Technical Memorandum | FINAL

To: Andy Moore, Michelle Garrison, Colorado Water Conservation Board
From: Ben Harding, Lynker Technologies
Subject: CRWAS Phase II Climate, Task 1, Approach for constructing climate scenarios.
Date: September 8, 2015

This Technical Memorandum summarizes information developed as part of Task 1 of the Colorado River Water Availability Study, Phase II, Updating Climate Impacted Hydrology (CRWAS-II or Study).

The objective of Task 1 is to develop an approach for creating future climate scenarios and model forcings. A principal deliverable for Task 1 is this technical memorandum describing the approach used to develop the climate scenarios used in the Study. A review of relevant literature and a discussion of issues related to the development of climate scenarios is summarized in CRWAS Phase II Technical Memorandum Task 1 – *Literature Review*, which provides useful background for this memorandum.

Scenario Development in CRWAS-I

The approach used to develop future climate scenarios in CRWAS-I is described in detail in the final report of the Colorado River Water Availability Study (Colorado Water Conservation Board, 2012, hereinafter CWCB, 2012).

The climate projections used in CRWAS-I were provided through the World Climate Research Programme's Coupled Model Inter-comparison Project Phase 3 (CMIP3) multi-model dataset (WCRP, 2013; PCMDI, 2013). Model projections of future climate that are part of the CMIP3, collectively referred to as the *CMIP3 ensemble,* were used as the basis for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4; IPCC, 2007).

In CRWAS-I future climate scenarios were employed because it was not practically feasible to evaluate all projections in the CMIP3 ensemble. At the time of development of the CRWAS-I approach, there were no comprehensive results from hydrology modeling that could be used to select or construct scenarios, so scenarios had to be identified based only on the projections of climate themselves. Downscaled projections were used in order to support hydrology modeling, and those data sets contained only projections for precipitation and temperature, so at the outset of the CRWAS-I work only those two variables were available for scenario construction.

CRWAS-I was coordinated with the Joint Front Range Climate Change Vulnerability Study (JFRCCVS, Woodbury, *et al*., 2012), which was initiated before CRWAS-I. For consistency between JFRCCVS and the CRWAS-I both studies used the same climate scenarios. After consultation between the JFRCCVS and CRWAS-I technical teams, and consultation with the Colorado Climate Change Technical Advisory Group (Colorado CCTAG), JFRCCVS adopted an approach for scenario development that involved selection of five projections to characterize each of two time frames, 2040 and 2070. CRWAS-I subsequently adopted the same scenarios, each consisting of a set of five individual projections.

The JFRCCVS method characterized each projection by its projected temperature and precipitation *anomalies.* An anomaly is the difference between current conditions and projected conditions. Five qualitative future climate scenarios were defined as shown in Table 1. The quantile definitions were used to locate characteristic points in the space defined by the temperature and precipitation anomalies. Each of the 112 CMIP3 projections was then plotted in the anomaly space according to its average temperature and precipitation anomaly. The anomaly space plots for 2040 and 2070 are shown in Figure 1. For each of the two time frames, five projections were selected based on their proximity to the characteristic points for the five scenarios and based on how similar their monthly pattern of precipitation change was to other projections near the characteristic values. The selected projections are shown in Figure 1 and listed in Table 2.

Table 1
Characteristics for CRWAS-I Qualitative Future Climate Scenarios

Qualitative Scenario	Characteristic Temperature	Characteristic Precipitation
Hot and Dry	90th Percentile	10th Percentile
Hot and Wet	70th Percentile	70th Percentile
Warm and Dry	30th Percentile	30th Percentile
Warm and Wet	10th Percentile	90th Percentile
Median	50th Percentile	50th Percentile

Figure 1 illustrates the characteristic conditions for the qualitative scenarios in the context of all 112 CMIP3 projections of future temperature and precipitation. Each projection is designated as an *x*, the characteristic conditions for the five scenarios are designated by the circles, and the selected projections are designated by triangles.

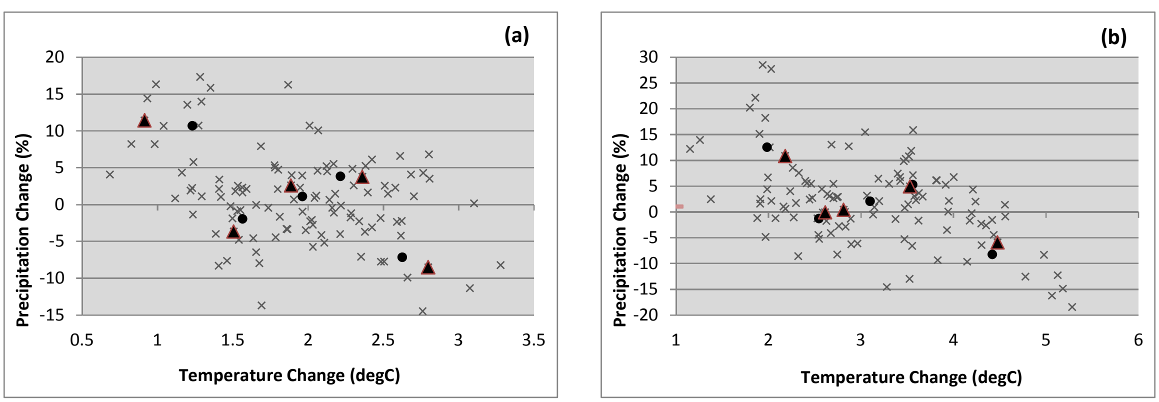

Figure 1. Anomaly Space Plots for 2040 (a) and 2070 (b)

Table 2
Selected Projections

Qualitative Scenario	Time Frame	SRES Scenario	Model	Version	Run
Warm & Wet	2040	A2	ncar_pcm	1	3
Warm & Dry	2040	A2	mri_cgcm	2.3.2a	1
Median	2040	B1	cccma_cgcm	3.1	2
Hot & Wet	2040	A1B	ncar_ccsm	3.0	2
Hot & Dry	2040	A2	miroc	3.2.medres	1
Warm & Wet	2070	A2	ncar_pcm	1	3
Warm & Dry	2070	A1B	mri_cgcm	2.3.2a	4
Median	2070	B1	mpi_echam	5	1
Hot & Wet	2070	A1B	ncar_ccsm	3.0	2
Hot & Dry	2070	A1B	gfdl_cm	2.0	1

The objective of this approach was to select projections that bounded 80 percent of the range of the distribution of *runoff* anomalies across the full 112-member CMIP3 ensemble, and to include additional projections that were characteristic of the interior of that distribution. At the time projections were selected, the CRWAS-I and JFRCCVS technical teams did not have information with which to verify the selection of scenarios with respect to the process objectives. After the CRWAS-I hydrologic modeling and water resources modeling had been completed, the Bureau of Reclamation began simulating the impact of projected climate on natural flows in the Colorado River Basin as part of the Colorado River Basin Water Supply and Demand Study (Bureau of Reclamation, 2012). As part of that work, Reclamation developed projected natural flows for 29 points in the Colorado River Basin for all of the available 112 downscaled projections using a Variable Infiltration Capacity (VIC) model that is very similar to the model used in CRWAS. Development of these projected natural flows is described in Gangopadhyay, *et al.* (2011) and Harding *et al.* (2012).

Placing the selected projections into the context of the distribution of runoff anomalies from the full set of projections revealed biases in the sets of selected projections. Figure 2 shows the original selected projections in the context of the cumulative distribution of flow anomaly (expressed as a percentage) for both time frames.

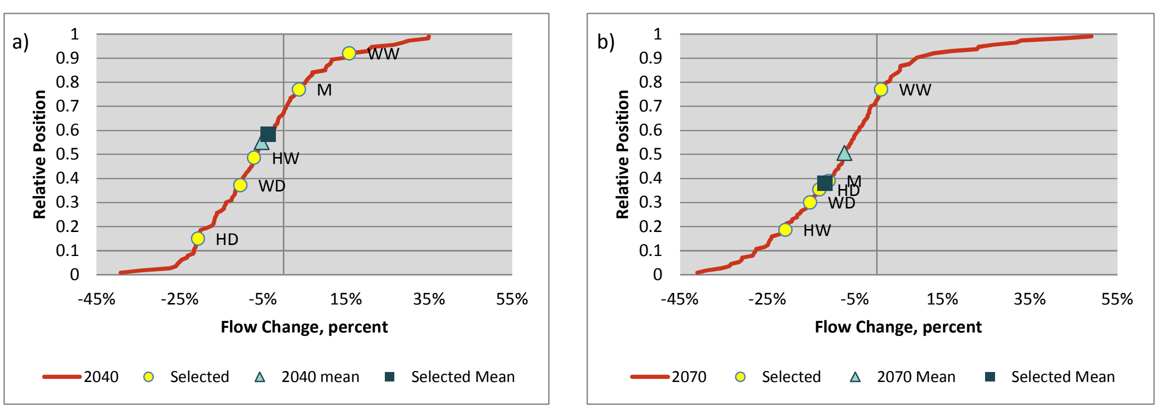

Figure 2. Distribution of Runoff Anomalies, 2040 (a) and 2070 (b)

The unexpected results for the 2070 time frame evident in Figure 2(b) illustrate the difficulty in estimating hydrologic impact based on temperature and precipitation alone.

The bias in the set of 2040 projections was judged to be small enough that it would not interfere with assessment of impacts for that time frame, but the bias in the set of 2070 projections was much larger and was judged to introduce an unacceptable bias in the assessment of hydrologic conditions at that time frame. In order to improve the representation of 2070 conditions, a new set of projections for 2070 were selected by matching the plotting position of the 2040 projections for the runoff anomaly; these are shown in Figure 3.

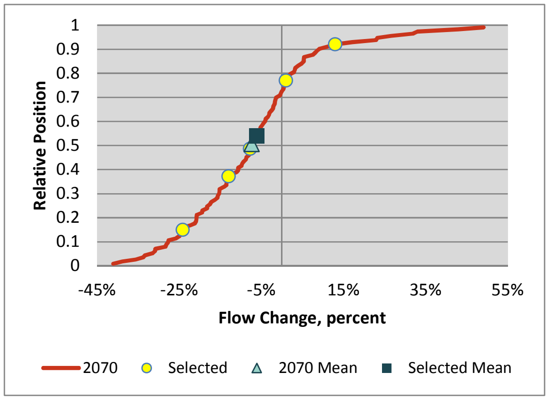

Figure 3. Selected 2070 Projections

To further illustrate the difficulty of using temperature and precipitation as a proxy for hydrologic impact, climate conditions in the projections selected based on the distribution of runoff anomalies are not consistent with the qualitative scenarios originally used for selection of projections; most of the new 2070 projections do not fall near the characteristic conditions of qualitative scenarios as shown in Figure 4 (symbols have the same meaning as in Figure 1).

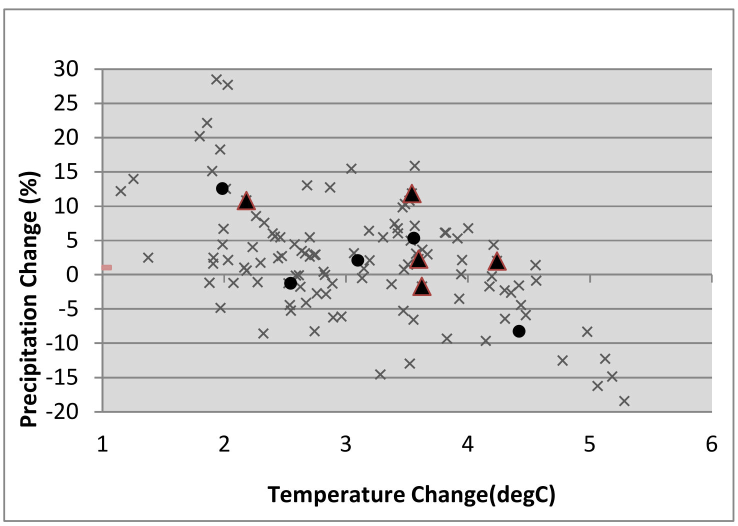

Figure 4. Precipitation and Temperature Anomalies for Selected 2070 Projections.
Characteristic points are circles, projections are triangles.

It is important to note that selection of the CRWS-I scenarios was done only in terms of the projected change in natural flows, but changes in natural flows alone do not fully represent the changes in stress on a water resources system. The approach identified for CRWAS-II and described below is intended to consider more fully the impact of projected conditions on system performance.

Scenario Development in CRWAS-II

Recognizing the difficulties encountered in the CRWAS-I scenario selection work, a new approach was developed for CRWAS-II. The first step in developing a new approach was to clarify the objective of scenario development. In CRWAS-I the objective was to represent the range of projected future runoff or natural streamflow anomalies. But, the true need for planning is an understanding of the future performance of *water resources systems*. The objective for scenario development in CRWAS-II was therefore refined to be full representation of the range of future *water resources system performance*.

Streamflow only represents the supply side of a water resources system; the success of the system in meeting demand for diversions from streams and reservoirs represents the primary performance metric for systems. On a basin scale, the balance between runoff and beneficial consumptive use is the primary metric of water supply stress. Accordingly, the approach developed for CRWAS-II used as proxy variables runoff and consumptive irrigation requirement (CIR, also referred to as irrigation water requirement, IWR). CIR represents the depth of water that must be applied to provide a full water supply to vegetation (to obtain a condition where actual evapotranspiration equals potential evapotranspiration) and is a measure of the consumptive use of irrigation water.

CRWAS-I also illustrated that potential bias will likely result when planning is based on a few selected projections. The approach adopted for CRWAS-II therefore was based on an approach that reduced the number of climate scenarios by pooling rather than culling or selection (Brekke, *et al.*, 2010; AMEC, 2011).

Projection Ensemble

A primary motivation for the CRWAS-II work was to incorporate information from the World Climate Research Programme's Coupled Model Inter-comparison Project Phase 5 (CMIP5) multi-model dataset (WCRP, 2013; PCMDI, 2013). Model projections of future climate that are part of the CMIP5, collectively referred to as the *CMIP5 ensemble,* were used as the basis for the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5; IPCC, 2013). CRWAS-I was based on the Coupled Model Inter-comparison Project Phase 3 (CMIP3) ensemble. Background on the CMIP3 and CMIP5 ensembles is provided in CRWAS Phase II Technical Memorandum Task 1 – *Literature Review.*

The CMIP3 projection ensemble consists of 112 runs of sixteen climate models. The CMIP5 projection ensemble consists of 234 runs of 37 climate models. The Bureau of Reclamation conducted hydrology modeling on all 112 of the CMIP3 projections and on 97of the CMIP5 projections. (Bureau of Reclamation, 2013) The 97-run subset of the CMIP5 ensemble is used in CRWAS-II and is designated herein as CMIP5 (hydrology). The projections in the CMIP5 (hydrology) ensemble are listed in Bureau of Reclamation (2013).

The CMIP5 ensemble is seen as extending but not replacing the CMIP3 ensemble (Rupp, *et al.*, 2013). Accordingly, the primary product of this work is a set of scenarios developed based on the combination of the CMIP3 and CMIP5 (hydrology) ensembles, designated herein as the CMIP3+5 ensemble. Two additional sets of scenarios were also developed, using the same methods, based on the CMIP3 and CMIP5 (hydrology) ensembles, respectively. These analyses are intended to allow comparison to CRWAS-I and for diagnosis of the influence of the individual projection ensembles.

Scenario Development Method

The approach adopted for CRWAS-II uses a clustering approach based on nearest neighbors in a two-dimensional space defined by anomalies in runoff and CIR. This is conceptually similar to the approach used by CRWAS-I, but the selected proxy variables have more plausible relationship to system performance. Estimates of future runoff and CIR are available from the hydrology modeling done across the continental United States by the Bureau of Reclamation. Figure 5 illustrates the method.

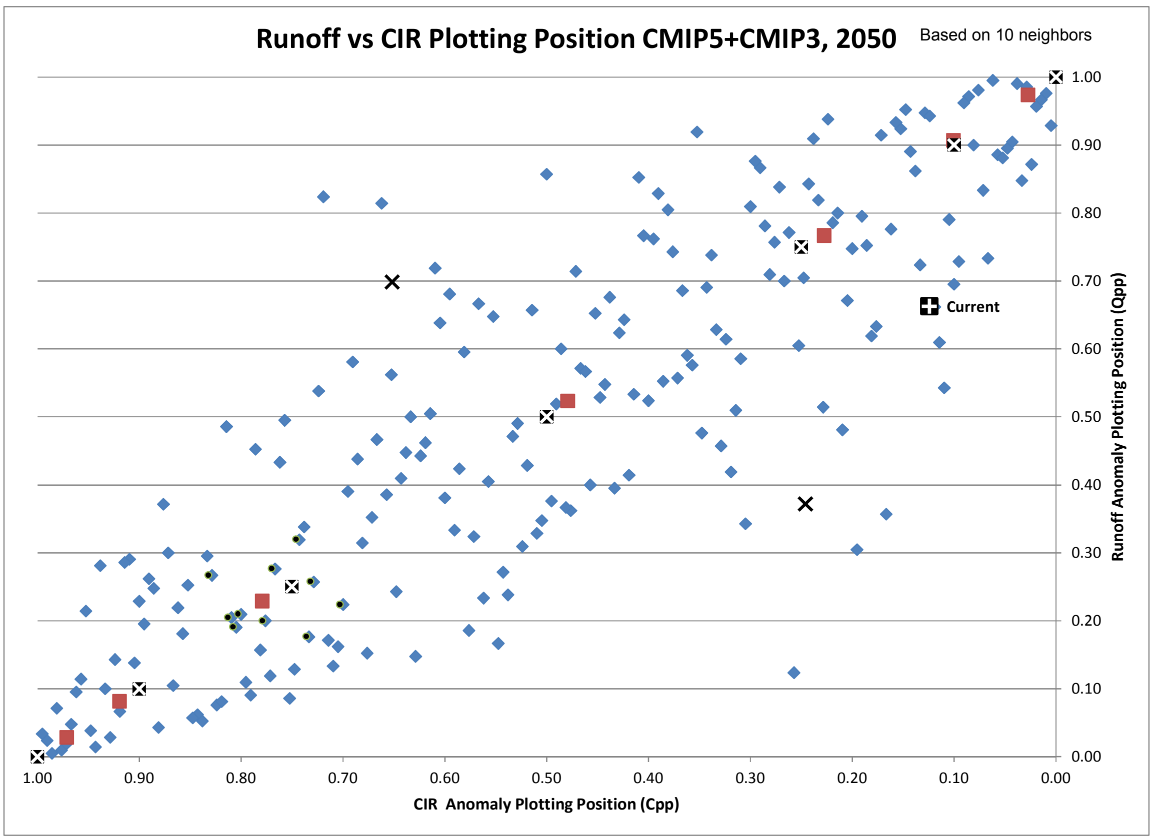

Figure 5. Illustration of CRWAS-II Scenario Development.
Diamonds are individual CMIP3 or CMIP5 projections, squares are characteristics of pooled scenarios.
Projections included in the 7525 pool are overlaid with small black circles.
Black square with a white *x* are the characteristic point for a pool.
The larger black square with a cross is the point of no change from current conditions.
The two large black *x* symbols represent unused projection pools (see text).

Figure 5 shows the projections from the combined CMIP3 and CMIP5 ensembles placed in the runoff/CIR anomaly space for the 2050 time frame. Because the objective is to place scenarios in terms of their position in the distributions of runoff and CIR, change values for those variables are expressed in terms of their respective plotting position, or percentile, ranked according to the magnitude of change. Each projection is placed on the space at coordinates set to the plotting position of its projected changes in runoff and CIR. This also serves to normalize the two variables to the same range. CIR plotting position is arranged with the origin on the right to show the greatest relative severity at the lower left, and the least relative severity at the upper right, but this is arbitrary.

The most severe condition is the largest increase in CIR (a plotting position of nearly 1) and the largest decrease in runoff (a plotting position of nearly zero) and is located at the lower left corner of the space. The inverse case is the least severe condition, which is located at the upper right corner of the space. Although the focus of the method is on relative change (i.e. the distribution of change) the most severe projection showed a decrease in runoff of 37% and an increase in CIR of 52%, while the least severe projection showed an increase in runoff of 29% and a decrease in CIR of 14%. The point of no change in runoff and CIR, which represents current conditions, is shown in Figure 5 as a larger black square with a white cross.

Seven characteristic points, each characterizing a scenario, were defined in the anomaly space. These are listed in Table 3 and shown in Figure 5 as the black squares with white *x* symbols.

Table 3
Characteristics for CRWAS-II Climate Scenarios

Designation	CIR Percentile	Runoff Percentile
Lower Left	100%	0%
9010	90%	10%
7525	75%	25%
Center	50%	50%
2575	25%	75%
1090	10%	90%
Upper Right	0%	100%

Projections were clustered by proximity to the characteristic points, using Euclidean distance. Ten projections were included in each pool. This process is illustrated in Figure 5 by the projections overlaid with small black circles, which are the projections included in the 7525 pool.

The pools were made as large as possible to increase the statistical significance of the estimate of the mean change conditions for a particular characteristic point in the anomaly space while limiting overlap between pools. When the pool size was increased above ten projections, pools began to overlap, thus overweighting the projections that were used in more than one pool. Modest overweighting probably does not introduce significant bias. No analysis of the significance of the pooled estimates of characteristic conditions has been done for this work, but estimates of the size of samples required to get a statistically significant estimate of the ensemble mean for the CMIP3 ensemble range from about 15 through 20 model runs (Pierce, *et al.,* 2009; Harding, *et al.,* 2012). Therefore, the mean of a ten-member pool is likely significant when characterizing a much smaller region of the ensemble distribution.

The mean changes for the pooled projections are shown in Figure 5 as the red squares. Because the nearest neighbors to the characteristic point may not be perfectly symmetrically arranged around that point the pooled mean values are close to but not exactly coincident with the characteristic points. This is particularly true for the best and worst cases (the lower left and upper left corners of the anomaly space); because projections are only located on the interior of the space there must be an “inward” bias.

CIR and runoff are strongly inversely correlated, i.e. projections that indicate a decrease in runoff are also likely to indicate an increase in CIR, and *vice versa*. But, runoff and CIR are not perfectly correlated, and there are notable outliers at significant distance from the center of the space along the orthogonal diagonal (.e.g. the projection located at a runoff plotting position of 0.26 and a CIR plotting position of 0.12. In terms of absolute change, this point might be in one tail of the distribution of system impacts that it is our objective to represent in our pools.) The two large black *x* symbols represent pools that would have been created from the ten nearest neighbors to the points 1,0 and 0,1 (upper left and lower right). In the case of the lower right pool, which includes the point at 0.26 and 0.12, the plotting position of the pooled changes is 0.37, 0.25. The respective absolute values of change in runoff and CIR are --11% and 7%. This pool would be in the interior of the distribution. The corresponding values for the upper left pool are 0.70 and 0.66 and 1% and 20%. These pools were not used because they would have been on the interior of the distribution of pooled impacts.

Source of Proxy Data

Reclamation used the Variable Infiltration Capacity hydrology model (Liang *et al*., 1994, 1996) to simulate land surface hydrology on a 1/8 degree grid over the western United States (for the CMIP3 ensemble) and for the entire land area of the continental United States (for the CMIP5 ensemble; Reclamation, 2013). Reclamation reported total runoff from the VIC model, which is the sum of direct surface runoff and base flow[1]. CIR was calculated by subtracting modeled actual evapotranspiration from modeled potential evapotranspiration, both of which are available in the Reclamation outputs[2].

Changes in runoff were calculated based on the entire area of the State of Colorado (this is smaller than the model domain, which extends to include contributing area above major gauges below the State boundaries.) Changes in CIR were calculated based on delineated irrigated agricultural lands as captured in spatial data that are part of CDSS

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[1] In the VIC model nomenclature, direct runoff is referred to as *out_runoff* and base flow as *out_baseflow.* The sum of direct runoff and base flow is of primary interest in climate change assessments because base flow and direct runoff are the source of natural streamflow. In its output from hydrology modeling of the CMIP3 ensemble, Reclamation used the term *runoff* to refer to the sum of the VIC variables *out_runoff* and *out_baseflow.* In order to reduce confusion in terms, Reclamation adopted the term *total_runoff* to refer to the sum of *out_runoff* and *out_baseflow* for data from the CMIP5 hydrology modeling.

[2] Actual evapotranspiraion is termed *out_evap* in VIC, and *et* by Reclamation. Potential evapotranspiration is referred to as *out_petnatveg* in VIC, and *petnatveg* by Reclamation. Potential evapotranspiration is not necessarily equal to reference evapotranspiration (Allen, *et al.,* 1998).

(CWCB, 2014). Runoff and CIR anomalies were averaged over the months of April through October.

Aggregation of Pools and Development of Hydrology Model Forcings

The approach used to develop the weather forcings for the hydrology model is the delta approach as described in the CRWAS-I report (CWCB, 2012). The only principal difference from the CRWAS-I delta approach is that in CRWAS-II the change factors (ratios for precipitation and offsets for temperature) are averaged across the ten pooled projections before being applied to the historical daily weather.

As is shown in Figure 5 for the 7525 pool, ten projections are identified for each pool. These ten projections are used to calculate a set of mean change factors for each grid cell in the model domain, which are in turn used to develop weather forcings (precipitation and temperature) for a VIC model run that will represent the pooled condition. The approach to developing projected model forcings is applied to each grid cell in the model domain, and is summarized as follows:

For each projection in a pool, a monthly set of change factors are calculated that represent the difference between the simulated historical condition and the simulated future condition. The historical simulation period is defined as 1970 through 1999. The three future time frames are defined as 2040 (2025-2054), 2050 (2035-2064) and 2070 (2055-2084). The average temperature and precipitation is determined for each of the twelve months of the year for both the historical simulation and the future simulation. For each month the change in precipitation is expressed as a factor (ratio) and the change in temperature is expressed as an offset.

The process of calculating the change factors is done for each grid cell and for each projection in a pool. Then the change factors (either ratios or offsets) are averaged over the ten projections in a pool. It is this step that differs from the approach used in CRWAS-I.

The average changes calculated for a particular future time frame for a particular pool are then applied to the historical daily weather forcings to create a set of climate-impacted forcings for the hydrology model, in the same manner as CRWAS-I.

Model runs and data reduction

The process of running the VIC model and adjusting streamflows for CRDSS inflow points is the same as in CRWAS-I, except that in this case a VIC model run will represent a pooled future scenario rather than a single climate projection. In CRWAS-II there are three future time frames and seven future climate scenarios, so there are a total of 21 sets of flow adjustments and adjusted flow sets.

Involvement of Colorado CCTAG

The Colorado Climate Change Technical Advisory Committee (CCTAG) was involved in the development of the approach for constructing climate scenarios for CRWAS-II. During the initial stages of conceptualizing the approach, the CRWAS-II technical team met twice with the CCTAG. At the first meeting, the CRWAS-II technical team provided a presentation that summarized some of the unexpected results from the CRWAS-I and suggesting alternative approaches to scenario development. Based on discussions at that meeting, the CRWAS-II technical team developed a proposal for a pooling approach and presented this to the CCTAG. The CCTAG suggested some refinements to the proposed approach. Based on these suggestions the pooling approach was implemented. The CRWAS technical team met with CCTAG one more time to review intermediate results from the pooling analysis. A summary of the technical issues explored with the CCTAG follow.

Prior to the first CCTAG meeting, CWCB had specified a set of constraints on the work designed to maintain the appropriate level of consistency with CRWAS_I and with the ongoing SWSI process. Those decisions were as follows:

- Use three time frames: 2040, 2050, 2070, characterized by periods 2025-2054, 2035-2064, 2055-2084;
- Use the period-change approach used in CRWAS-I (quasi-steady-state approach, Bureau of Reclamation, 2007, Appendix U.);
- Use the Maurer, *et al.*, (2002) gridded historical weather, as extended, to represent baseline weather;
- Base projected natural flows on perturbation of historical natural flows;
- Use the delta (change factor) approach to perturb historical natural flows (second delta process);
- Use the VIC model;
- Include in the hydrology model spatial domain all of the CRDSS domain and the expected domain of prospective CDSS models;
- Develop separate sets of scenarios based on each of the CMIP3 and CMIP5 ensembles (see discussion below);
- Pool projections to provide the basis for projected climate forcing scenarios for hydrology modeling;
- Do not separate projections by SRES scenarios (for CMIP3) or RCPs (for CMIP5);
- Identify the GCM runs used as the basis for each forcing scenario (pool), including their associated SRES scenario or RCP;
- Calculate change factors for total runoff, baseflow, CIR and open-water evaporation; and
- Map change factors to 12-digit hydrologic units in addition to CRDSS and JFRCCVS watersheds.

An additional time frame (2050) was added to the CRWAS-I time frames (2040 and 2070) in order to be consistent with the SWSI planning process. Other changes included expanding the study domain to the entire State, using a pooling approach rather than selected projections and including the CMIP5 archive (which was a principal objective of the CRWAS-II work.)

The CRWAS-II technical team solicited advice from the CCTAG on the following suggested elements of the approach:

- Use a variant of the HDe approach (Reclamation, 2010) that uses pooled mean differences (deltas) for adjustment rather than using quantile mapping to define and assign differences;
- Develop five forcing scenarios, from five pools, from five "regions" of the anomaly space. (Later expanded to seven pools.);
- Define each pool to include a subset of projections defined by proximity as quantified by Euclidean distance from the point defined by characteristic anomalies;
- Define Pools so as to contain a number of projections set to be a percentage of the ensemble total, but with that number sufficiently large to provide stability (e.g. 10 or more);
- Do not constrain the pools to include, in aggregate, all projections in the ensemble;
- Use statewide averages as basis for anomalies;
- Analyze all four CMIP5 RCPs (2.6, 4.5, 6 and 8.5);
- Determine the proxy variables for definition of projection pools (initial candidates included annual P/T anomalies and anomalies of annual T, warm-season P and cool-season P);
- Evaluate whether there is sufficient information to adjust tmin and tmax separately and to different degrees;
- Determine if CRWAS-II should analyze projections taken from a "super-ensemble" that includes both CMIP3 and CMIP5 projections; and
- Evaluate how to address the "wettening" effect.

The CCTAG provided significant insight to development of the approach. Important points of discussion were the apparent "wettening" of changes in the CMIP3 BCSD downscaled data and the apparent positive offset of precipitation in the CMIP5 projections. In the course of the discussion there was agreement that the differences, both those attributed to the BCSD method and those attributed to the CMIP5 projections, were significant from a water resources planning perspective. However, there was also a consensus that the most that the CCTAG and the CRWAS-II technical team could do was advocate for diagnostic studies by other agencies with more resources, and then, once those studies are completed, report the results of those diagnoses with suggestions for any appropriate compensation or mitigation.

Another issue that was explored over several meetings was the approach to developing climate scenarios, the proxy variables to use to define pools of projections that represent a climate scenario, and how to aggregate those projections across a pool. A number of approaches to developing pools were discussed. All involved some form of an anomaly space. There was consensus that the objective of the development of the pools was to cover a range of possible future impacts to the water resources systems, but there was less confidence about the specifics of how to develop those pools. The approach used by Reclamation in Oklahoma (Reclamation, 2010) had the advantage of using the aggregation of many projections for each pool (which exploits the skill advantage of an ensemble mean compared to any ensemble member) but the approach suppressed variability across the ensemble and did not provide a sufficient range of possible futures. This suppression of variability may be due to the large pools used (all projections were in at least one pool and many were in two) or due to the use of the precipitation/temperature anomaly space, given that those variables have been shown to be poor predictors of even hydrologic changes, much less system changes.

Several alternatives were explored based on analysis of the best predictor variables for system performance. Runoff was generally recognized as a good predictor for water supply. One variable that was suggested as a predictor for changes in water demand was shift in precipitation into or out of the irrigation season. The CRWAS-II technical team conducted analyses of a number of alternative predictor variables for water demand and found problems with the use of the seasonal shift in precipitation. However, in the course of that work, the CRWAS-II technical team recognized that changes in irrigation season CIR incorporated the effect of changes in temperature and any shift in precipitation. Accordingly, the CRWAS technical team suggested the use of changes in runoff and CIR as predictor variables for pooling.

With respect to aggregation, members of the CCTAG with relevant experience suggested that a simple averaging approach was sufficient, as opposed to a quantile-mapping approach.

The CRWAS technical team met with CCTAG following development of the pooling approach to present intermediate results of pooling analyses and initial VIC model runs based on pooled forcings. Systematic differences were found between the pooled changes to runoff and CIR calculated from the Reclamation hydrology runs, and the corresponding changes based on the VIC runs using the pooled forcings, but these were resolved adequately when the final methods were applied consistently over the ensembles.

Results

Results of pooling and of hydrology modeling using the pooled forcings for the CMIP3+CMIP5 combined ensemble are shown for 2040, 2050 and 2070, respectively, in the figures below. In the analyses for which results are plotted below, runoff anomalies have been averaged over the entire area of the State, while CIR anomalies have been averaged over irrigated lands. Anomalies for both runoff and CIR are averaged over the period of April through October. Figures 6, 7 and 8 illustrate the results in the anomaly space of runoff and CIR. In Figures 6, 7 and 8, the symbols are as follows. The small blue diamonds represent individual projections from the CMIP3+5 ensemble, based on the results of the Bureau of Reclamation hydrology modeling of the individual projections. The seven white x symbols with a black background represent the seven characteristic points that define the seven projection pools. The seven red squares represent the mean conditions for each of the pools, calculated across the ten nearest neighbors to the respective characteristic points. The seven yellow circles represent the anomalies as simulated by VIC using pooled forcings developed as described above. The white cross with a black background represents current conditions (no change in runoff

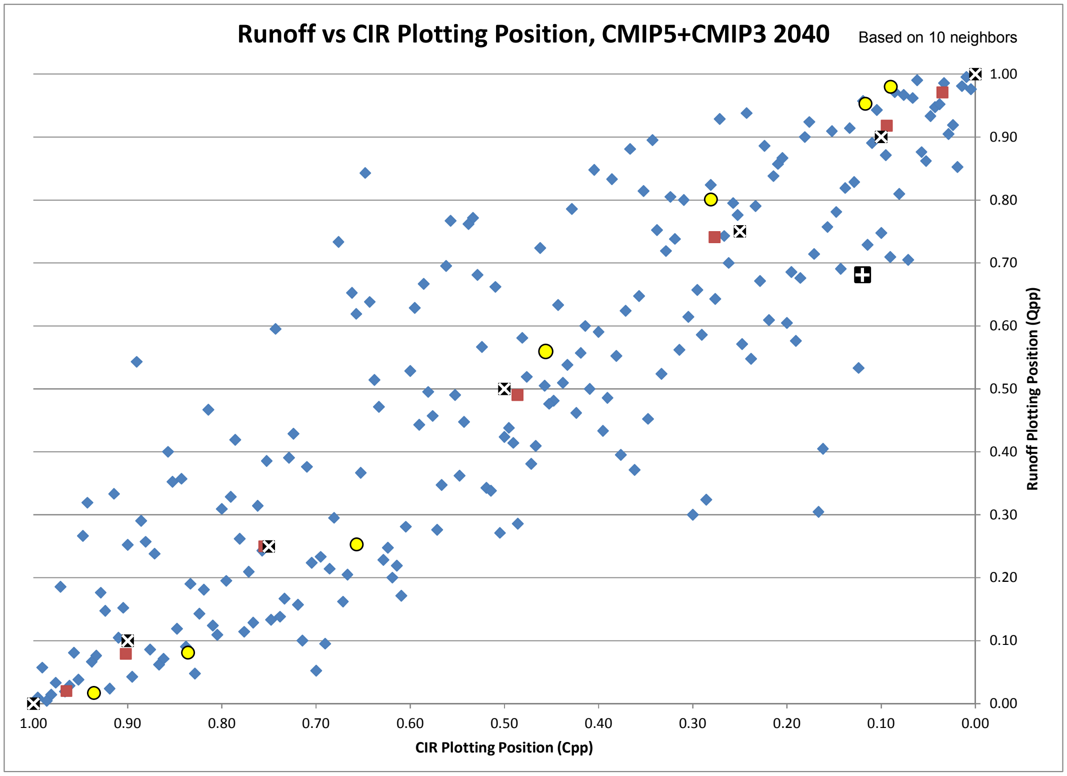

Figure 6. Pooling for CMIP3+5, 2040.

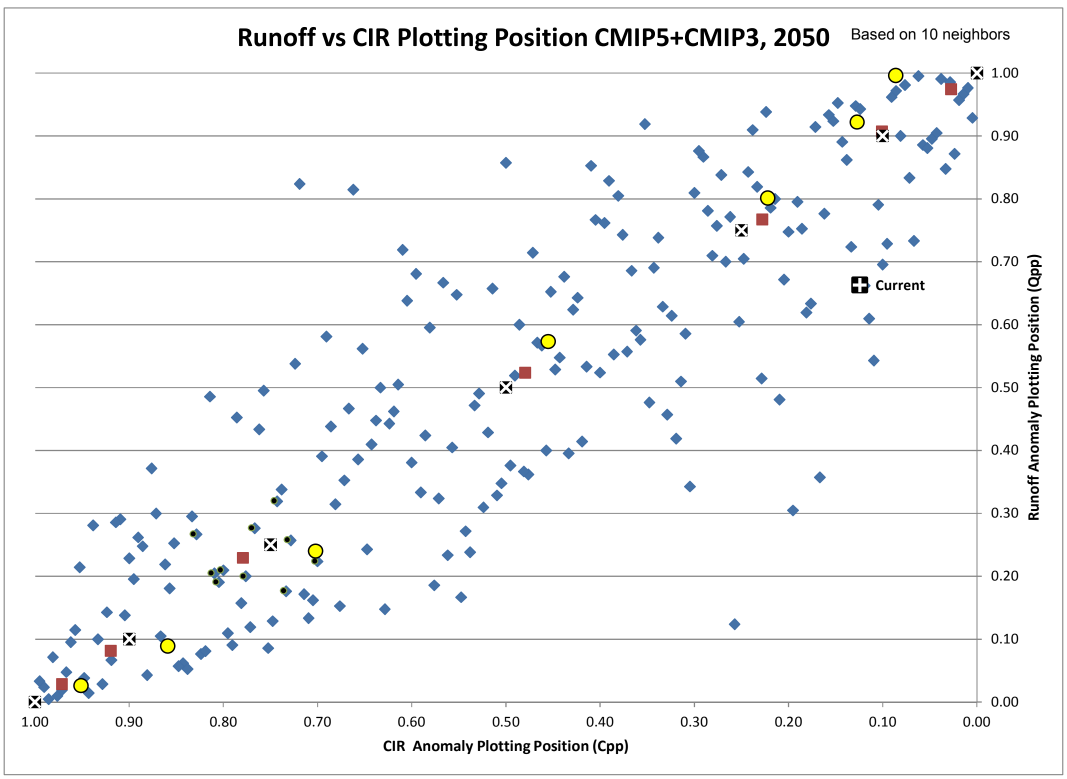

Figure 7. Pooling for CMIP3+5, 2050.

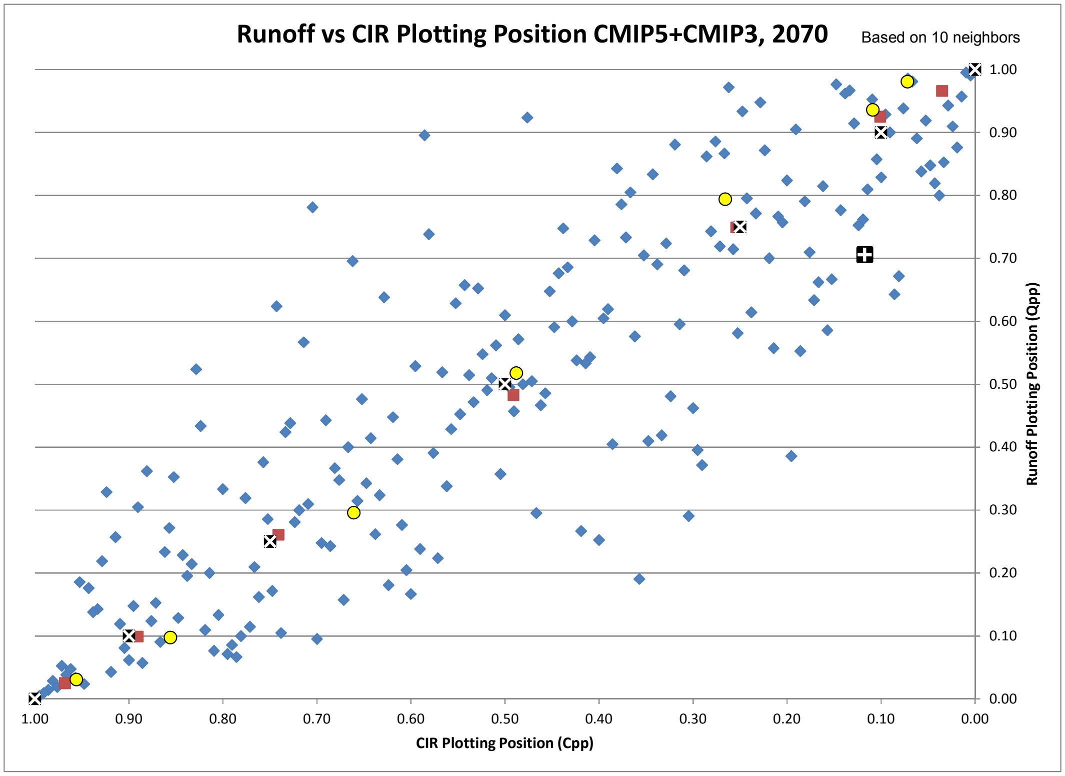

Figure 8. Pooling for CMIP3+5, 2070.

Figures 9, 10 and 11 show the independent empirical cumulative distribution function (ECDF) for runoff and CIR for 2040, 2050 and 2070, respectively. In Figures 9, 10 and 11, the symbols are as follows. The blue line represents the ECDF of runoff based on the USBR model runs. The orange line represents the ECDF of CIR based on the USBR model runs. Red squares represent the runoff or CIR anomaly based on the USBR model runs, averaged across the ten members of the respective pools. The seven yellow circles represent the anomalies as simulated by VIC using pooled forcings developed as described above. Note that when constructing pools, the CIR and runoff conditions are combined from opposite ends of the ECDFs. That is, the upper right pool (see Figure 6 and explanation above) is the combination of the runoff value that is highest on the runoff ECDF and the CIR value that is lowest on the CIR ECDF.

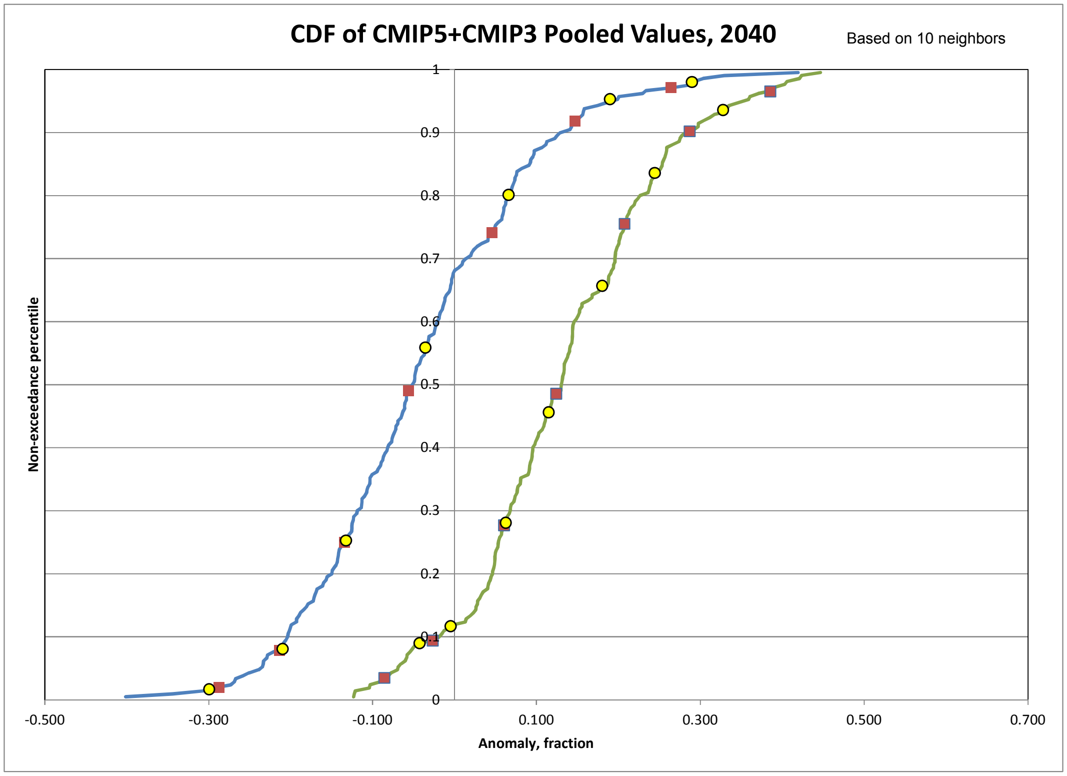

Figure 9. ECDFs for CMIP3+5, 2040.

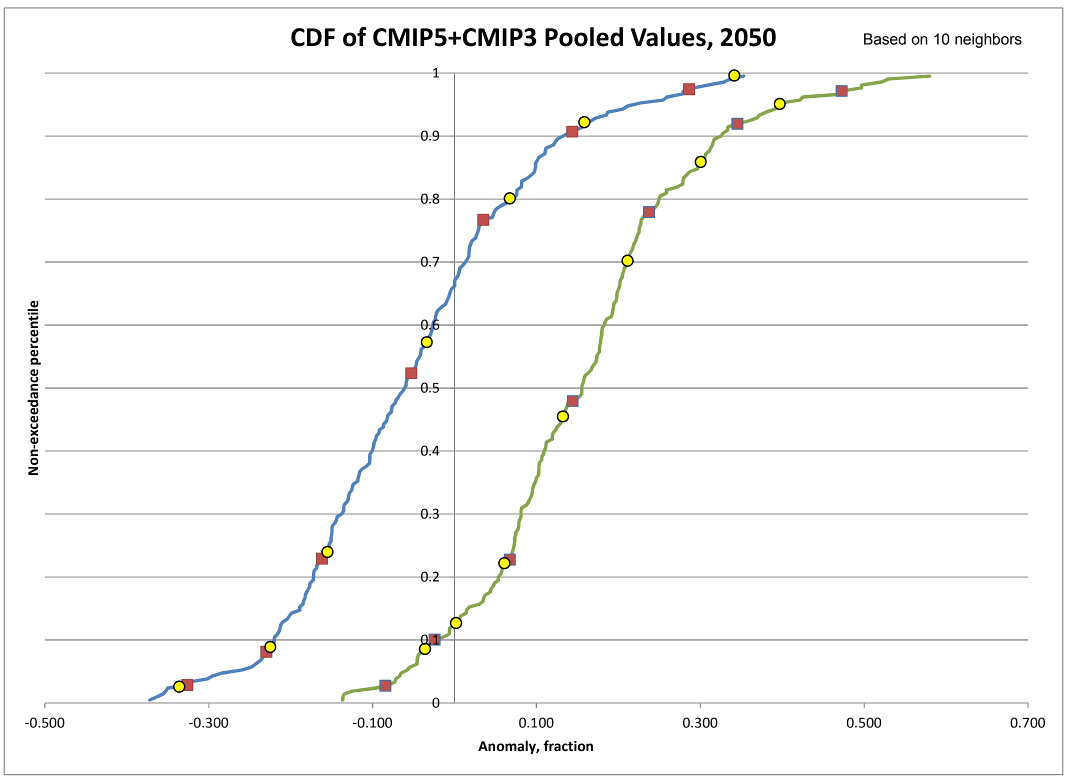

Figure 10. ECDFs for CMIP3+5, 2050.

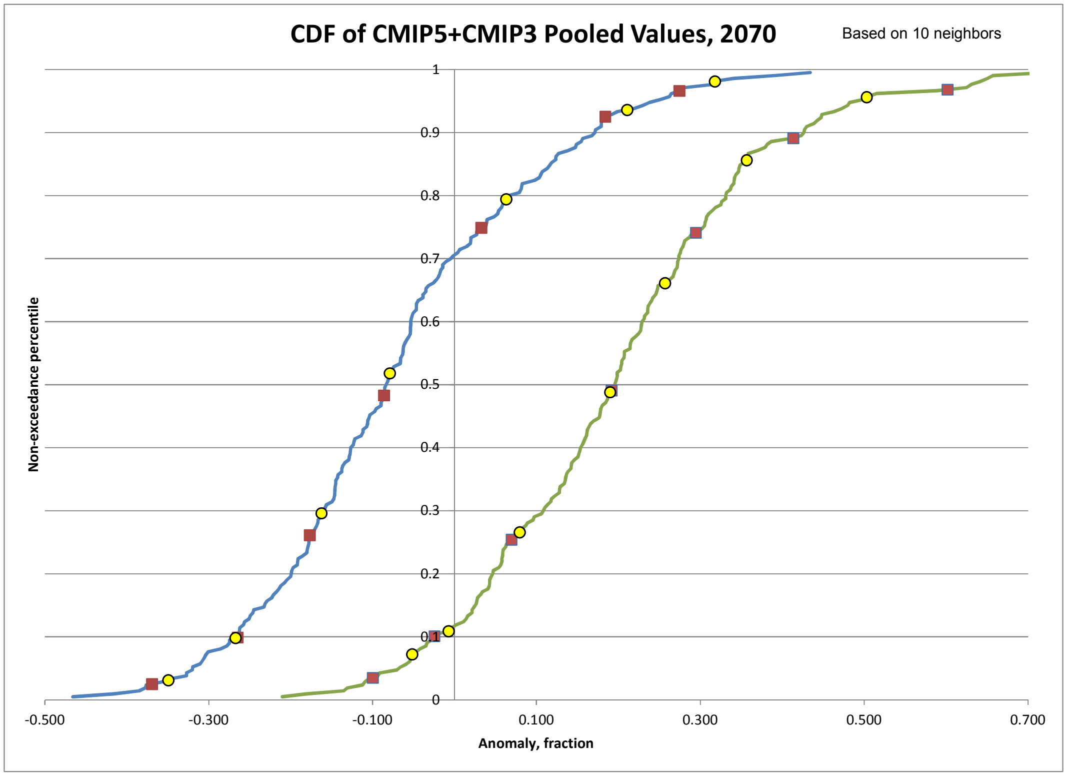

Figure 11. ECDFs for CMIP3+5, 2070.

Discussion

The principal objective for the set of scenarios developed for CRWAS-II is to represent the range of projected future impacts *to the water resources systems*. The success in meeting this objective cannot be verified without evaluating impacts to each system for each member of the ensemble (209 members, in the combined CMIP3 and CMIP5 Hydro ensemble.) A requisite for realistically representing impacts to water resources systems is realistically representing the range of projected changes to runoff (system water supply) and CIR (system water use). This can be evaluated.

Figures 6 through 11 show that the pooling approach does meet that requisite. All of the figures show results placed in the context of the comprehensive hydrologic modeling of the CMIP3, CMIP5 (hydrology) and CMIP3+5 ensembles done by Reclamation. Figures 6, 7 and 8 show, in order of the progression of the methodology: the values of anomalies for each projection from the USBR modeling, the characteristic points for each pool, the average values of anomalies from the USBR modeling across the ten-neighbor pools associated with each characteristic point, and the simulated anomalies from hydrology modeling using pooled forcings averaged across each ten-member pool.

The characteristic points represent the idealized sets of conditions for which we wish to develop scenarios. These are the white x symbol with the black background in Figures 6, 7 and 8. The characteristic conditions range from the worst case (lower left; the largest increase in CIR and the largest reduction in runoff) to the best case (upper right; the largest decrease in CIR and the largest increase in runoff) and include intermediate combinations of conditions.

To represent each of these characteristic conditions, pools of the ten projections nearest to each characteristic point are identified and the values of the runoff and CIR anomalies for those ten neighbors are averaged to provide the best representation of the idealized characteristic conditions. The pools for each scenario are listed in Appendix B. Average conditions across each pool are represented by the red squares. The proximity of those red squares to the characteristic points shows the degree to which the available projections can represent the idealized conditions. This agreement does not have to be perfect; Figures 6, 7 and 8 show that agreement to be quite good. The best and worst case conditions are biased toward the interior of the anomaly space because the available projections are all less severe and less beneficial than the idealized worst-case condition. The agreement between characteristic points and pooled values is not quite as good for the individual CMIP3 and CMIP5 Hydro ensembles (corresponding charts are in Appendix A) because those ensembles have fewer members, so their spatial granularity is larger.

The final scenarios used by CRWAS-II are developed by forcing the VIC model with perturbed weather created using the average anomalies from each of the pools. This modeling step is required because the CRWAS-I approach, which CRWAS-II has adopted, requires hydrology modeling to be done using the historical and perturbed weather, so as to create a time series of adjustments to natural flow (see CRWAS Phase II Technical Memorandum Task 1 – *Literature Review* and CWCB, 2012 for details.) Once those runs are completed, the average anomalies of runoff and CIR can be calculated by the same approach used in calculating the anomalies of the individual Reclamation runs. When these anomalies are put into the same context (i.e. the distribution of anomalies across the entire Reclamation ensemble), the results provide an indication of the validity of the approach.

Figures 6, 7 and 8 illustrate that the results from modeling using pooled forcings (the yellow circles) are very close to the characteristic points and the average anomalies across the pools calculated based on the Reclamation modeling, and there is little systematic bias in their relationship to the pooled conditions. The proximity of these points indicates that the method has met the requisite of accurately representing the hydrologic stresses on the water resources systems.

The agreement between the simulations using pooled forcings and the values calculated across the Reclamation results are not expected to be perfect due to non-linear responses in hydrology processes (and in simulation of those processes.) It is most important that the scenarios represent the range of conditions and remain ordered, which they do. Figures 9, 10 and 11 show the results (but not the characteristic conditions) as individual ECDFs for runoff and CIR. This allows some diagnosis, which shows that the simulated results differ from the pooled results primarily by reduced range in the representation of CIR, and a high bias in the simulation of runoff at the upper end of the CDF. This may result in a slight increase in hydrologic stress for the most severe conditions and a larger reduction in hydrologic stress in the most optimistic projections. However, the exact magnitude of these differences in terms of system impacts cannot be estimated.

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Appendix A: Results for CMIP3 and CMIP5 Ensembles

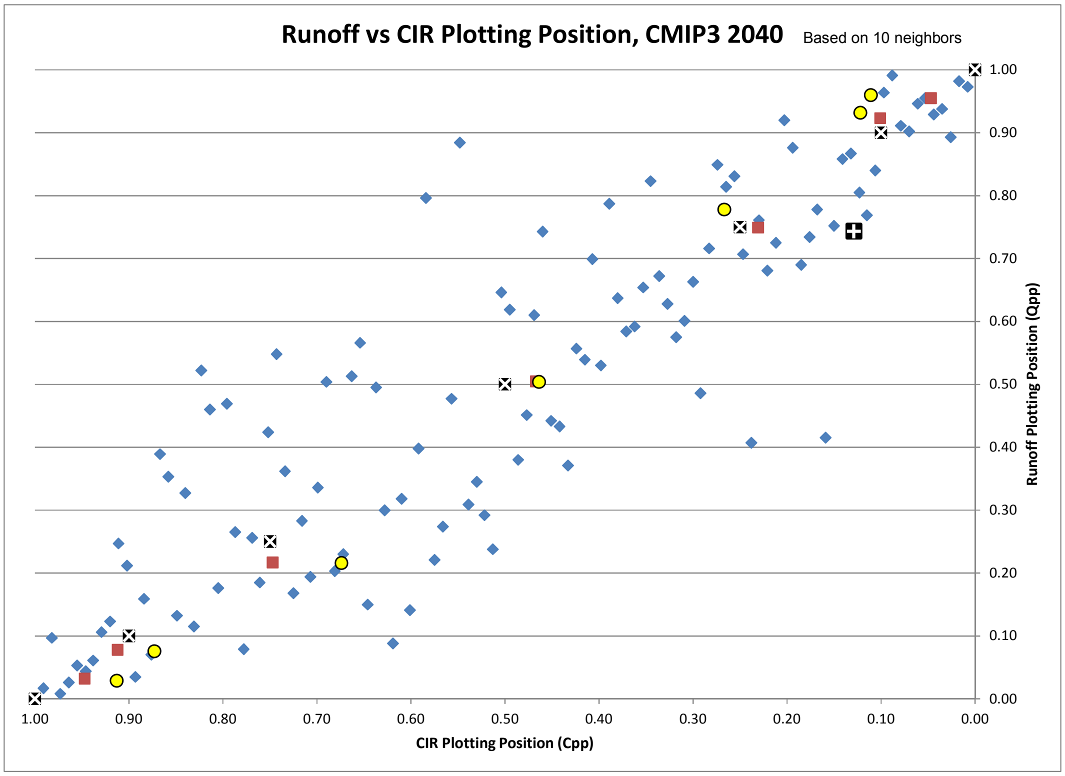

Figure A.1. Pooling for CMIP3, 2040.

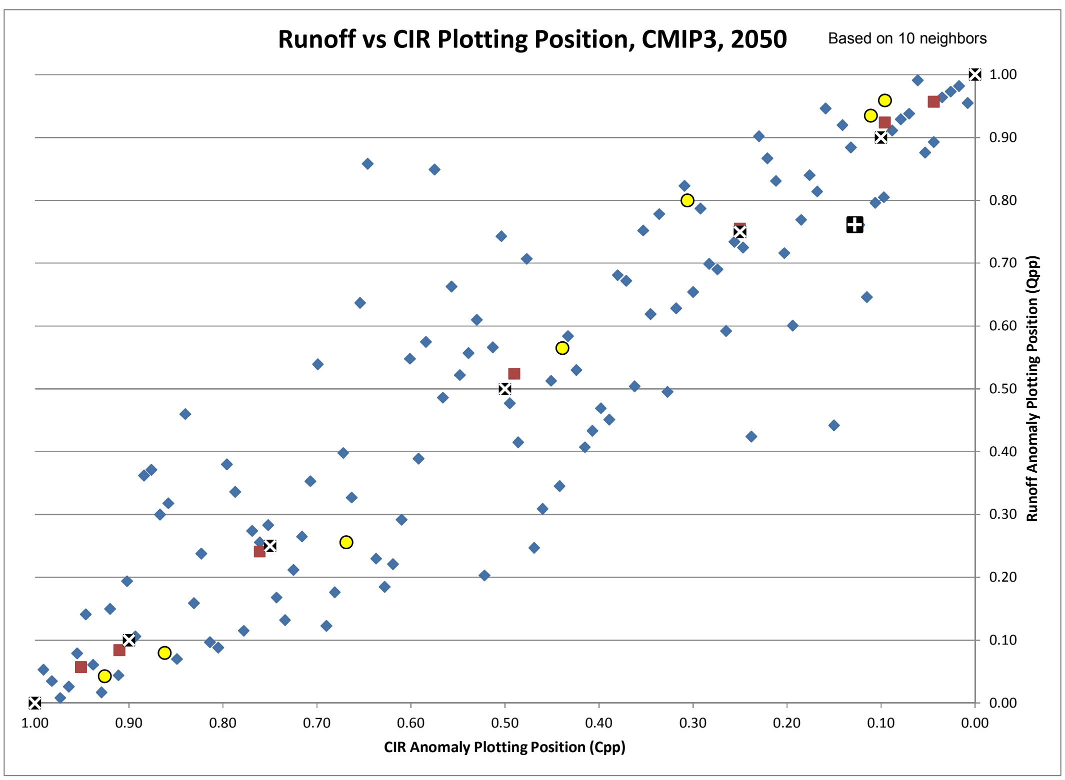

Figure A.2. Pooling for CMIP3, 2050.

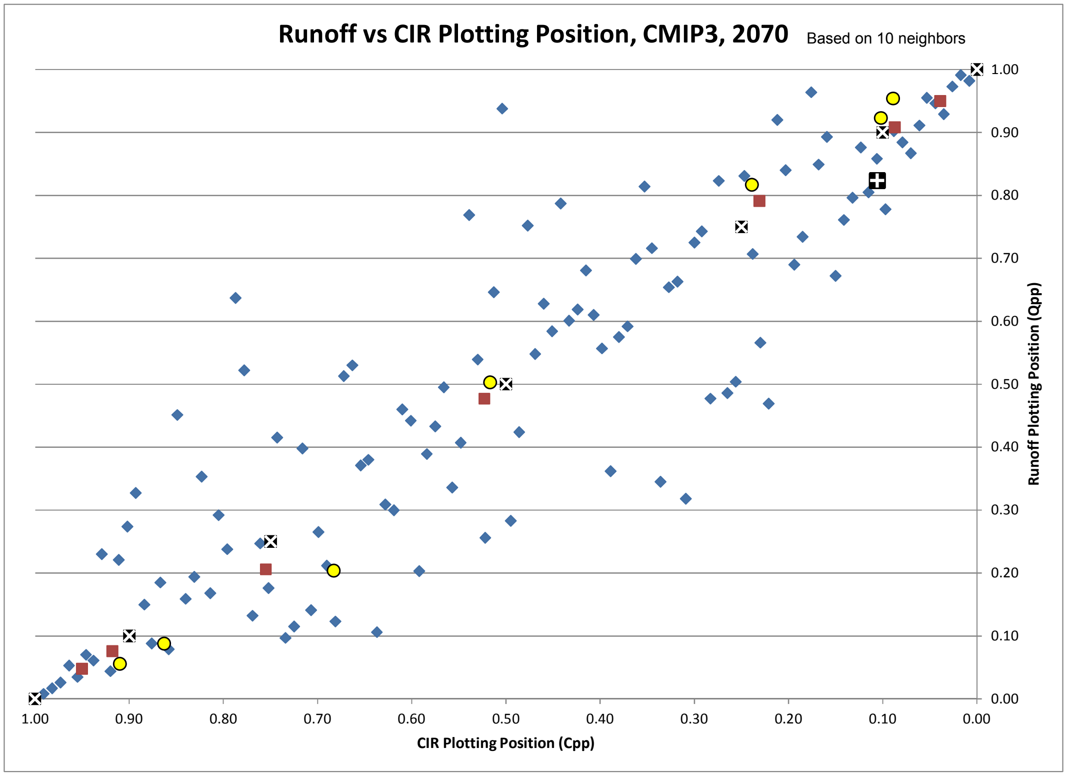

Figure A.3. Pooling for CMIP3, 2070.

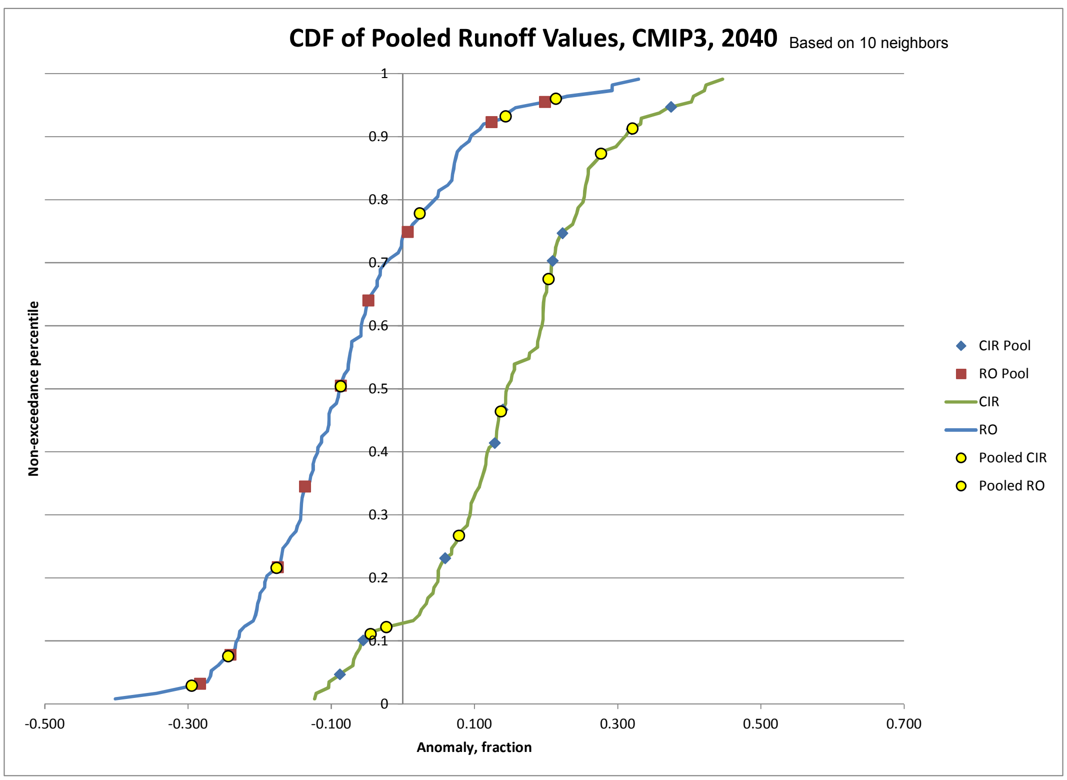

Figure A.4. ECDFs for CMIP3, 2040.

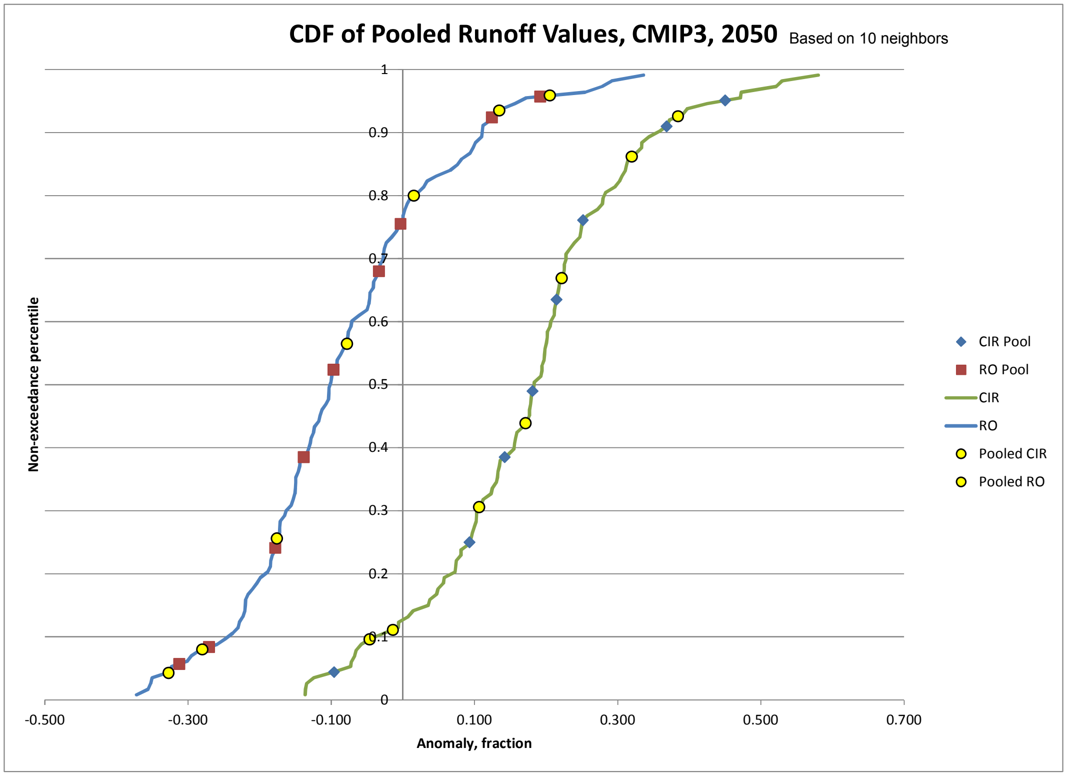

Figure A.5. ECDFs for CMIP3, 2050.

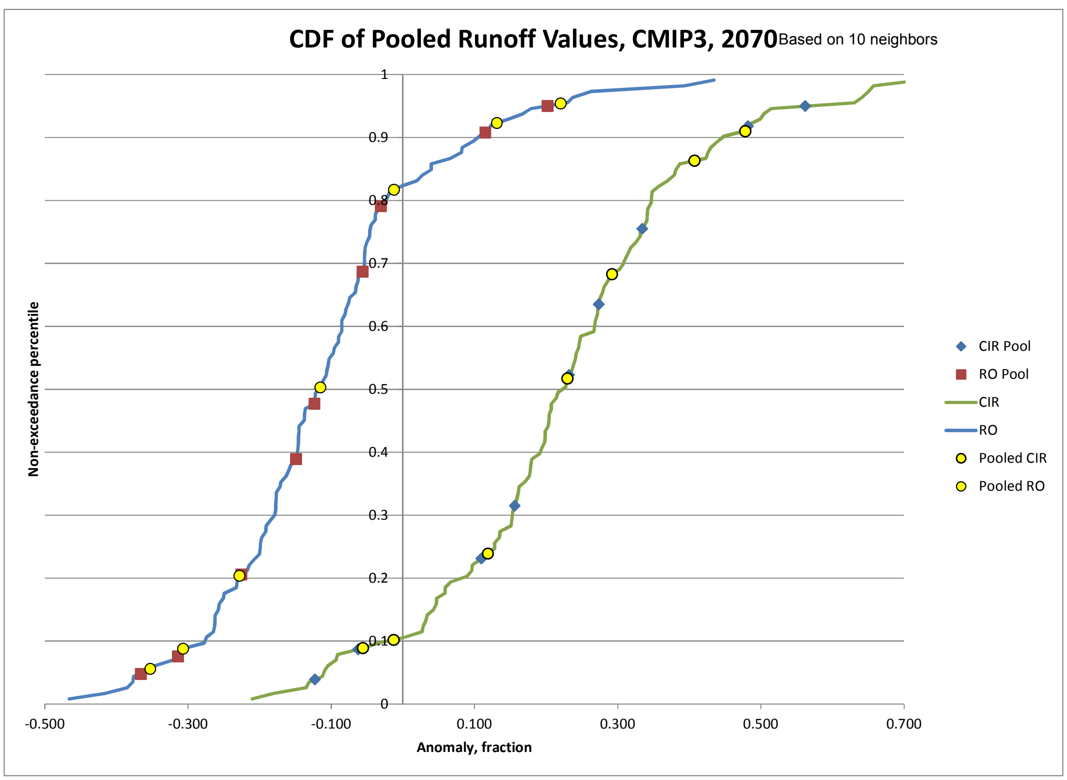

Figure A.6. ECDFs for CMIP3, 2070.

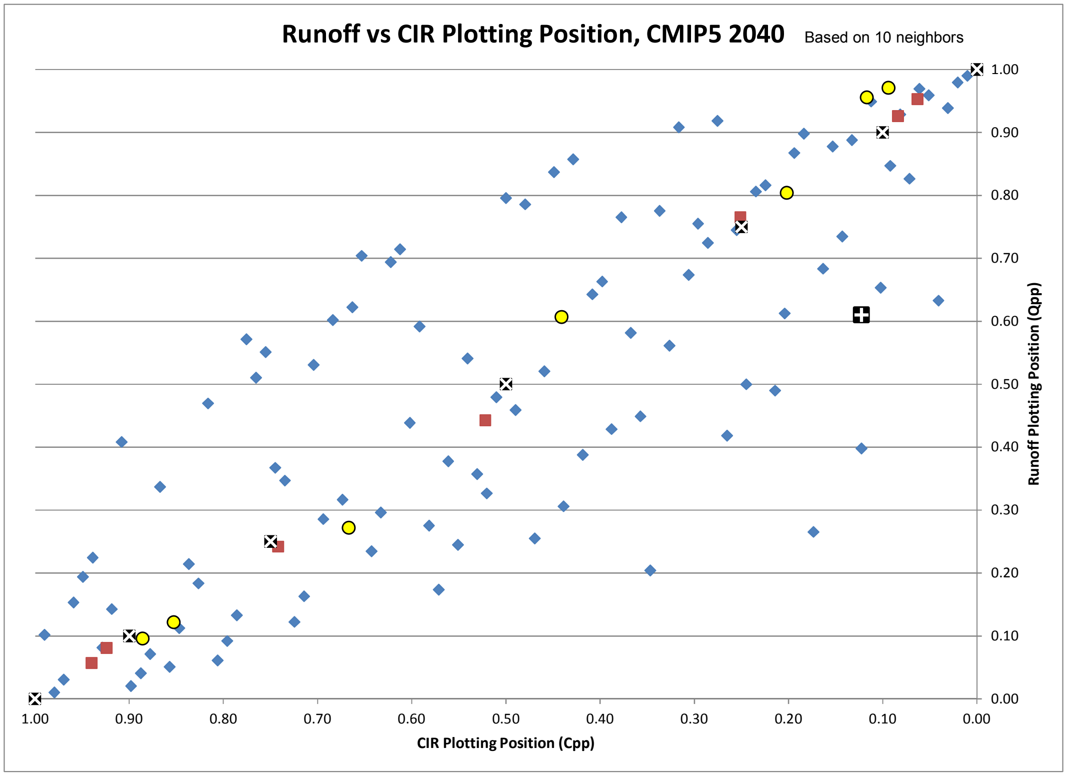

Figure A.7. Pooling for CMIP5 (hydrology), 2040.

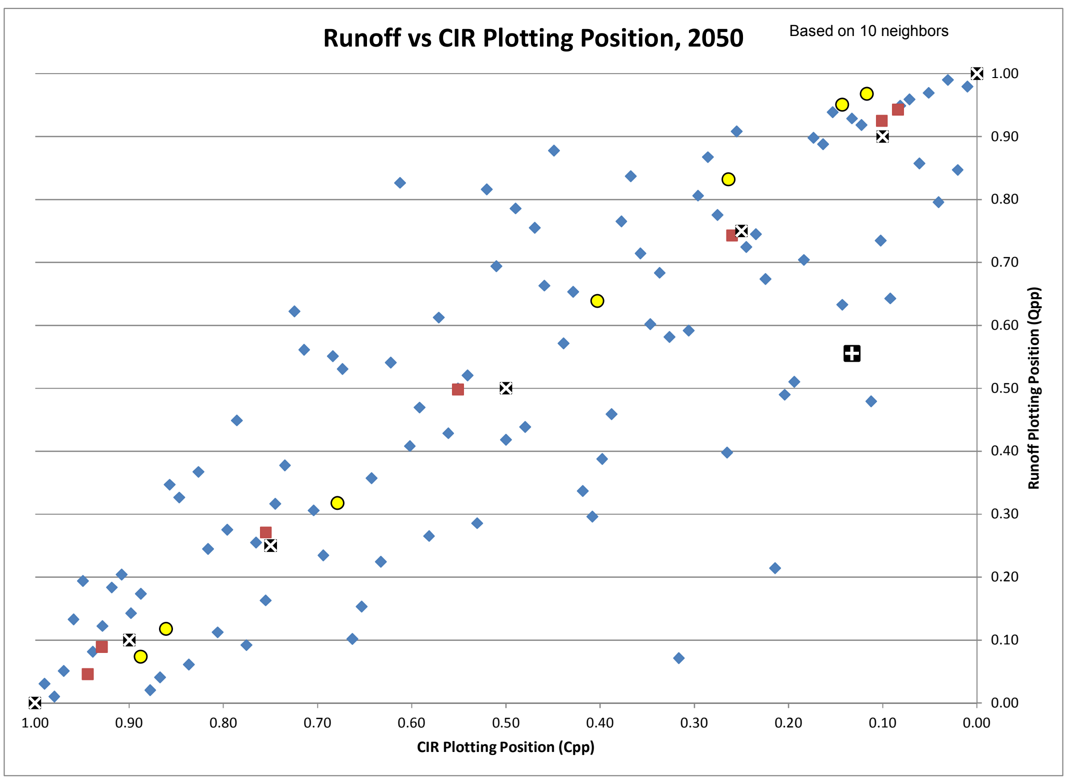

Figure A.8. Pooling for CMIP5 (hydrology), 2050.

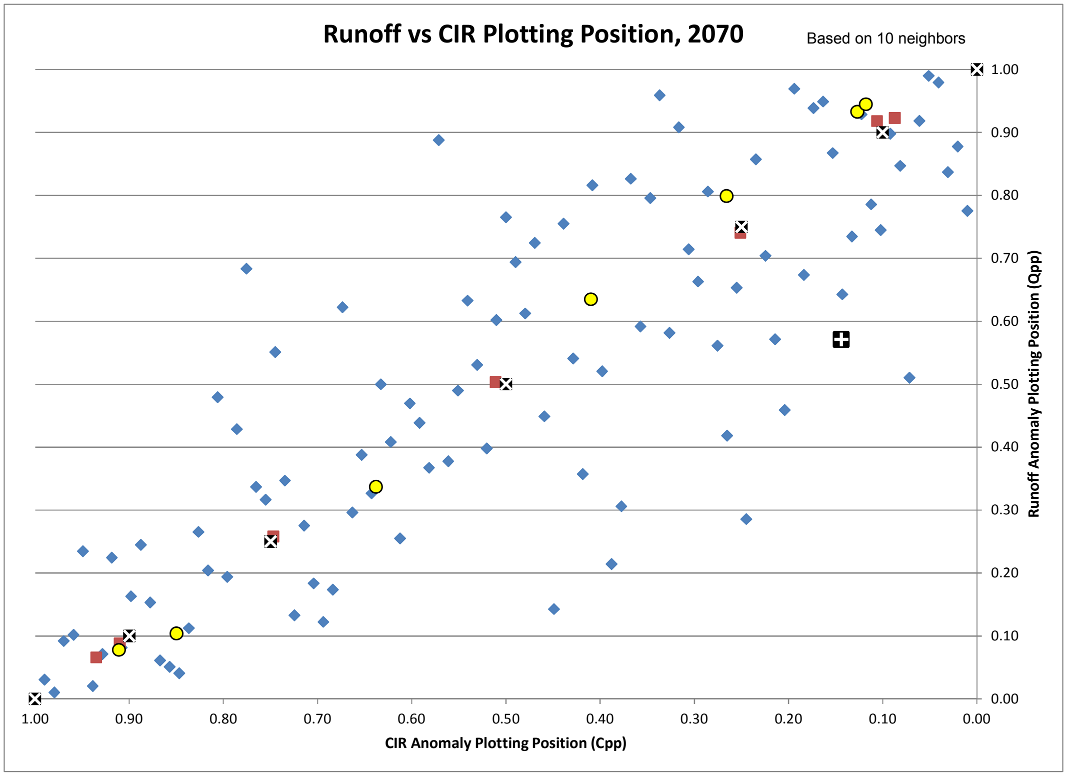

Figure A.9. Pooling for CMIP5 (hydrology), 2070.

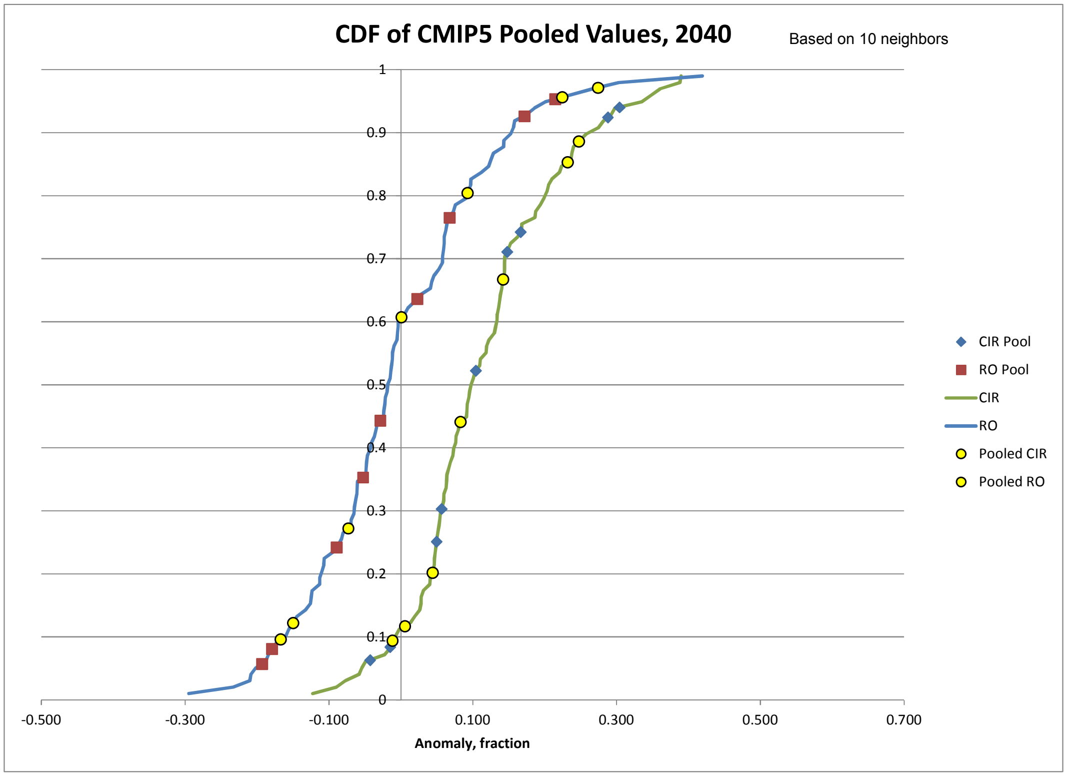

Figure A.10. ECDFs for CMIP5 (hydrology), 2040.

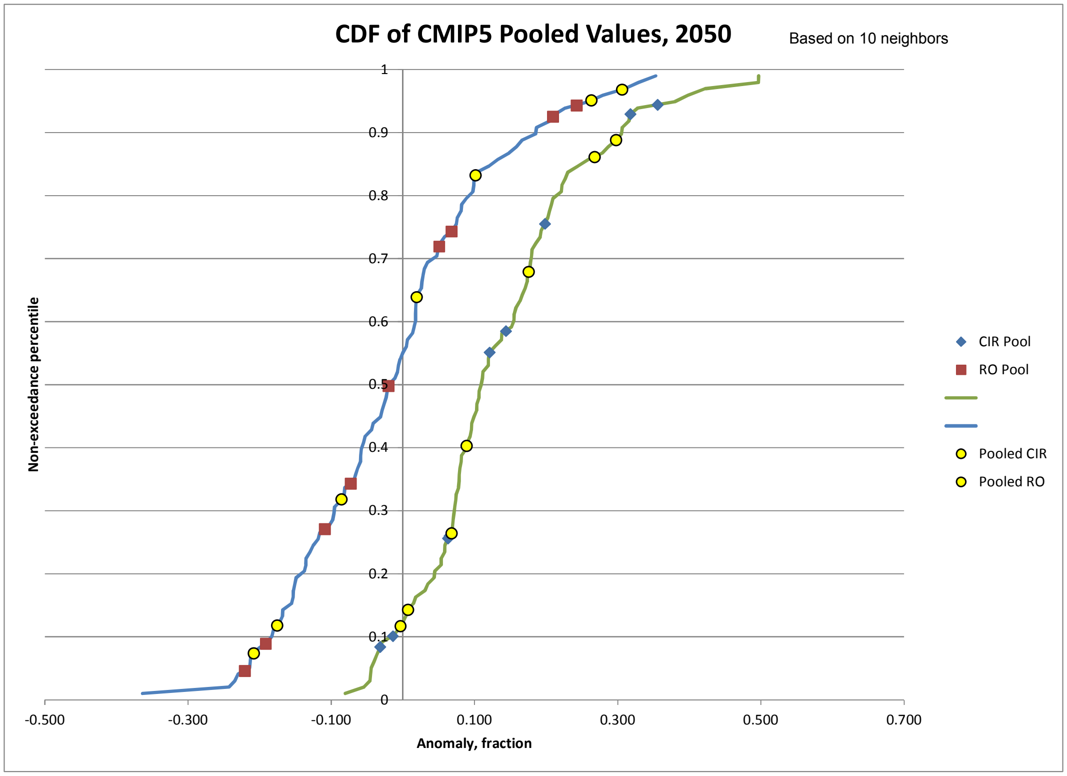

Figure A.11. ECDFs for CMIP5 (hydrology), 2050.

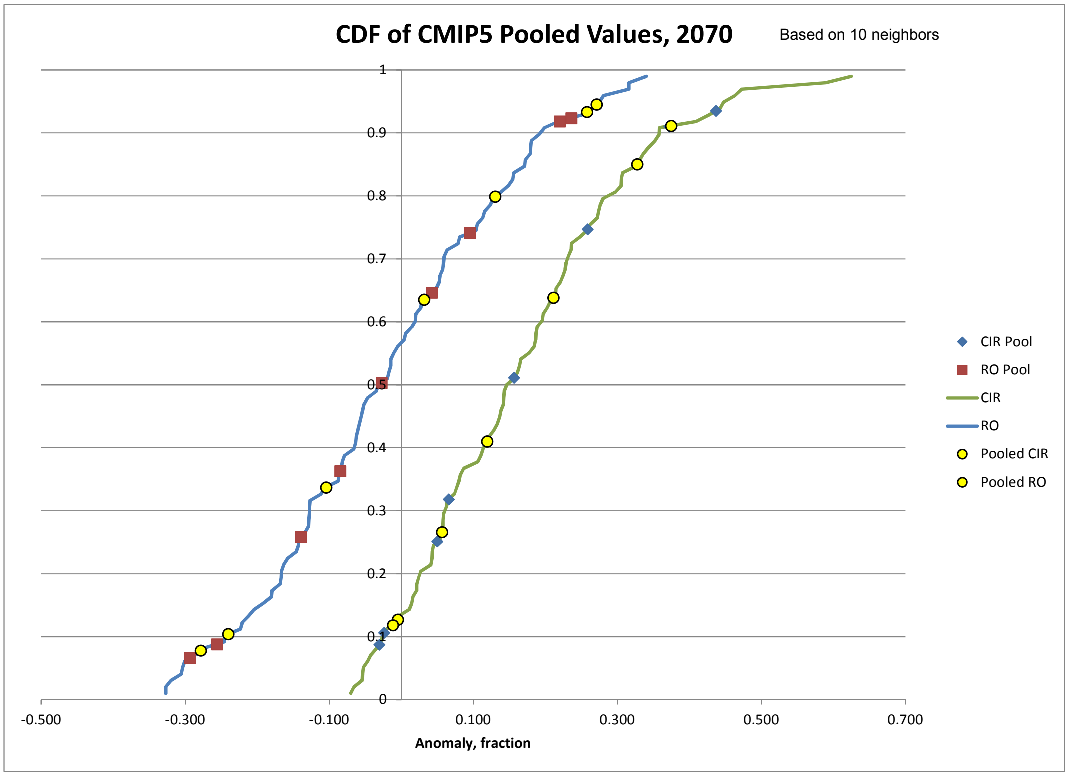

Figure A.12. ECDFs for CMIP5 (hydrology), 2070.

Appendix B: Scenario Pools

Table B.1. CMIP3 Ensemble Pools

Period	Pool	Run
2040	ll	sresb1.mri_cgcm2_3_2a.4
2040	ll	sresb1.miroc3_2_medres.2
2040	ll	sresa2.mri_cgcm2_3_2a.2
2040	ll	sresa2.miroc3_2_medres.3
2040	ll	sresa2.miroc3_2_medres.2
2040	ll	sresa2.miroc3_2_medres.1
2040	ll	sresa1b.ncar_ccsm3_0.1
2040	ll	sresa1b.miroc3_2_medres.3
2040	ll	sresa1b.miroc3_2_medres.2
2040	ll	sresa1b.gfdl_cm2_1.1
2040	lr	sresb1.ncar_ccsm3_0.2
2040	lr	sresb1.miub_echo_g.2
2040	lr	sresa2.mpi_echam5.1
2040	lr	sresa1b.ncar_ccsm3_0.7
2040	lr	sresa1b.ncar_ccsm3_0.3
2040	lr	sresa1b.miub_echo_g.3
2040	lr	sresa1b.miub_echo_g.2
2040	lr	sresa1b.miub_echo_g.1
2040	lr	sresa1b.csiro_mk3_0.1
2040	lr	sresa1b.bccr_bcm2_0.1
2040	ul	sresb1.inmcm3_0.1
2040	ul	sresb1.cccma_cgcm3_1.5
2040	ul	sresa2.ukmo_hadcm3.1
2040	ul	sresa2.inmcm3_0.1
2040	ul	sresa2.giss_model_e_r.1
2040	ul	sresa2.gfdl_cm2_1.1
2040	ul	sresa2.cccma_cgcm3_1.3
2040	ul	sresa1b.ipsl_cm4.1
2040	ul	sresa1b.inmcm3_0.1
2040	ul	sresa1b.cccma_cgcm3_1.3
2040	ur	sresb1.ncar_ccsm3_0.5
2040	ur	sresa2.ncar_pcm1.4
2040	ur	sresa2.ncar_pcm1.3
2040	ur	sresa2.ncar_pcm1.1
2040	ur	sresa2.mri_cgcm2_3_2a.5
2040	ur	sresa1b.ncar_pcm1.4
2040	ur	sresa1b.ncar_pcm1.3
2040	ur	sresa1b.ncar_pcm1.2
2040	ur	sresa1b.ncar_pcm1.1
2040	ur	sresa1b.cccma_cgcm3_1.2
2040	c	sresb1.mri_cgcm2_3_2a.3
2040	c	sresb1.mpi_echam5.1
2040	c	sresb1.miub_echo_g.2
2040	c	sresb1.cccma_cgcm3_1.4
2040	c	sresb1.cccma_cgcm3_1.1
2040	c	sresa2.ncar_ccsm3_0.4
2040	c	sresa2.ncar_ccsm3_0.3
2040	c	sresa2.mpi_echam5.1
2040	c	sresa1b.mri_cgcm2_3_2a.1
2040	c	sresa1b.mpi_echam5.1
2040	7525	sresb1.giss_model_e_r.1
2040	7525	sresa2.ncar_ccsm3_0.1
2040	7525	sresa2.mri_cgcm2_3_2a.1
2040	7525	sresa2.miub_echo_g.3
2040	7525	sresa2.cnrm_cm3.1
2040	7525	sresa2.cccma_cgcm3_1.5
2040	7525	sresa1b.ukmo_hadcm3.1
2040	7525	sresa1b.mri_cgcm2_3_2a.4
2040	7525	sresa1b.mri_cgcm2_3_2a.2
2040	7525	sresa1b.cnrm_cm3.1

Period	Pool	Run
2040	2575	sresb1.ncar_ccsm3_0.7
2040	2575	sresb1.ncar_ccsm3_0.3
2040	2575	sresb1.mri_cgcm2_3_2a.5
2040	2575	sresb1.mri_cgcm2_3_2a.1
2040	2575	sresb1.miub_echo_g.1
2040	2575	sresb1.bccr_bcm2_0.1
2040	2575	sresa2.cccma_cgcm3_1.4
2040	2575	sresa2.cccma_cgcm3_1.2
2040	2575	sresa1b.ncar_ccsm3_0.5
2040	2575	sresa1b.cccma_cgcm3_1.4
2040	9010	sresb1.ncar_ccsm3_0.6
2040	9010	sresb1.mri_cgcm2_3_2a.4
2040	9010	sresb1.miroc3_2_medres.3
2040	9010	sresb1.miroc3_2_medres.2
2040	9010	sresa2.mri_cgcm2_3_2a.4
2040	9010	sresa2.mri_cgcm2_3_2a.3
2040	9010	sresa2.miroc3_2_medres.2
2040	9010	sresa1b.ncar_ccsm3_0.1
2040	9010	sresa1b.miroc3_2_medres.3
2040	9010	sresa1b.gfdl_cm2_1.1
2040	1090	sresb1.ncar_pcm1.3
2040	1090	sresb1.ncar_ccsm3_0.5
2040	1090	sresa2.ncar_pcm1.3
2040	1090	sresa2.ncar_pcm1.2
2040	1090	sresa2.ncar_pcm1.1
2040	1090	sresa2.mri_cgcm2_3_2a.5
2040	1090	sresa2.mpi_echam5.2
2040	1090	sresa1b.ncar_pcm1.4
2040	1090	sresa1b.ncar_pcm1.3
2040	1090	sresa1b.giss_model_e_r.2
2050	ll	sresa2.mri_cgcm2_3_2a.3
2050	ll	sresa2.mri_cgcm2_3_2a.2
2050	ll	sresa2.miroc3_2_medres.3
2050	ll	sresa2.miroc3_2_medres.2
2050	ll	sresa2.miroc3_2_medres.1
2050	ll	sresa2.cnrm_cm3.1
2050	ll	sresa1b.miroc3_2_medres.3
2050	ll	sresa1b.miroc3_2_medres.2
2050	ll	sresa1b.miroc3_2_medres.1
2050	ll	sresa1b.cnrm_cm3.1
2050	lr	sresb1.ncar_ccsm3_0.2
2050	lr	sresb1.ncar_ccsm3_0.1
2050	lr	sresa2.ncar_ccsm3_0.3
2050	lr	sresa2.mpi_echam5.1
2050	lr	sresa2.bccr_bcm2_0.1
2050	lr	sresa1b.ncar_ccsm3_0.7
2050	lr	sresa1b.ncar_ccsm3_0.3
2050	lr	sresa1b.ncar_ccsm3_0.2
2050	lr	sresa1b.mri_cgcm2_3_2a.4
2050	lr	sresa1b.bccr_bcm2_0.1
2050	ul	sresb1.cccma_cgcm3_1.5
2050	ul	sresa2.ukmo_hadcm3.1
2050	ul	sresa2.ncar_ccsm3_0.4
2050	ul	sresa2.ipsl_cm4.1
2050	ul	sresa2.inmcm3_0.1
2050	ul	sresa2.giss_model_e_r.1
2050	ul	sresa1b.mri_cgcm2_3_2a.3
2050	ul	sresa1b.inmcm3_0.1
2050	ul	sresa1b.giss_model_e_r.4
2050	ul	sresa1b.cccma_cgcm3_1.3

Period	Pool	Run
2050	ur	sresb1.ncar_pcm1.3
2050	ur	sresb1.ncar_ccsm3_0.5
2050	ur	sresa2.ncar_pcm1.4
2050	ur	sresa2.ncar_pcm1.3
2050	ur	sresa2.ncar_pcm1.1
2050	ur	sresa1b.ncar_pcm1.4
2050	ur	sresa1b.ncar_pcm1.3
2050	ur	sresa1b.ncar_pcm1.2
2050	ur	sresa1b.ncar_pcm1.1
2050	ur	sresa1b.cccma_cgcm3_1.2
2050	c	sresb1.ukmo_hadcm3.1
2050	c	sresb1.mpi_echam5.3
2050	c	sresb1.mpi_echam5.2
2050	c	sresb1.miub_echo_g.2
2050	c	sresb1.cccma_cgcm3_1.4
2050	c	sresa2.mri_cgcm2_3_2a.1
2050	c	sresa2.mpi_echam5.3
2050	c	sresa2.cccma_cgcm3_1.1
2050	c	sresa1b.ukmo_hadcm3.1
2050	c	sresa1b.cccma_cgcm3_1.1
2050	7525	sresb1.ncar_ccsm3_0.4
2050	7525	sresb1.miroc3_2_medres.2
2050	7525	sresb1.inmcm3_0.1
2050	7525	sresb1.gfdl_cm2_1.1
2050	7525	sresa2.mri_cgcm2_3_2a.4
2050	7525	sresa2.miub_echo_g.2
2050	7525	sresa1b.ncar_ccsm3_0.6
2050	7525	sresa1b.mri_cgcm2_3_2a.2
2050	7525	sresa1b.miub_echo_g.3
2050	7525	sresa1b.miub_echo_g.1
2050	2575	sresb1.ncar_ccsm3_0.3
2050	2575	sresb1.mri_cgcm2_3_2a.2
2050	2575	sresb1.mri_cgcm2_3_2a.1
2050	2575	sresb1.miub_echo_g.1
2050	2575	sresa2.ncar_ccsm3_0.2
2050	2575	sresa2.mpi_echam5.2
2050	2575	sresa2.cccma_cgcm3_1.4
2050	2575	sresa1b.mri_cgcm2_3_2a.5
2050	2575	sresa1b.mpi_echam5.2
2050	2575	sresa1b.cccma_cgcm3_1.4
2050	9010	sresb1.miroc3_2_medres.3
2050	9010	sresa2.mri_cgcm2_3_2a.3
2050	9010	sresa2.mri_cgcm2_3_2a.2
2050	9010	sresa2.miub_echo_g.3
2050	9010	sresa2.gfdl_cm2_0.1
2050	9010	sresa2.cnrm_cm3.1
2050	9010	sresa1b.mpi_echam5.3
2050	9010	sresa1b.miroc3_2_medres.3
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2050	1090	sresa2.ncar_pcm1.3
2050	1090	sresa2.ncar_pcm1.2
2050	1090	sresa2.ncar_pcm1.1
2050	1090	sresa2.mri_cgcm2_3_2a.5
2050	1090	sresa1b.ncar_pcm1.2
2050	1090	sresa1b.ncar_pcm1.1
2050	1090	sresa1b.giss_model_e_r.2
2070	ll	sresb1.miroc3_2_medres.3
2070	ll	sresa2.miub_echo_g.3
2070	ll	sresa2.miroc3_2_medres.3
2070	ll	sresa2.miroc3_2_medres.2
2070	ll	sresa2.miroc3_2_medres.1
2070	ll	sresa2.cnrm_cm3.1
2070	ll	sresa1b.miroc3_2_medres.3

Period	Pool	Run
2070	ll	sresa1b.miroc3_2_medres.2
2070	ll	sresa1b.miroc3_2_medres.1
2070	ll	sresa1b.cnrm_cm3.1
2070	lr	sresb1.ncar_ccsm3_0.4
2070	lr	sresb1.mri_cgcm2_3_2a.5
2070	lr	sresb1.mri_cgcm2_3_2a.4
2070	lr	sresb1.miub_echo_g.1
2070	lr	sresa2.ncar_ccsm3_0.3
2070	lr	sresa2.ncar_ccsm3_0.2
2070	lr	sresa1b.ncar_ccsm3_0.7
2070	lr	sresa1b.ncar_ccsm3_0.2
2070	lr	sresa1b.ncar_ccsm3_0.1
2070	lr	sresa1b.csiro_mk3_0.1
2070	ul	sresb1.inmcm3_0.1
2070	ul	sresa2.inmcm3_0.1
2070	ul	sresa2.giss_model_e_r.1
2070	ul	sresa2.cccma_cgcm3_1.5
2070	ul	sresa2.cccma_cgcm3_1.3
2070	ul	sresa2.cccma_cgcm3_1.1
2070	ul	sresa1b.mpi_echam5.1
2070	ul	sresa1b.inmcm3_0.1
2070	ul	sresa1b.cccma_cgcm3_1.5
2070	ul	sresa1b.cccma_cgcm3_1.3
2070	ur	sresb1.ncar_pcm1.3
2070	ur	sresb1.ncar_pcm1.2
2070	ur	sresb1.ncar_ccsm3_0.5
2070	ur	sresa2.ncar_pcm1.4
2070	ur	sresa2.ncar_pcm1.2
2070	ur	sresa2.ncar_pcm1.1
2070	ur	sresa1b.ncar_pcm1.4
2070	ur	sresa1b.ncar_pcm1.3
2070	ur	sresa1b.ncar_pcm1.1
2070	ur	sresa1b.ncar_ccsm3_0.5
2070	c	sresb1.ukmo_hadcm3.1
2070	c	sresb1.cccma_cgcm3_1.3
2070	c	sresa2.mpi_echam5.2
2070	c	sresa2.mpi_echam5.1
2070	c	sresa2.csiro_mk3_0.1
2070	c	sresa2.bccr_bcm2_0.1
2070	c	sresa1b.ukmo_hadcm3.1
2070	c	sresa1b.mri_cgcm2_3_2a.3
2070	c	sresa1b.mri_cgcm2_3_2a.1
2070	c	sresa1b.bccr_bcm2_0.1
2070	7525	sresb1.miub_echo_g.3
2070	7525	sresb1.cnrm_cm3.1
2070	7525	sresa2.ncar_ccsm3_0.4
2070	7525	sresa2.mri_cgcm2_3_2a.3
2070	7525	sresa2.mri_cgcm2_3_2a.2
2070	7525	sresa2.miub_echo_g.2
2070	7525	sresa2.miub_echo_g.1
2070	7525	sresa1b.mpi_echam5.3
2070	7525	sresa1b.miub_echo_g.1
2070	7525	sresa1b.giss_model_e_r.4
2070	2575	sresb1.ncar_ccsm3_0.2
2070	2575	sresb1.ncar_ccsm3_0.1
2070	2575	sresb1.mpi_echam5.2
2070	2575	sresb1.miub_echo_g.2
2070	2575	sresb1.csiro_mk3_0.1
2070	2575	sresa2.mri_cgcm2_3_2a.5
2070	2575	sresa2.cccma_cgcm3_1.4
2070	2575	sresa1b.mri_cgcm2_3_2a.5
2070	2575	sresa1b.mpi_echam5.2
2070	2575	sresa1b.giss_model_e_r.2
2070	9010	sresb1.miroc3_2_medres.3
2070	9010	sresb1.miroc3_2_medres.1
2070	9010	sresa2.miub_echo_g.3
2070	9010	sresa2.miroc3_2_medres.1

Period	Pool	Run
2070	9010	sresa2.cnrm_cm3.1
2070	9010	sresa1b.mri_cgcm2_3_2a.2
2070	9010	sresa1b.miroc3_2_medres.2
2070	9010	sresa1b.miroc3_2_medres.1
2070	9010	sresa1b.ipsl_cm4.1
2070	9010	sresa1b.cnrm_cm3.1
2070	1090	sresb1.ncar_pcm1.3
2070	1090	sresb1.ncar_pcm1.2
2070	1090	sresb1.ncar_ccsm3_0.5
2070	1090	sresb1.cccma_cgcm3_1.2
2070	1090	sresb1.bccr_bcm2_0.1
2070	1090	sresa2.ncar_pcm1.4
2070	1090	sresa2.ncar_pcm1.2
2070	1090	sresa1b.ncar_pcm1.1
2070	1090	sresa1b.ncar_ccsm3_0.5
2070	1090	sresa1b.cccma_cgcm3_1.4

Table B.2. CMIP5 (hydrology) Ensemble Pools

Period	Pool	Run
2040	ll	ipsl-cm5a-mr_rcp85_r1i1p1
2040	ll	hadgem2-ao_rcp85_r1i1p1
2040	ll	hadgem2-ao_rcp45_r1i1p1
2040	ll	hadgem2-ao_rcp26_r1i1p1
2040	ll	csiro-mk3-6-0_rcp45_r1i1p1
2040	ll	cmcc-cm_rcp85_r1i1p1
2040	ll	cesm1-bgc_rcp45_r1i1p1
2040	ll	bcc-csm1-1_rcp45_r1i1p1
2040	ll	access1-0_rcp85_r1i1p1
2040	ll	access1-0_rcp45_r1i1p1
2040	lr	noresm1-m_rcp45_r1i1p1
2040	lr	mri-cgcm3_rcp45_r1i1p1
2040	lr	ipsl-cm5b-lr_rcp45_r1i1p1
2040	lr	gfdl-esm2m_rcp60_r1i1p1
2040	lr	fio-esm_rcp85_r1i1p1
2040	lr	fio-esm_rcp60_r1i1p1
2040	lr	fio-esm_rcp45_r1i1p1
2040	lr	fio-esm_rcp26_r1i1p1
2040	lr	ccsm4_rcp26_r1i1p1
2040	lr	bcc-csm1-1_rcp26_r1i1p1
2040	ul	mpi-esm-mr_rcp85_r1i1p1
2040	ul	mpi-esm-mr_rcp45_r1i1p1
2040	ul	ipsl-cm5a-mr_rcp45_r1i1p1
2040	ul	inmcm4_rcp45_r1i1p1
2040	ul	hadgem2-ao_rcp60_r1i1p1
2040	ul	giss-e2-r_rcp60_r1i1p1
2040	ul	giss-e2-r_rcp45_r1i1p1
2040	ul	giss-e2-r_rcp26_r1i1p1
2040	ul	fgoals-g2_rcp85_r1i1p1
2040	ul	cesm1-cam5_rcp85_r1i1p1
2040	ur	miroc5_rcp26_r1i1p1
2040	ur	miroc-esm_rcp85_r1i1p1
2040	ur	miroc-esm_rcp45_r1i1p1
2040	ur	miroc-esm_rcp26_r1i1p1
2040	ur	miroc-esm-chem_rcp60_r1i1p1
2040	ur	miroc-esm-chem_rcp26_r1i1p1
2040	ur	gfdl-esm2m_rcp85_r1i1p1
2040	ur	gfdl-cm3_rcp26_r1i1p1
2040	ur	cnrm-cm5_rcp85_r1i1p1
2040	ur	cnrm-cm5_rcp45_r1i1p1
2040	c	noresm1-m_rcp26_r1i1p1
2040	c	mri-cgcm3_rcp45_r1i1p1
2040	c	mpi-esm-lr_rcp45_r1i1p1
2040	c	miroc5_rcp85_r1i1p1
2040	c	miroc5_rcp60_r1i1p1
2040	c	inmcm4_rcp85_r1i1p1
2040	c	gfdl-esm2g_rcp26_r1i1p1
2040	c	cesm1-cam5_rcp45_r1i1p1
2040	c	ccsm4_rcp85_r1i1p1
2040	c	canesm2_rcp45_r1i1p1
2040	7525	ipsl-cm5a-mr_rcp60_r1i1p1
2040	7525	hadgem2-es_rcp60_r1i1p1
2040	7525	hadgem2-cc_rcp45_r1i1p1
2040	7525	giss-e2-h-cc_rcp45_r1i1p1
2040	7525	gfdl-cm3_rcp60_r1i1p1
2040	7525	csiro-mk3-6-0_rcp60_r1i1p1
2040	7525	cmcc-cm_rcp45_r1i1p1
2040	7525	cesm1-bgc_rcp85_r1i1p1
2040	7525	ccsm4_rcp45_r1i1p1
2040	7525	bcc-csm1-1-m_rcp45_r1i1p1
2040	2575	mri-cgcm3_rcp85_r1i1p1
2040	2575	miroc5_rcp45_r1i1p1
2040	2575	miroc-esm-chem_rcp85_r1i1p1
2040	2575	ipsl-cm5a-mr_rcp26_r1i1p1
2040	2575	giss-e2-r_rcp85_r1i1p1
2040	2575	gfdl-esm2g_rcp85_r1i1p1
2040	2575	gfdl-esm2g_rcp60_r1i1p1
2040	2575	cesm1-cam5_rcp60_r1i1p1
2040	2575	cesm1-cam5_rcp26_r1i1p1
2040	2575	canesm2_rcp26_r1i1p1
2040	9010	hadgem2-ao_rcp85_r1i1p1
2040	9010	hadgem2-ao_rcp45_r1i1p1
2040	9010	hadgem2-ao_rcp26_r1i1p1
2040	9010	gfdl-esm2g_rcp45_r1i1p1
2040	9010	csiro-mk3-6-0_rcp45_r1i1p1
2040	9010	cmcc-cm_rcp85_r1i1p1
2040	9010	cesm1-bgc_rcp45_r1i1p1
2040	9010	bcc-csm1-1_rcp45_r1i1p1
2040	9010	access1-0_rcp85_r1i1p1
2040	9010	access1-0_rcp45_r1i1p1
2040	1090	miroc5_rcp26_r1i1p1
2040	1090	miroc-esm_rcp45_r1i1p1
2040	1090	miroc-esm_rcp26_r1i1p1
2040	1090	miroc-esm-chem_rcp60_r1i1p1
2040	1090	miroc-esm-chem_rcp45_r1i1p1
2040	1090	gfdl-esm2m_rcp85_r1i1p1
2040	1090	gfdl-cm3_rcp26_r1i1p1
2040	1090	fgoals-g2_rcp26_r1i1p1
2040	1090	cnrm-cm5_rcp85_r1i1p1
2040	1090	cnrm-cm5_rcp45_r1i1p1
2050	ll	ipsl-cm5a-mr_rcp85_r1i1p1
2050	ll	ipsl-cm5a-mr_rcp60_r1i1p1
2050	ll	hadgem2-es_rcp85_r1i1p1
2050	ll	hadgem2-ao_rcp85_r1i1p1
2050	ll	hadgem2-ao_rcp45_r1i1p1
2050	ll	csiro-mk3-6-0_rcp60_r1i1p1
2050	ll	cmcc-cm_rcp45_r1i1p1
2050	ll	bcc-csm1-1_rcp45_r1i1p1
2050	ll	bcc-csm1-1-m_rcp45_r1i1p1
2050	ll	access1-0_rcp85_r1i1p1
2050	lr	noresm1-m_rcp45_r1i1p1
2050	lr	mri-cgcm3_rcp45_r1i1p1
2050	lr	miroc5_rcp60_r1i1p1
2050	lr	ipsl-cm5b-lr_rcp45_r1i1p1

Period	Pool	Run
2050	lr	gfdl-esm2g_rcp26_r1i1p1
2050	lr	fio-esm_rcp85_r1i1p1
2050	lr	fio-esm_rcp60_r1i1p1
2050	lr	fio-esm_rcp45_r1i1p1
2050	lr	fio-esm_rcp26_r1i1p1
2050	lr	bcc-csm1-1_rcp26_r1i1p1
2050	ul	mpi-esm-mr_rcp85_r1i1p1
2050	ul	mpi-esm-lr_rcp85_r1i1p1
2050	ul	miroc-esm-chem_rcp85_r1i1p1
2050	ul	inmcm4_rcp45_r1i1p1
2050	ul	hadgem2-cc_rcp85_r1i1p1
2050	ul	hadgem2-ao_rcp60_r1i1p1
2050	ul	giss-e2-r_rcp60_r1i1p1
2050	ul	gfdl-cm3_rcp85_r1i1p1
2050	ul	fgoals-g2_rcp85_r1i1p1
2050	ul	cesm1-cam5_rcp85_r1i1p1
2050	ur	mri-cgcm3_rcp85_r1i1p1
2050	ur	miroc5_rcp26_r1i1p1
2050	ur	miroc-esm_rcp85_r1i1p1
2050	ur	miroc-esm_rcp60_r1i1p1
2050	ur	miroc-esm_rcp26_r1i1p1
2050	ur	miroc-esm-chem_rcp60_r1i1p1
2050	ur	miroc-esm-chem_rcp45_r1i1p1
2050	ur	miroc-esm-chem_rcp26_r1i1p1
2050	ur	fgoals-g2_rcp26_r1i1p1
2050	ur	cnrm-cm5_rcp45_r1i1p1
2050	c	noresm1-m_rcp26_r1i1p1
2050	c	mpi-esm-lr_rcp26_r1i1p1
2050	c	ipsl-cm5a-mr_rcp26_r1i1p1
2050	c	hadgem2-cc_rcp85_r1i1p1
2050	c	hadgem2-cc_rcp45_r1i1p1
2050	c	giss-e2-r_rcp26_r1i1p1
2050	c	gfdl-esm2g_rcp45_r1i1p1
2050	c	gfdl-esm2g_rcp26_r1i1p1
2050	c	gfdl-cm3_rcp60_r1i1p1
2050	c	canesm2_rcp26_r1i1p1
2050	7525	noresm1-m_rcp85_r1i1p1
2050	7525	miroc5_rcp85_r1i1p1
2050	7525	hadgem2-es_rcp45_r1i1p1
2050	7525	csiro-mk3-6-0_rcp85_r1i1p1
2050	7525	csiro-mk3-6-0_rcp45_r1i1p1
2050	7525	cesm1-bgc_rcp85_r1i1p1
2050	7525	cesm1-bgc_rcp45_r1i1p1
2050	7525	ccsm4_rcp85_r1i1p1
2050	7525	ccsm4_rcp45_r1i1p1
2050	7525	bcc-csm1-1_rcp85_r1i1p1
2050	2575	mpi-esm-mr_rcp26_r1i1p1
2050	2575	mpi-esm-lr_rcp45_r1i1p1
2050	2575	miroc5_rcp45_r1i1p1
2050	2575	miroc-esm_rcp45_r1i1p1
2050	2575	ipsl-cm5b-lr_rcp85_r1i1p1
2050	2575	giss-e2-r_rcp85_r1i1p1
2050	2575	giss-e2-r-cc_rcp45_r1i1p1
2050	2575	gfdl-esm2g_rcp85_r1i1p1
2050	2575	cnrm-cm5_rcp85_r1i1p1
2050	2575	cesm1-cam5_rcp26_r1i1p1
2050	9010	ipsl-cm5a-mr_rcp60_r1i1p1
2050	9010	ipsl-cm5a-mr_rcp45_r1i1p1
2050	9010	hadgem2-es_rcp85_r1i1p1
2050	9010	hadgem2-ao_rcp85_r1i1p1
2050	9010	hadgem2-ao_rcp45_r1i1p1
2050	9010	hadgem2-ao_rcp26_r1i1p1
2050	9010	csiro-mk3-6-0_rcp60_r1i1p1
2050	9010	cmcc-cm_rcp45_r1i1p1
2050	9010	bcc-csm1-1_rcp45_r1i1p1
2050	9010	bcc-csm1-1-m_rcp45_r1i1p1

Period	Pool	Run
2050	1090	mri-cgcm3_rcp85_r1i1p1
2050	1090	miroc5_rcp26_r1i1p1
2050	1090	miroc-esm_rcp60_r1i1p1
2050	1090	miroc-esm_rcp26_r1i1p1
2050	1090	miroc-esm-chem_rcp60_r1i1p1
2050	1090	miroc-esm-chem_rcp45_r1i1p1
2050	1090	gfdl-cm3_rcp26_r1i1p1
2050	1090	fgoals-g2_rcp26_r1i1p1
2050	1090	cnrm-cm5_rcp45_r1i1p1
2050	1090	cesm1-cam5_rcp60_r1i1p1
2070	ll	ipsl-cm5a-mr_rcp85_r1i1p1
2070	ll	ipsl-cm5a-mr_rcp60_r1i1p1
2070	ll	ipsl-cm5a-mr_rcp45_r1i1p1
2070	ll	hadgem2-es_rcp85_r1i1p1
2070	ll	hadgem2-ao_rcp45_r1i1p1
2070	ll	csiro-mk3-6-0_rcp85_r1i1p1
2070	ll	csiro-mk3-6-0_rcp60_r1i1p1
2070	ll	cmcc-cm_rcp85_r1i1p1
2070	ll	cmcc-cm_rcp45_r1i1p1
2070	ll	access1-0_rcp85_r1i1p1
2070	lr	noresm1-m_rcp26_r1i1p1
2070	lr	mpi-esm-lr_rcp26_r1i1p1
2070	lr	gfdl-esm2g_rcp26_r1i1p1
2070	lr	fio-esm_rcp85_r1i1p1
2070	lr	fio-esm_rcp60_r1i1p1
2070	lr	fio-esm_rcp45_r1i1p1
2070	lr	fio-esm_rcp26_r1i1p1
2070	lr	csiro-mk3-6-0_rcp26_r1i1p1
2070	lr	ccsm4_rcp26_r1i1p1
2070	lr	bcc-csm1-1_rcp26_r1i1p1
2070	ul	mpi-esm-mr_rcp85_r1i1p1
2070	ul	miroc-esm-chem_rcp85_r1i1p1
2070	ul	inmcm4_rcp85_r1i1p1
2070	ul	hadgem2-ao_rcp60_r1i1p1
2070	ul	giss-e2-r_rcp85_r1i1p1
2070	ul	giss-e2-r_rcp60_r1i1p1
2070	ul	gfdl-cm3_rcp85_r1i1p1
2070	ul	gfdl-cm3_rcp45_r1i1p1
2070	ul	gfdl-cm3_rcp26_r1i1p1
2070	ul	fgoals-g2_rcp85_r1i1p1
2070	ur	mri-cgcm3_rcp85_r1i1p1
2070	ur	miroc5_rcp26_r1i1p1
2070	ur	miroc-esm_rcp26_r1i1p1
2070	ur	miroc-esm-chem_rcp45_r1i1p1
2070	ur	miroc-esm-chem_rcp26_r1i1p1
2070	ur	giss-e2-r-cc_rcp45_r1i1p1
2070	ur	gfdl-esm2m_rcp26_r1i1p1
2070	ur	gfdl-esm2g_rcp45_r1i1p1
2070	ur	fgoals-g2_rcp26_r1i1p1
2070	ur	cesm1-cam5_rcp26_r1i1p1
2070	c	noresm1-m_rcp60_r1i1p1
2070	c	noresm1-m_rcp45_r1i1p1
2070	c	hadgem2-cc_rcp45_r1i1p1
2070	c	giss-e2-r_rcp26_r1i1p1
2070	c	gfdl-esm2g_rcp85_r1i1p1
2070	c	gfdl-esm2g_rcp60_r1i1p1
2070	c	gfdl-cm3_rcp60_r1i1p1
2070	c	fgoals-g2_rcp45_r1i1p1
2070	c	canesm2_rcp26_r1i1p1
2070	c	bcc-csm1-1_rcp60_r1i1p1
2070	7525	noresm1-m_rcp85_r1i1p1
2070	7525	miroc5_rcp85_r1i1p1
2070	7525	hadgem2-es_rcp26_r1i1p1
2070	7525	hadgem2-ao_rcp26_r1i1p1
2070	7525	giss-e2-r_rcp45_r1i1p1
2070	7525	cesm1-bgc_rcp85_r1i1p1

Period	Pool	Run
2070	7525	cesm1-bgc_rcp45_r1i1p1
2070	7525	ccsm4_rcp85_r1i1p1
2070	7525	bcc-csm1-1-m_rcp85_r1i1p1
2070	7525	bcc-csm1-1-m_rcp45_r1i1p1
2070	2575	mpi-esm-mr_rcp45_r1i1p1
2070	2575	mpi-esm-lr_rcp45_r1i1p1
2070	2575	miroc-esm_rcp45_r1i1p1
2070	2575	ipsl-cm5b-lr_rcp85_r1i1p1
2070	2575	ipsl-cm5b-lr_rcp45_r1i1p1
2070	2575	gfdl-esm2m_rcp60_r1i1p1
2070	2575	cnrm-cm5_rcp45_r1i1p1
2070	2575	cesm1-cam5_rcp60_r1i1p1
2070	2575	canesm2_rcp85_r1i1p1
2070	2575	canesm2_rcp45_r1i1p1
2070	9010	mpi-esm-lr_rcp85_r1i1p1
2070	9010	ipsl-cm5a-mr_rcp60_r1i1p1
2070	9010	hadgem2-es_rcp85_r1i1p1
2070	9010	hadgem2-es_rcp60_r1i1p1
2070	9010	hadgem2-ao_rcp45_r1i1p1
2070	9010	csiro-mk3-6-0_rcp85_r1i1p1

Period	Pool	Run
2070	9010	csiro-mk3-6-0_rcp60_r1i1p1
2070	9010	cmcc-cm_rcp85_r1i1p1
2070	9010	cmcc-cm_rcp45_r1i1p1
2070	9010	bcc-csm1-1_rcp85_r1i1p1
2070	1090	mri-cgcm3_rcp85_r1i1p1
2070	1090	miroc5_rcp26_r1i1p1
2070	1090	miroc-esm_rcp26_r1i1p1
2070	1090	miroc-esm-chem_rcp60_r1i1p1
2070	1090	miroc-esm-chem_rcp45_r1i1p1
2070	1090	giss-e2-r-cc_rcp45_r1i1p1
2070	1090	gfdl-esm2m_rcp26_r1i1p1
2070	1090	gfdl-esm2g_rcp45_r1i1p1
2070	1090	fgoals-g2_rcp26_r1i1p1
2070	1090	cesm1-cam5_rcp26_r1i1p1

Table B.3. CMIP3+5 Ensemble Pools

Period	Pool	Run
2040	ll	sresb1.mri_cgcm2_3_2a.4
2040	ll	sresb1.miroc3_2_medres.2
2040	ll	sresa2.mri_cgcm2_3_2a.2
2040	ll	sresa2.miroc3_2_medres.3
2040	ll	sresa2.miroc3_2_medres.2
2040	ll	sresa2.miroc3_2_medres.1
2040	ll	sresa1b.miroc3_2_medres.3
2040	ll	sresa1b.miroc3_2_medres.2
2040	ll	sresa1b.gfdl_cm2_1.1
2040	ll	ipsl-cm5a-mr_rcp85_r1i1p1
2040	lr	sresa1b.ncar_ccsm3_0.7
2040	lr	sresa1b.ncar_ccsm3_0.3
2040	lr	sresa1b.csiro_mk3_0.1
2040	lr	sresa1b.bccr_bcm2_0.1
2040	lr	noresm1-m_rcp45_r1i1p1
2040	lr	gfdl-esm2m_rcp60_r1i1p1
2040	lr	fio-esm_rcp85_r1i1p1
2040	lr	fio-esm_rcp45_r1i1p1
2040	lr	ccsm4_rcp60_r1i1p1
2040	lr	bcc-csm1-1_rcp26_r1i1p1
2040	ul	sresa2.inmcm3_0.1
2040	ul	sresa1b.inmcm3_0.1
2040	ul	mpi-esm-mr_rcp85_r1i1p1
2040	ul	mpi-esm-mr_rcp45_r1i1p1
2040	ul	hadgem2-cc_rcp85_r1i1p1
2040	ul	giss-e2-r_rcp60_r1i1p1
2040	ul	giss-e2-r_rcp45_r1i1p1
2040	ul	fgoals-g2_rcp85_r1i1p1
2040	ul	cesm1-cam5_rcp85_r1i1p1
2040	ul	bcc-csm1-1-m_rcp85_r1i1p1
2040	ur	sresa2.ncar_pcm1.4
2040	ur	sresa2.ncar_pcm1.1
2040	ur	sresa2.mri_cgcm2_3_2a.5
2040	ur	sresa1b.ncar_pcm1.4
2040	ur	sresa1b.ncar_pcm1.2
2040	ur	sresa1b.cccma_cgcm3_1.2
2040	ur	miroc-esm_rcp85_r1i1p1
2040	ur	miroc-esm-chem_rcp26_r1i1p1
2040	ur	cnrm-cm5_rcp85_r1i1p1
2040	ur	cnrm-cm5_rcp45_r1i1p1
2040	c	sresb1.cccma_cgcm3_1.1
2040	c	sresa2.ncar_ccsm3_0.4
2040	c	sresa2.mpi_echam5.3
2040	c	sresa2.cccma_cgcm3_1.1

Period	Pool	Run
2040	c	sresa1b.cccma_cgcm3_1.1
2040	c	mpi-esm-lr_rcp45_r1i1p1
2040	c	inmcm4_rcp85_r1i1p1
2040	c	giss-e2-h-cc_rcp45_r1i1p1
2040	c	cesm1-cam5_rcp45_r1i1p1
2040	c	bcc-csm1-1_rcp85_r1i1p1
2040	7525	sresb1.ncar_ccsm3_0.1
2040	7525	sresb1.gfdl_cm2_1.1
2040	7525	sresb1.gfdl_cm2_0.1
2040	7525	sresa1b.ukmo_hadcm3.1
2040	7525	sresa1b.mri_cgcm2_3_2a.3
2040	7525	sresa1b.cnrm_cm3.1
2040	7525	sresa1b.cccma_cgcm3_1.5
2040	7525	gfdl-esm2g_rcp45_r1i1p1
2040	7525	csiro-mk3-6-0_rcp60_r1i1p1
2040	7525	bcc-csm1-1-m_rcp45_r1i1p1
2040	2575	sresb1.mri_cgcm2_3_2a.1
2040	2575	sresb1.miub_echo_g.1
2040	2575	noresm1-m_rcp85_r1i1p1
2040	2575	mpi-esm-mr_rcp26_r1i1p1
2040	2575	miroc5_rcp45_r1i1p1
2040	2575	miroc-esm-chem_rcp85_r1i1p1
2040	2575	ipsl-cm5a-mr_rcp26_r1i1p1
2040	2575	giss-e2-r_rcp85_r1i1p1
2040	2575	cesm1-cam5_rcp26_r1i1p1
2040	2575	canesm2_rcp26_r1i1p1
2040	9010	sresb1.ncar_ccsm3_0.6
2040	9010	sresb1.ncar_ccsm3_0.4
2040	9010	sresb1.miroc3_2_medres.3
2040	9010	sresa2.mri_cgcm2_3_2a.4
2040	9010	sresa2.mri_cgcm2_3_2a.3
2040	9010	sresa1b.ncar_ccsm3_0.1
2040	9010	sresa1b.mri_cgcm2_3_2a.2
2040	9010	sresa1b.gfdl_cm2_1.1
2040	9010	hadgem2-ao_rcp85_r1i1p1
2040	9010	csiro-mk3-6-0_rcp45_r1i1p1
2040	1090	sresb1.ncar_ccsm3_0.5
2040	1090	sresa2.ncar_pcm1.2
2040	1090	sresa2.ncar_pcm1.1
2040	1090	sresa2.mri_cgcm2_3_2a.5
2040	1090	miroc5_rcp26_r1i1p1
2040	1090	miroc-esm_rcp45_r1i1p1
2040	1090	miroc-esm-chem_rcp60_r1i1p1
2040	1090	miroc-esm-chem_rcp45_r1i1p1

Period	Pool	Run
2040	1090	gfdl-esm2m_rcp85_r1i1p1
2040	1090	gfdl-cm3_rcp26_r1i1p1
2050	ll	sresa2.mri_cgcm2_3_2a.3
2050	ll	sresa2.mri_cgcm2_3_2a.2
2050	ll	sresa2.miroc3_2_medres.3
2050	ll	sresa2.miroc3_2_medres.2
2050	ll	sresa2.miroc3_2_medres.1
2050	ll	sresa2.cnrm_cm3.1
2050	ll	sresa1b.miroc3_2_medres.3
2050	ll	sresa1b.miroc3_2_medres.2
2050	ll	ipsl-cm5a-mr_rcp85_r1i1p1
2050	ll	access1-0_rcp85_r1i1p1
2050	lr	sresb1.ncar_pcm1.2
2050	lr	sresb1.ncar_ccsm3_0.7
2050	lr	sresa1b.ncar_ccsm3_0.7
2050	lr	sresa1b.ncar_ccsm3_0.3
2050	lr	noresm1-m_rcp45_r1i1p1
2050	lr	mri-cgcm3_rcp45_r1i1p1
2050	lr	fio-esm_rcp45_r1i1p1
2050	lr	fio-esm_rcp26_r1i1p1
2050	lr	csiro-mk3-6-0_rcp26_r1i1p1
2050	lr	bcc-csm1-1_rcp26_r1i1p1
2050	ul	sresa2.ipsl_cm4.1
2050	ul	sresa2.inmcm3_0.1
2050	ul	sresa2.giss_model_e_r.1
2050	ul	sresa1b.inmcm3_0.1
2050	ul	mpi-esm-lr_rcp85_r1i1p1
2050	ul	inmcm4_rcp85_r1i1p1
2050	ul	hadgem2-ao_rcp60_r1i1p1
2050	ul	giss-e2-r_rcp60_r1i1p1
2050	ul	cesm1-cam5_rcp85_r1i1p1
2050	ul	bcc-csm1-1-m_rcp85_r1i1p1
2050	ur	sresa2.ncar_pcm1.4
2050	ur	sresa1b.ncar_pcm1.4
2050	ur	sresa1b.ncar_pcm1.3
2050	ur	sresa1b.ncar_pcm1.2
2050	ur	sresa1b.cccma_cgcm3_1.2
2050	ur	miroc-esm_rcp85_r1i1p1
2050	ur	miroc-esm_rcp60_r1i1p1
2050	ur	miroc-esm_rcp26_r1i1p1
2050	ur	miroc-esm-chem_rcp45_r1i1p1
2050	ur	miroc-esm-chem_rcp26_r1i1p1
2050	c	sresb1.mpi_echam5.3
2050	c	sresb1.miub_echo_g.2
2050	c	sresb1.cccma_cgcm3_1.1
2050	c	sresa1b.mri_cgcm2_3_2a.1
2050	c	sresa1b.mpi_echam5.1
2050	c	sresa1b.cccma_cgcm3_1.5
2050	c	hadgem2-es_rcp60_r1i1p1
2050	c	giss-e2-r_rcp26_r1i1p1
2050	c	gfdl-esm2g_rcp45_r1i1p1
2050	c	cesm1-cam5_rcp45_r1i1p1
2050	7525	sresb1.ncar_ccsm3_0.4
2050	7525	sresb1.mpi_echam5.1
2050	7525	sresb1.inmcm3_0.1
2050	7525	sresb1.gfdl_cm2_1.1
2050	7525	sresa2.ncar_ccsm3_0.1
2050	7525	sresa2.mri_cgcm2_3_2a.4
2050	7525	sresa2.cccma_cgcm3_1.5
2050	7525	sresa1b.mri_cgcm2_3_2a.2
2050	7525	sresa1b.miub_echo_g.1
2050	7525	noresm1-m_rcp60_r1i1p1
2050	2575	sresb1.mri_cgcm2_3_2a.1
2050	2575	sresa2.csiro_mk3_0.1
2050	2575	mpi-esm-mr_rcp26_r1i1p1
2050	2575	miroc5_rcp45_r1i1p1
2050	2575	miroc-esm_rcp45_r1i1p1

Period	Pool	Run
2050	2575	gfdl-esm2m_rcp45_r1i1p1
2050	2575	gfdl-esm2g_rcp85_r1i1p1
2050	2575	gfdl-esm2g_rcp60_r1i1p1
2050	2575	cesm1-cam5_rcp26_r1i1p1
2050	2575	canesm2_rcp85_r1i1p1
2050	9010	sresb1.miroc3_2_medres.3
2050	9010	sresb1.miroc3_2_medres.1
2050	9010	sresa2.miub_echo_g.3
2050	9010	sresa2.gfdl_cm2_0.1
2050	9010	sresa1b.mpi_echam5.3
2050	9010	sresa1b.miroc3_2_medres.1
2050	9010	sresa1b.cnrm_cm3.1
2050	9010	ipsl-cm5a-mr_rcp60_r1i1p1
2050	9010	hadgem2-ao_rcp45_r1i1p1
2050	9010	csiro-mk3-6-0_rcp60_r1i1p1
2050	1090	sresb1.ncar_pcm1.3
2050	1090	sresb1.bccr_bcm2_0.1
2050	1090	sresa2.ncar_pcm1.3
2050	1090	sresa2.ncar_pcm1.1
2050	1090	sresa1b.giss_model_e_r.2
2050	1090	mri-cgcm3_rcp85_r1i1p1
2050	1090	miroc5_rcp26_r1i1p1
2050	1090	fgoals-g2_rcp26_r1i1p1
2050	1090	cnrm-cm5_rcp45_r1i1p1
2050	1090	cesm1-cam5_rcp60_r1i1p1
2070	ll	sresa2.miroc3_2_medres.3
2070	ll	sresa2.miroc3_2_medres.2
2070	ll	sresa2.miroc3_2_medres.1
2070	ll	sresa2.cnrm_cm3.1
2070	ll	sresa1b.miroc3_2_medres.3
2070	ll	sresa1b.miroc3_2_medres.2
2070	ll	sresa1b.miroc3_2_medres.1
2070	ll	sresa1b.cnrm_cm3.1
2070	ll	ipsl-cm5a-mr_rcp85_r1i1p1
2070	ll	access1-0_rcp85_r1i1p1
2070	lr	sresb1.ncar_ccsm3_0.4
2070	lr	sresb1.mri_cgcm2_3_2a.4
2070	lr	sresa2.ncar_ccsm3_0.2
2070	lr	sresa1b.ncar_ccsm3_0.7
2070	lr	sresa1b.ncar_ccsm3_0.2
2070	lr	sresa1b.csiro_mk3_0.1
2070	lr	fio-esm_rcp85_r1i1p1
2070	lr	fio-esm_rcp26_r1i1p1
2070	lr	csiro-mk3-6-0_rcp26_r1i1p1
2070	lr	bcc-csm1-1_rcp26_r1i1p1
2070	ul	sresb1.inmcm3_0.1
2070	ul	sresa2.inmcm3_0.1
2070	ul	sresa1b.inmcm3_0.1
2070	ul	mpi-esm-mr_rcp85_r1i1p1
2070	ul	inmcm4_rcp85_r1i1p1
2070	ul	hadgem2-es_rcp45_r1i1p1
2070	ul	hadgem2-ao_rcp60_r1i1p1
2070	ul	giss-e2-r_rcp85_r1i1p1
2070	ul	gfdl-cm3_rcp85_r1i1p1
2070	ul	fgoals-g2_rcp85_r1i1p1
2070	ur	sresb1.ncar_pcm1.3
2070	ur	sresa2.ncar_pcm1.4
2070	ur	sresa2.ncar_pcm1.1
2070	ur	sresa1b.ncar_pcm1.4
2070	ur	sresa1b.ncar_pcm1.3
2070	ur	miroc5_rcp26_r1i1p1
2070	ur	miroc-esm_rcp26_r1i1p1
2070	ur	miroc-esm-chem_rcp26_r1i1p1
2070	ur	gfdl-esm2g_rcp45_r1i1p1
2070	ur	fgoals-g2_rcp26_r1i1p1
2070	c	sresb1.mri_cgcm2_3_2a.2
2070	c	sresb1.mri_cgcm2_3_2a.1

Period	Pool	Run
2070	c	sresb1.ipsl_cm4.1
2070	c	sresb1.cccma_cgcm3_1.5
2070	c	sresa2.ukmo_hadcm3.1
2070	c	sresa2.mpi_echam5.3
2070	c	sresa1b.mri_cgcm2_3_2a.3
2070	c	sresa1b.bccr_bcm2_0.1
2070	c	miroc5_rcp45_r1i1p1
2070	c	ccsm4_rcp45_r1i1p1
2070	7525	sresb1.mpi_echam5.3
2070	7525	sresb1.mpi_echam5.1
2070	7525	sresb1.giss_model_e_r.1
2070	7525	sresb1.cnrm_cm3.1
2070	7525	sresa2.mri_cgcm2_3_2a.4
2070	7525	sresa2.mri_cgcm2_3_2a.2
2070	7525	sresa1b.mpi_echam5.3
2070	7525	sresa1b.cccma_cgcm3_1.1
2070	7525	noresm1-m_rcp85_r1i1p1
2070	7525	bcc-csm1-1-m_rcp45_r1i1p1
2070	2575	sresb1.ncar_ccsm3_0.3
2070	2575	sresa2.cccma_cgcm3_1.4
2070	2575	sresa1b.giss_model_e_r.2
2070	2575	miroc5_rcp60_r1i1p1
2070	2575	ipsl-cm5b-lr_rcp85_r1i1p1
2070	2575	gfdl-esm2m_rcp60_r1i1p1
2070	2575	gfdl-esm2g_rcp26_r1i1p1
2070	2575	cnrm-cm5_rcp85_r1i1p1
2070	2575	canesm2_rcp85_r1i1p1
2070	2575	canesm2_rcp45_r1i1p1
2070	9010	sresb1.miroc3_2_medres.3
2070	9010	sresb1.miroc3_2_medres.1
2070	9010	sresa2.mri_cgcm2_3_2a.3
2070	9010	sresa2.miub_echo_g.3
2070	9010	sresa1b.mri_cgcm2_3_2a.2
2070	9010	sresa1b.ipsl_cm4.1
2070	9010	ipsl-cm5a-mr_rcp60_r1i1p1
2070	9010	hadgem2-es_rcp85_r1i1p1
2070	9010	hadgem2-ao_rcp45_r1i1p1
2070	9010	cmcc-cm_rcp85_r1i1p1
2070	1090	mri-cgcm3_rcp85_r1i1p1
2070	1090	mri-cgcm3_rcp45_r1i1p1
2070	1090	mpi-esm-mr_rcp26_r1i1p1
2070	1090	miroc5_rcp26_r1i1p1
2070	1090	miroc-esm-chem_rcp60_r1i1p1
2070	1090	giss-e2-r-cc_rcp45_r1i1p1
2070	1090	gfdl-esm2m_rcp26_r1i1p1
2070	1090	gfdl-esm2g_rcp45_r1i1p1
2070	1090	fgoals-g2_rcp26_r1i1p1
2070	1090	cesm1-cam5_rcp26_r1i1p1