

# Climate Service Needs of Decision Makers

David Behar

Climate Program Director

San Francisco Public Utilities Commission

International Conference on Climate Services (ICCSII)

Brussels

September 7, 2012



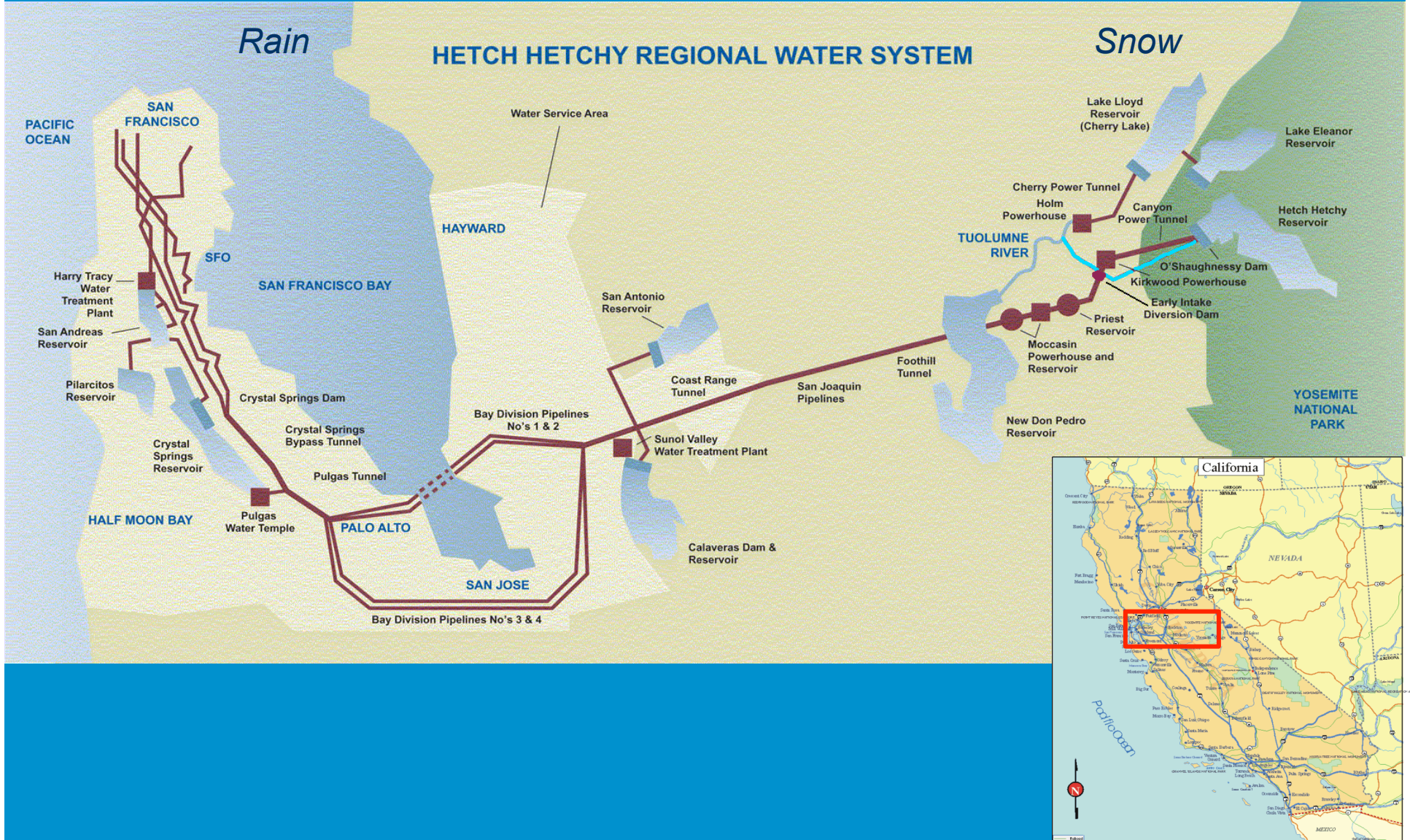
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Services of the San Francisco Public Utilities Commission



San Francisco  
Water  
Power  
Sewer

# Regional Water System





## The Stakes on Climate Change: Water and Clean Water Sector Only

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### 2011-2031: Without Adaptation

Drinking Water  
Infrastructure Investment

**\$335 Billion**<sup>1</sup>

Clean Water  
Infrastructure Investment

**\$298 Billion**<sup>2</sup>

***OR \$1 Trillion through 2035 (AWWA)***<sup>4</sup>

### By 2050: Potential Adaptation Costs

Drinking Water + Clean Water Sector:

**\$448 - 944 Billion**<sup>3</sup>

<sup>1</sup> "2009 Drinking Water Infrastructure Needs Survey and Assessment: Third Report to Congress." USEPA Office of Water, 2005.

<sup>2</sup> "Clean Watersheds Needs Survey 2008: Report to Congress." USEPA, May 2010.

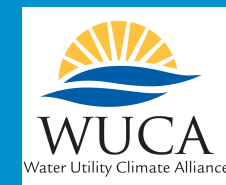
<sup>3</sup> "Confronting Climate Change: An Early Analysis of Water and Wastewater Adaptation Costs," Association of Metropolitan Water Agencies, National Association of Clean Water Agencies, 2009.

<sup>4</sup> "Buried No Longer: Confronting America's Water Infrastructure Challenge", American Water Works Association, 2012.



# Water Utility Climate Alliance

43 million drinking water customers



## Mission Statement

*The Water Utility Climate Alliance provides leadership in assessing and adapting to the potential effects of climate change through collaborative action. We seek to enhance the usefulness of climate science for the adaptation community and improve water management decision-making in the face of climate uncertainty.*

# The Wild Wild West ...





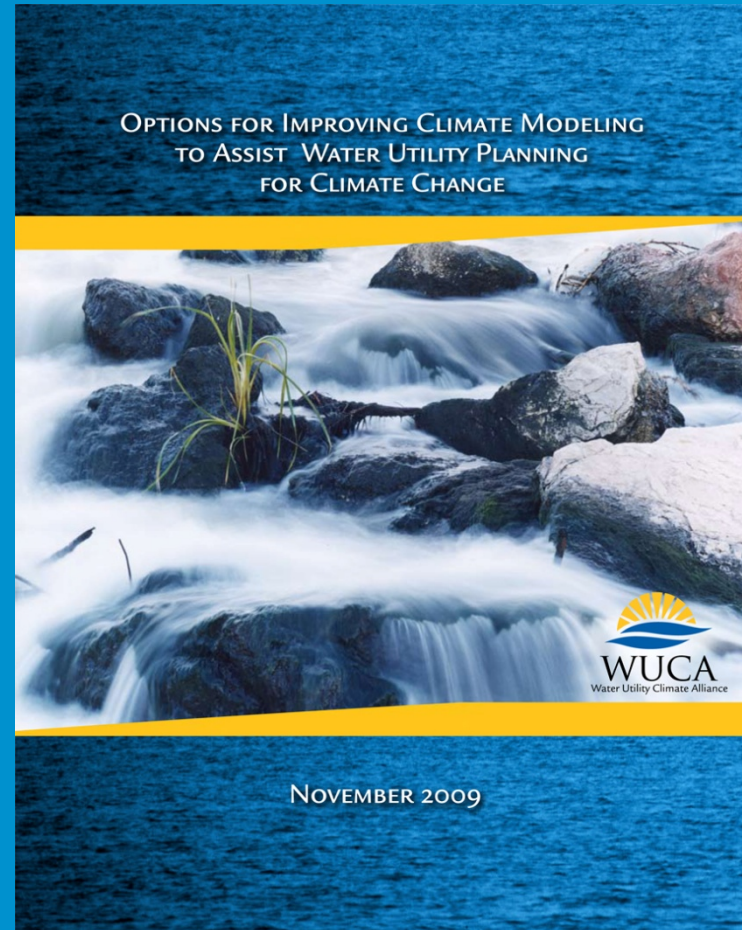
# Climate Modeling White Paper

*“Options for Improving Climate Modeling to Assist Water Utility Planning for Climate Change”*

Authors:

Joe Barsugli, Chris Anderson,  
Joel Smith, Jason Vogel

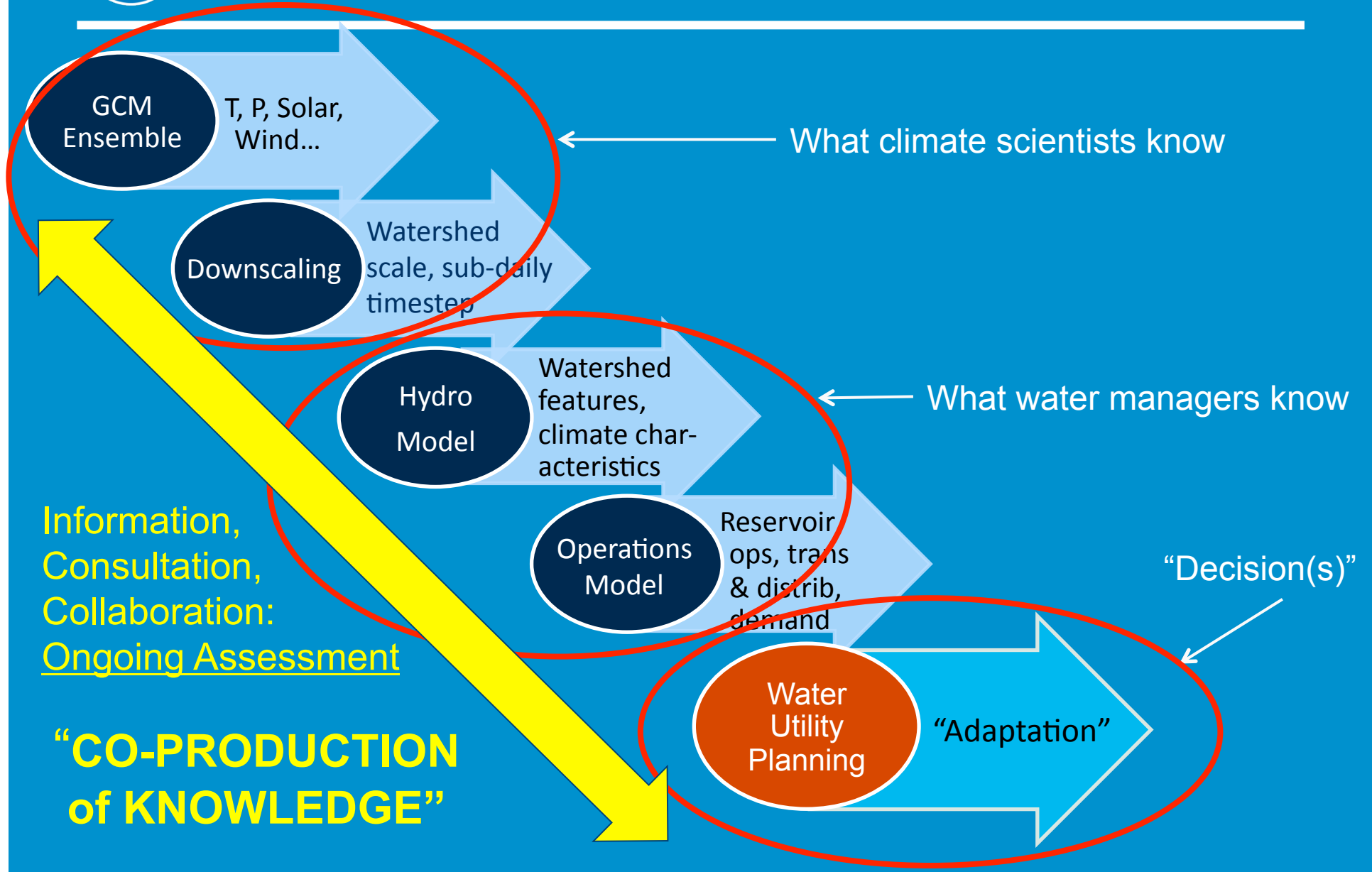
Available at  
[www.wucaonline.org](http://www.wucaonline.org)



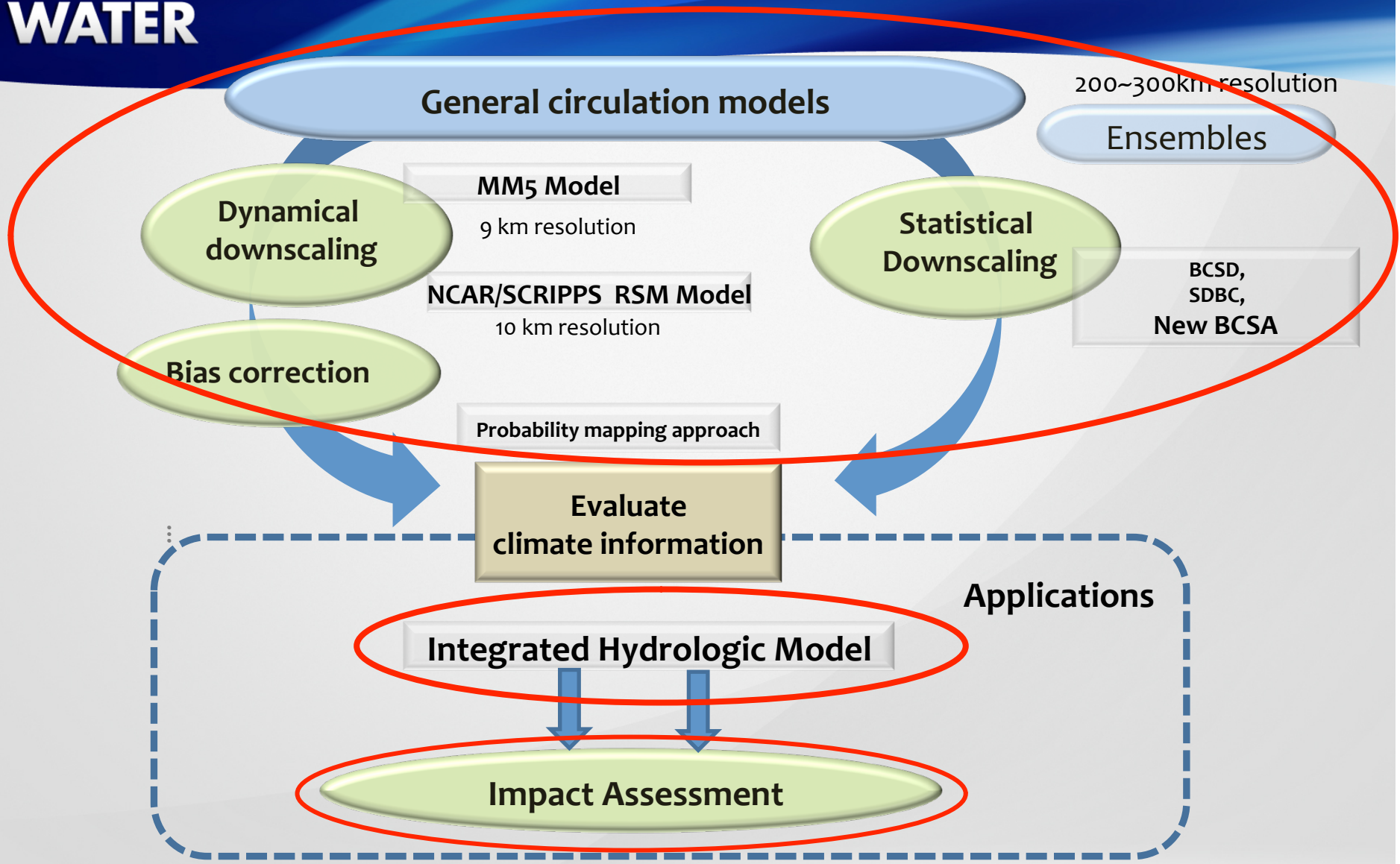


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# Chain of Models



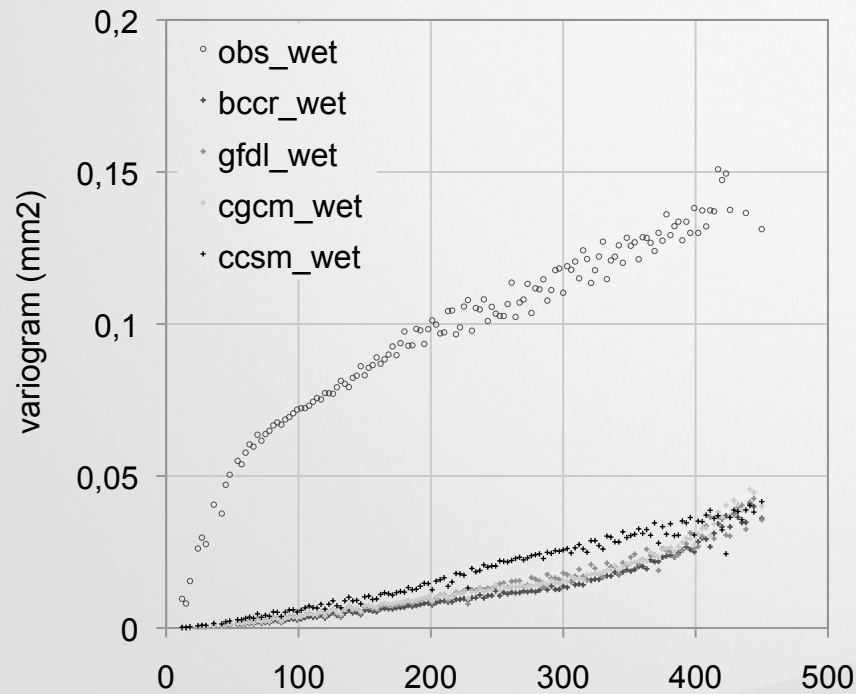
# Climate Change Assessment Framework



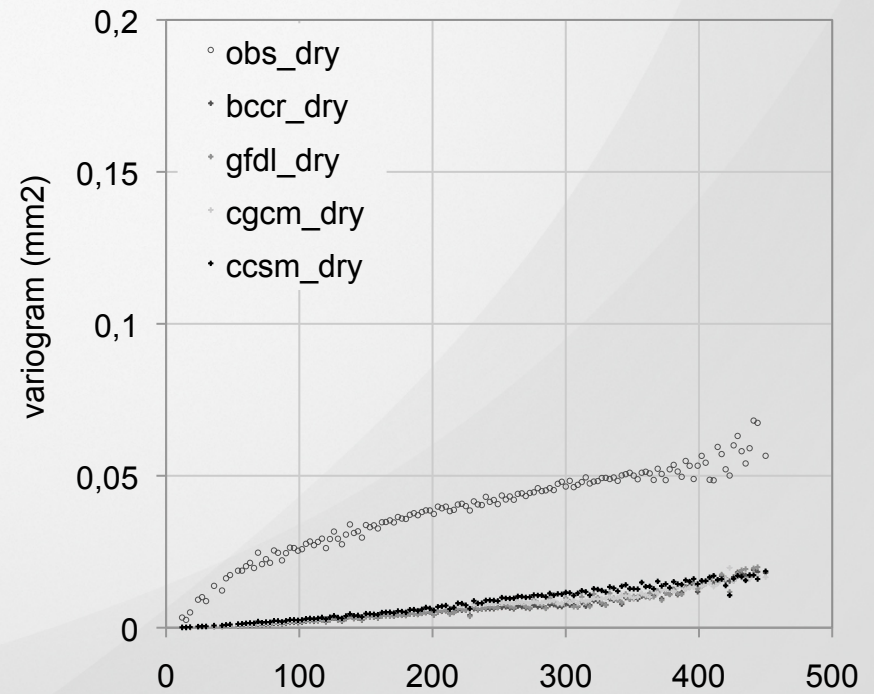


# BCSD: Variogram Comparisons

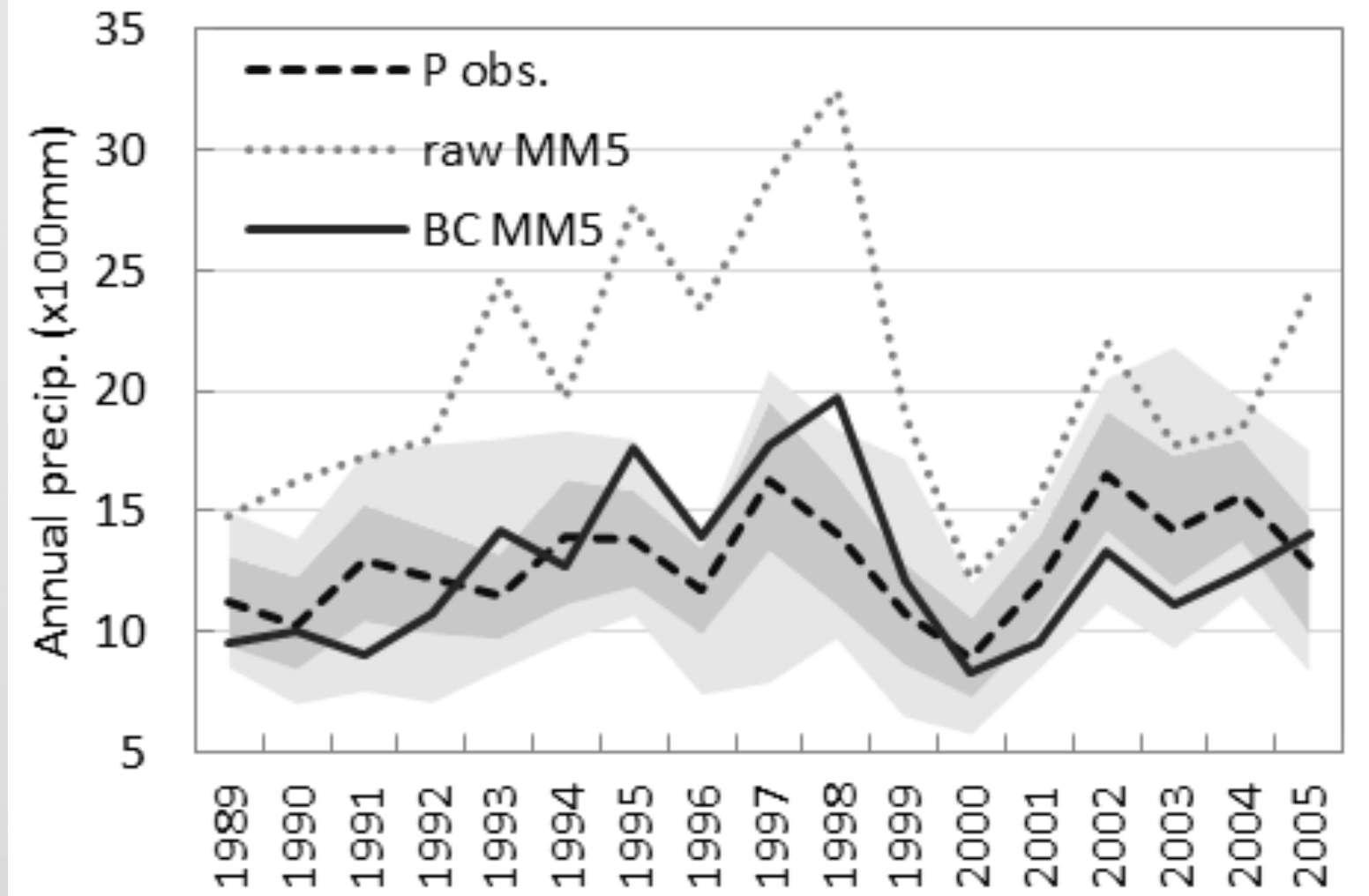
## BCSD\_wet



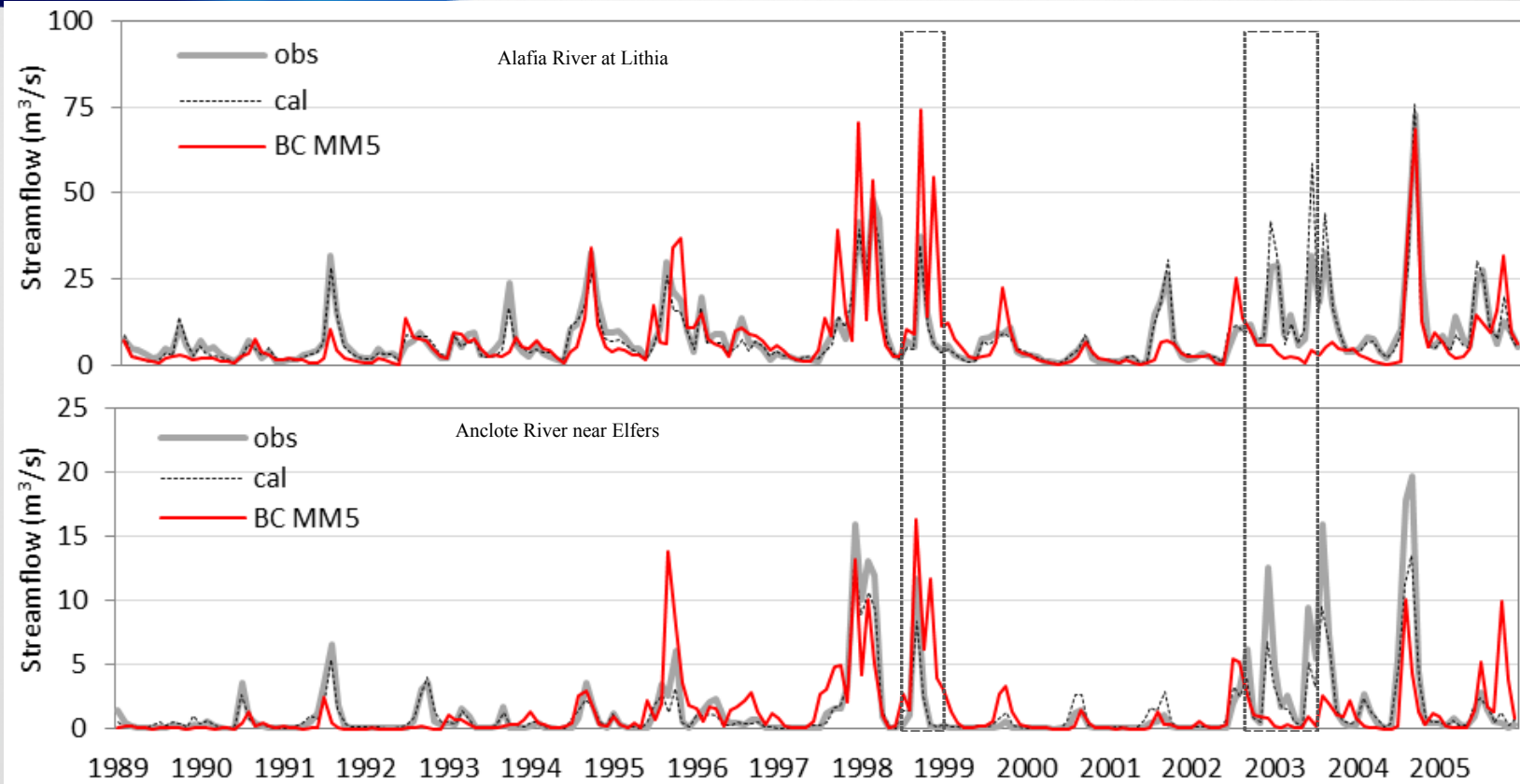
## BCSD\_dry



## Comparison of annual observed, modeled and bias-corrected rainfall timeseries



# Monthly Streamflow Hydrographs

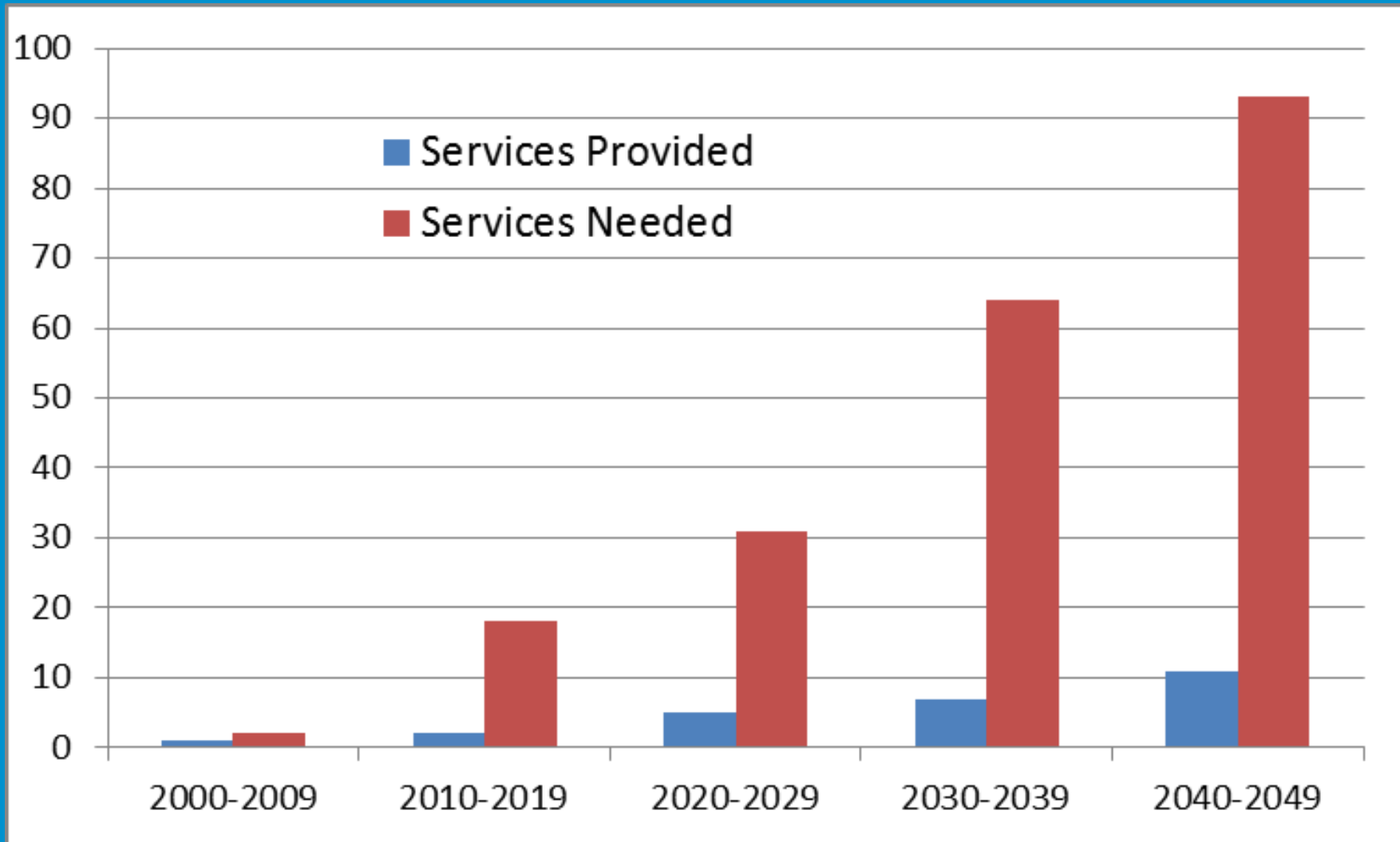


# SFPUC Next Stage: Full Assessment

- Task 1: Detect trends in obs data, acquire paleo data
- Task 2: Clean and assemble climate data
  - Survey quality and statistical properties of data collections (Ruppel)
  - Approaches
    - A. Broad Ensemble
    - B. Bayesian
    - C. Hybrid
- Task 3: ...
- Task 4: ...
- Task 5: ... (RM, RDM)
- Task 6: Produce report, stakeholder workshop

**Team: David Yates (Project Manager) and Caspar Amman, NCAR; Bridget Thrasher, Climate Central; David Behar and Alexis Dufour, SFPUC.**

# A Climate Services Scenario



*Note: fake data – for illustration purposes only*



# Piloting Utility Modeling Applications (PUMA): A Water Utility Climate Alliance initiative

## Five Utilities

San Francisco PUC  
Portland Water Bureau  
Seattle Public Utilities  
Tampa Bay Water  
New York City DEP

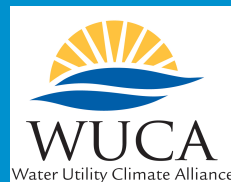
## Four Climate Science Consortia

NCAR/Climate Central/CNAP (CA-NV RISA)  
Climate Decision Support Consortium  
(Northwest RISA)  
Southeast Climate Consortium  
CUNY/Kansas State Univ./Columbia Univ.

## Modeling Advisory Committee (MAC)

Phil Duffy (Climate Central); Ed Maurer (Santa Clara); Tom Johnson (EPA); Levi Brekke (BoR); Linda Mearns (NCAR); John Abatzaglou (U. Idaho); Mike Dettinger (Scripps); Claudia Tebaldi (Climate Central); Joe Barsugli (Western Water Assessment)

Project Mgr, WUCA: David Behar



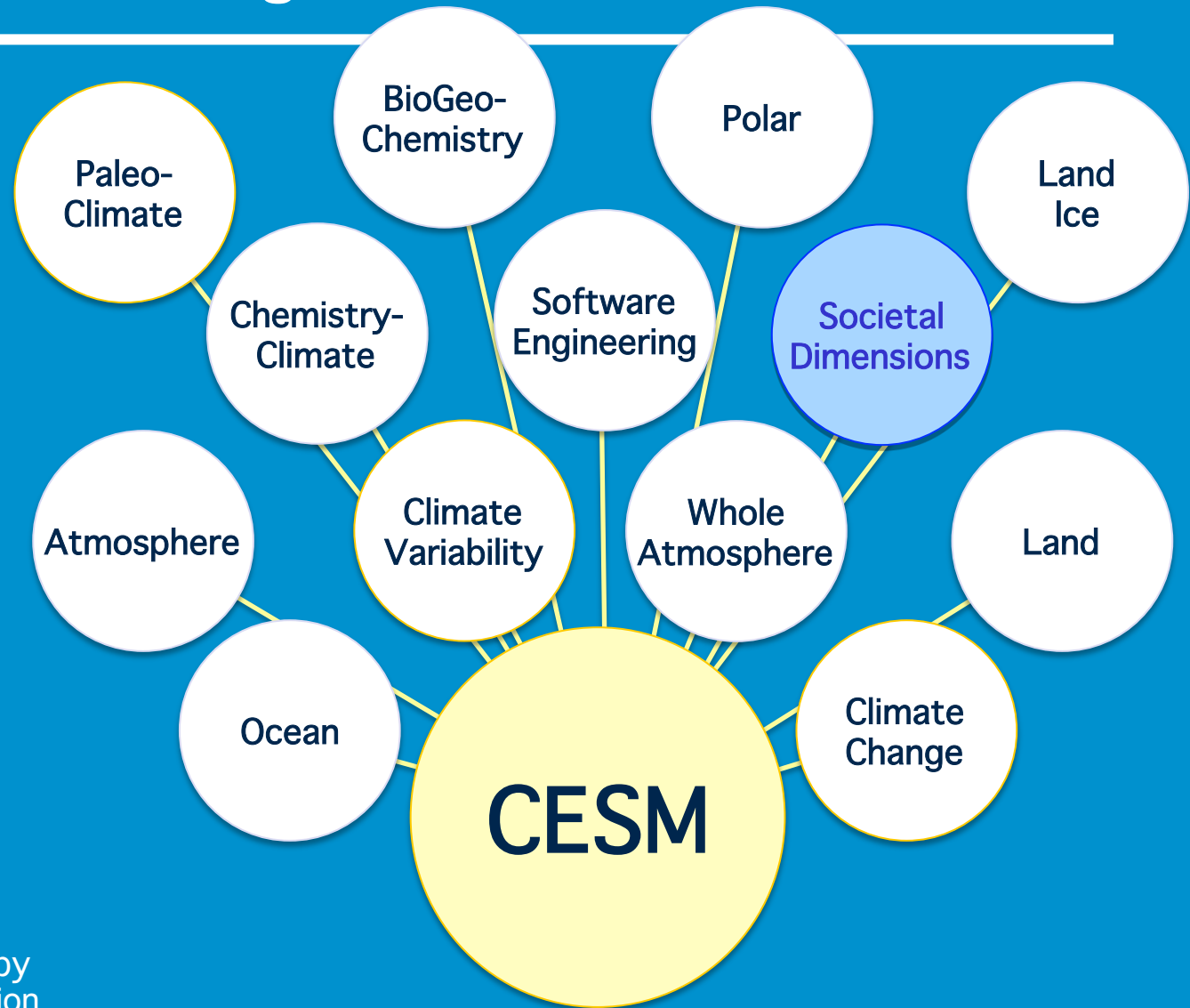
Project Mgr, RISAs: Phil Mote



# Community Involvement: CESM Management

CESM Advisory Board

CESM Scientific Steering Committee



CESM is primarily sponsored by the National Science Foundation and the Department of Energy

<http://www.cesm.ucar.edu/management>



# Projections Inventory – Work in Progress

Compiled by David Rupp, OCCRI and David Behar, SFPUC

Emissions/ Concentration Scenario	Spatial Domain	Temporal Domain	Spatial Resolution*	Finest Temporal Resolution Available*	GCM	RCM
<b>Contact: Chris Castro, U of Arizona (Dominguez et al, 2011, PNAS)</b>						
SRES A2	US and N. Mexico	1967-2081	35 km	6 hr	HADCM3	WRF
SRES A2	US and Mexico	1950-2100	35 km	6 hr	ECHAM5	WRF
SRES A2	US and Mexico	1950-2100	35 km	6 hr	CESM (CMIP5)	WRF
<b>Contact: L. Ruby Leung, PNNL</b>						
RCP4.5	North America	1975 - 2005, 2005 - 2100	20 km	hourly	CCSM4	WRF-CLM
<b>Contact: Xin-Zhong Liang, Univ Maryland</b>						
SRES A2	US+PartialMex/Can	2090-2099	30 km	3 hr	HadCM3P	CMM5
SRES B2	US+PartialMex/Can	2090-2099	30 km	3 hr	HadCM3P	CMM5
SRES B1	US+PartialMex/Can	2045-2055, 2090-2099	30 km	3 hr	PCM	CMM5
SRES A1Fi	US+PartialMex/Can	2090-2099	30km	3 hr	PCM	CMM5
SRES A1b	US+PartialMex/Can	2045-2055, 2090-2099	30 km	3 hr	CCSM	CMM5
SRES B1	US+PartialMex/Can	2045-2055, 2090-2099	30 km	3 hr	CCSM	CMM5
SRES A1Fi	US+PartialMex/Can	2045-2055, 2090-2099	30 km	3 hr	CCSM	CMM5
<b>Contact: Steve Hostetler, USGS</b>						
SRES A2	US & S. CANADA	2010-2099	50 km	Monthly stats	MPI ECHAM5	RegCM3
SRES A2	US & S. CANADA	2038-2069	50 km	Monthly stats	GFDL CM2.0	RegCM3
SRES A2	US & S. CANADA	2010-2099	50 km	Monthly stats	PSU/SGS GENMOM	RegCM3
SRES A2	W. US (with Canada)	2010-2099	15 km	Monthly stats	MPI ECHAM5	RegCM3
SRES A2	W. US (with Canada)	2038-2069	15 km	Monthly stats	GFDL CM2.0	RegCM3
SRES A2	W. US (with Canada)	2010-2099	15 km	Monthly stats	PSU/USGS GENMOM	RegCM3
SRES A2	E. US (with Canada)	2020-2099	15 km	Monthly stats	MPI ECHAM5	RegCM3
SRES A2	E. US (with Canada)	2038-2069	15 km	Monthly stats	GFDL CM2.0	RegCM3
SRES A2	E. US (with Canada)	2020-2080	15 km	Monthly stats	PSU/USGS GENMOM	RegCM3
Total						
<b>Contact: John Mejia, Desert Research Institute, Nevada</b>						
SRES A2	Western N. America	1980-2000, 2041-2070	36 and 12 km	3 hr	CCSM	WRF
SRES A2	Western N. America	1980-2000	36 and 12 km	3 hr	CCSM-SST biases	WRF
<b>Contact: Norm Miller, Lawrence Berkeley Laboratory</b>						
SRES or RCP x	Western US and CA/NV	1985-1994, 2060-2069	32 km (10 km CA/ NV)	?	CCSM3	WRF-CLM
SRES or RCP y	Western US and CA/NV	1985-1994, 2060-2070	32 km (10 km CA/ NV)	?	CCSM3	WRF-CLM
SRES or RCP x	Western US and CA/NV	1985-1994, 2060-2071	32 km (10 km CA/ NV)	?	CCSM3	RegCM
SRES or RCP y	Western US and CA/NV	1985-1994, 2060-2072	32 km (10 km CA/ NV)	?	CCSM3	RegCM

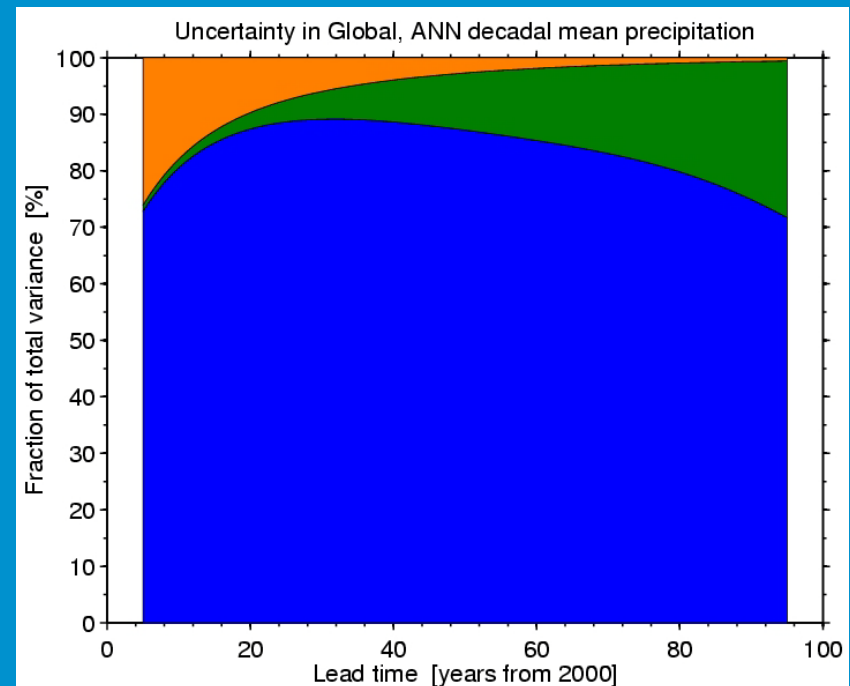
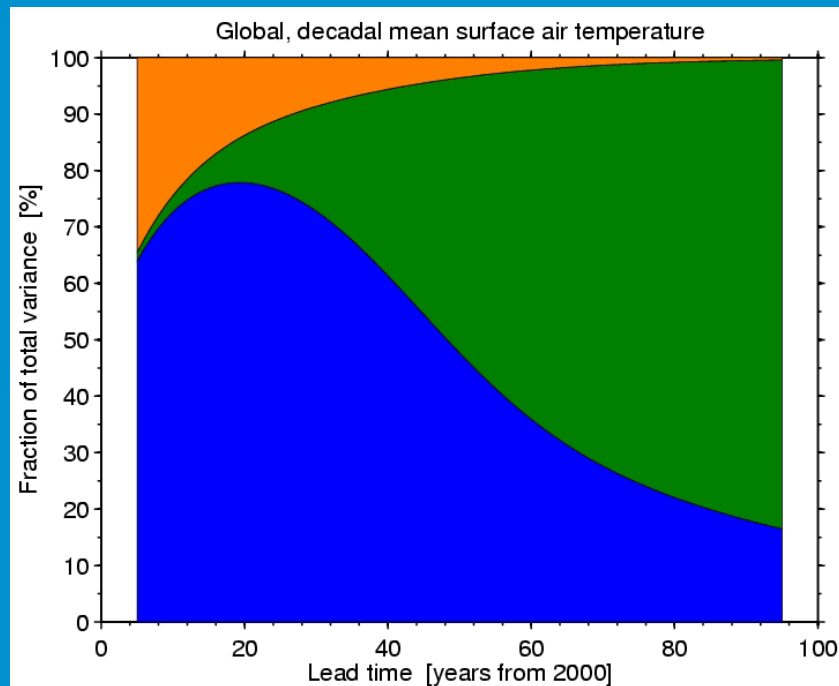


# Symbiosis



# Uncertainty

- Emissions uncertainty
- Internal variability
- Model uncertainty



*From Hawkins & Sutton 2009  
(BAMS) and 2010 (Climate  
Dynamics)*



# Median Runoff into Hetch Hetchy

(results based on 1975-2008, median year is 2003)

Change in Median Runoff volume for future climate conditions

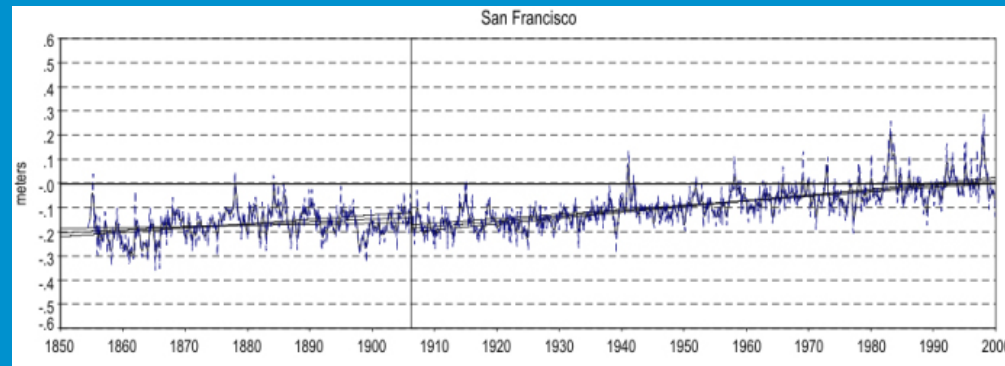
Climate Change Scenario		Hetch Hetchy Runoff (% change from 2010)		
		2040	2070	2100
<b>1A</b>	Low temperature increase No precipitation change	-1%	-2%	-3%
<b>2A</b>	Moderate temperature increase No precipitation change	-1%	-3%	-5%
<b>2B</b>	Moderate temperature increase Precipitation decrease	-8%	-16%	-25%
<b>2C</b>	Moderate temperature increase Precipitation increase	-1%	+2%	+2%
<b>3A</b>	High temperature increase No precipitation change	-2%	-6%	-10%
<b>3B</b>	High temperature increase Precipitation decrease	-9%	-19%	-29%

## A core objective...

# “Actionable Science”

*A Working Definition:*

Data, analysis, and forecasts that are sufficiently predictive, accepted and understandable to support decision-making, including capital investment decision-making.



# Thank you

David Behar, Climate Program Director  
San Francisco Public Utilities Commission  
525 Golden Gate Avenue, 10th Floor  
San Francisco, CA 94102  
dbehar@sfwater.org 415-554-3221

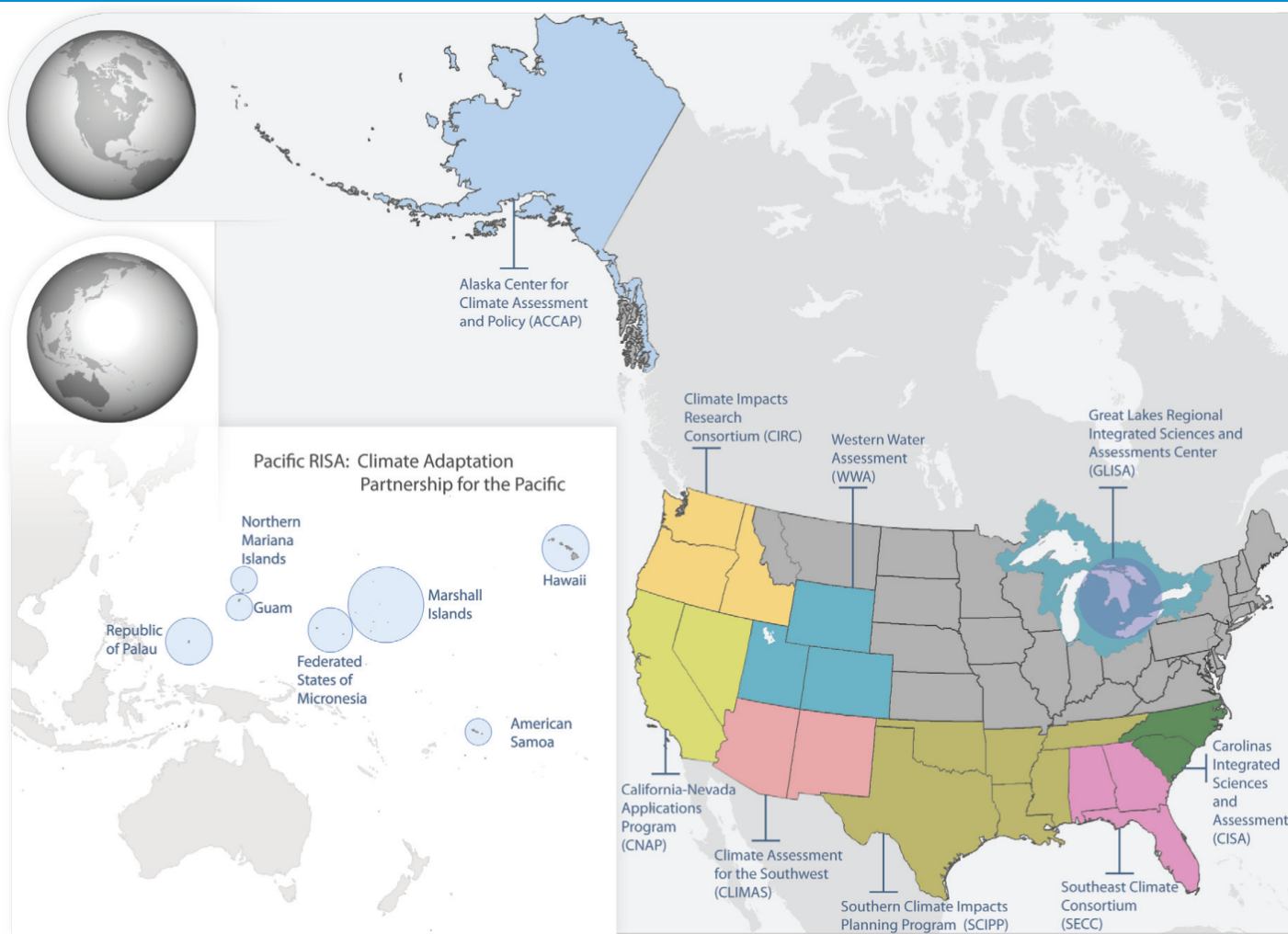


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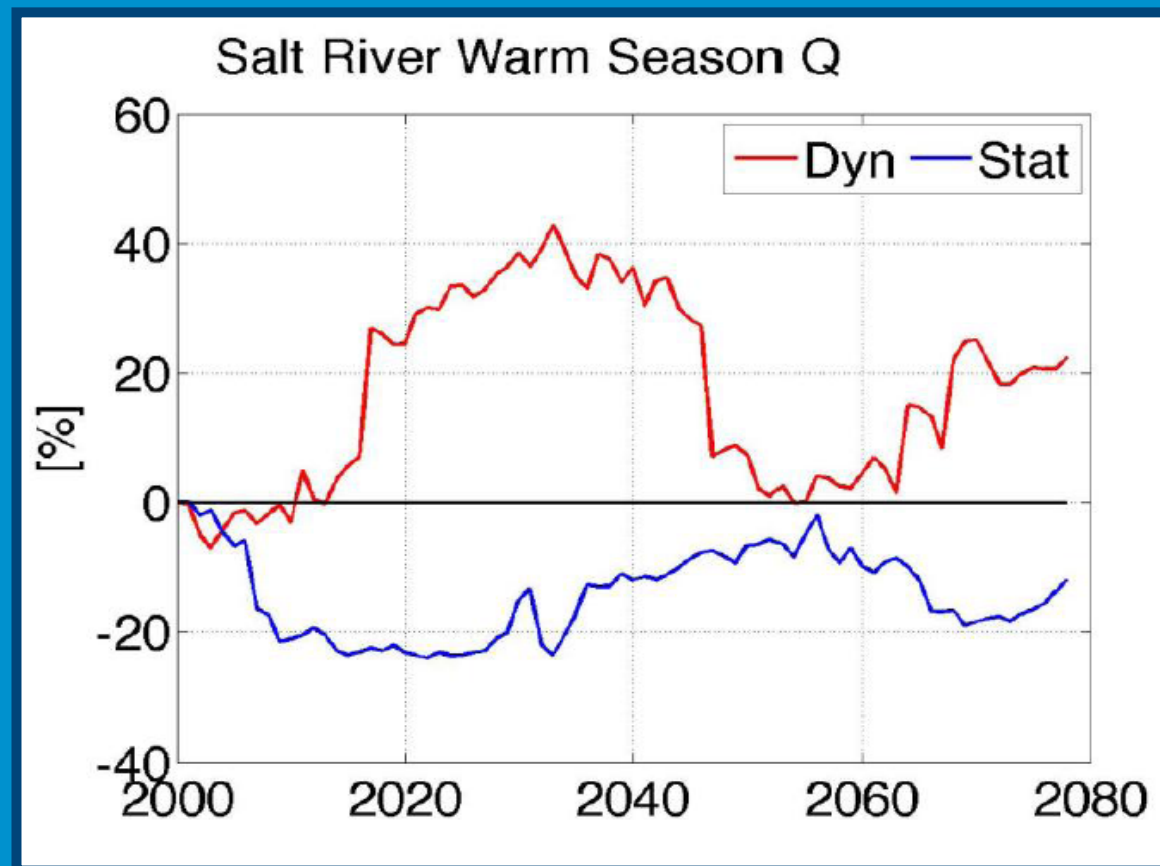


# Regional Integrated Sciences and Assessments (RISA) Program



“supports research that addresses complex climate sensitive issues of concern to decision-makers and policy planners at a regional level.”

## Southwestern United States: Salt River



Boundary conditions from HadleyCM3.

Statistically DS data from Maurer et al; dynamically DS data generated using nested WRF

Dominguez, Rajagopal, Castro, Troch, Demaria, Gupta, Durcik, Chang, University of Arizona.  
Slide courtesy Gregg Garfin, Institute of the Environment, University of Arizona