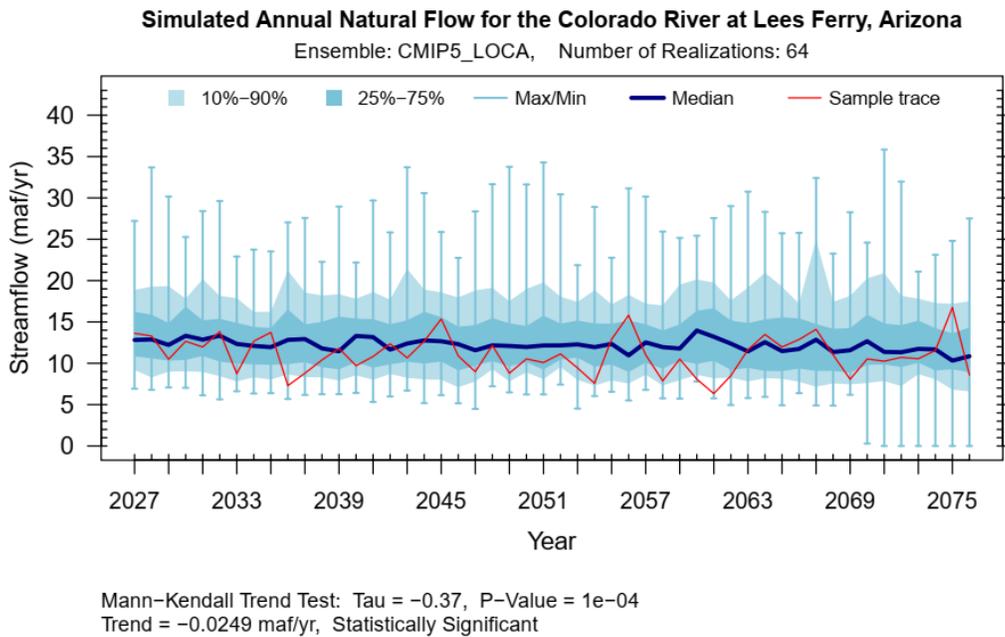
**Figure S92.** Reservoir storage-yield and reliability analysis for CMIP5\_BCSD. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



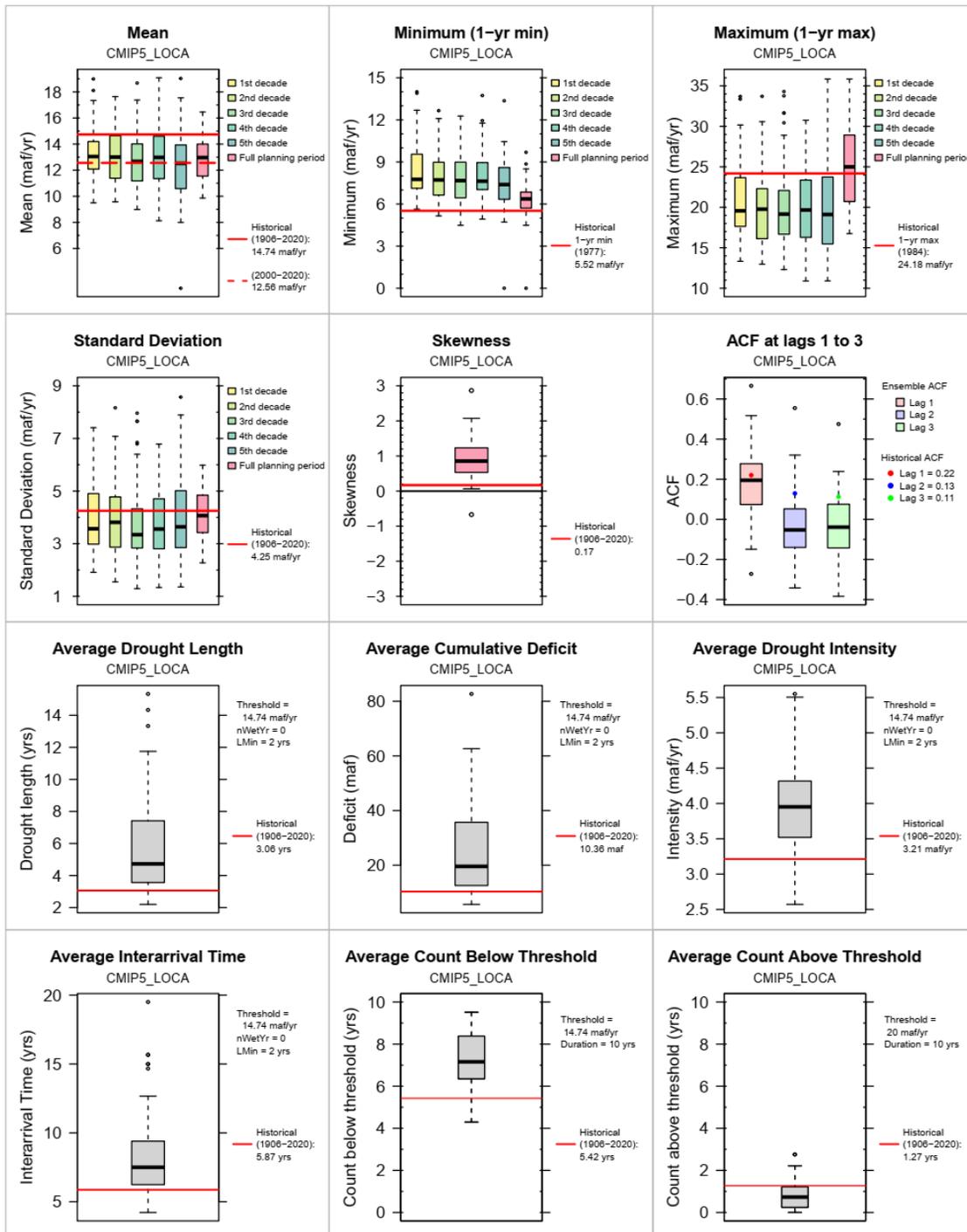
**Figure S93.** Hurst coefficient for the CMIP5\_BCSD ensemble.

### Text S14. CMIP5\_LOCA Ensemble

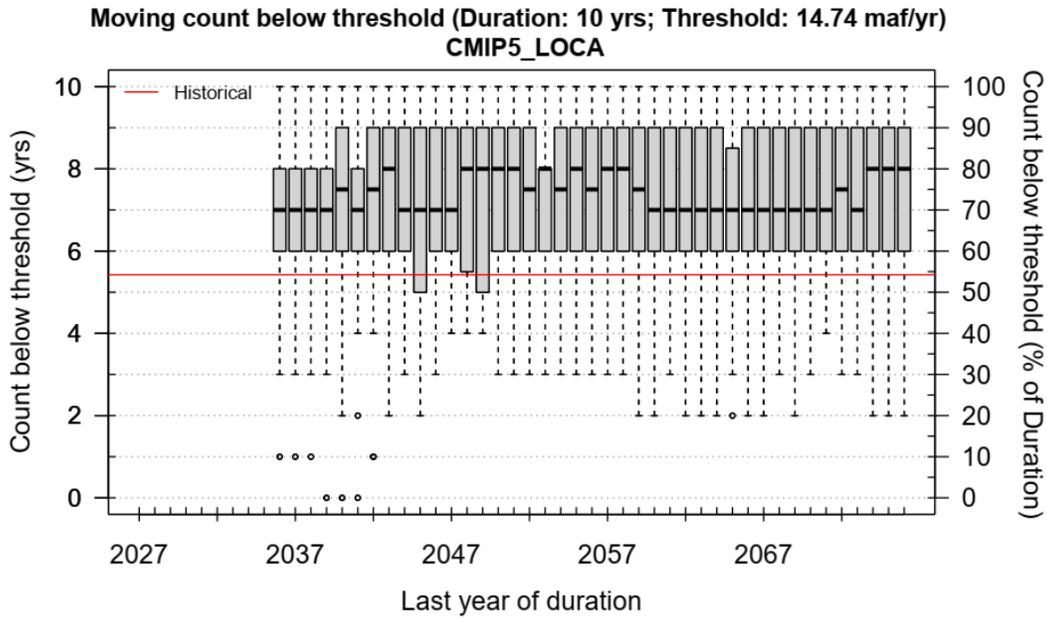
Figure S94 through Figure S100 present the metrics calculated for LOCA CMIP5 hydrology projections from Vano et al. (2020), labeled as “CMIP5\_LOCA”. This ensemble comprises 64 time series, projected by Vano et al. (2020) using CMIP5 climate model simulations, the Localized Constructed Analogs (LOCA) downscaling method, and Variable Infiltration Capacity (VIC) hydrology model.



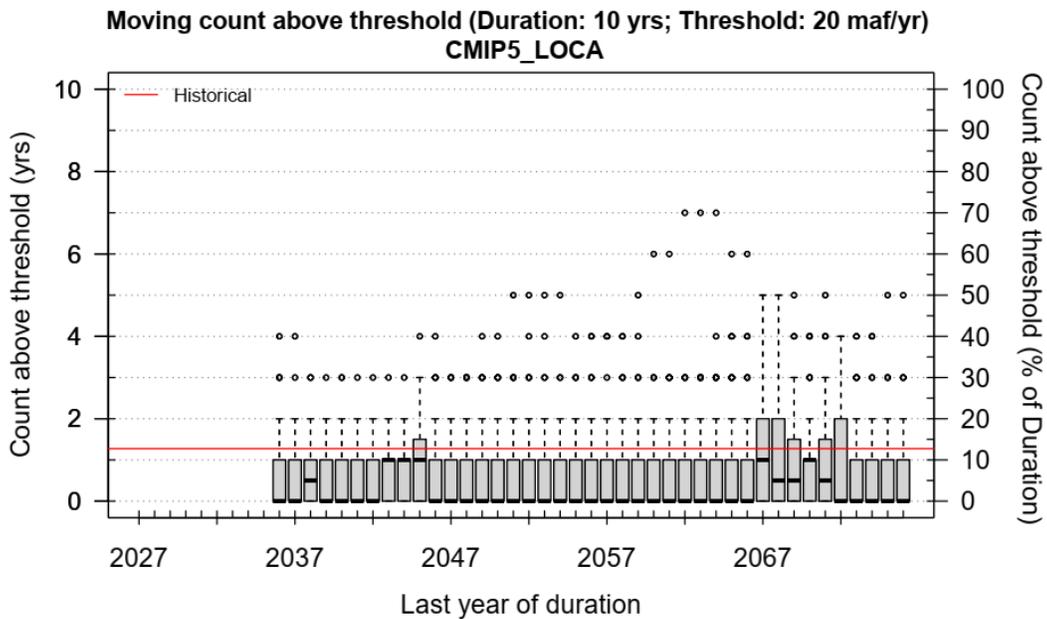
**Figure S94.** Time series of the simulated annual natural flow at Lees Ferry for the CMIP5\_LOCA ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



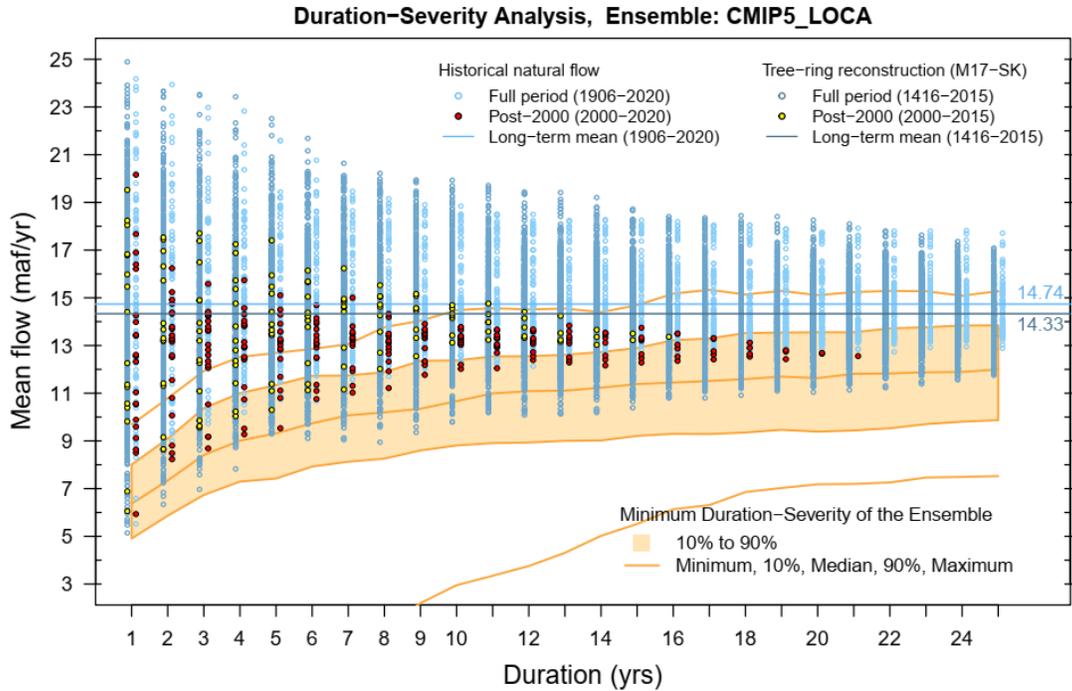
**Figure S95.** Summary metrics of simulated annual natural flow at Lees Ferry for the CMIP5\_LOCA ensemble.



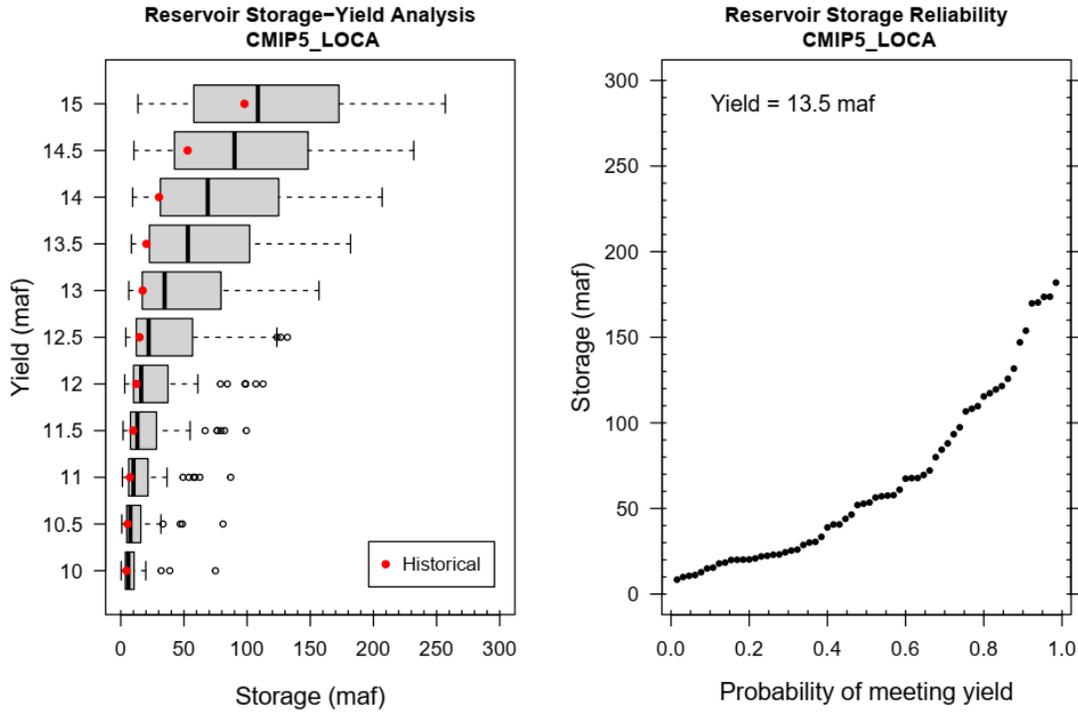
**Figure S96.** Moving count below threshold for the CMIP5\_LOCA ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



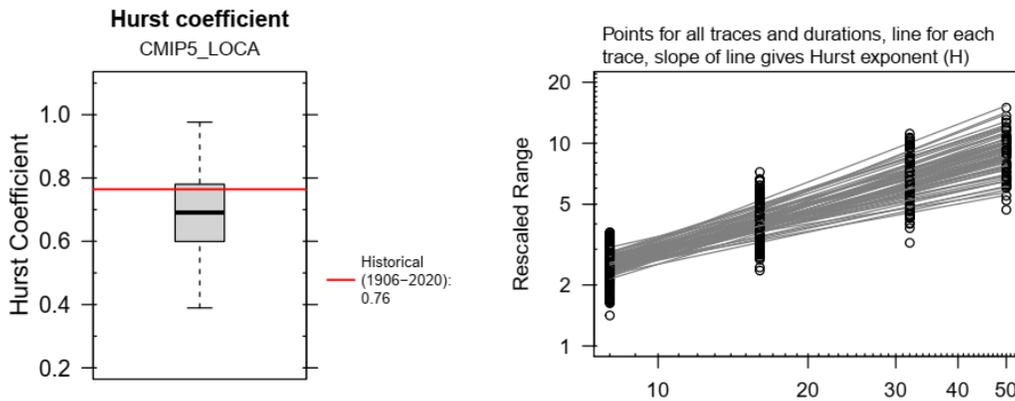
**Figure S97.** Moving count above threshold for the CMIP5\_LOCA ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S98.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the CMIP5\_LOCA ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



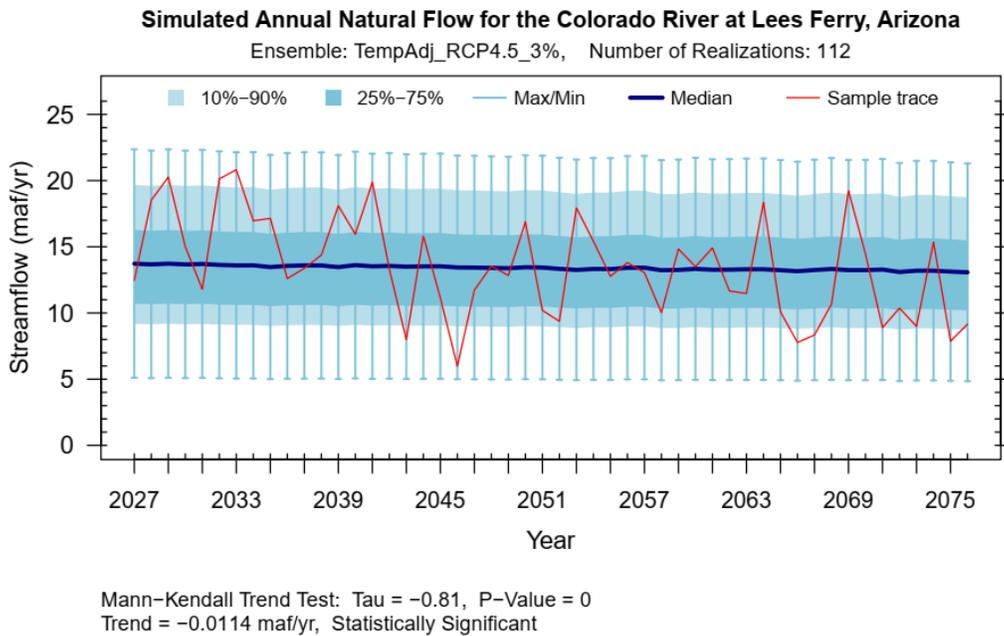
**Figure S99.** Reservoir storage-yield and reliability analysis for CMIP5\_LOCA. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



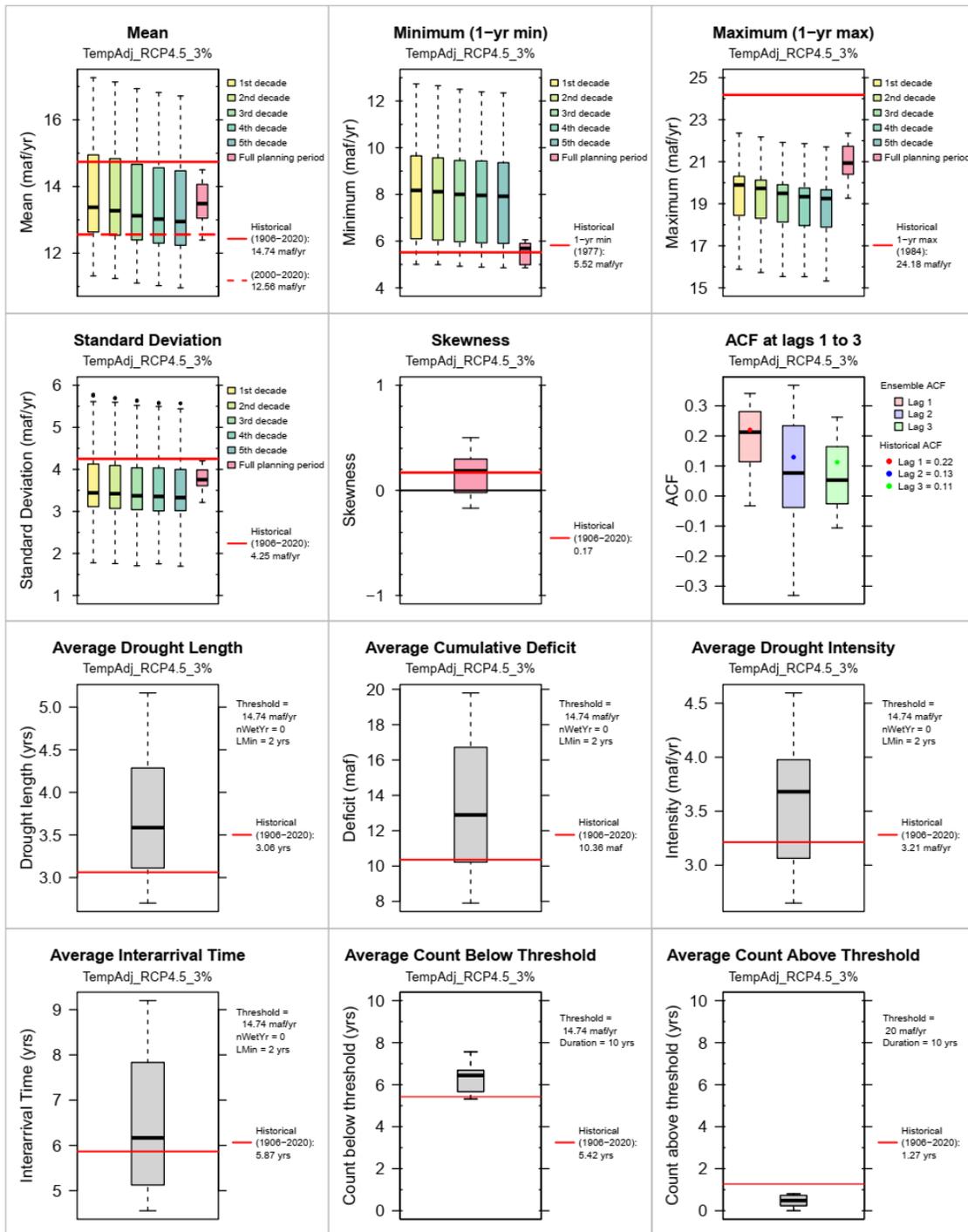
**Figure S100.** Hurst coefficient for the CMIP5\_LOCA ensemble.

**Text S15. TempAdj\_RCP4.5\_3%: RCP4.5-3% Temperature-Adjusted Flow**

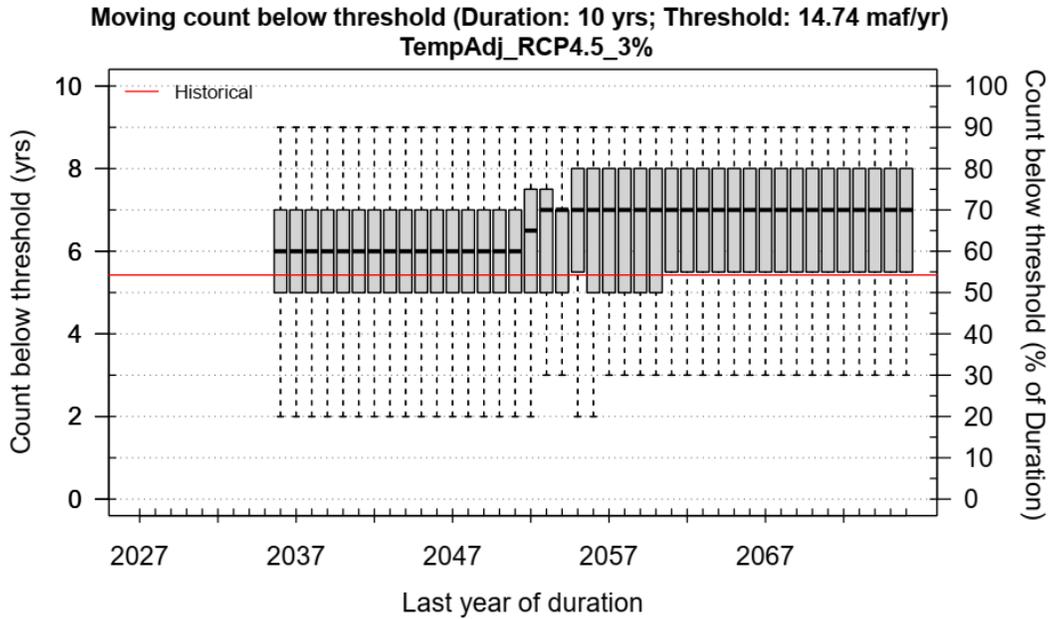
Figure S101 through Figure S107 present the metrics calculated for the RCP4.5-3% Temperature-Adjusted Flow ensemble from Udall (2020), labeled as "TempAdj\_RCP4.5\_3%". This ensemble comprises 112 time series, generated by Udall (2020) through temperature adjustment of the historical natural flow using RCP4.5 projected future temperatures and a 6.5% streamflow sensitivity to temperature.



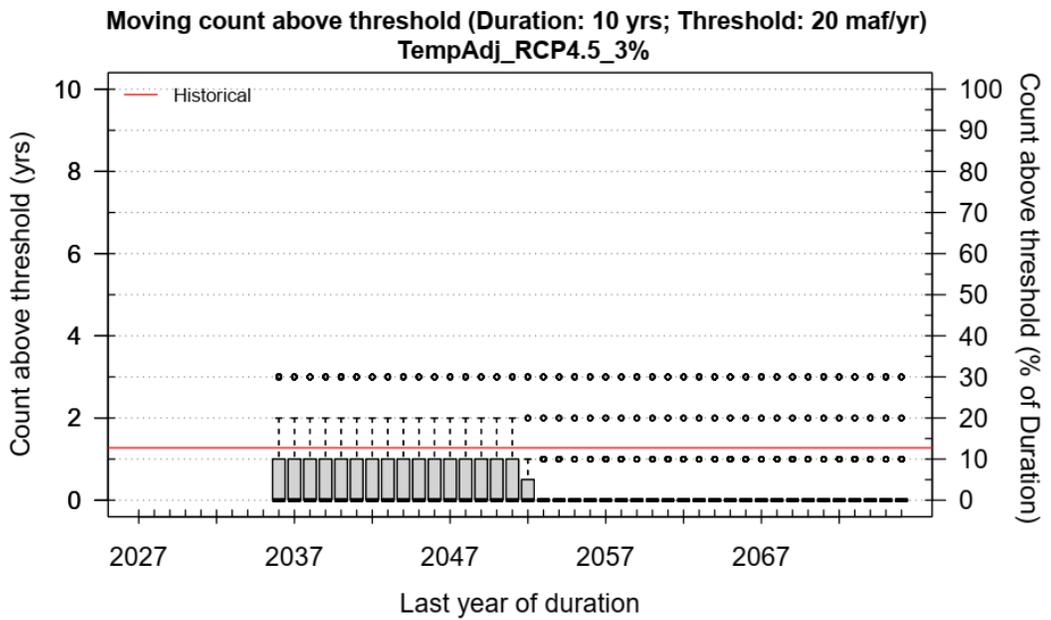
**Figure S101.** Time series of the simulated annual natural flow at Lees Ferry for the TempAdj\_RCP4.5\_3% ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



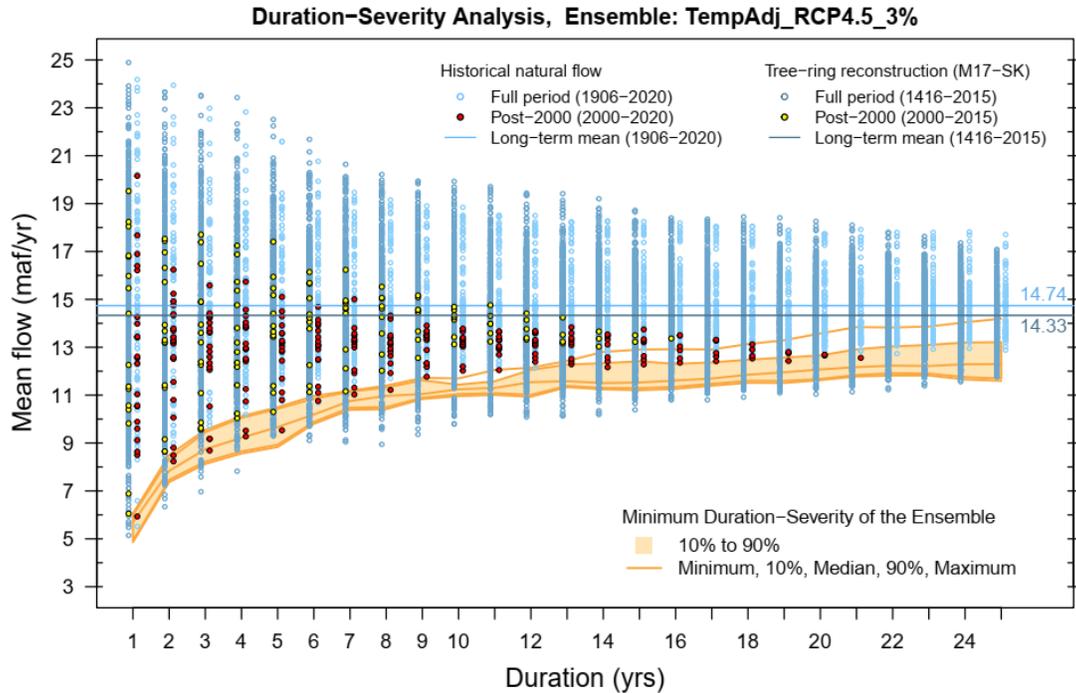
**Figure S102.** Summary metrics of simulated annual natural flow at Lees Ferry for the TempAdj\_RCP4.5\_3% ensemble.



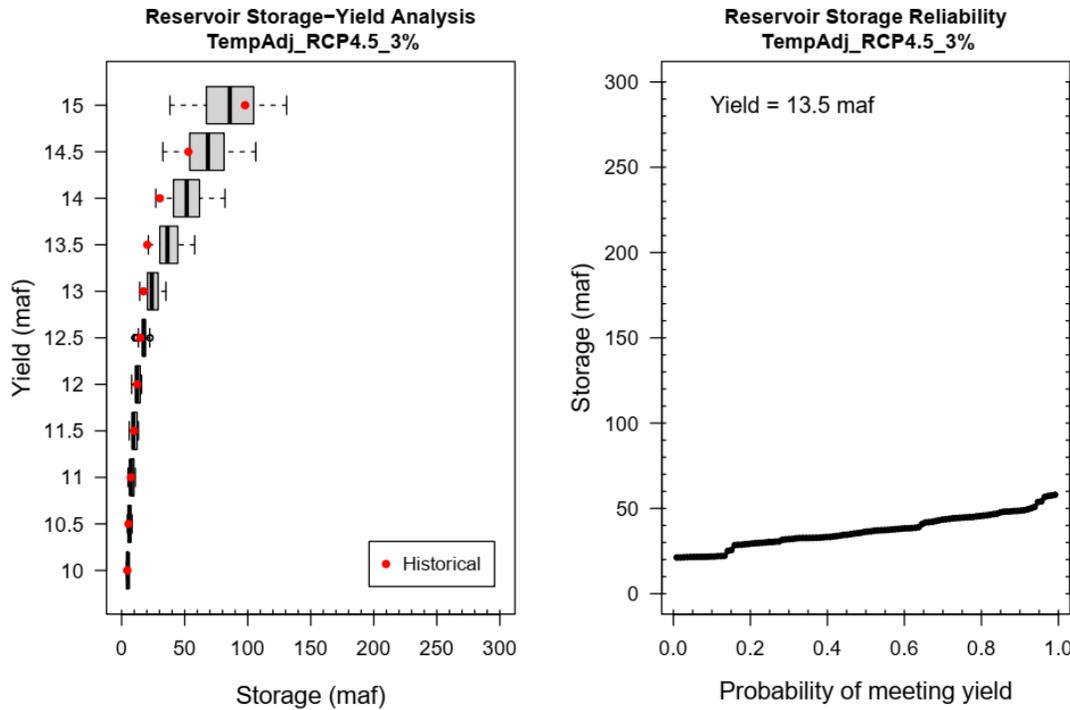
**Figure S103.** Moving count below threshold for the TempAdj\_RCP4.5\_3% ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



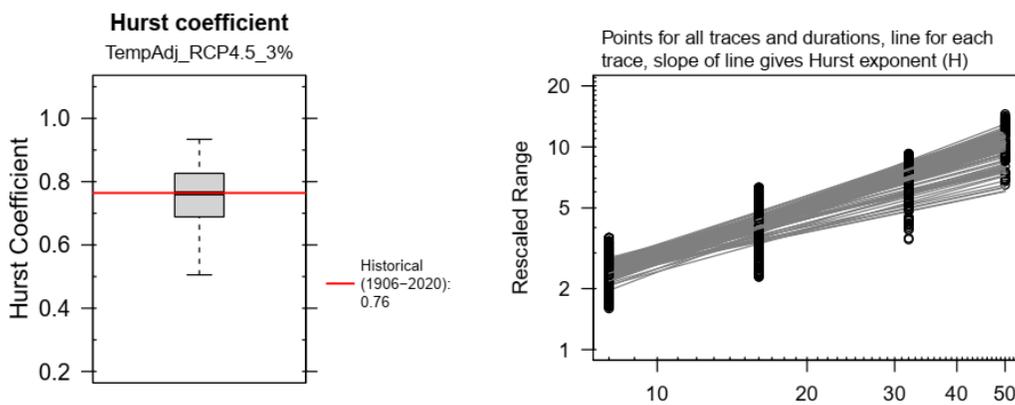
**Figure S104.** Moving count above threshold for the TempAdj\_RCP4.5\_3% ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S105.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the TempAdj\_RCP4.5\_3% ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



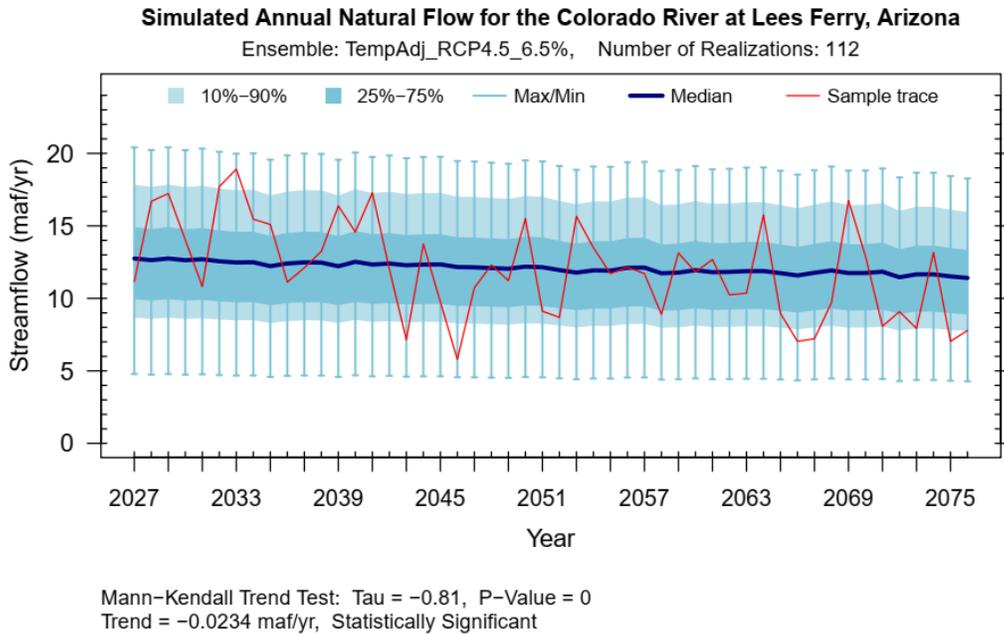
**Figure S106.** Reservoir storage-yield and reliability analysis for TempAdj\_RCP4.5\_3%. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



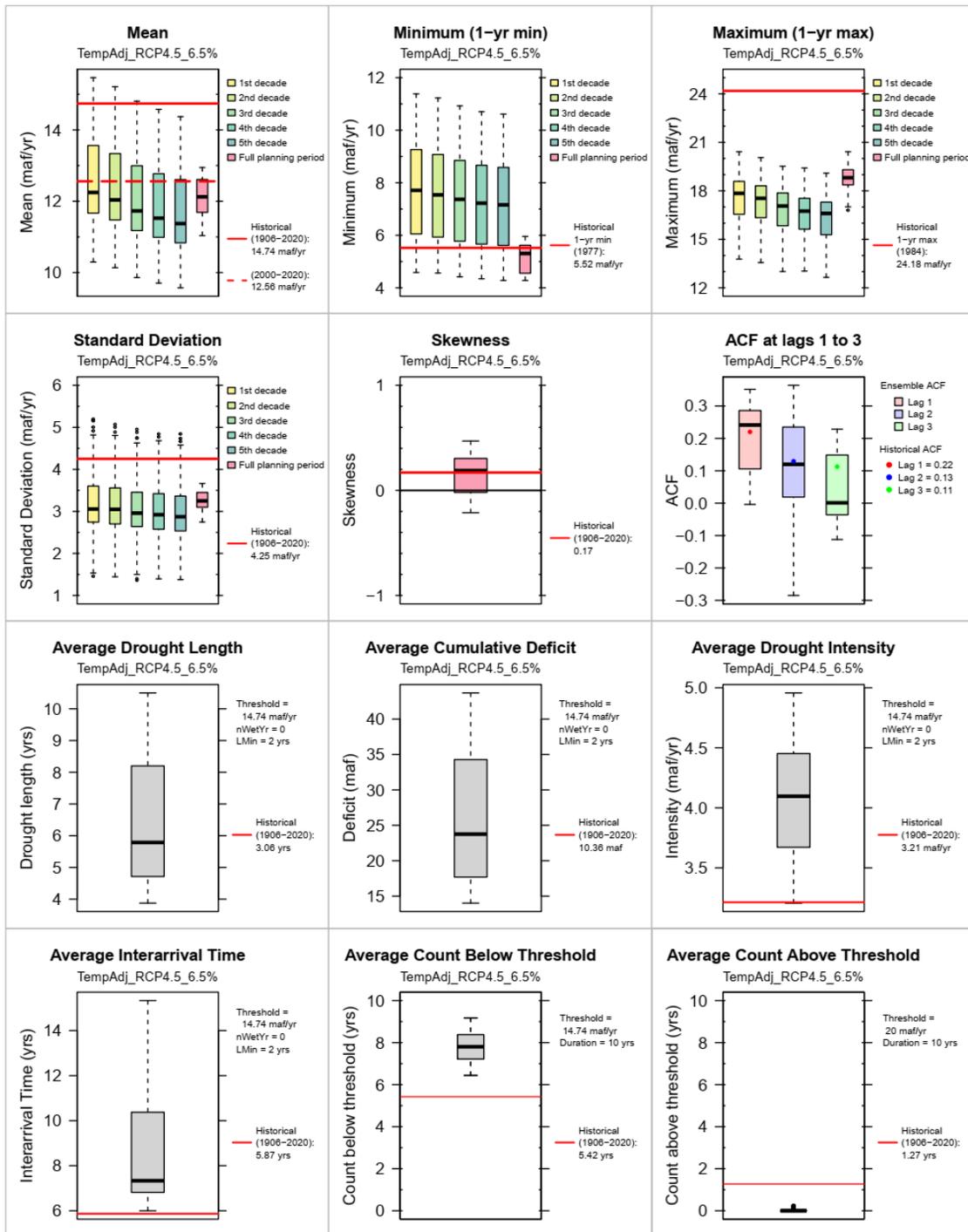
**Figure S107.** Hurst coefficient for the TempAdj\_RCP4.5\_3% ensemble.

**Text S16. TempAdj\_RCP4.5\_6.5%: RCP4.5-6.5% Temperature-Adjusted Flow**

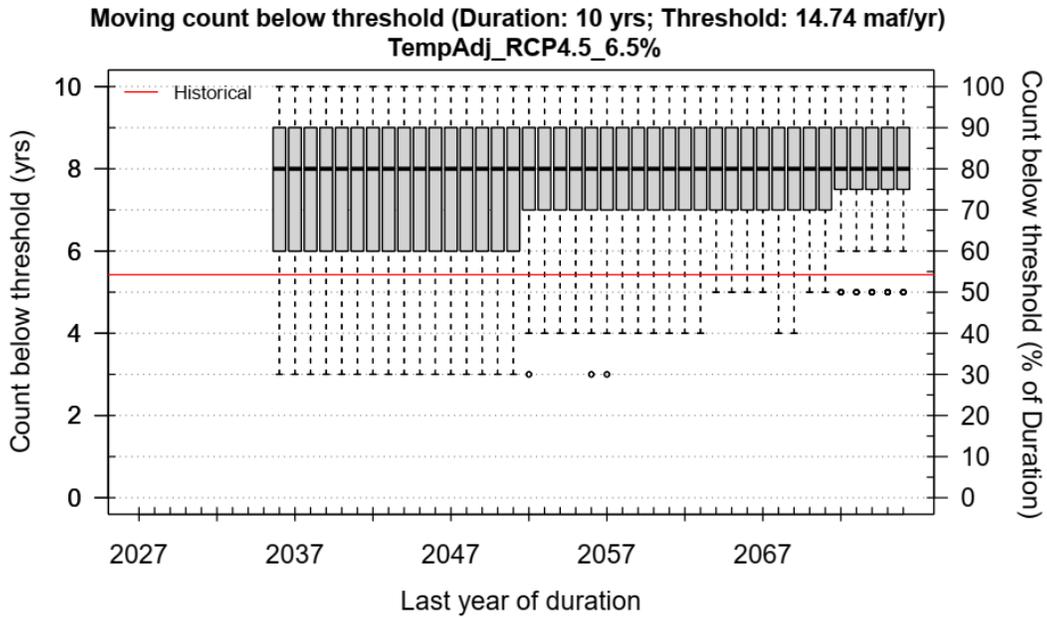
Figure S108 through Figure S114 present the metrics calculated for the RCP4.5-6.5% Temperature-Adjusted Flow ensemble from Udall (2020), labeled as "TempAdj\_RCP4.5\_6.5%". This ensemble comprises 112 time series, generated by Udall (2020) through temperature adjustment of the historical natural flow using RCP4.5 projected future temperatures and a 6.5% streamflow sensitivity to temperature.



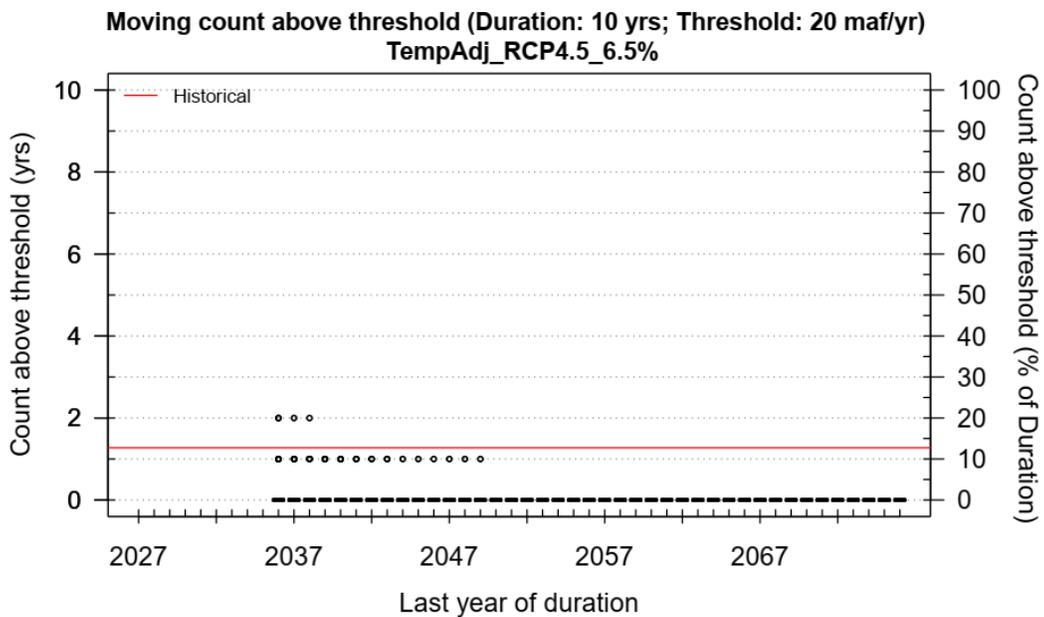
**Figure S108.** Time series of the simulated annual natural flow at Lees Ferry for the TempAdj\_RCP4.5\_6.5% ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



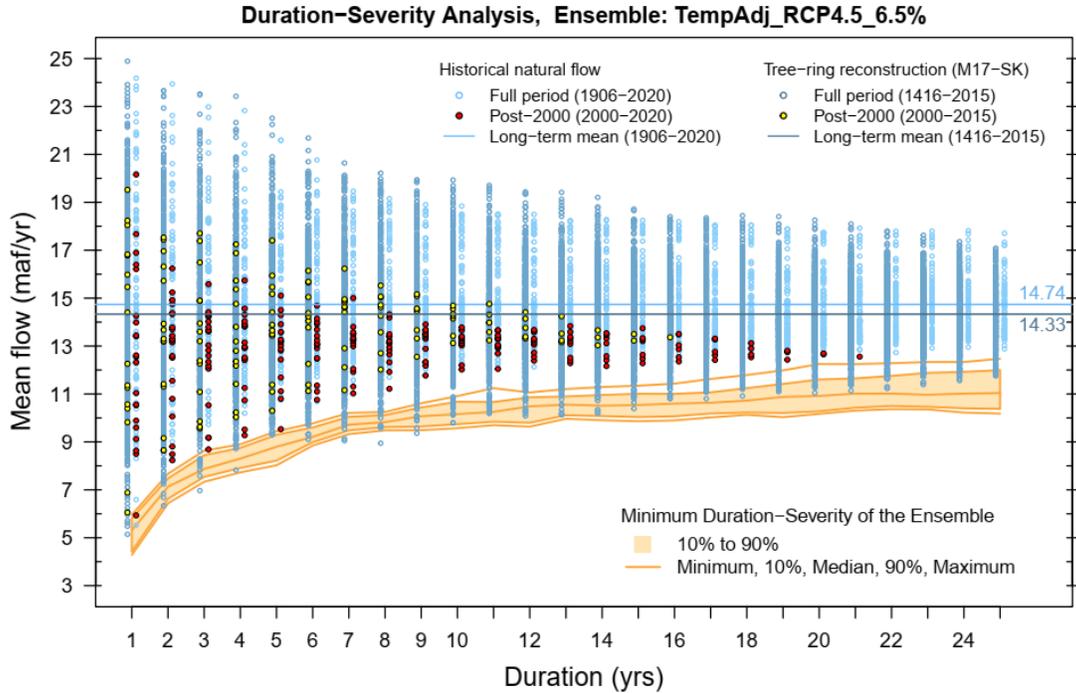
**Figure S109.** Summary metrics of simulated annual natural flow at Lees Ferry for the TempAdj\_RCP4.5\_6.5% ensemble.



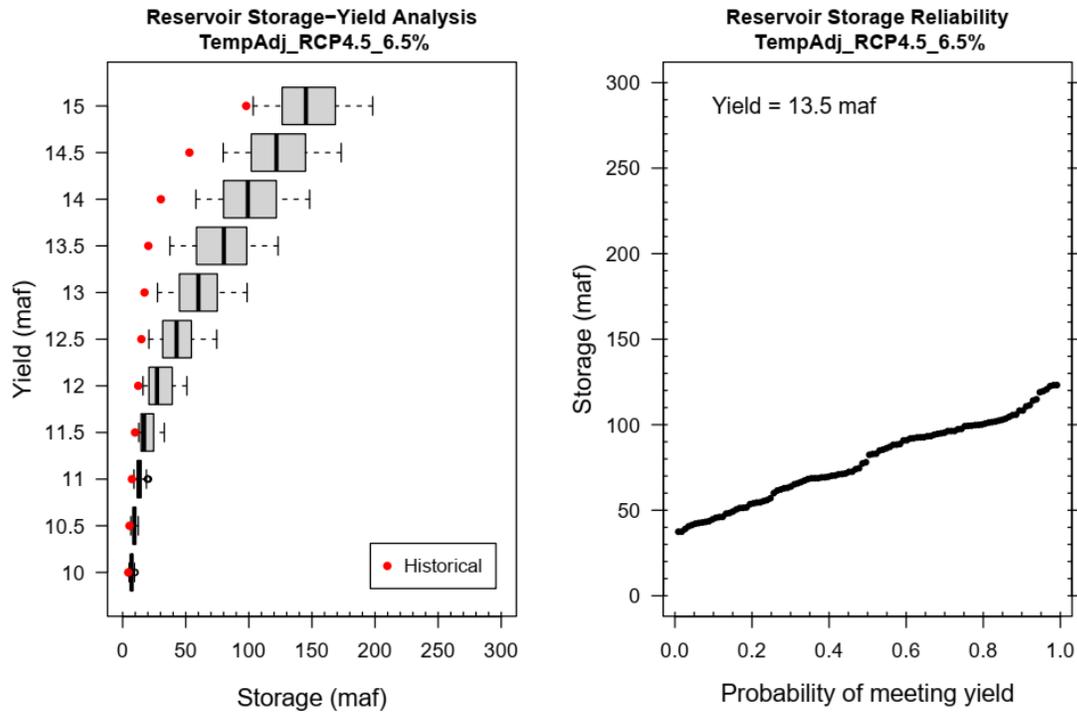
**Figure S110.** Moving count below threshold for the TempAdj\_RCP4.5\_6.5% ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



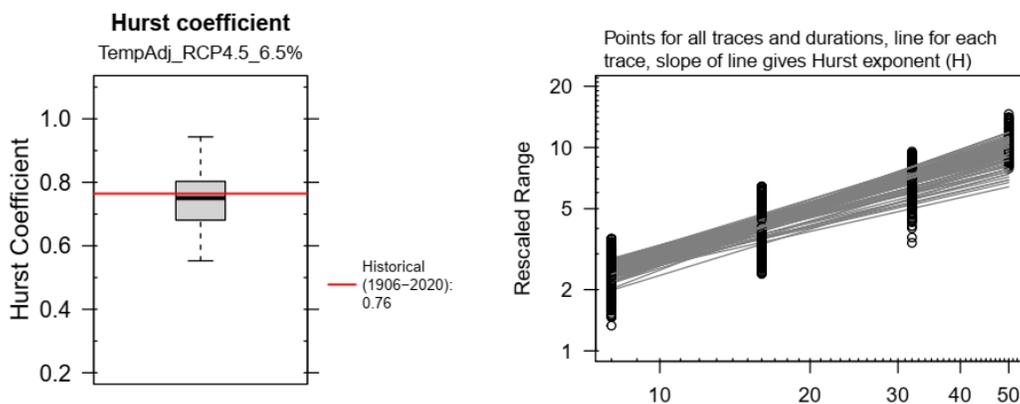
**Figure S111.** Moving count above threshold for the TempAdj\_RCP4.5\_6.5% ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S112.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the TempAdj\_RCP4.5\_6.5% ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



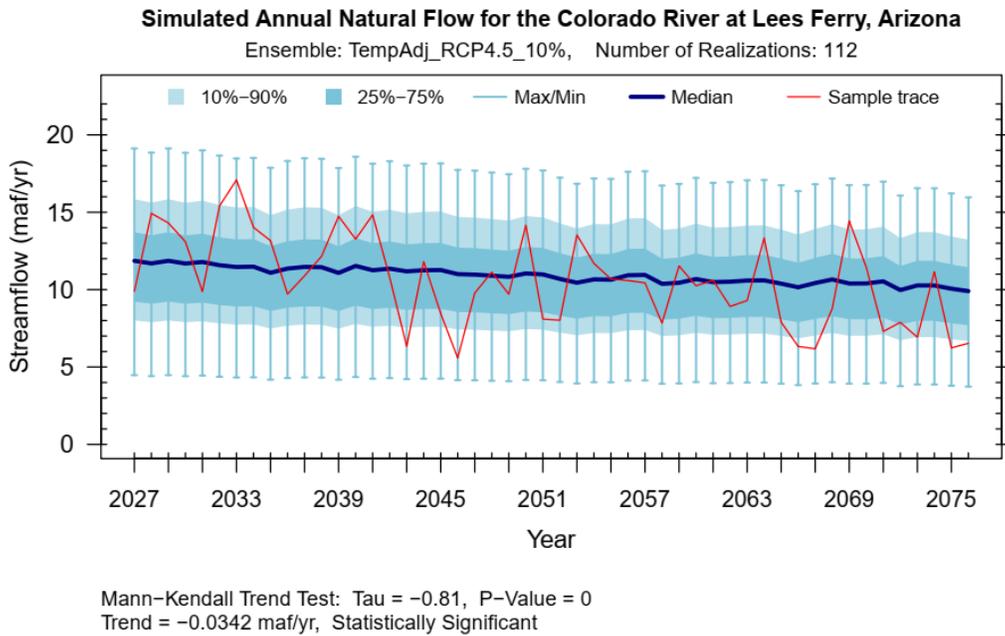
**Figure S113.** Reservoir storage-yield and reliability analysis for TempAdj\_RCP4.5\_6.5%. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



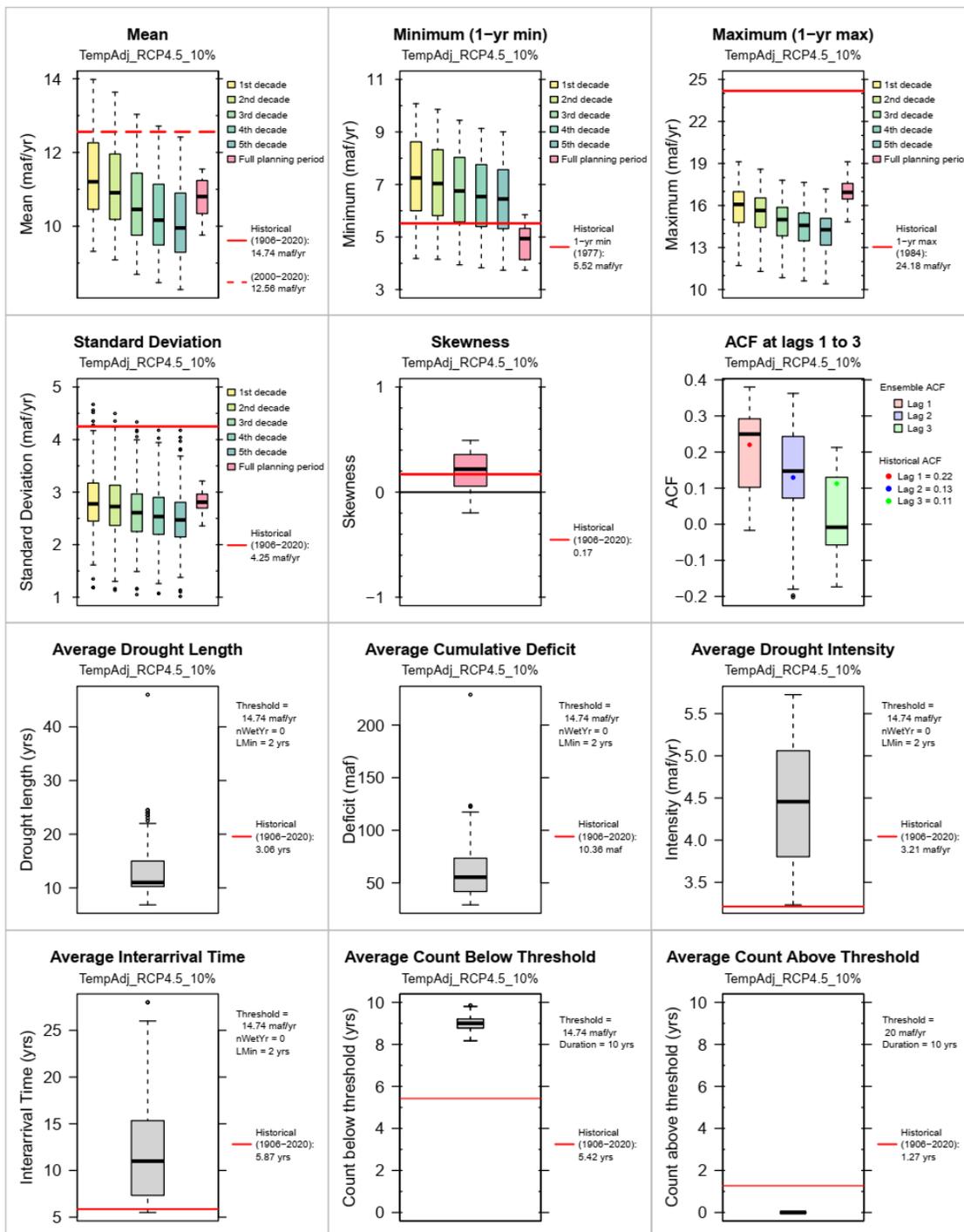
**Figure S114.** Hurst coefficient for the TempAdj\_RCP4.5\_6.5% ensemble.

**Text S17. TempAdj\_RCP4.5\_10%: RCP4.5-10% Temperature-Adjusted Flow**

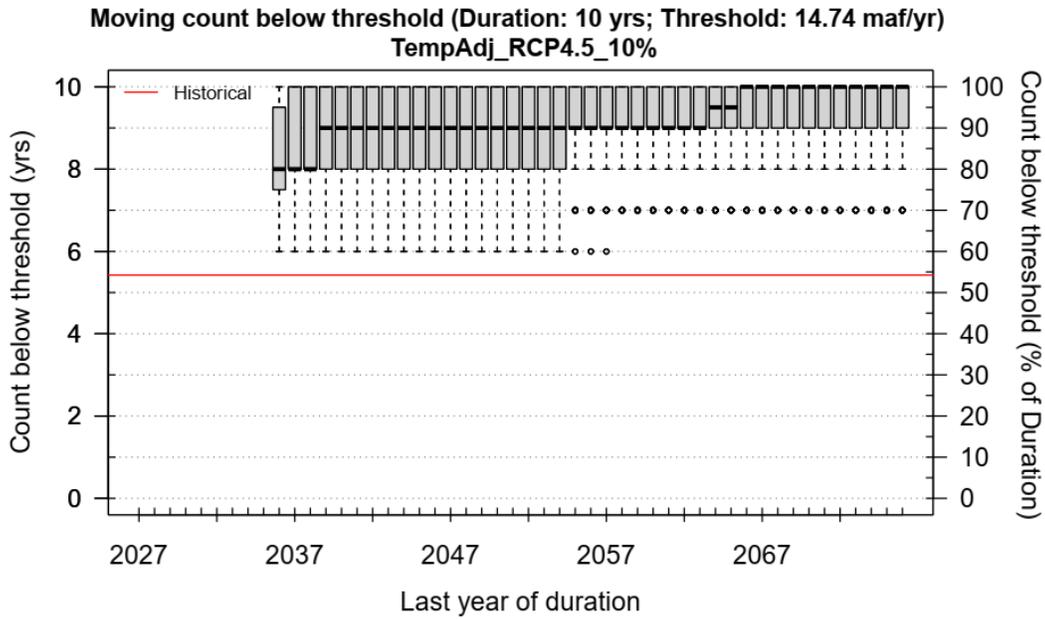
Figure S115 through Figure S121 present the metrics calculated for the RCP4.5-10% Temperature-Adjusted Flow ensemble from Udall (2020), labeled as "TempAdj\_RCP4.5\_10%". This ensemble comprises 112 time series, generated by Udall (2020) through temperature adjustment of the historical natural flow using RCP4.5 projected future temperatures and a 10% streamflow sensitivity to temperature.



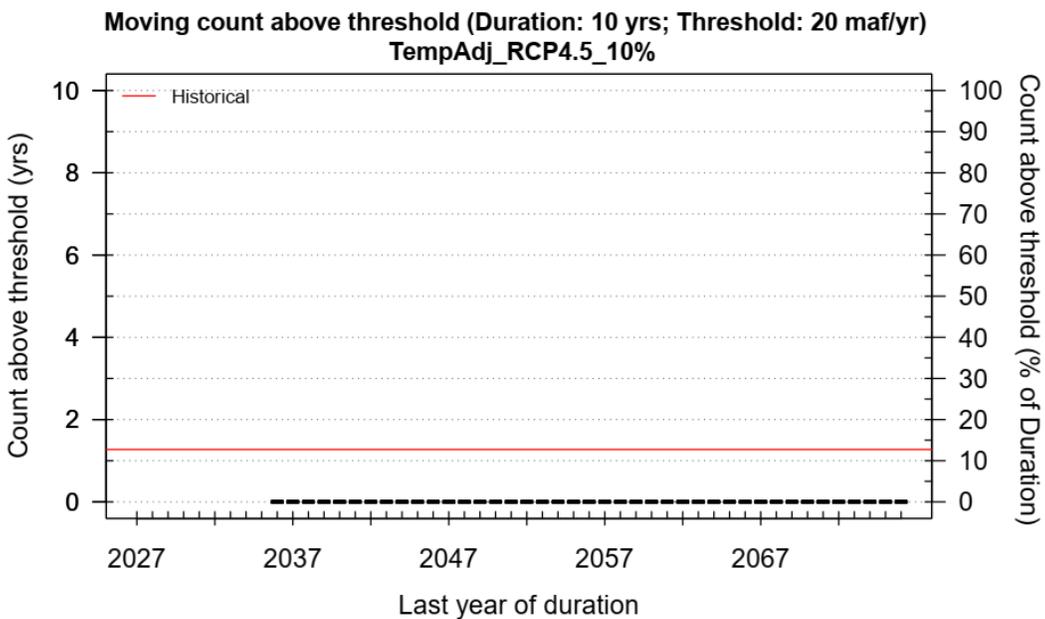
**Figure S115.** Time series of the simulated annual natural flow at Lees Ferry for the TempAdj\_RCP4.5\_10% ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



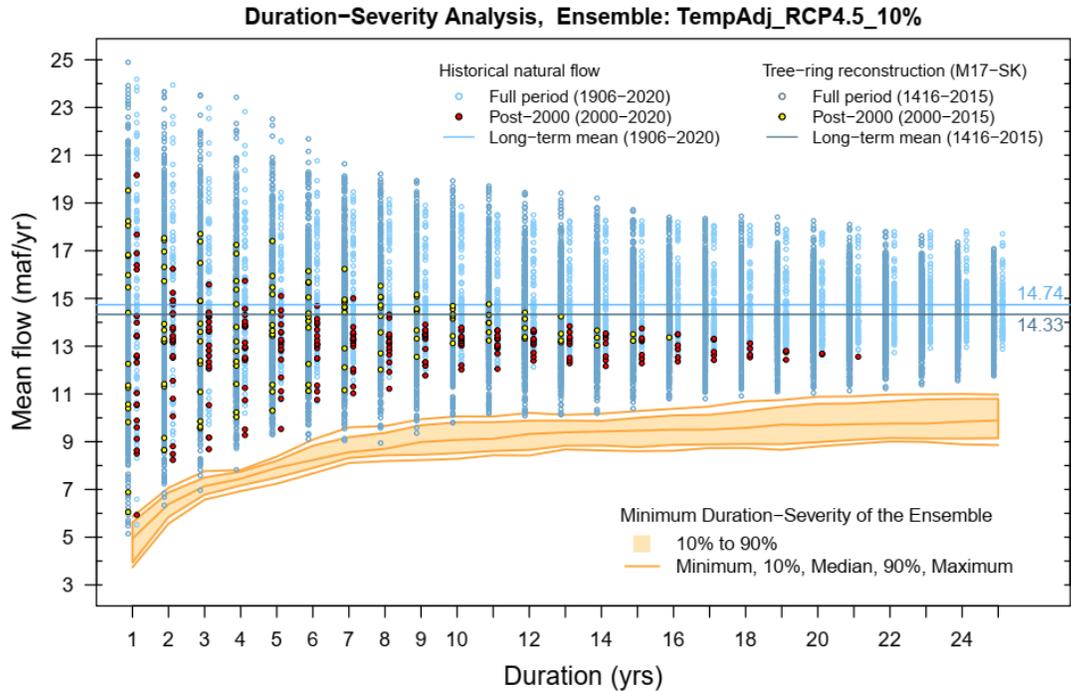
**Figure S116.** Summary metrics of simulated annual natural flow at Lees Ferry for the TempAdj\_RCP4.5\_10% ensemble.



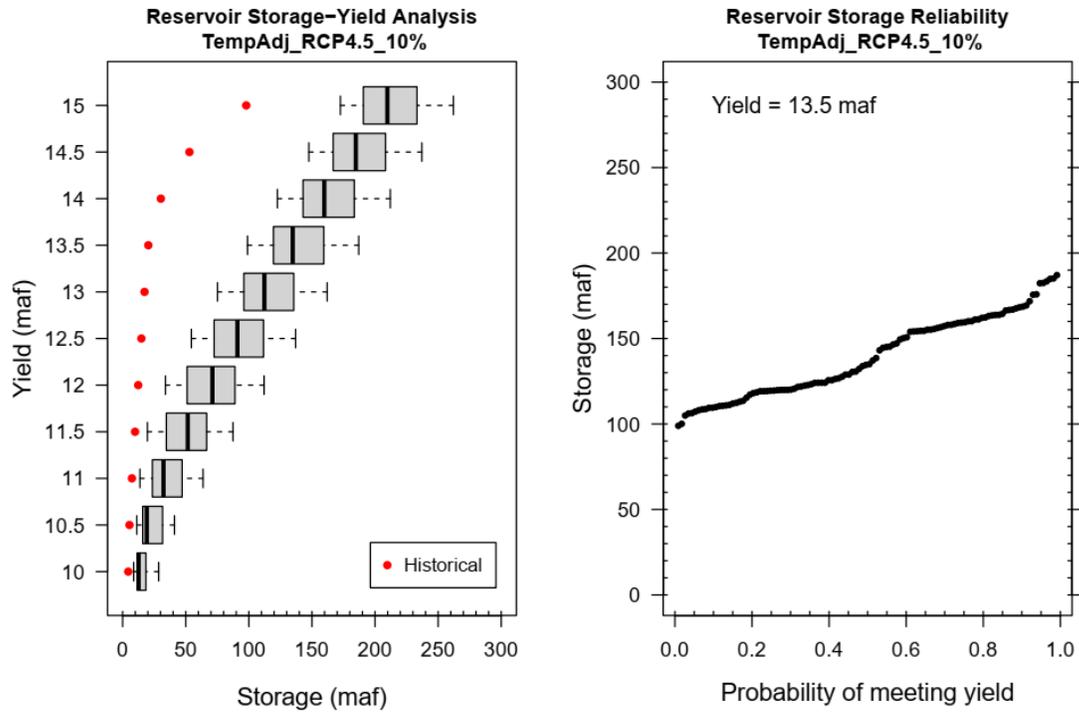
**Figure S117.** Moving count below threshold for the TempAdj\_RCP4.5\_10% ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



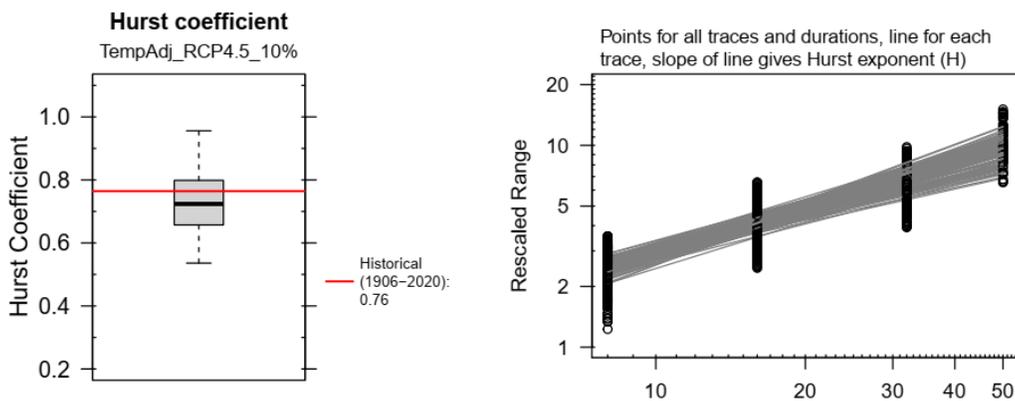
**Figure S118.** Moving count above threshold for the TempAdj\_RCP4.5\_10% ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S119.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the TempAdj\_RCP4.5\_10% ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



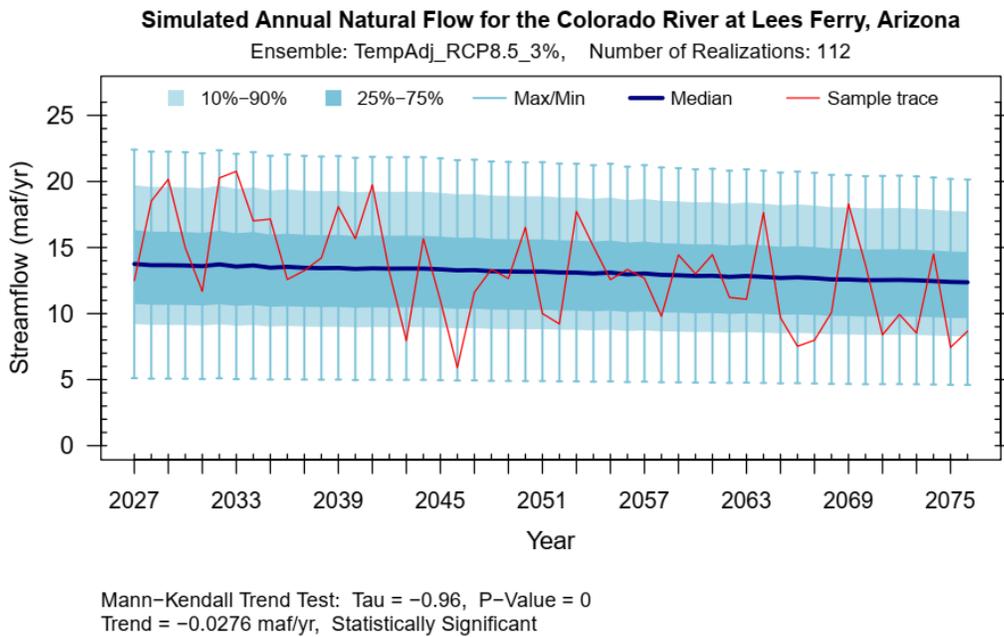
**Figure S120.** Reservoir storage-yield and reliability analysis for TempAdj\_RCP4.5\_10%. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



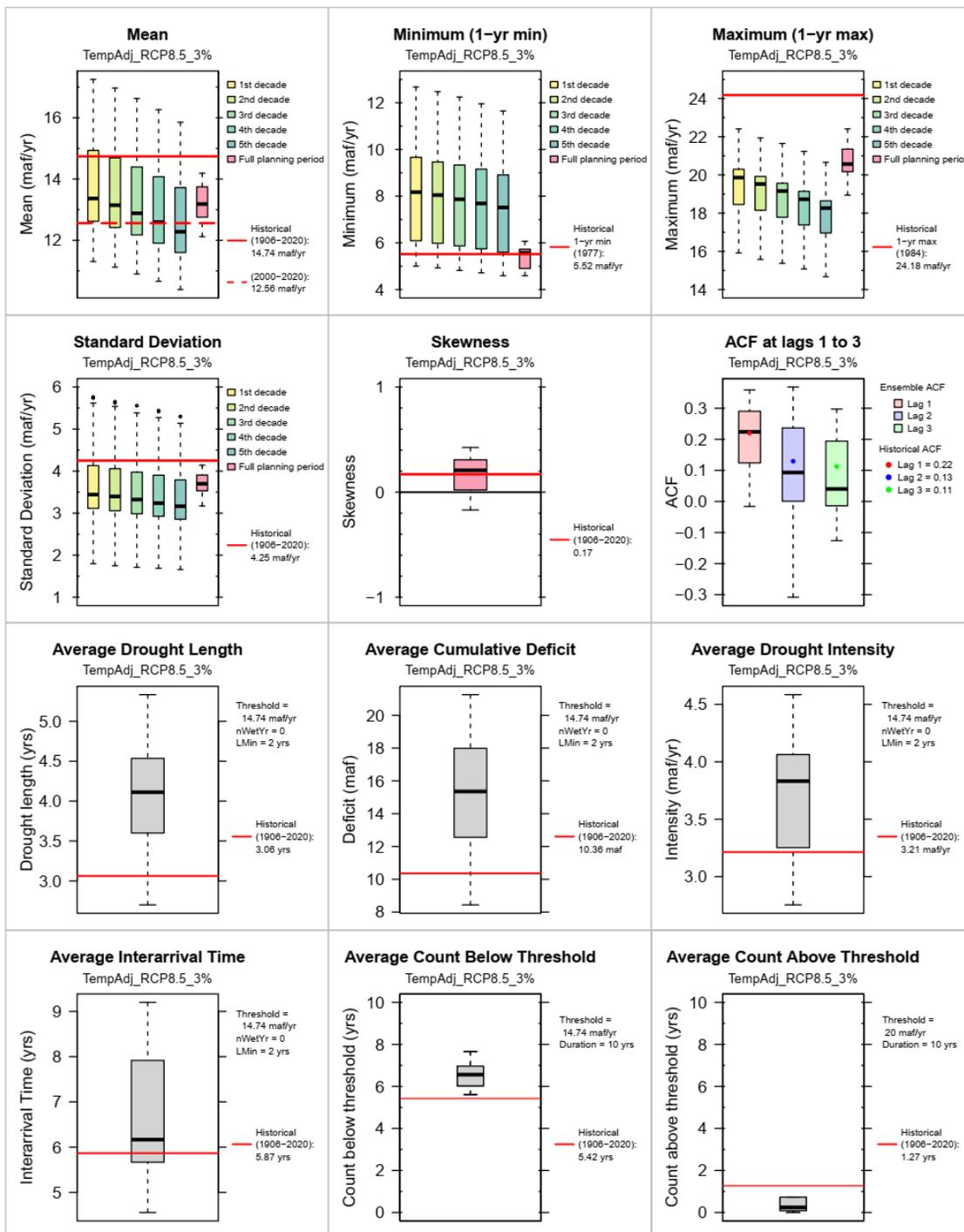
**Figure S121.** Hurst coefficient for the TempAdj\_RCP4.5\_10% ensemble.

**Text S18. TempAdj\_RCP8.5\_3%: RCP8.5\_3% Temperature-Adjusted Flow**

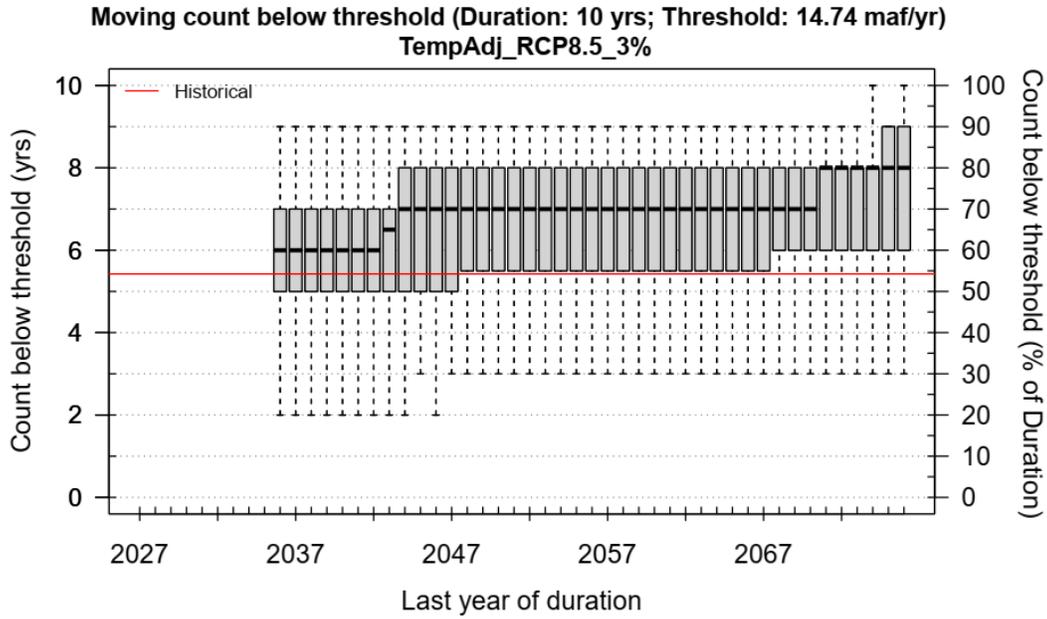
Figure S122 through Figure S128 present the metrics calculated for the RCP8.5-3% Temperature-Adjusted Flow ensemble from Udall (2020), labeled as "TempAdj\_RCP8.5\_3%". This ensemble comprises 112 time series, generated by Udall (2020) through temperature adjustment of the historical natural flow using RCP8.5 projected future temperatures and a 3% streamflow sensitivity to temperature.



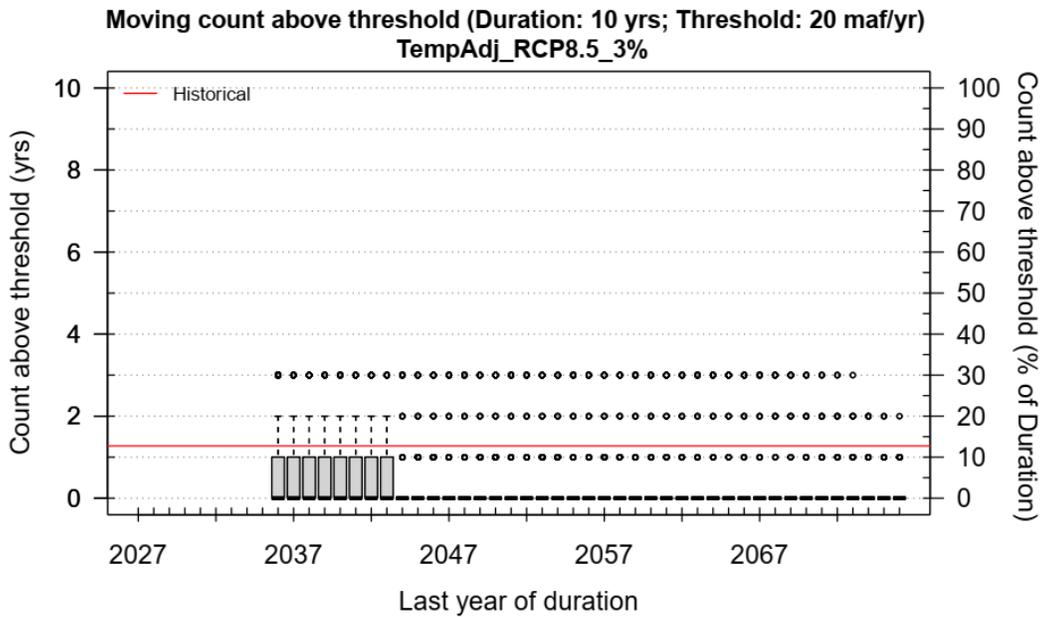
**Figure S122.** Time series of the simulated annual natural flow at Lees Ferry for the TempAdj\_RCP8.5\_3% ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



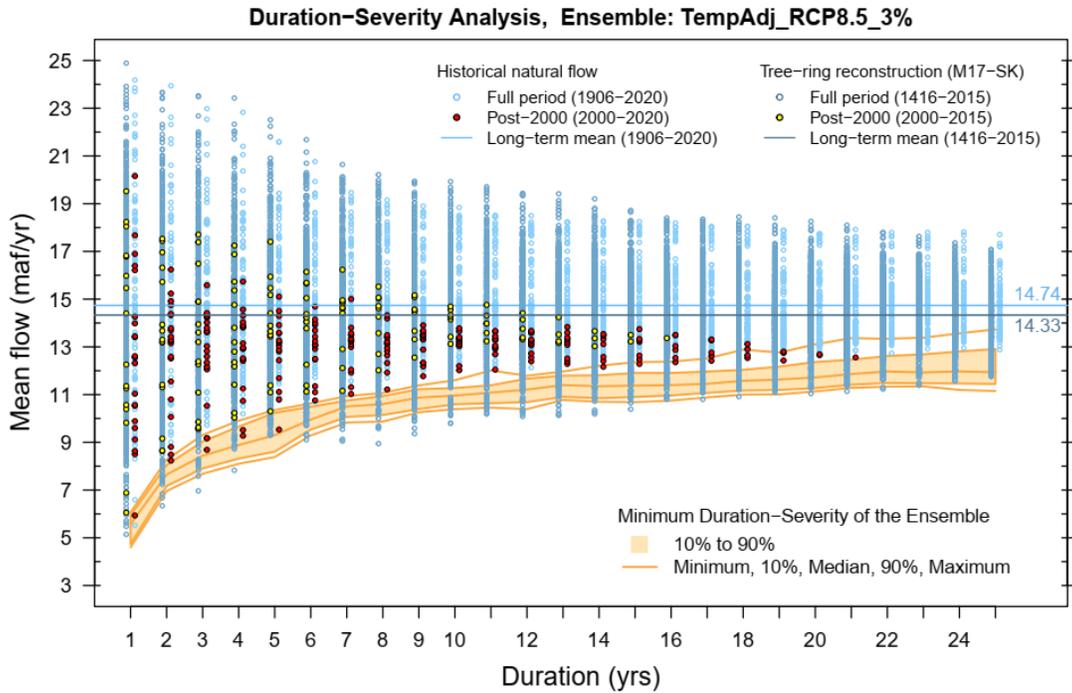
**Figure S123.** Summary metrics of simulated annual natural flow at Lees Ferry for the TempAdj\_RCP8.5\_3% ensemble.



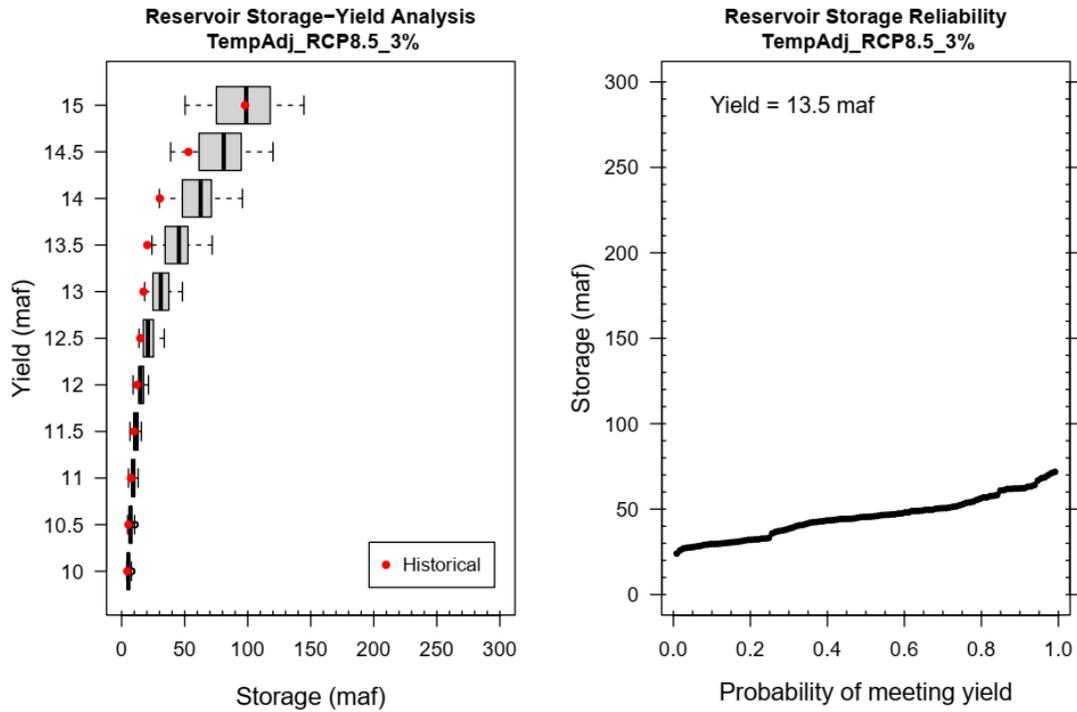
**Figure S124.** Moving count below threshold for the TempAdj\_RCP8.5\_3% ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



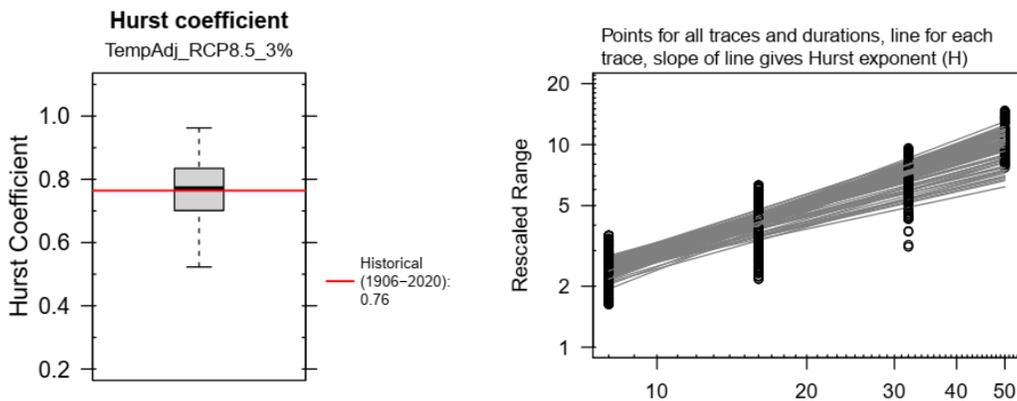
**Figure S125.** Moving count above threshold for the TempAdj\_RCP8.5\_3% ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S126.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the TempAdj\_RCP8.5\_3% ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



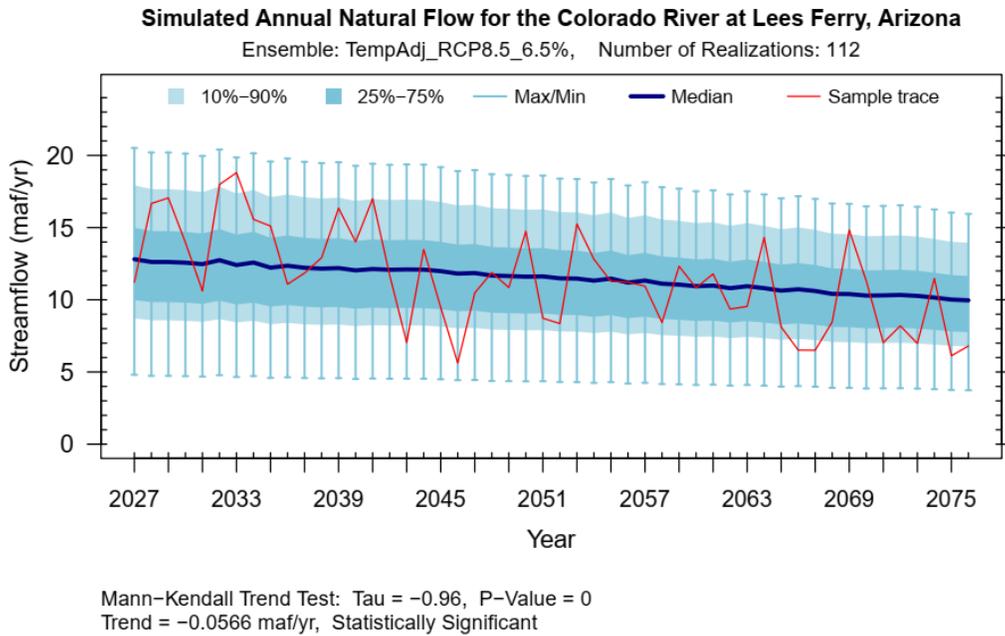
**Figure S127.** Reservoir storage-yield and reliability analysis for TempAdj\_RCP8.5\_3%. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



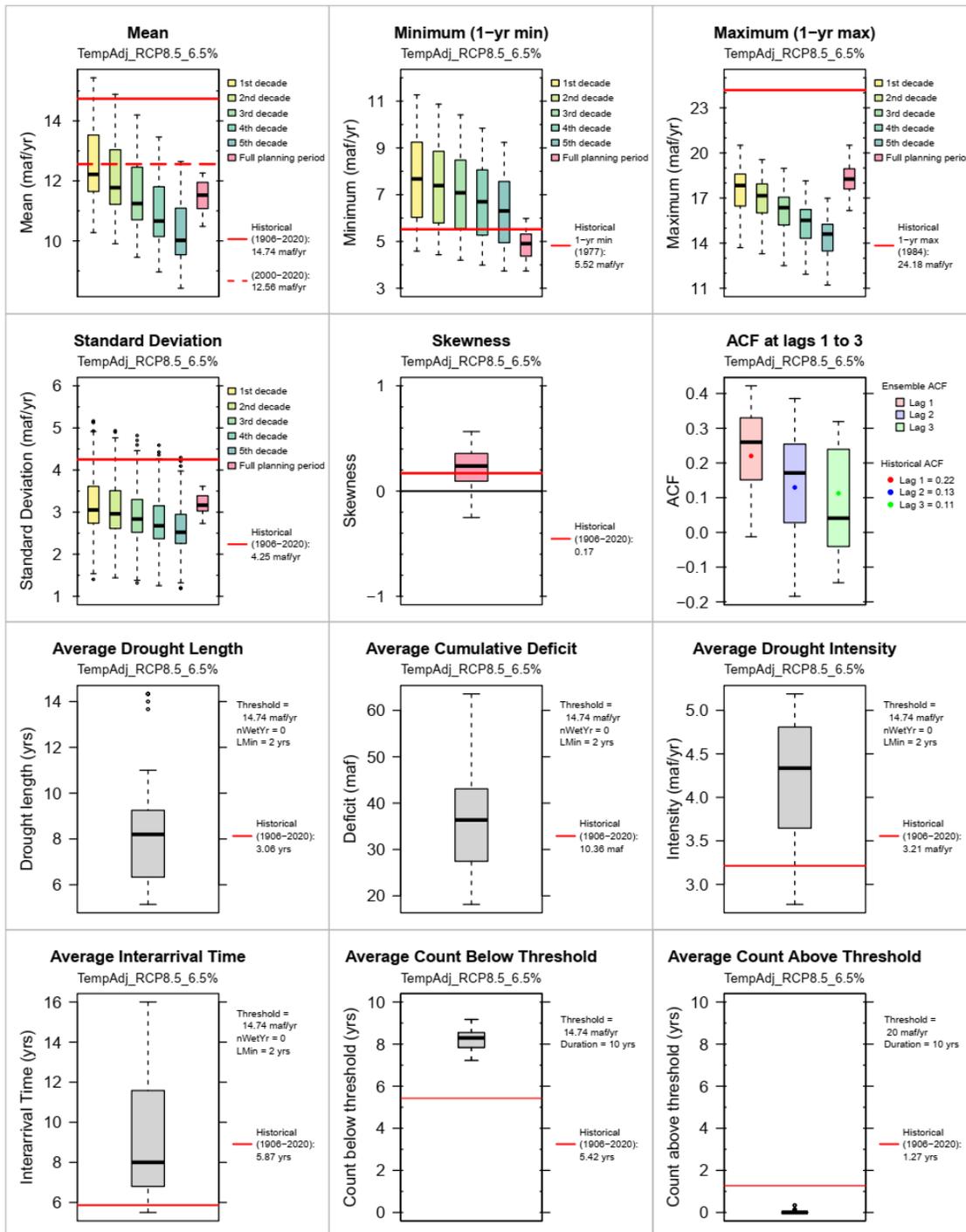
**Figure S128.** Hurst coefficient for the TempAdj\_RCP8.5\_3% ensemble.

**Text S19. TempAdj\_RCP8.5\_6.5%: RCP8.5\_6.5% Temperature-Adjusted Flow**

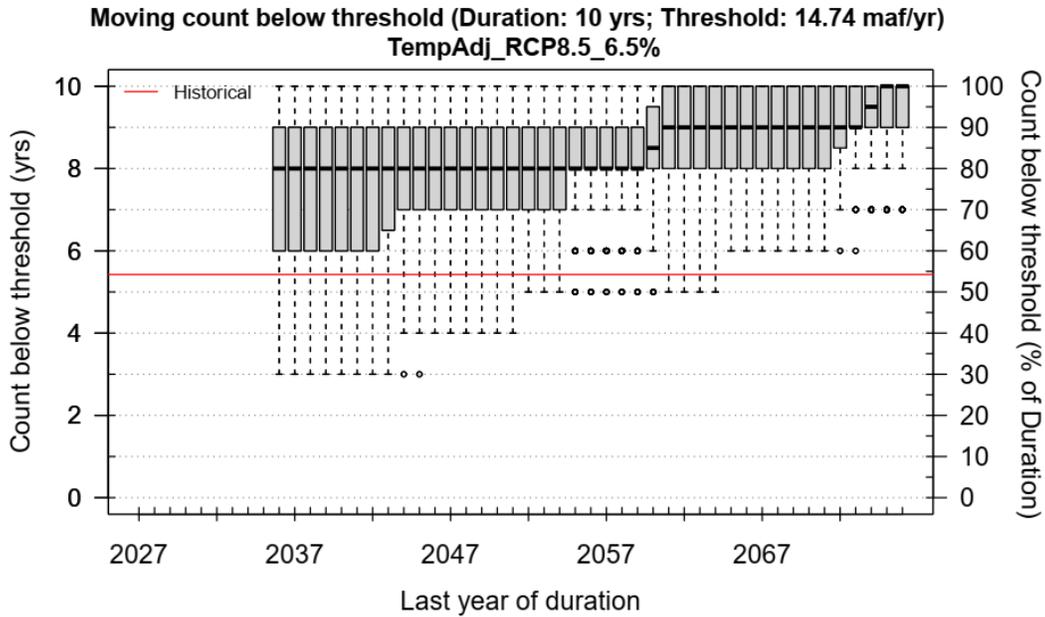
Figure S129 through Figure S135 present the metrics calculated for the RCP8.5-6.5% Temperature-Adjusted Flow ensemble from Udall (2020), labeled as "TempAdj\_RCP8.5\_6.5%". This ensemble comprises 112 time series, generated by Udall (2020) through temperature adjustment of the historical natural flow using RCP8.5 projected future temperatures and a 6.5% streamflow sensitivity to temperature.



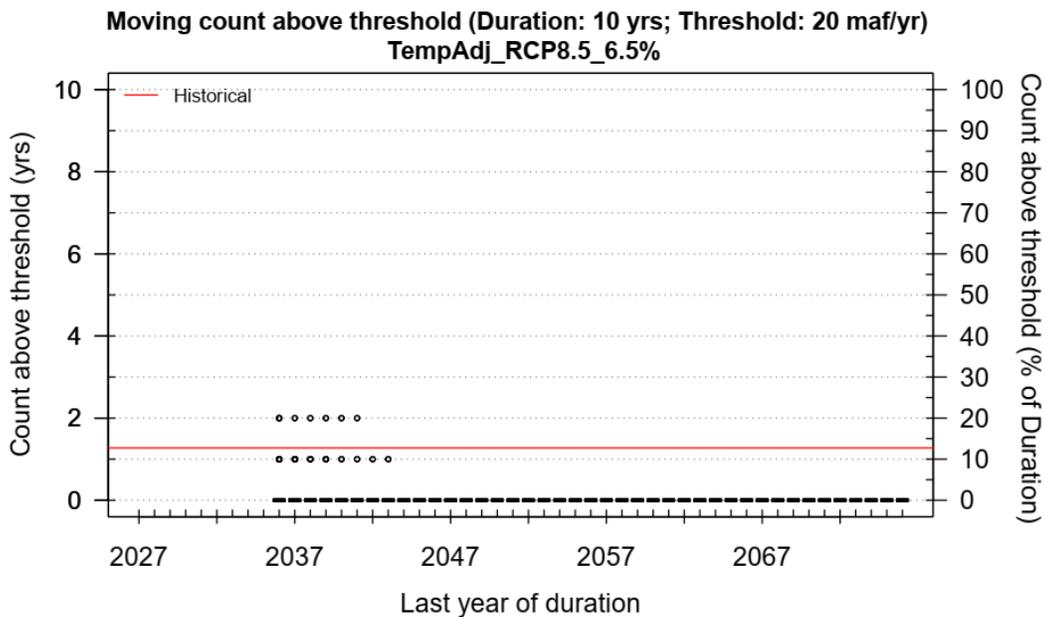
**Figure S129.** Time series of the simulated annual natural flow at Lees Ferry for the TempAdj\_RCP8.5\_6.5% ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



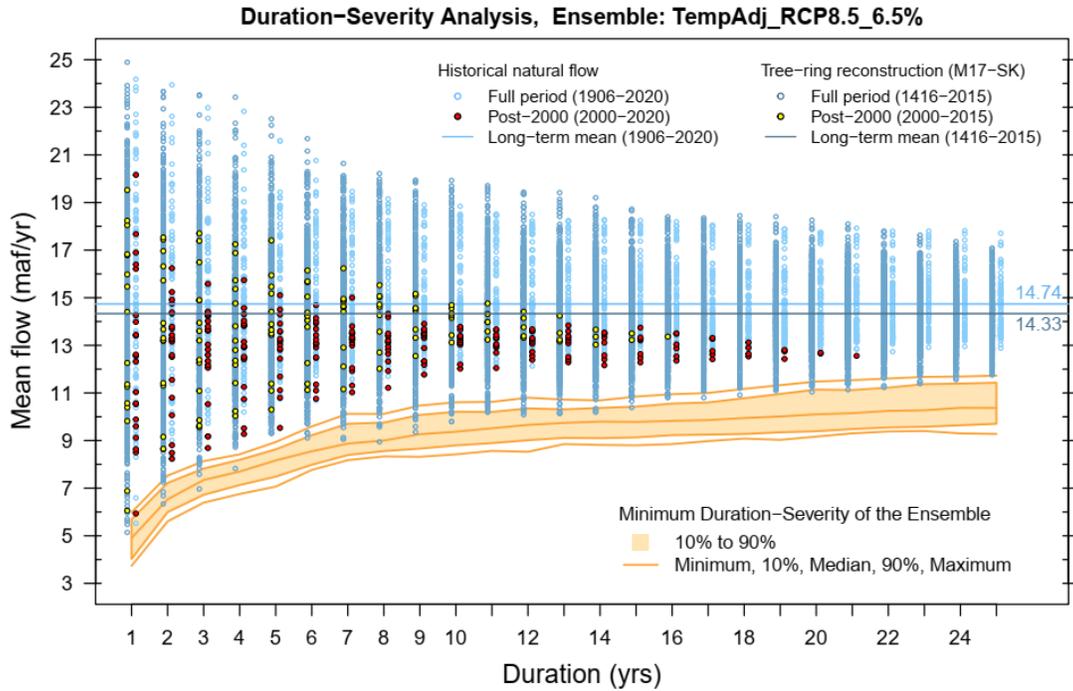
**Figure S130.** Summary metrics of simulated annual natural flow at Lees Ferry for the TempAdj\_RCP8.5\_6.5% ensemble.



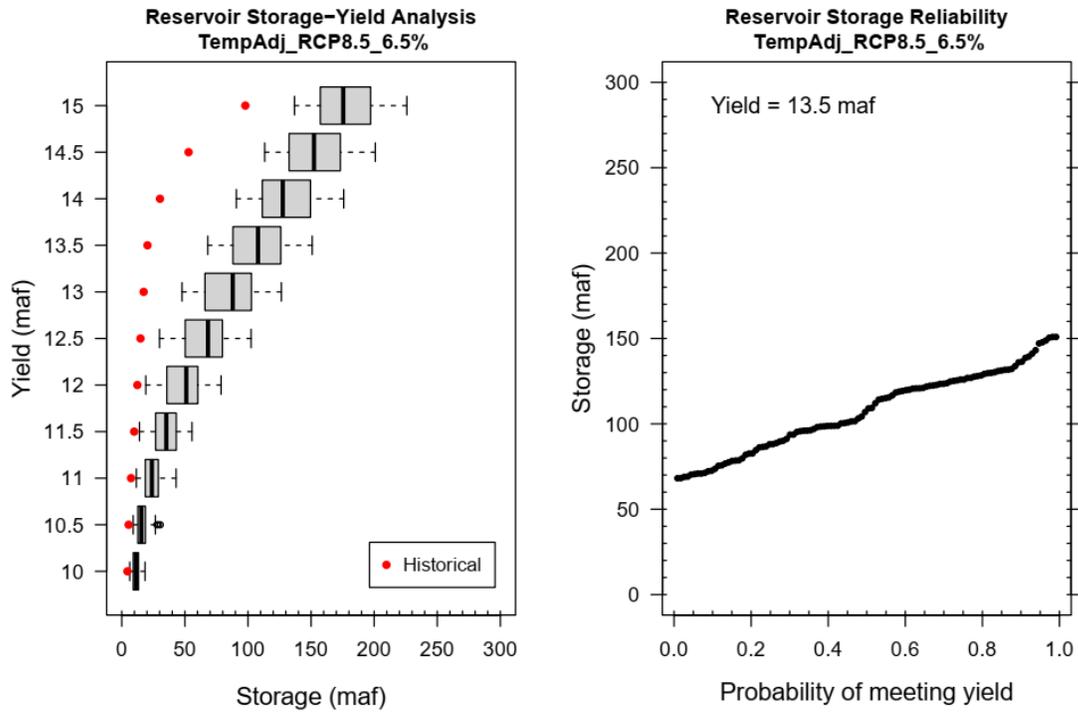
**Figure S131.** Moving count below threshold for the TempAdj\_RCP8.5\_6.5% ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



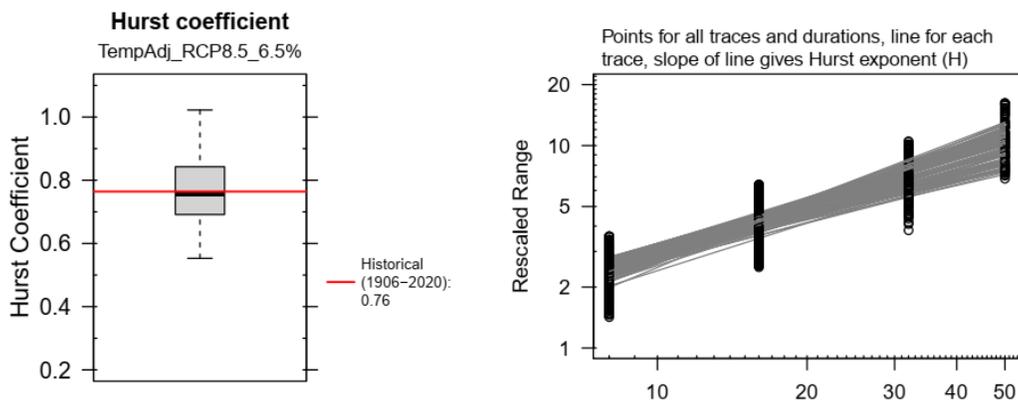
**Figure S132.** Moving count above threshold for the TempAdj\_RCP8.5\_6.5% ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S133.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the TempAdj\_RCP8.5\_6.5% ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



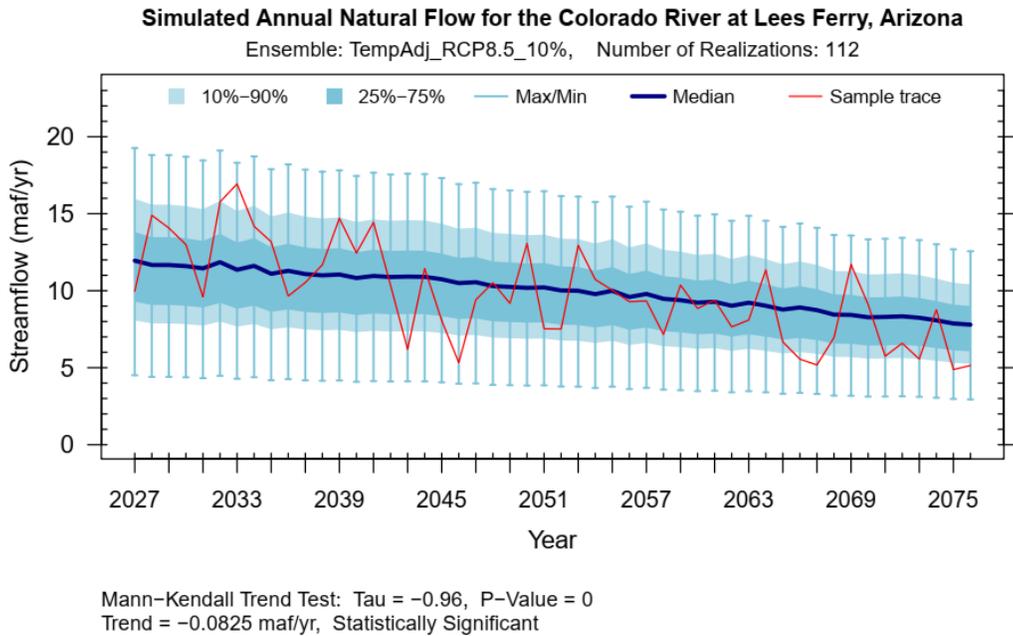
**Figure S134.** Reservoir storage-yield and reliability analysis for TempAdj\_RCP8.5\_6.5%. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



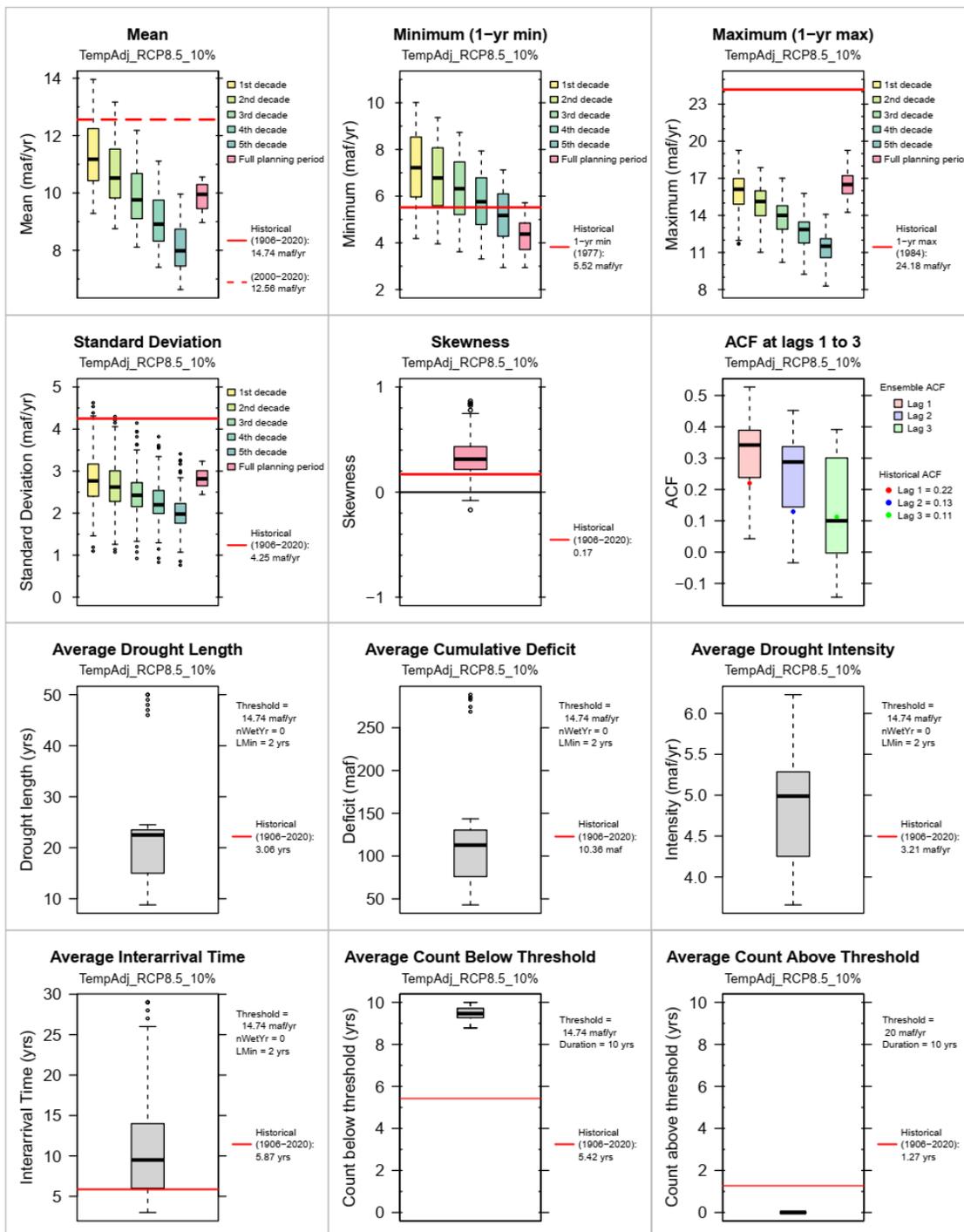
**Figure S135.** Hurst coefficient for the TempAdj\_RCP8.5\_6.5% ensemble.

**Text S20. TempAdj\_RCP4.5\_10%: RCP8.5-10% Temperature-Adjusted Flow**

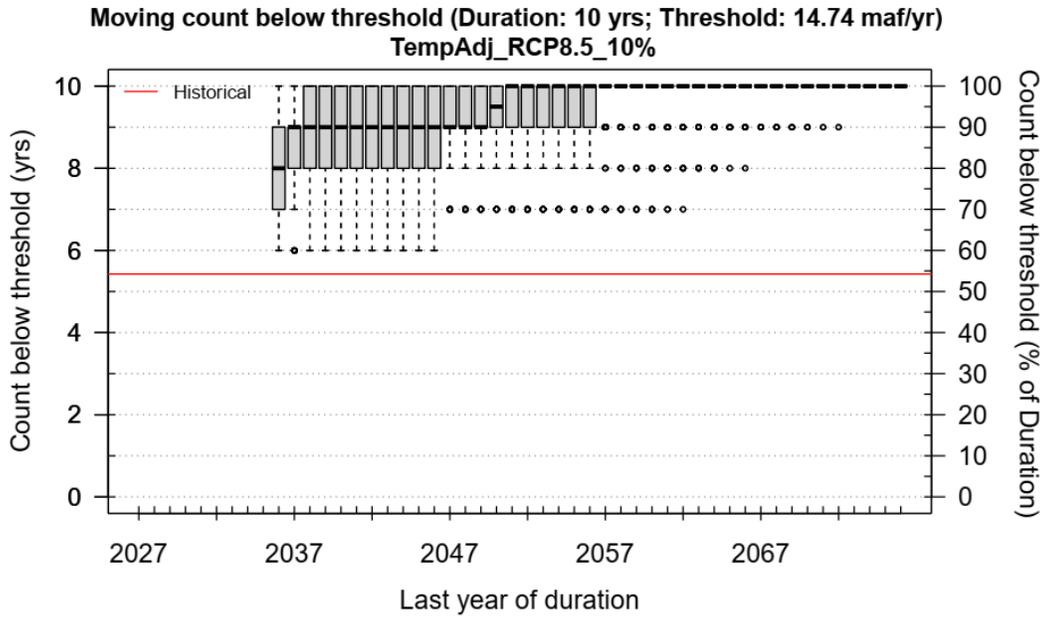
Figure S136 through Figure S142 present the metrics calculated for the RCP8.5-10% Temperature-Adjusted Flow ensemble from Udall (2020), labeled as "TempAdj\_RCP8.5\_10%". This ensemble comprises 112 time series, generated by Udall (2020) through temperature adjustment of the historical natural flow using RCP8.5 projected future temperatures and a 10% streamflow sensitivity to temperature.



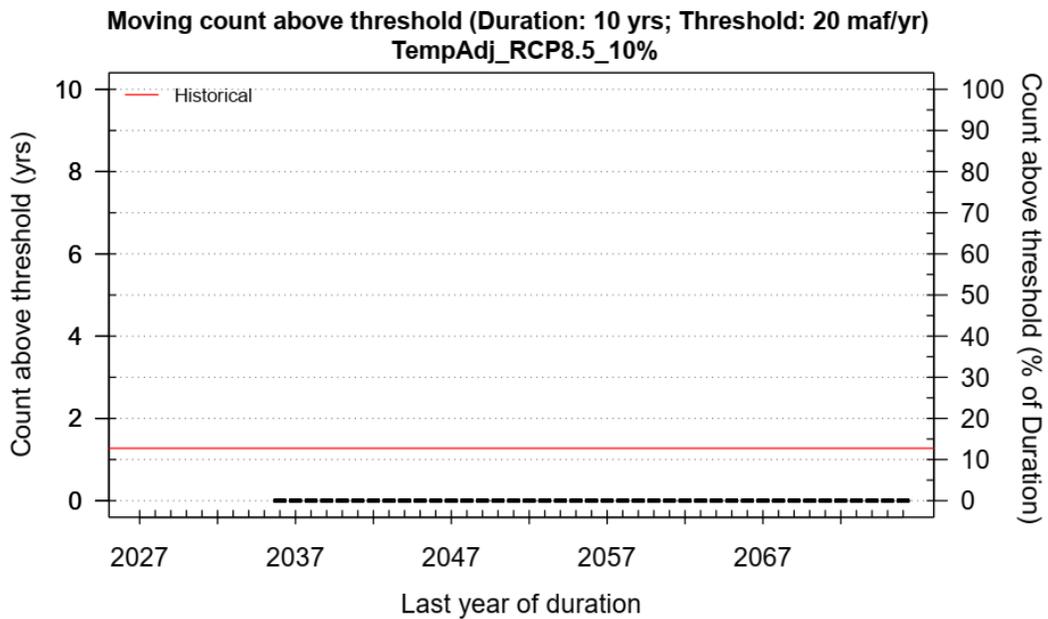
**Figure S136.** Time series of the simulated annual natural flow at Lees Ferry for the TempAdj\_RCP8.5\_10% ensemble. This figure shows 10<sup>th</sup> to 90<sup>th</sup> percentiles (light blue area), and 25<sup>th</sup> to 75<sup>th</sup> percentiles (dark blue area), maximum and minimum (whiskers), median (navy line), and a sample sequence of the ensemble (red line).



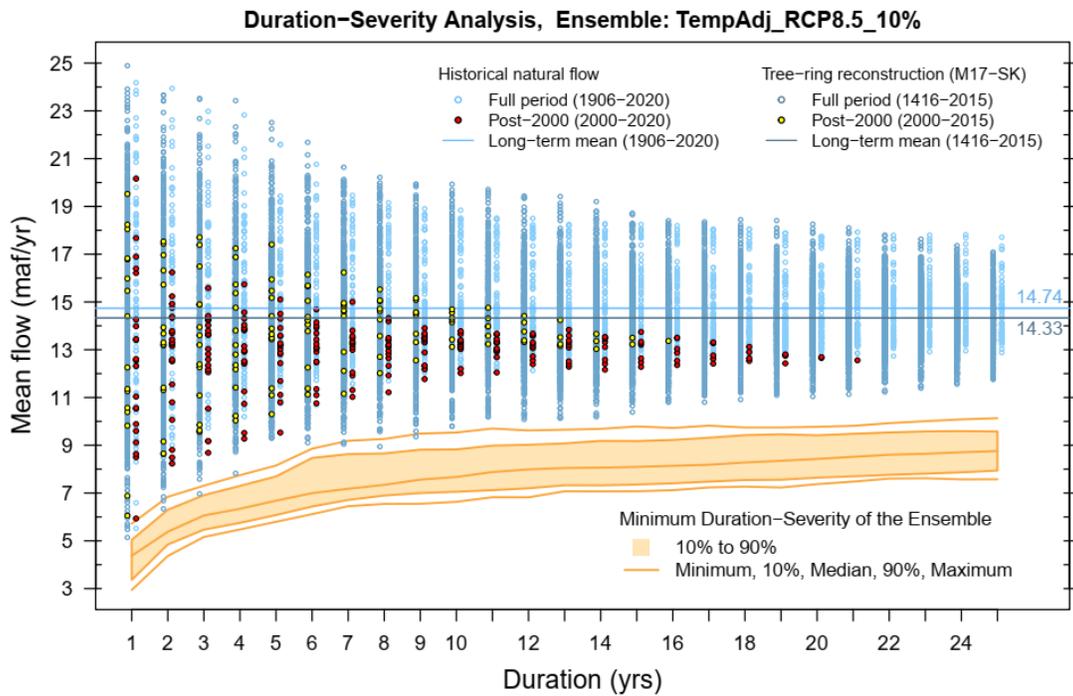
**Figure S137.** Summary metrics of simulated annual natural flow at Lees Ferry for the TempAdj\_RCP8.5\_10% ensemble.



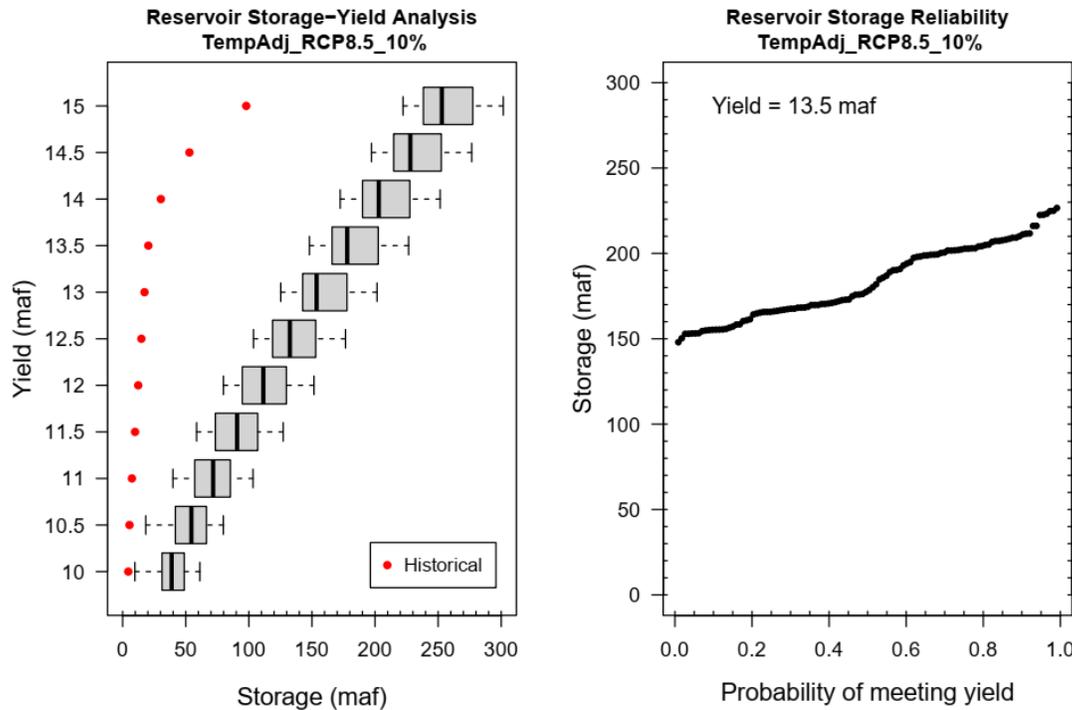
**Figure S138.** Moving count below threshold for the TempAdj\_RCP8.5\_10% ensemble. This plot shows the moving number of below threshold (long-term mean of 14.74 maf/yr) years within a decade.



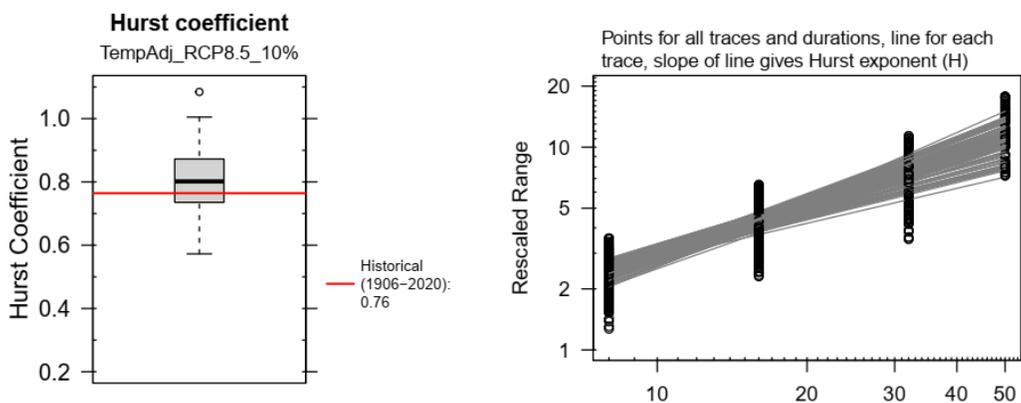
**Figure S139.** Moving count above threshold for the TempAdj\_RCP8.5\_10% ensemble. This plot shows the moving number of above threshold (20 maf/yr) years within a decade.



**Figure S140.** Duration-severity analysis; Overlaying the range of extreme droughts (quantified as the minimum duration-severity) within the TempAdj\_RCP8.5\_10% ensemble (orange area) on the duration-severity plot of the observed (light dots) and tree-ring-reconstructed (dark dots) natural flows at Lees Ferry. The spread of the orange area illustrates how the ensemble's extreme droughts may vary across various durations, comparing them with the historical and tree-ring-reconstructed records. Each dot represents mean annual flow averaged over the duration on the x-axis. There is a dot for each duration (including overlaps) within the record.



**Figure S141.** Reservoir storage-yield and reliability analysis for TempAdj\_RCP8.5\_10%. These plots illustrate the response of the streamflow ensemble to a set of desired yields and reliabilities. The metric captures the storage attributes of the streamflow ensemble at an abstract level distinct from particular reservoir sizing or operation policies. The plot on the left shows the storage needed for releasing the desired yields shown on the y axis. The plot on the right shows the storage needed for a specific yield and desired reliabilities.



**Figure S142.** Hurst coefficient for the TempAdj\_RCP8.5\_10% ensemble.