



PLANNING FOR CLIMATE CHANGE

The Joint Front Range Climate Change Vulnerability Study

September 22th 2009

*Laurna Kaatz
Denver Water*

REGIONAL CONCERNS

Temperature

Precipitation

Snowpack

Run-Off

Extreme
Conditions

Evaporation

Soil Moisture

Wildfire

Water Quality

Use



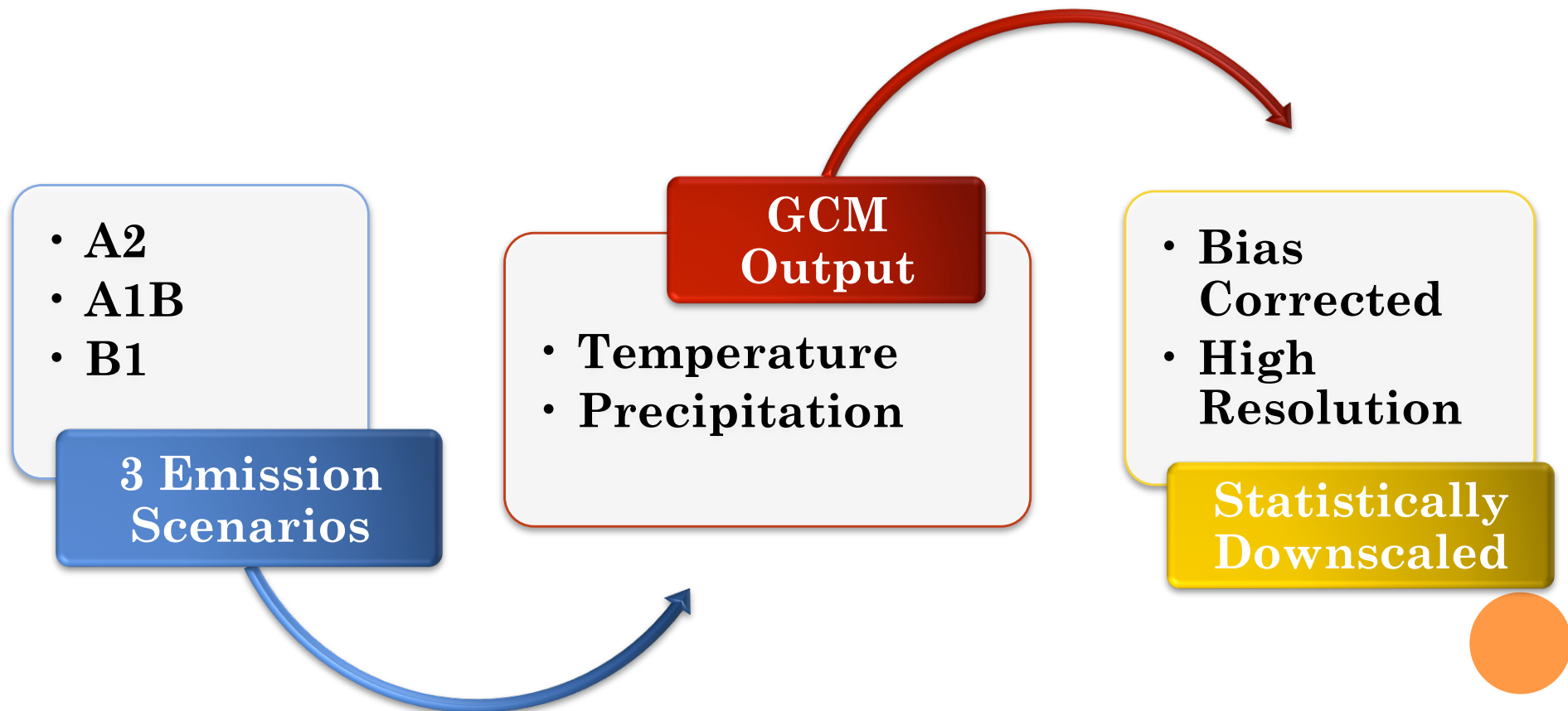
DILEMMAS

- Which projection(s) should be used?
- Available data differs from our needs.
- How do we use the data?
- How do you incorporate uncertainties?
- How do you make a long range plan that will work for a variety of futures?

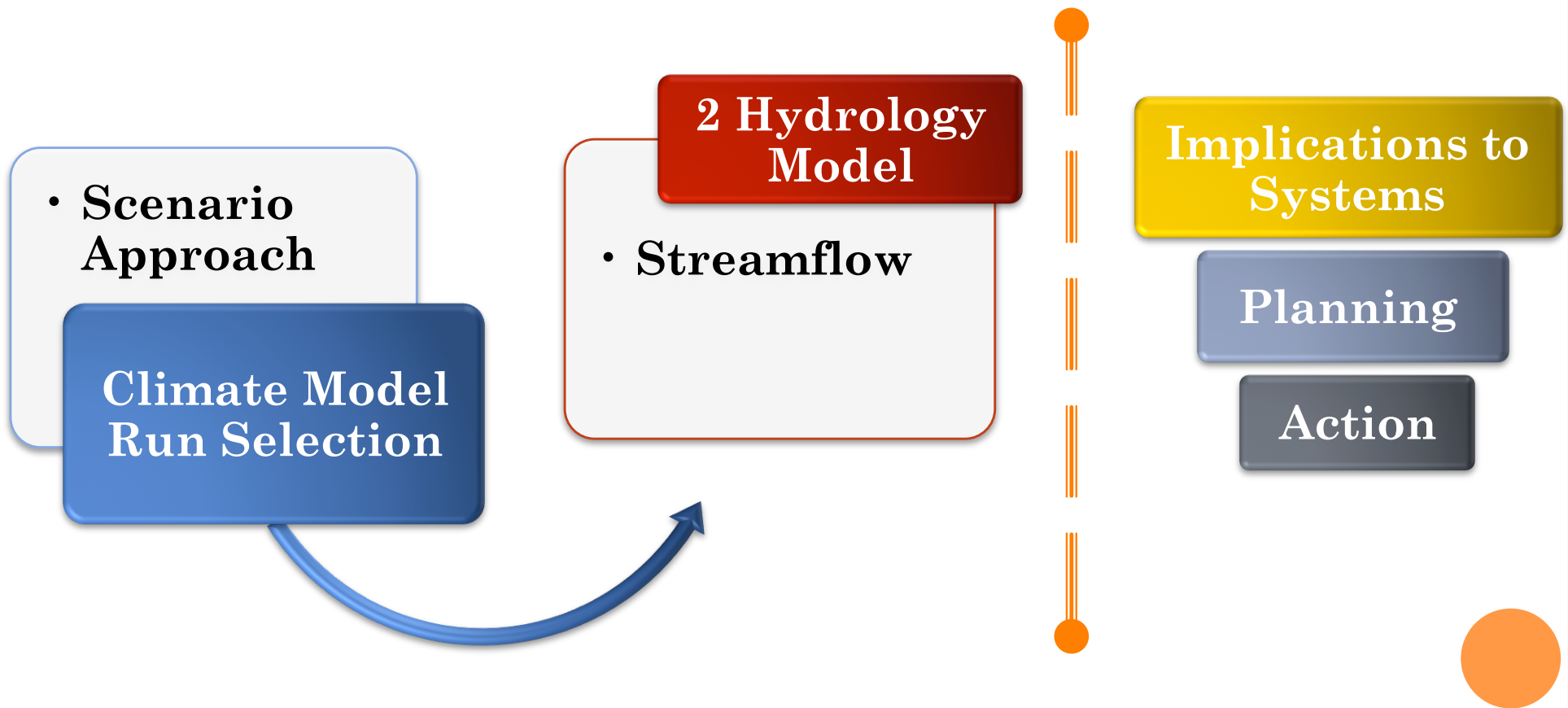


THE JOINT FRONT RANGE CLIMATE CHANGE VULNERABILITY STUDY

Determine streamflow sensitivity to projected changes in temperature and precipitation



METHODOLOGY CONTINUED



PARTICIPANTS

6 Water Providers

- Aurora Water
- City of Boulder
- Colorado Springs Utilities
- Denver Water
- City of Fort Collins
- Northern Water

3 Water Agencies

- Colorado Water Conservation Board
- Water Research Foundation (AwwaRF)
- Western Water Assessment

Other Interested Parties

Cheyenne	Westminster
Longmont	Pueblo



A REGIONAL APPROACH

- ***Communication***

Cohesively communicate with customers and the media.

- ***Coordination***

Coordinate with other studies and participants.

- ***Collaboration***

Initiate or continue collaboration on different studies.

- ***Resources***

Pool finances, staff, and expert resources

- ***Scale***

Projections are coarse and cover watersheds



EDUCATIONAL SESSIONS



○ 2007

- WEAP 101, Sac/SMA 101 – D. Yates, Riverside

○ 2008

- WWA Climate, Water, and Modeling Workshop – B. Udall, B. Rajagopalan, L. Brekke, C. Anderson, J. Barsugli, J. Lowrey
- Methodology logistics at NCAR and Kick-off meeting – L. Kaatz
- Global Climate Modeling 101 – J. Barsugli
- Long Term Precipitation Trends – N. Doesken
- Temperature Trends and Water Management – K. Wolter
- Riverside's C2D2S2 climate interface with NOAA - Riverside

○ 2009

- The complexity of the Climate System and Human Roles – R. Pielke Sr.
- Impacts to snowpack in the Colorado headwaters – D. Yates
- The Colorado River Water Availability Study – B. Harding
- Statistical Downscaling 101 – L. Brekke
- Adapting to Climate Change – J. Lowrey
- Incorporating Climate Uncertainty into Planning – J. Daw
- Improving Climate Modeling – J. Smith, J. Barsugli, C. Anderson



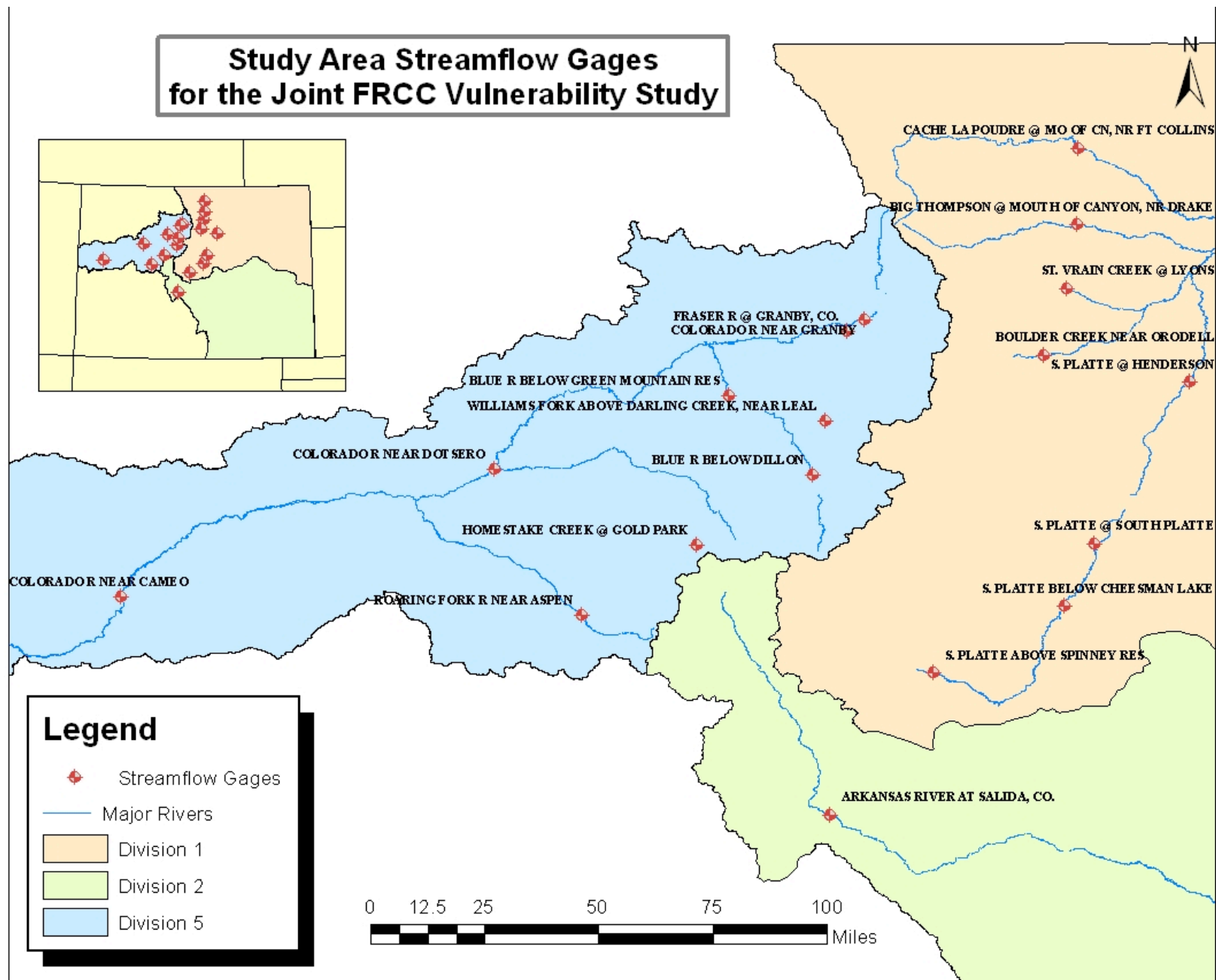
HYDROLOGY MODELS

- Develop Two Models

- Water Evaluation and Planning (WEAP) Model
 - Dr. David Yates and Team
- Linked Sacramento Soil Moisture and Snow-17 Model
 - Mark Woodbury and Riverside Team



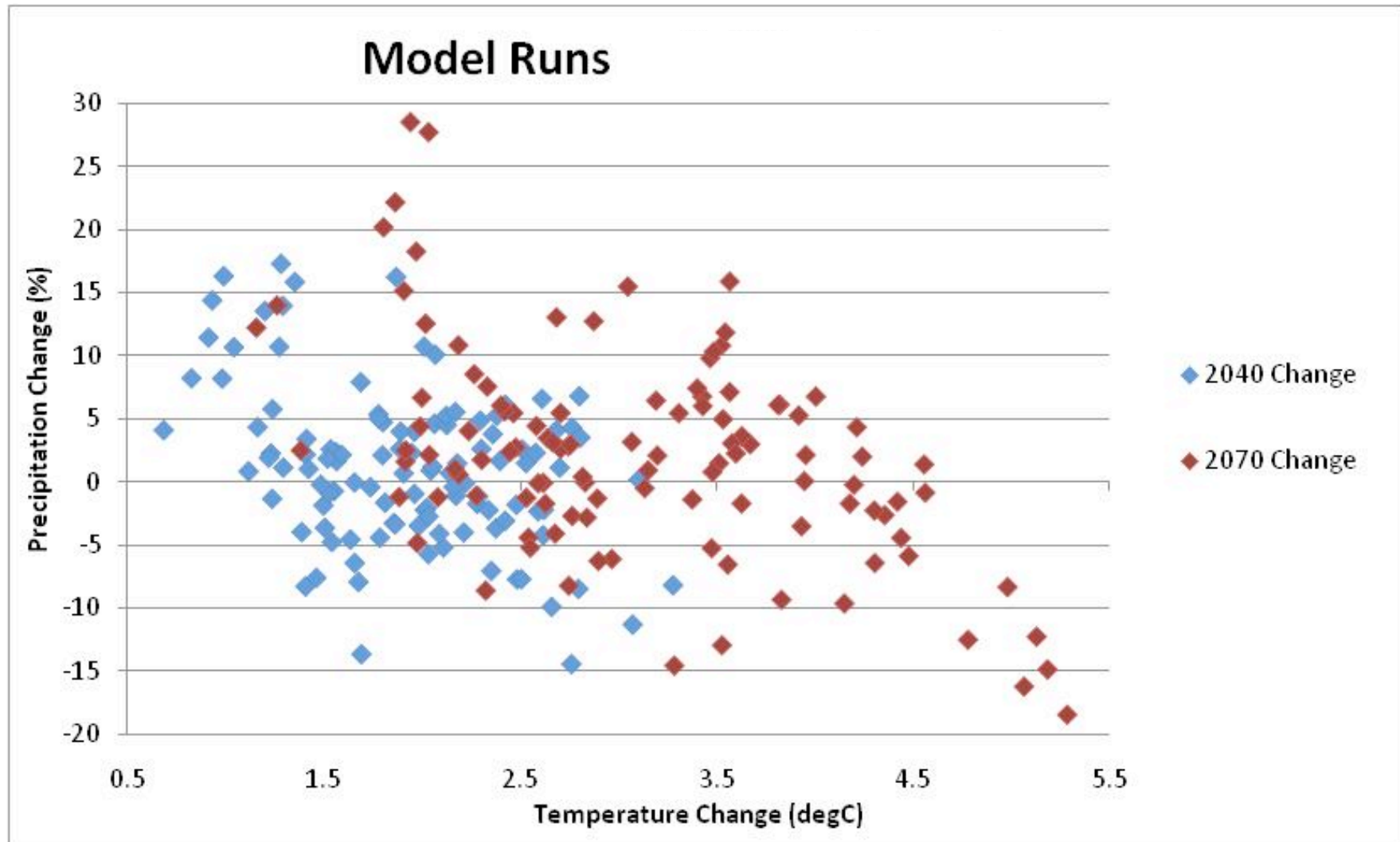
MODEL DEVELOPMENT: 18 GAUGES



A REGIONAL PLANNING EFFORT



PROJECTED CHANGES FOR NORTH CENTRAL COLORADO



CLIMATE OFFSET SCENARIOS

○ *Simple Assessment*

- Constant Temperature or Precipitation offsets
 - Increase of 1°C
 - Increase of 5°F
 - Increase of 7.5%
 - Decrease of 3%

○ *Sophisticated Approach*

- Scenarios for 2040 and 2070
 - warm and wet
 - warm and dry
 - median
 - very warm and wet
 - very warm and dry



16 Sets of
NEW
Streamflow



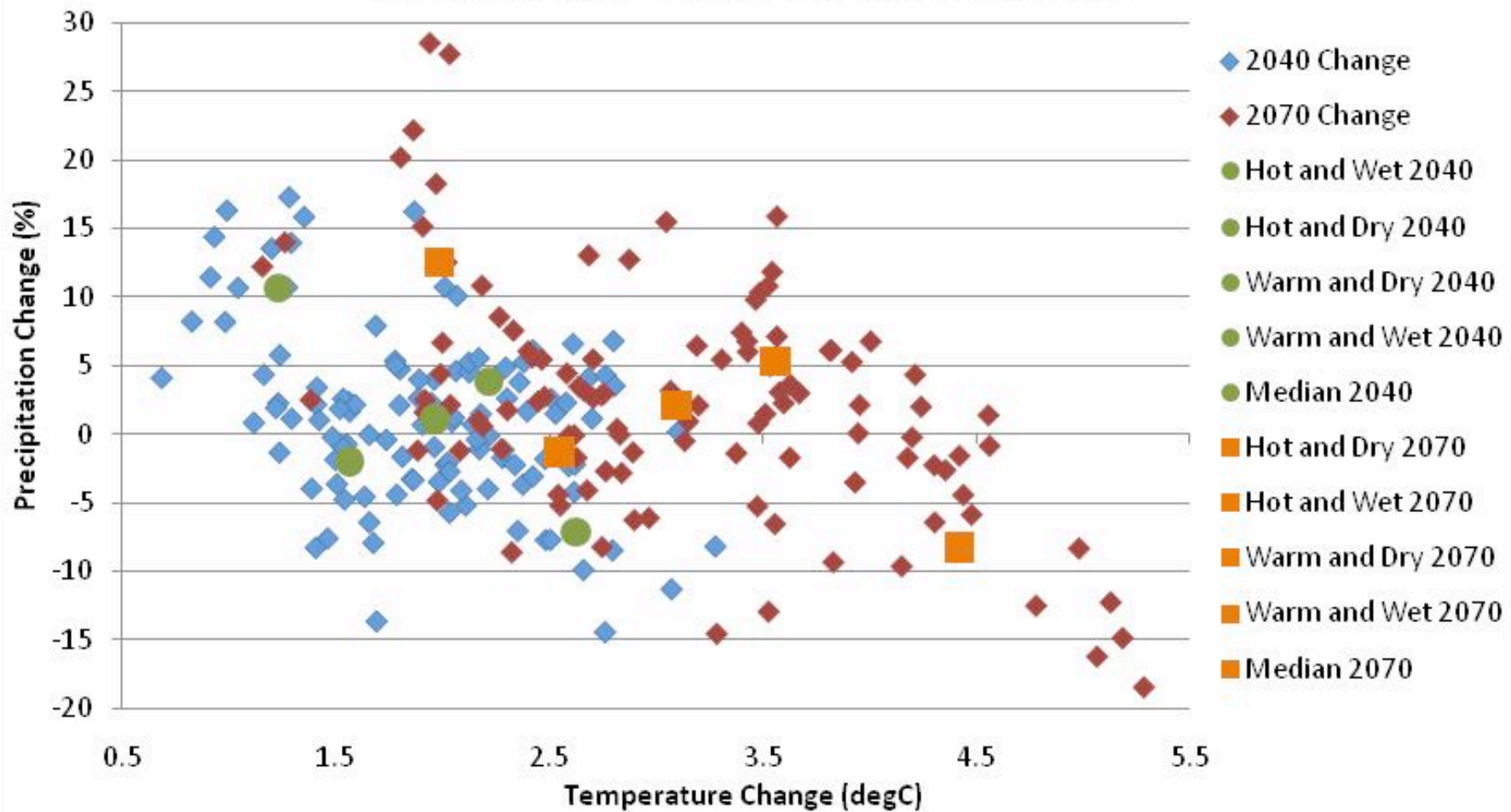
MODEL RUN SELECTION

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



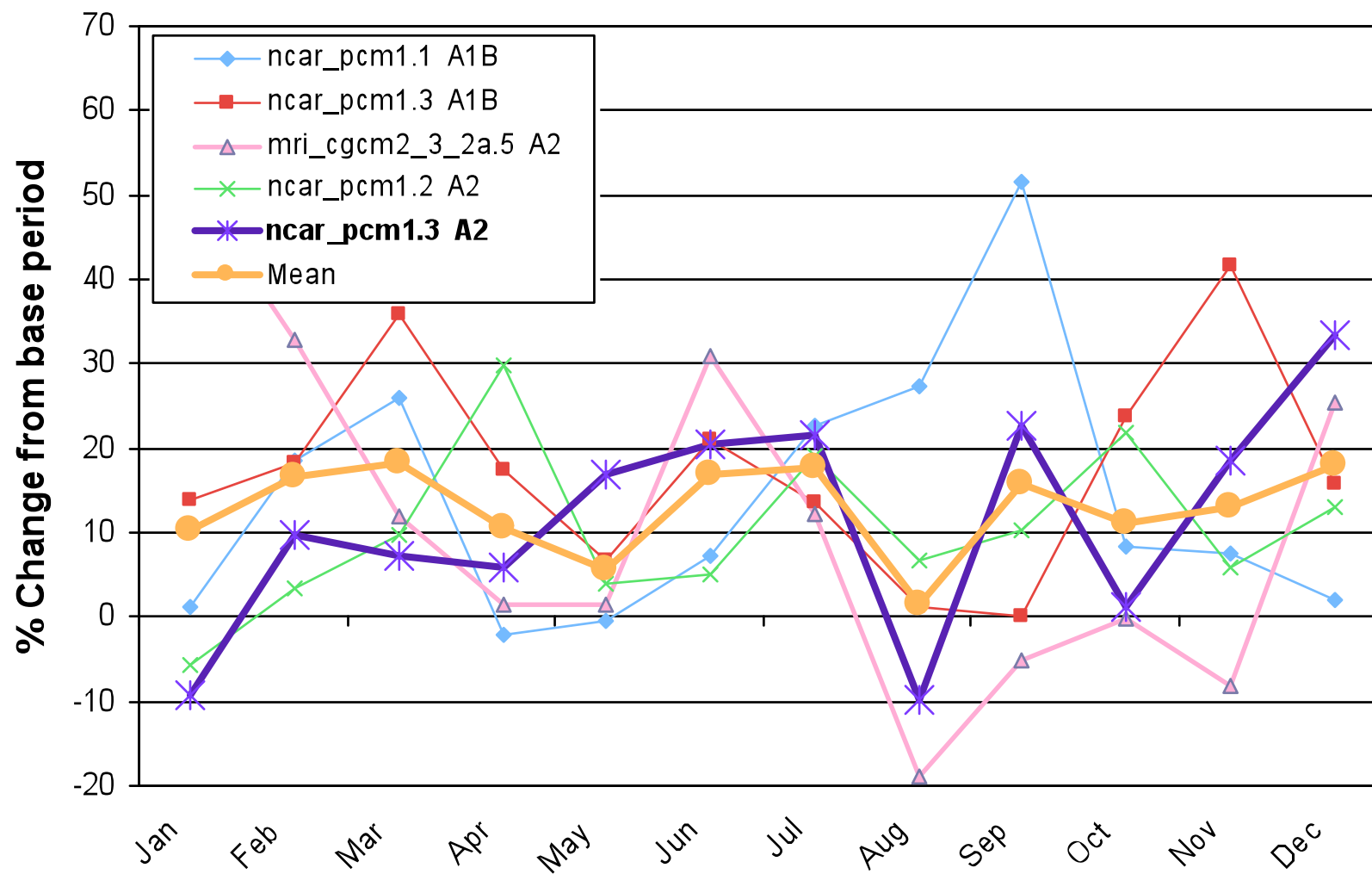
PROJECTIONS AND SCENARIOS

Model Runs and Offset Scenarios



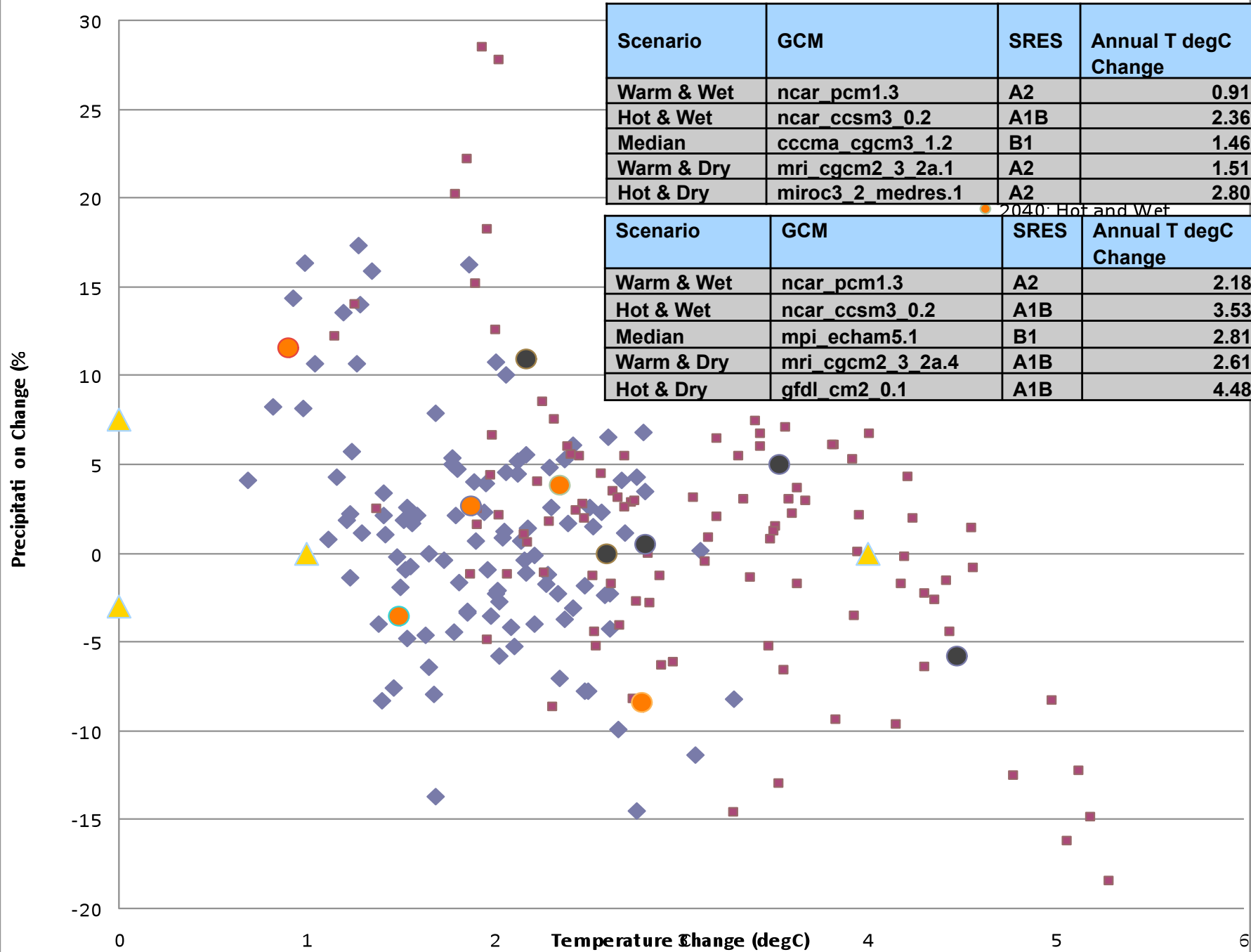
MODEL RUN SELECTION

Warm/Wet Model Selection 2040



Actual Model Selection for Five Climate Scenarios: 2040 (Blue, Orange), 2070 (Red, Green)

- 2040
- 2070
- 2070: Warm and Wet



Scenario	GCM	SRES	Annual T degC Change	Annual P % Change
Warm & Wet	ncar_pcm1.3	A2	0.91	11.43
Hot & Wet	ncar_ccsm3_0.2	A1B	2.36	3.77
Median	cccma_cgcm3_1.2	B1	1.46	2.6
Warm & Dry	mri_cgcm2_3_2a.1	A2	1.51	-3.67
Hot & Dry	miroc3_2_medres.1	A2	2.80	-8.51

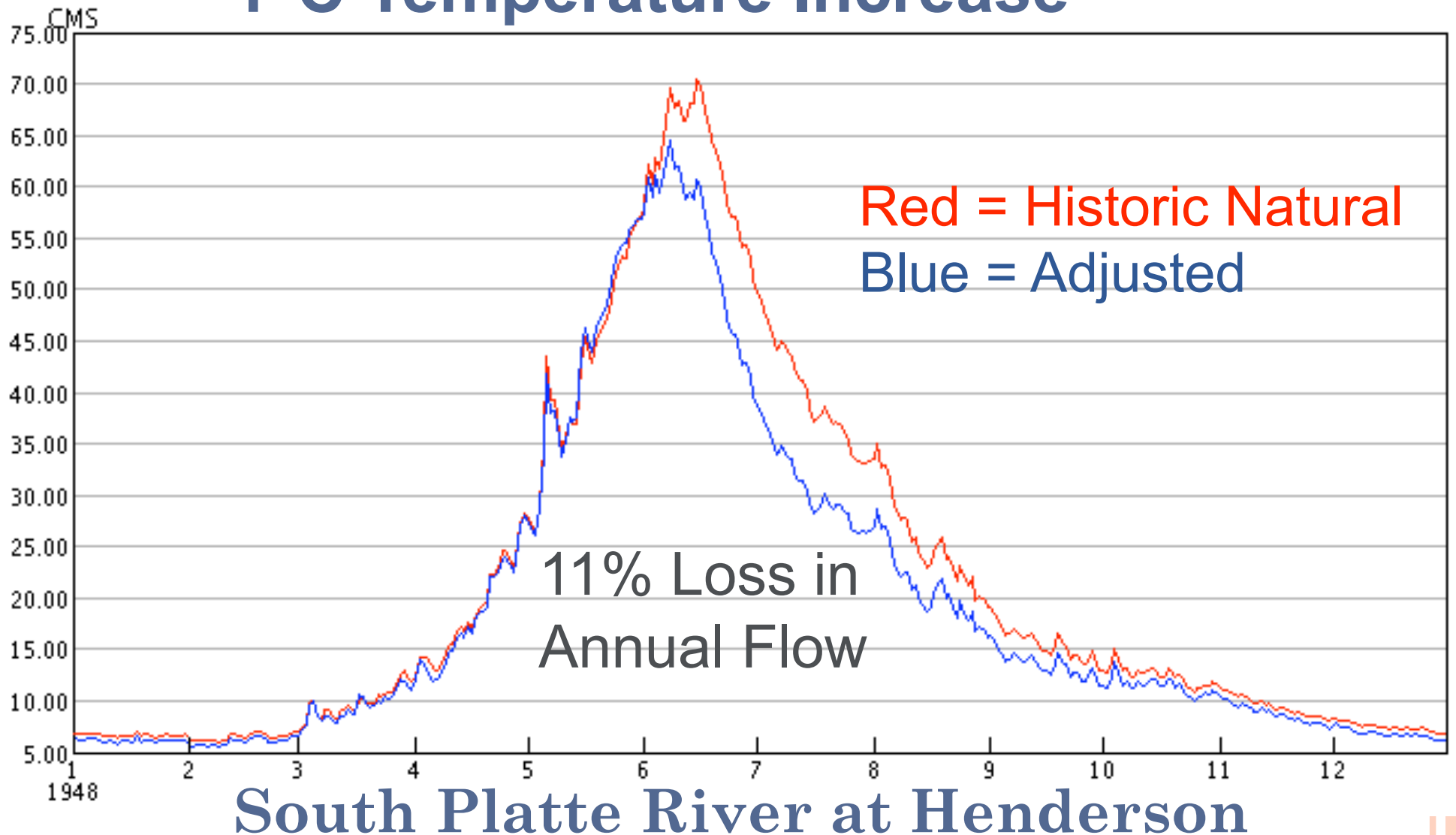
Scenario	GCM	SRES	Annual T degC Change	Annual P % Change
Warm & Wet	ncar_pcm1.3	A2	2.18	10.81
Hot & Wet	ncar_ccsm3_0.2	A1B	3.53	4.95
Median	mpi_echam5.1	B1	2.81	0.38
Warm & Dry	mri_cgcm2_3_2a.4	A1B	2.61	-0.097
Hot & Dry	gfdl_cm2_0.1	A1B	4.48	-5.9



PRELIMINARY RESULTS*: SACRAMENTO MODEL

*Results have not been released

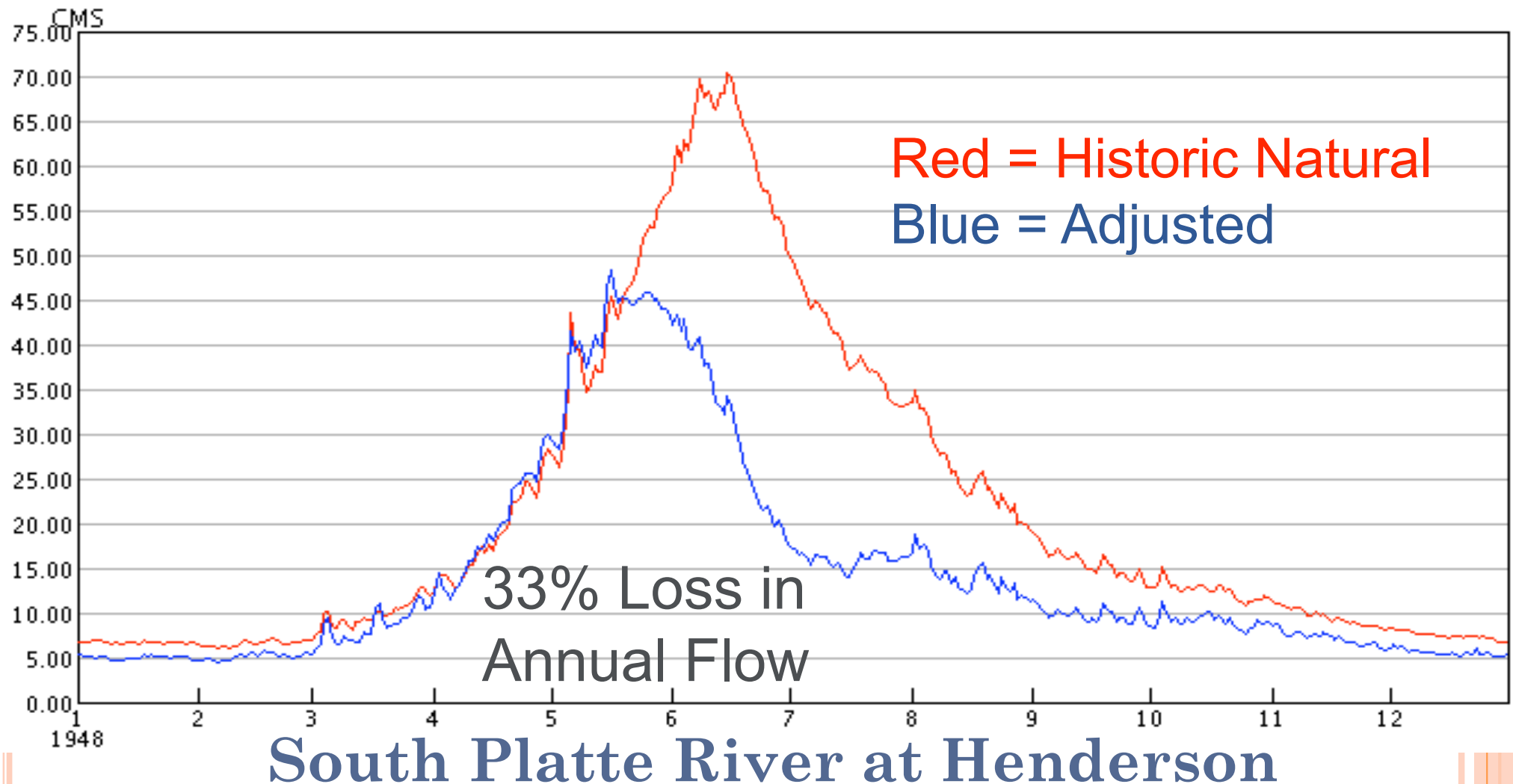
1°C Temperature Increase



PRELIMINARY RESULTS*: SACRAMENTO MODEL

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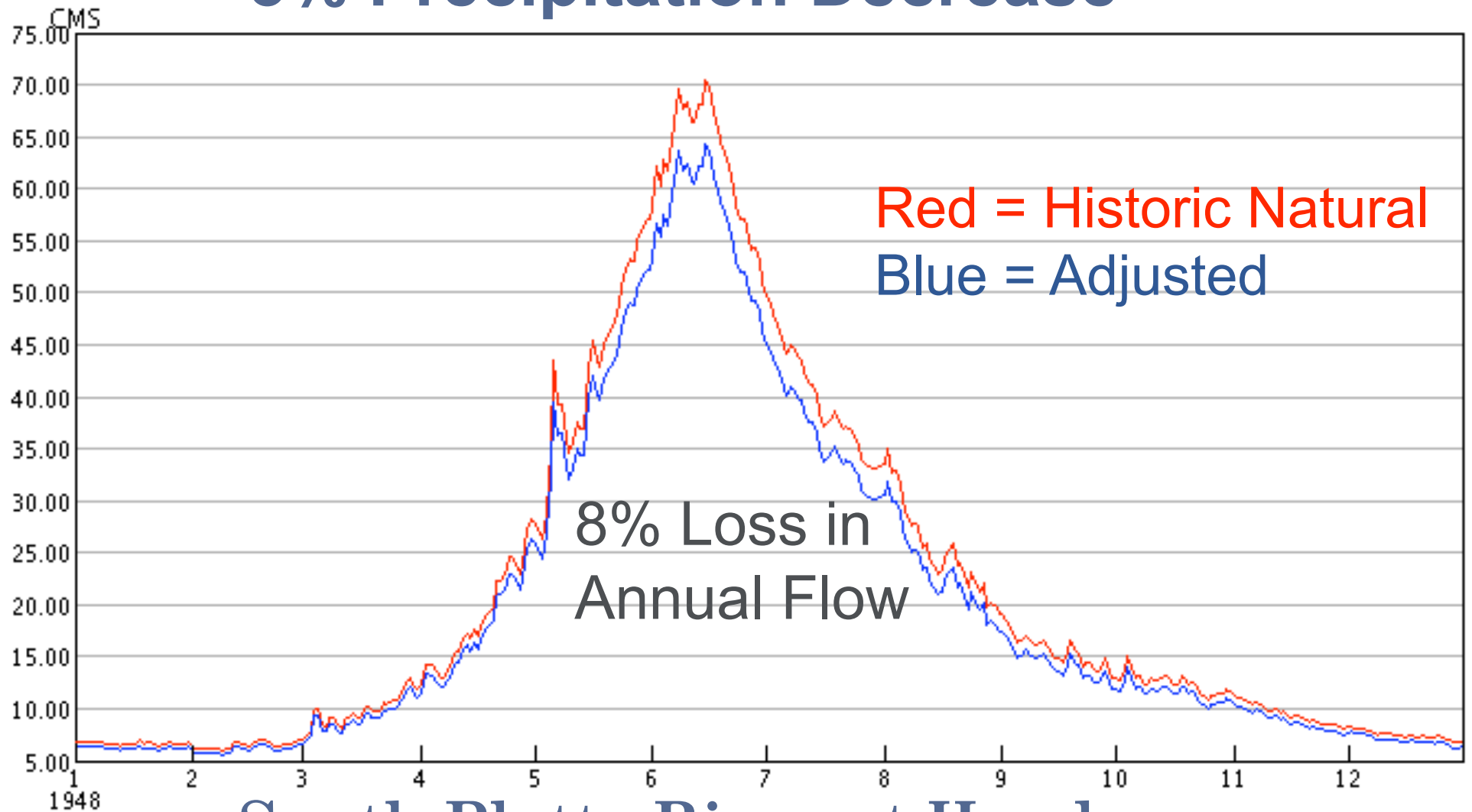
4°C Temperature Increase



PRELIMINARY RESULTS*: SACRAMENTO MODEL

*Results have not been released

3% Precipitation Decrease

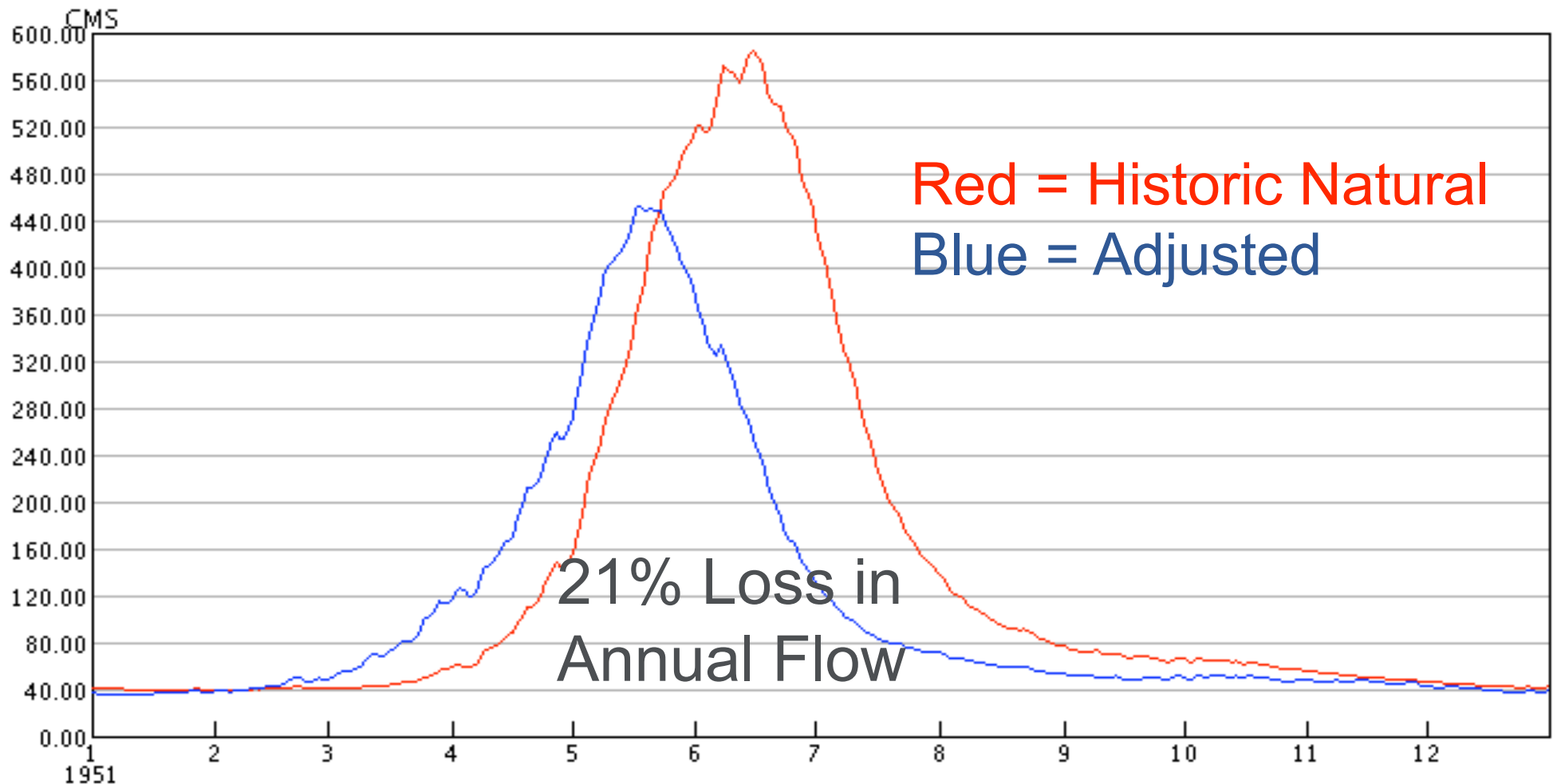


South Platte River at Henderson

PRELIMINARY RESULTS*: SACRAMENTO MODEL

*Results have not been released

4°C Temperature Increase



Colorado River at Cameo

RESULTS AND NEXT STEPS



- Results: Adjusted Historic Natural Streamflow
 - Results: October 2009
 - Final Report: March 2010
- Continue our education
- What's Next?
 - Apply the results to each water system model
 - Compare and analyze water system model results
 - Further develop the hydrology models?
 - Pursue other options?



QUESTIONS

[http://cwcb.state.co.us/Home/
ClimateChange/
JointFRCCVulnerabilityStudy/](http://cwcb.state.co.us/Home/ClimateChange/JointFRCCVulnerabilityStudy/)

