Drought Ready Communities: Arizona and U.S. Drought Monitoring and Decision Support

Maricopa County Cooperative Extension
March 24, 2011, Phoenix, AZ

National Drought Mitigation Center
University of Nebraska–Lincoln

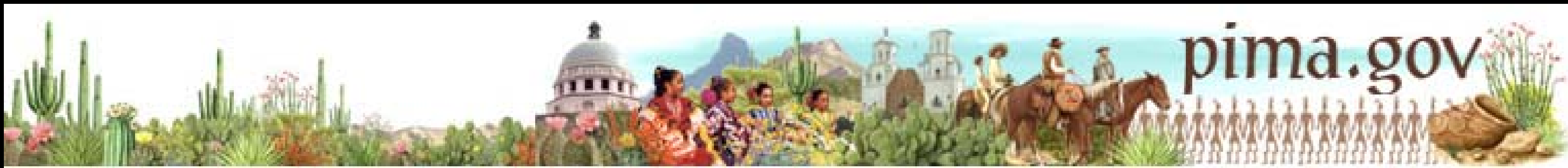
CLIMAS
Climate Assessment for the Southwest

ARIZONA COOPERATIVE EXTENSION
COLLEGE OF AGRICULTURE AND LIFE SCIENCES

CSAP

ASU

ARIZONA STATE CLIMATE OFFICE



Thanks, Kathy!

ADWR
eGovernment
Arizona Department of Water Resources

Thanks, Susan

Discussion

Questions:

- What motivates communities to plan for drought?
- What keeps communities focused on drought planning, monitoring, education, and related activities?
- What information do communities use for planning, monitoring, education?
- What are the policy motivations for drought planning and related activities?

Questions:

- How well does your municipal drought plan work?
- What could you suggest to improve municipal drought planning?

Welcome and Introductions

- Meeting Goals: Drought Ready Communities

Pima County concerns about being drought ready

Drought Monitoring Arizona and the U.S.

- Overview: local → state → national

Drought Impacts monitoring

- Arizona DroughtWatch
- CoCoRAHS – Cooperative Rain, Hail & Snow Network
- U.S. Drought Impacts Reporter
- Monitoring and Policy:
  - How are drought impacts reports and other information used by decision makers?
  - How does this affect policy?

Break

Group discussion
1. What motivates you to plan for drought? 2. What keeps you focused on drought planning, monitoring, education, etc.? 3. What information do you use for planning, monitoring, education? 4. What are the policy motivations for drought planning and related activities?
NDMC Drought Ready Communities
Final comments and adjournment

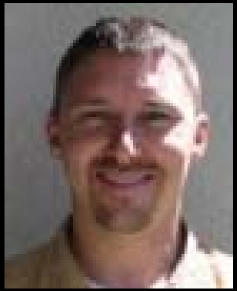
NDMC Droughtians

Kelly Helm Smith
Science Communicator

Mark Svoboda
Climatologist

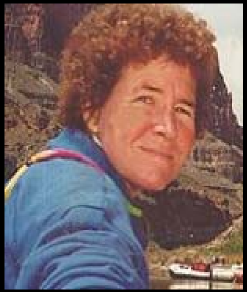
Melissa Widhalm
Climatologist

Arizona Droughtians



Mike Crimmins
Climatologist
UA Cooperative
Extension

Gregg Garfin
Climatologist
UA School of
Natural Resources

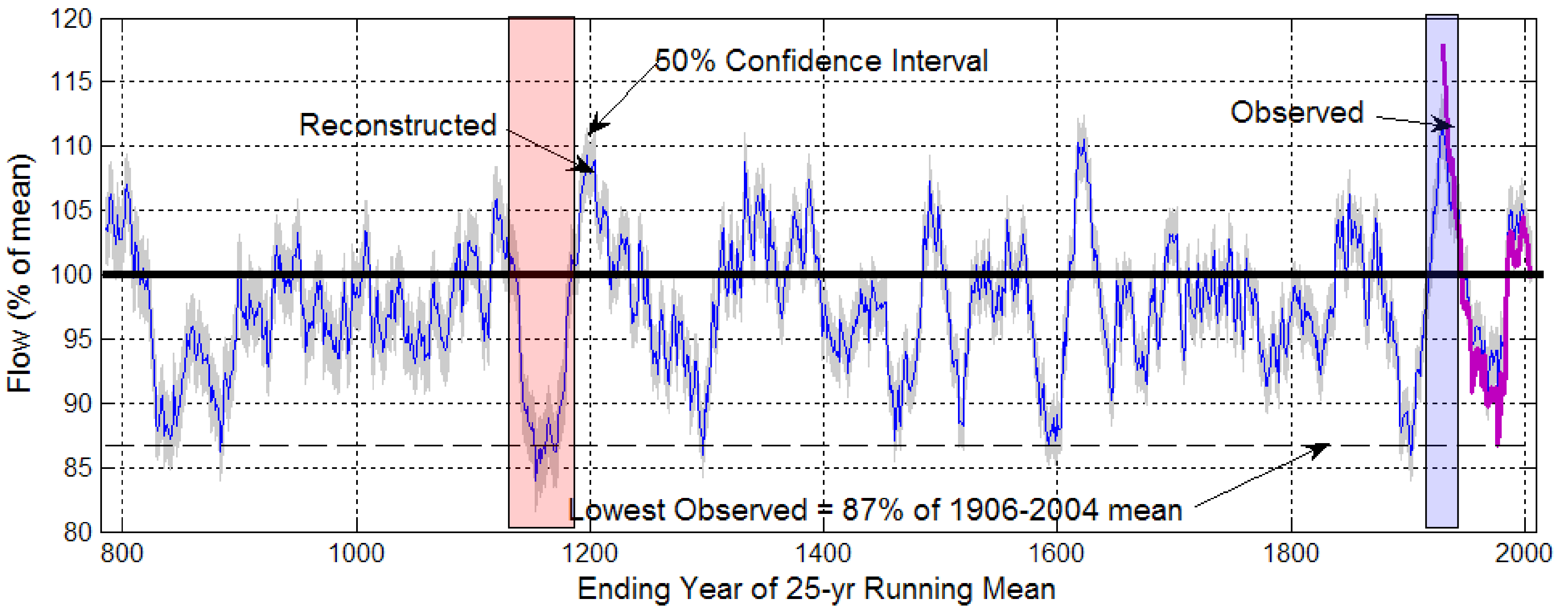


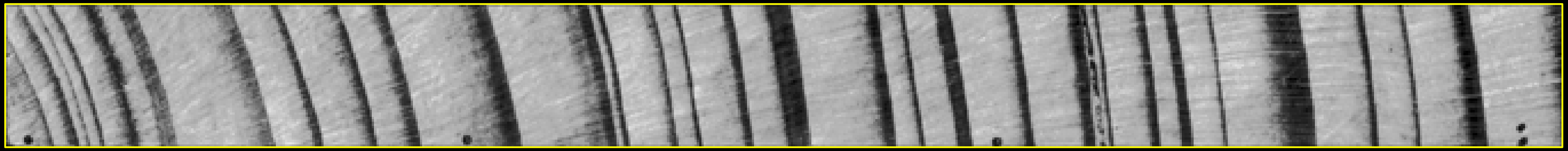
Nancy Selover
State Climatologist
Arizona State University

Pima County concerns
about being drought ready

"What keeps you up at night?"

Colorado River Flow, 762-2005





Dave Meko, UA Laboratory of Tree-Ring Research

State Drought Monitoring Technical Committee

NRCS Natural Resources Conservation Service

Arizona Department of Water Resources

CLIMAS

National Weather Service

SRP Delivering More Than Power

The University of Arizona Arizona Cooperative Extension College of Agriculture and Life Sciences

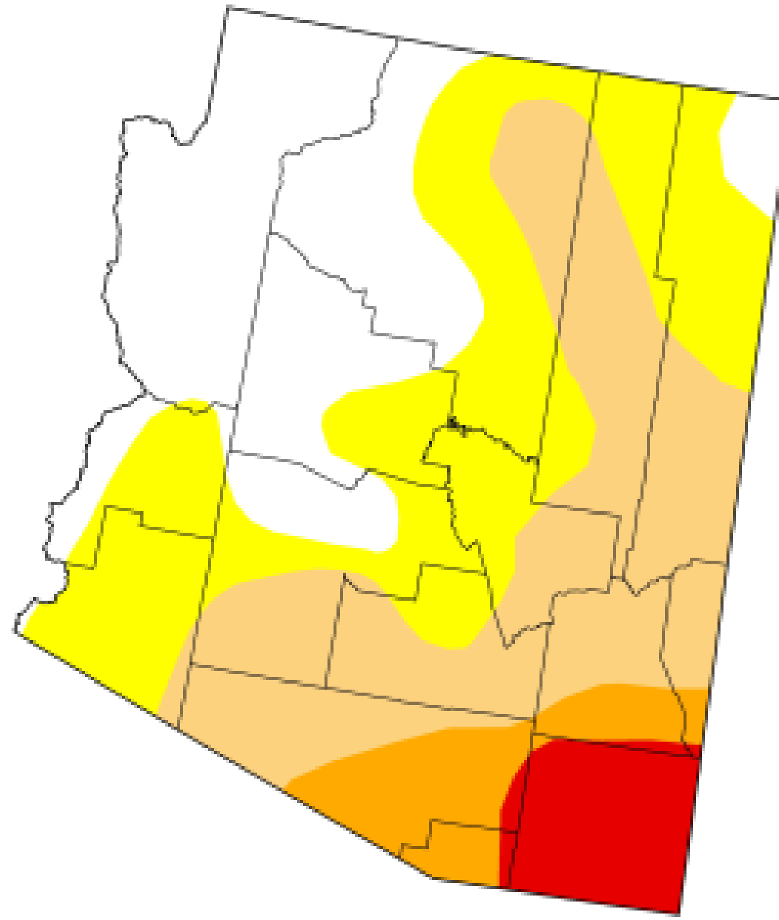
USGS science for a changing world Water Resources of Arizona

+

AZ DroughtWatch
Arizona's Drought Impact Reporting System

+

U.S. Drought Monitor



Every Week!

State Drought Monitoring Technical Committee

NRCS Natural Resources Conservation Service

Securing Arizona's Water Future — Arizona Department of Water Resources

CLIMAS

Delivering More Than Power.

The University of Arizona — Arizona Cooperative Extension — College of Agriculture and Life Sciences

USGS science for a changing world — Water Resources of ARIZONA

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AZ DroughtWatch
Arizona's Drought Impact Reporting System

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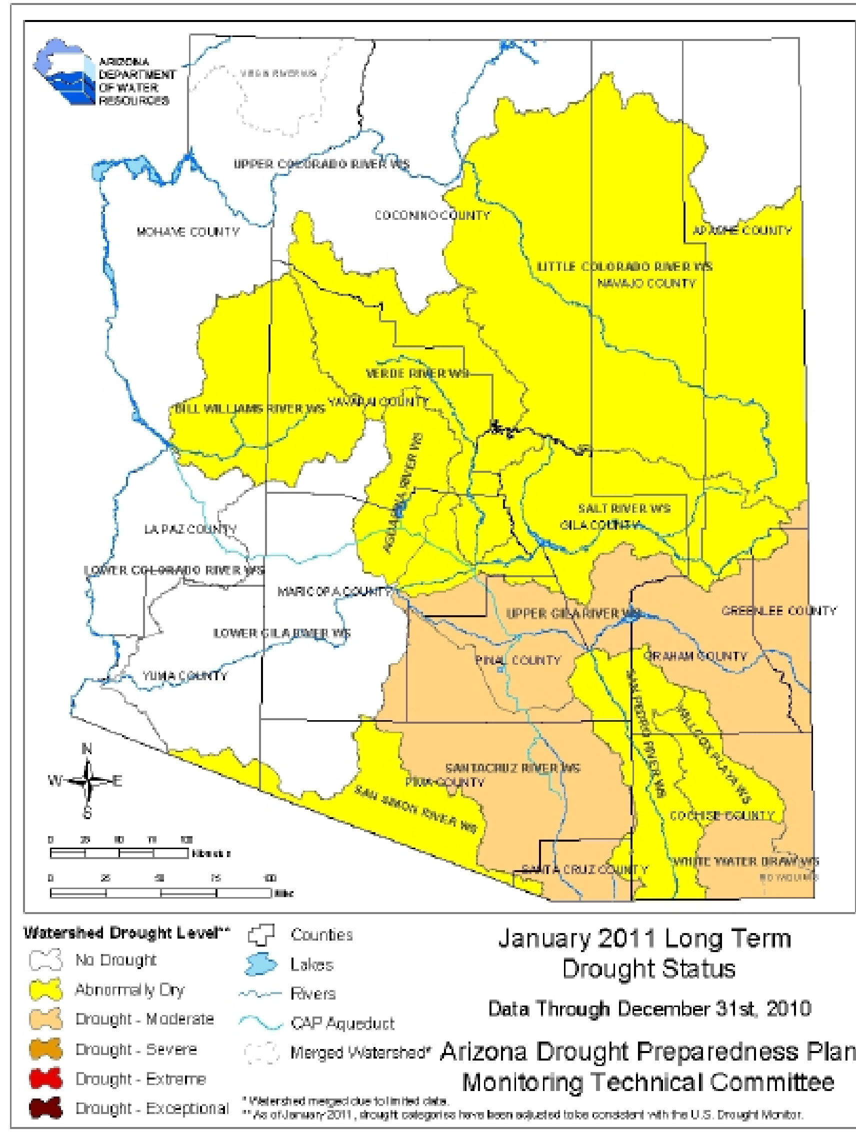
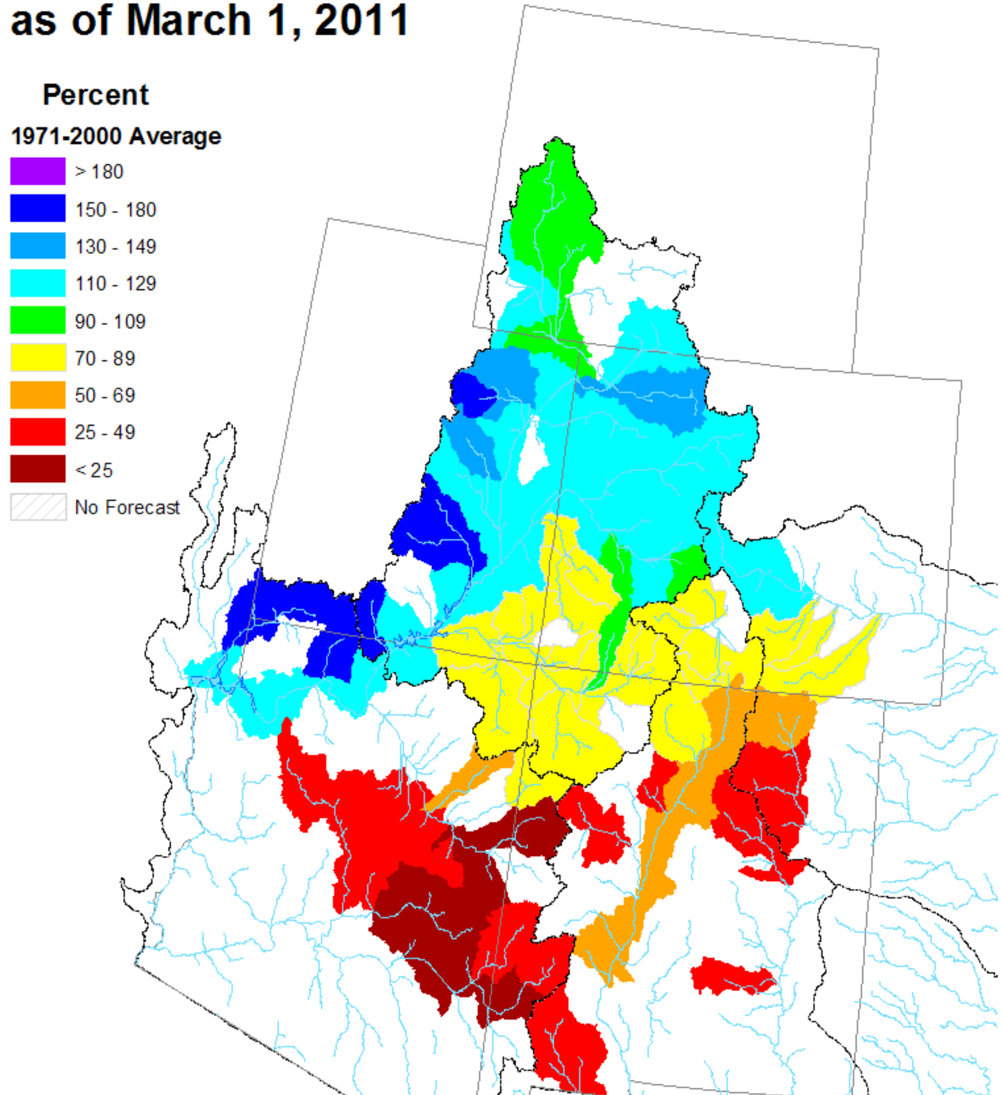


Every 3 Months

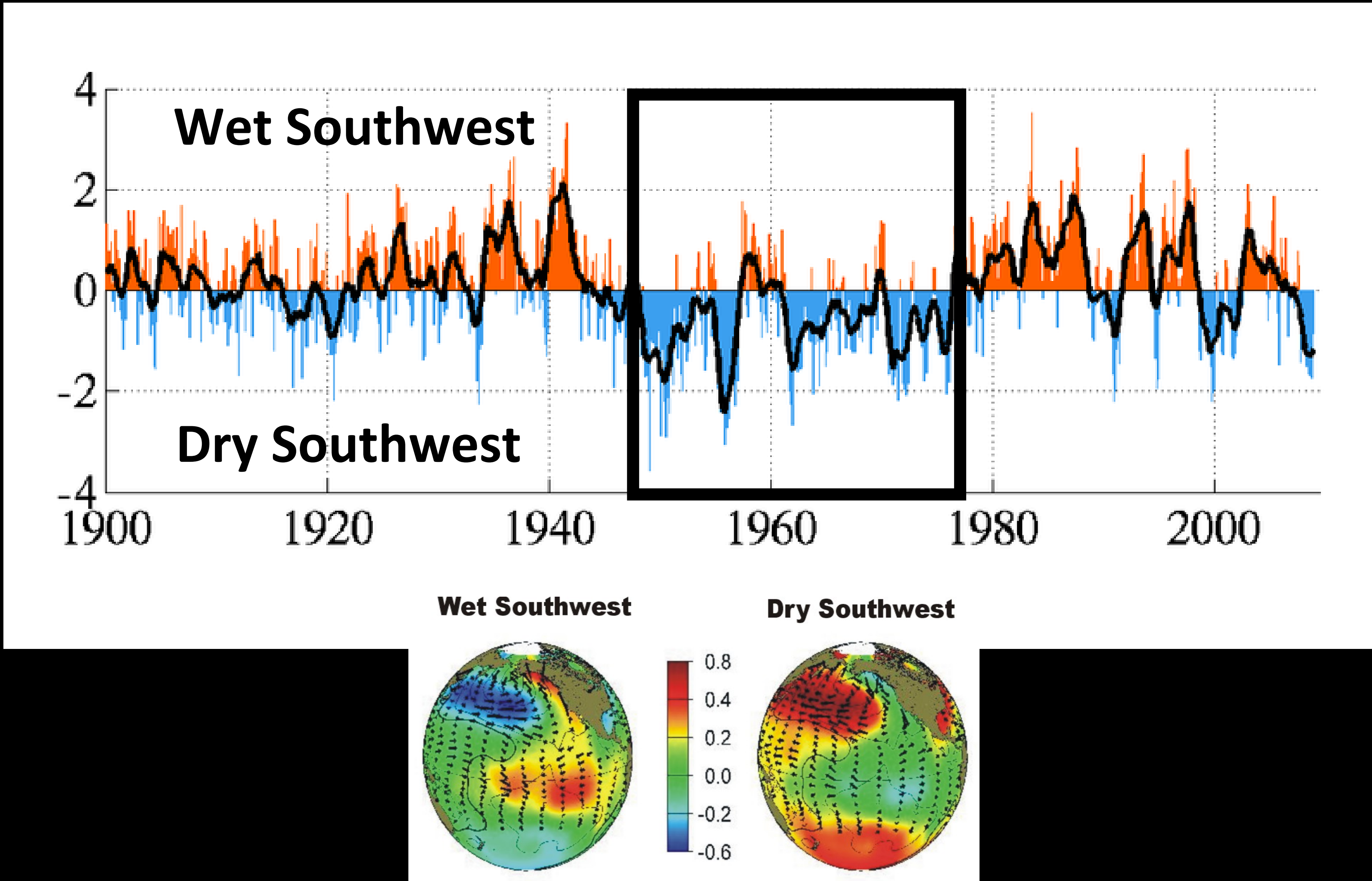
Group discussion

1. What **motivates** your community to plan for drought?
2. **What keeps your community focused** on drought planning, monitoring, education, etc.?
3. What **information** does your community use for planning, monitoring, education?
4. What are the **policy motivations** for drought planning and related activities?

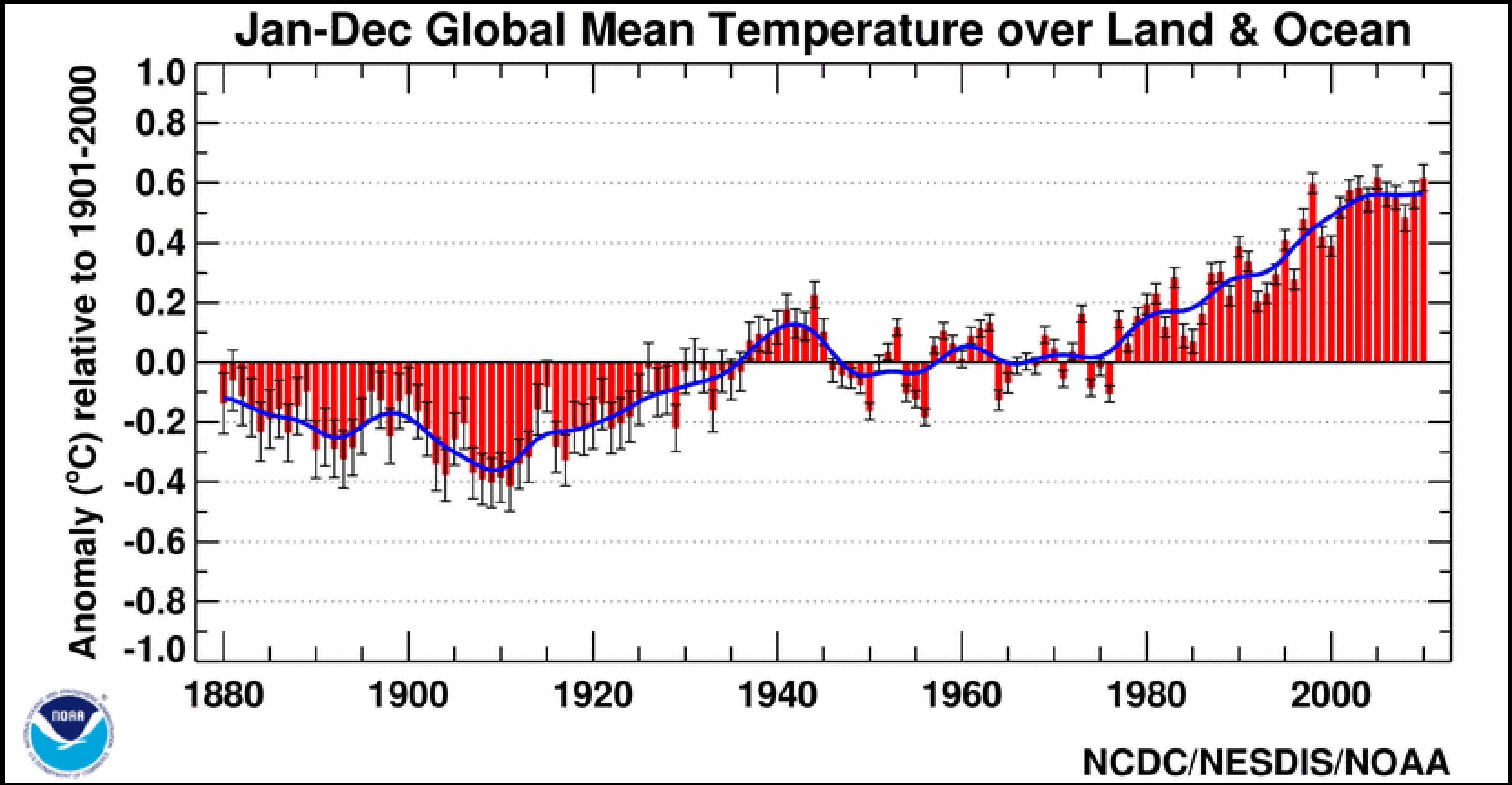
Arkansas, Colorado and Rio Grande Spring and Summer Streamflow Forecasts as of March 1, 2011



Prepared by
USDA, Natural Resources Conservation Service
National Water and Climate Center
Portland, Oregon
http://www.wcc.nrcs.usda.gov



Joint Institute for the Study of the Atmosphere and Ocean
http://jisao.washington.edu/pdo/



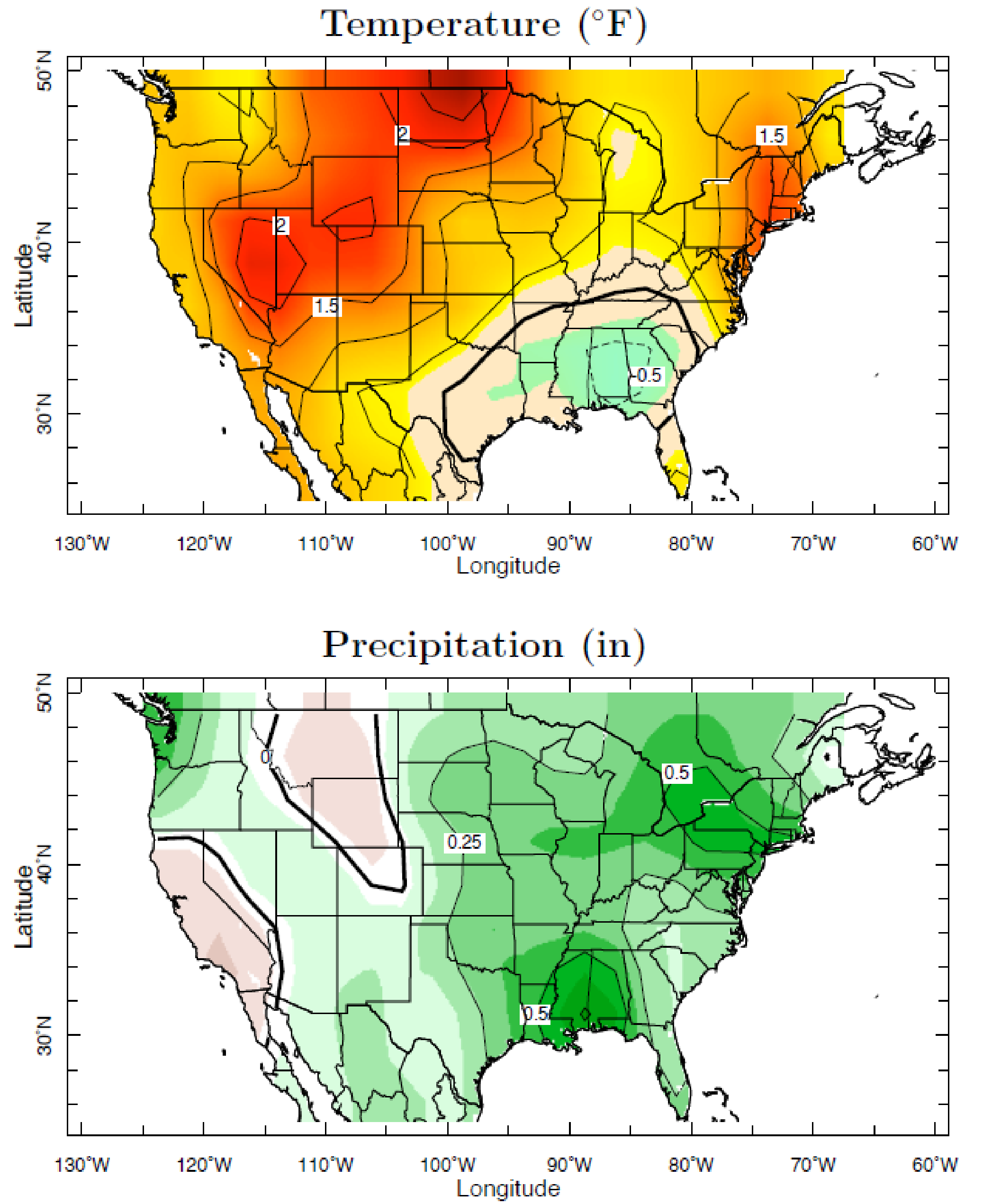
Increases:

Ocean heat content, Atmospheric water vapor

Decreases:

NH snow, sea ice extent, Stratospheric temperature

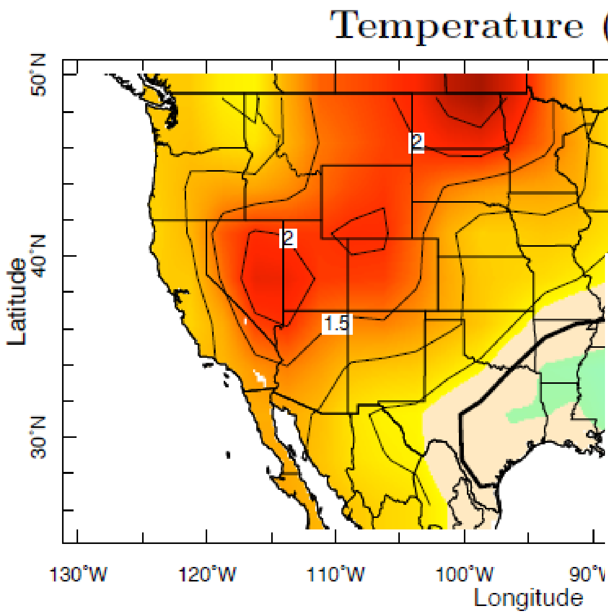
http://www.ncdc.noaa.gov/sotc/global/

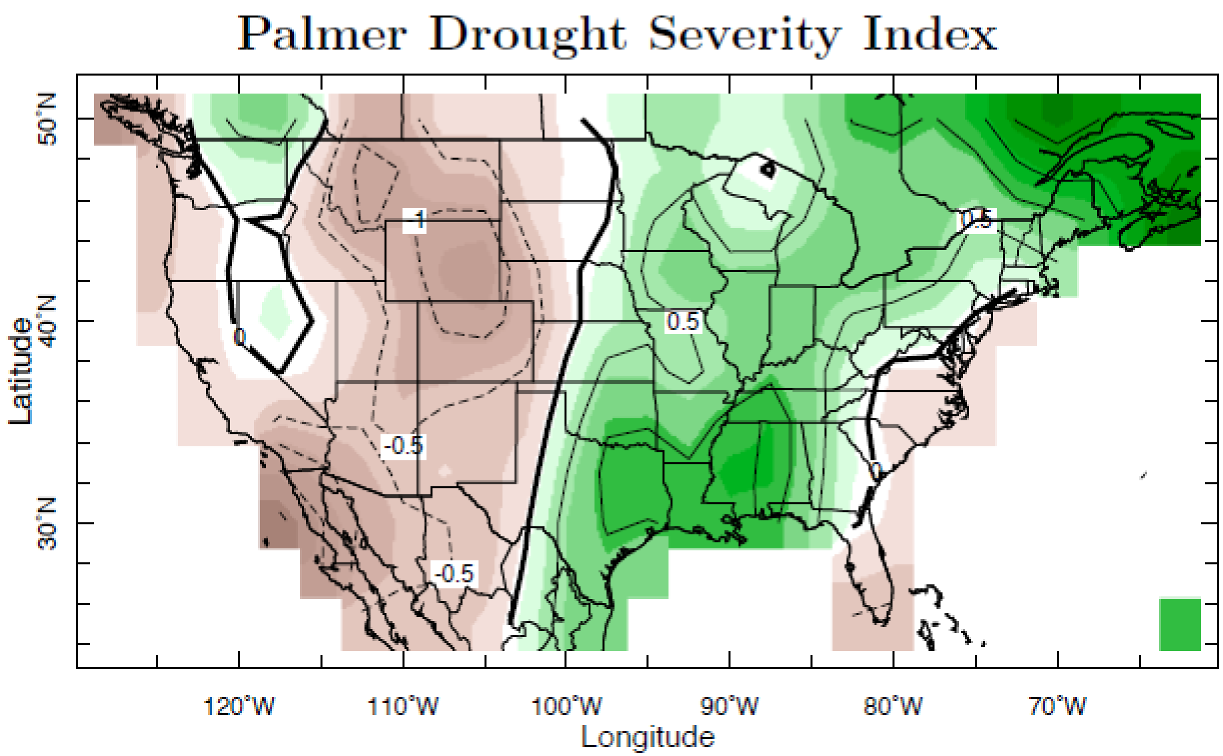


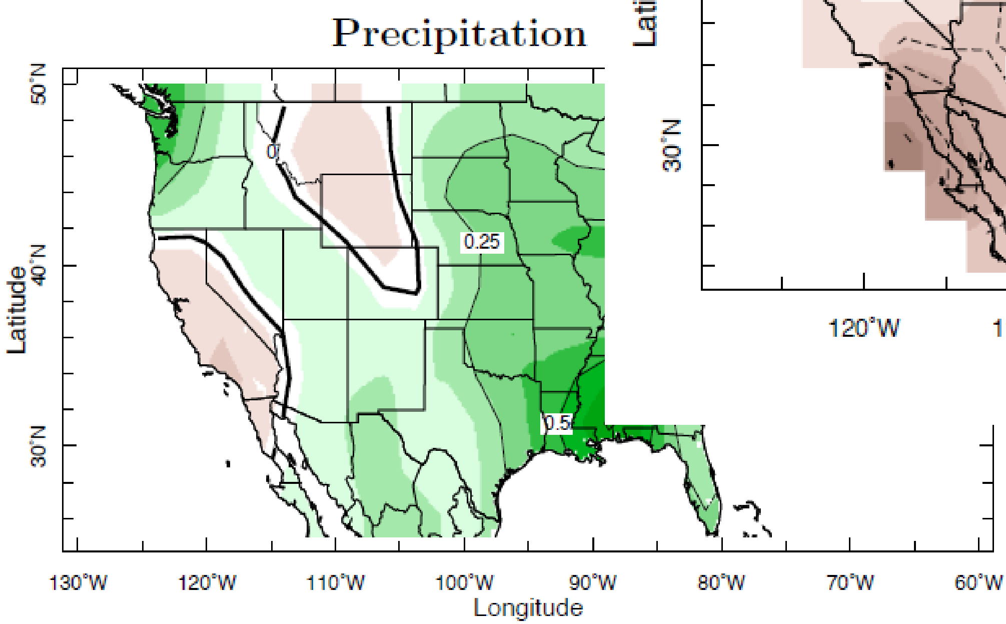
Trend Since 1895

R. Seager (presented at WGA Drought Workshop, September, 2010) Check http://www.westgov.org for PDF

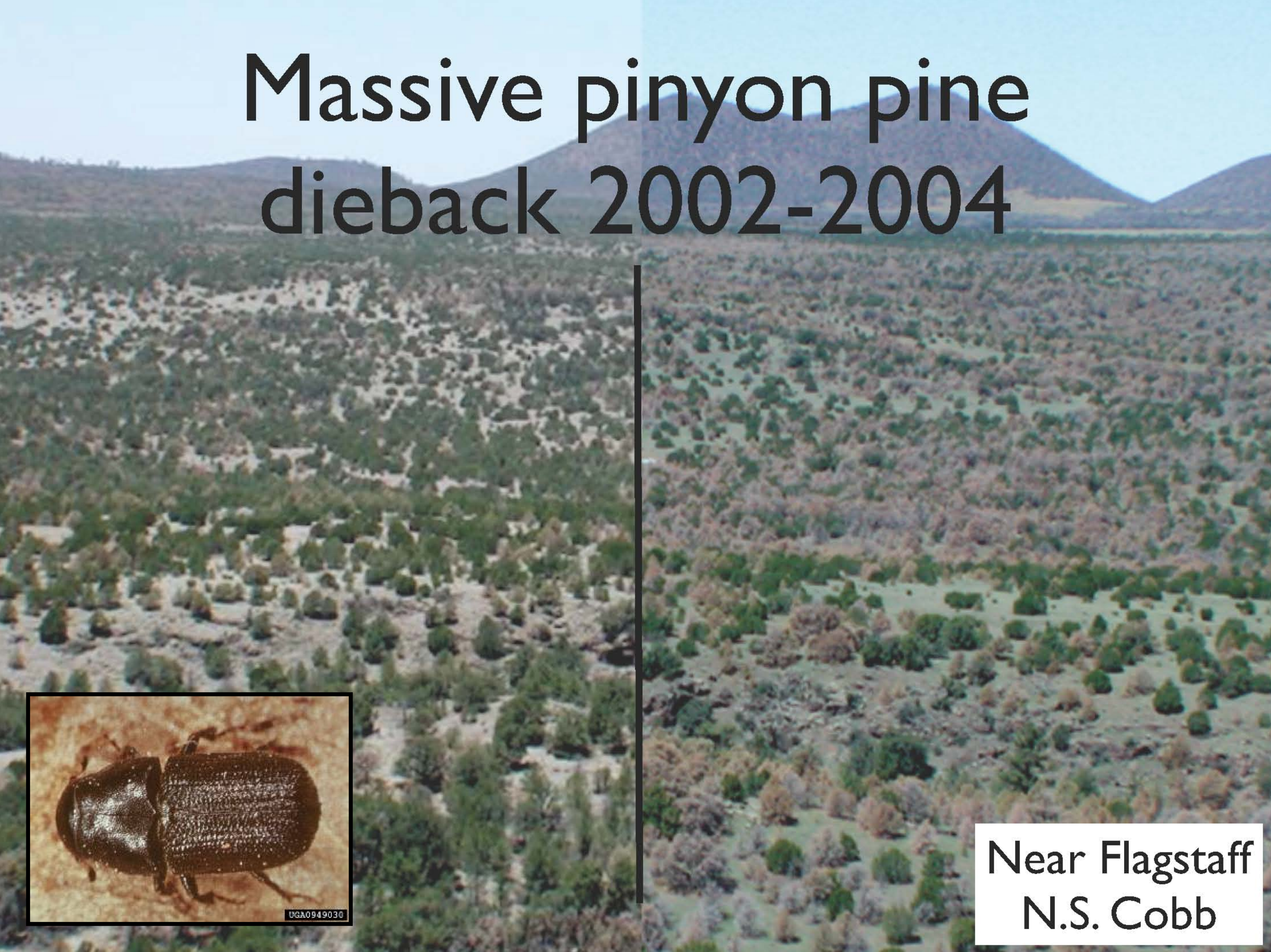
Trend Since 1895

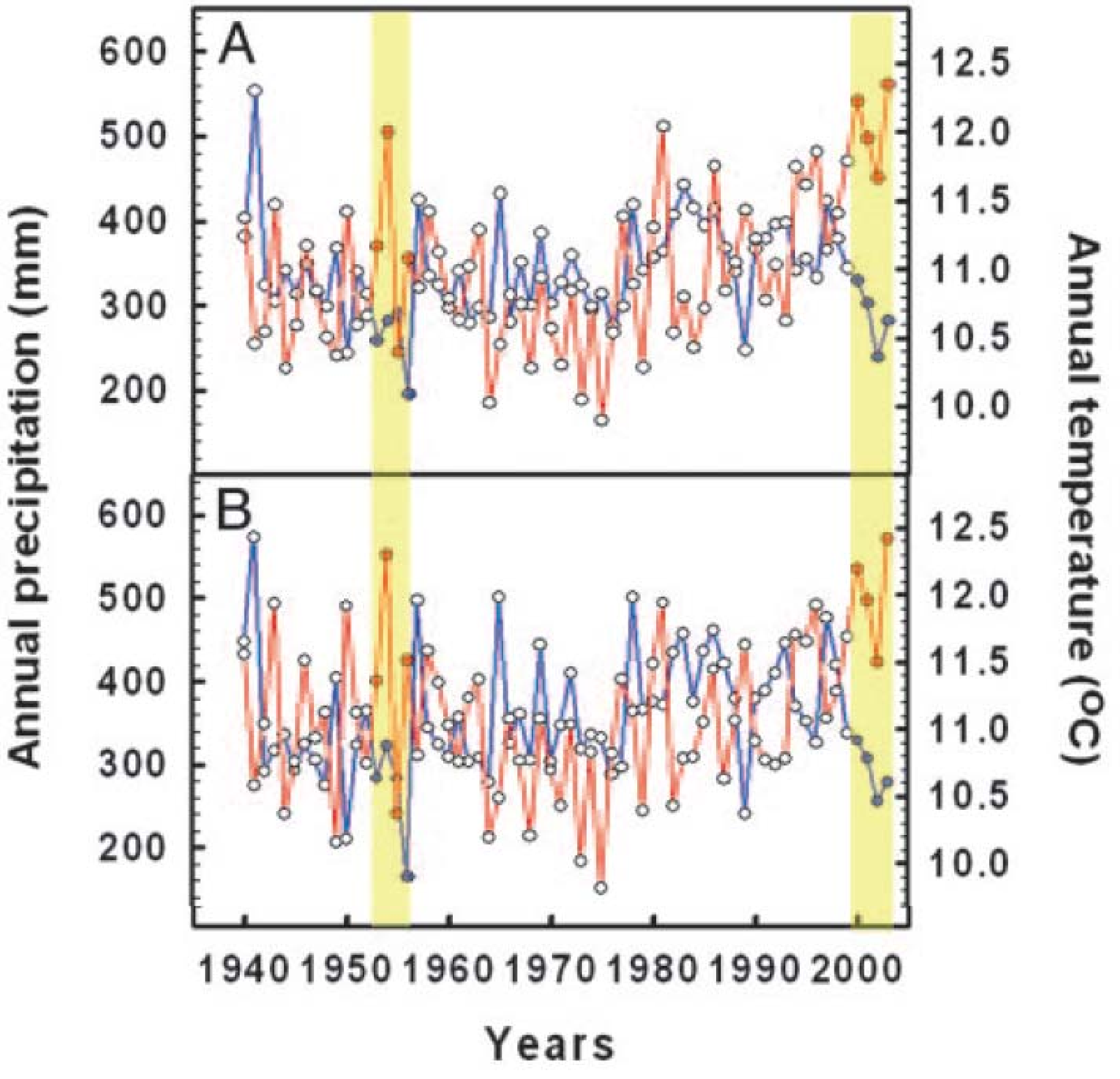




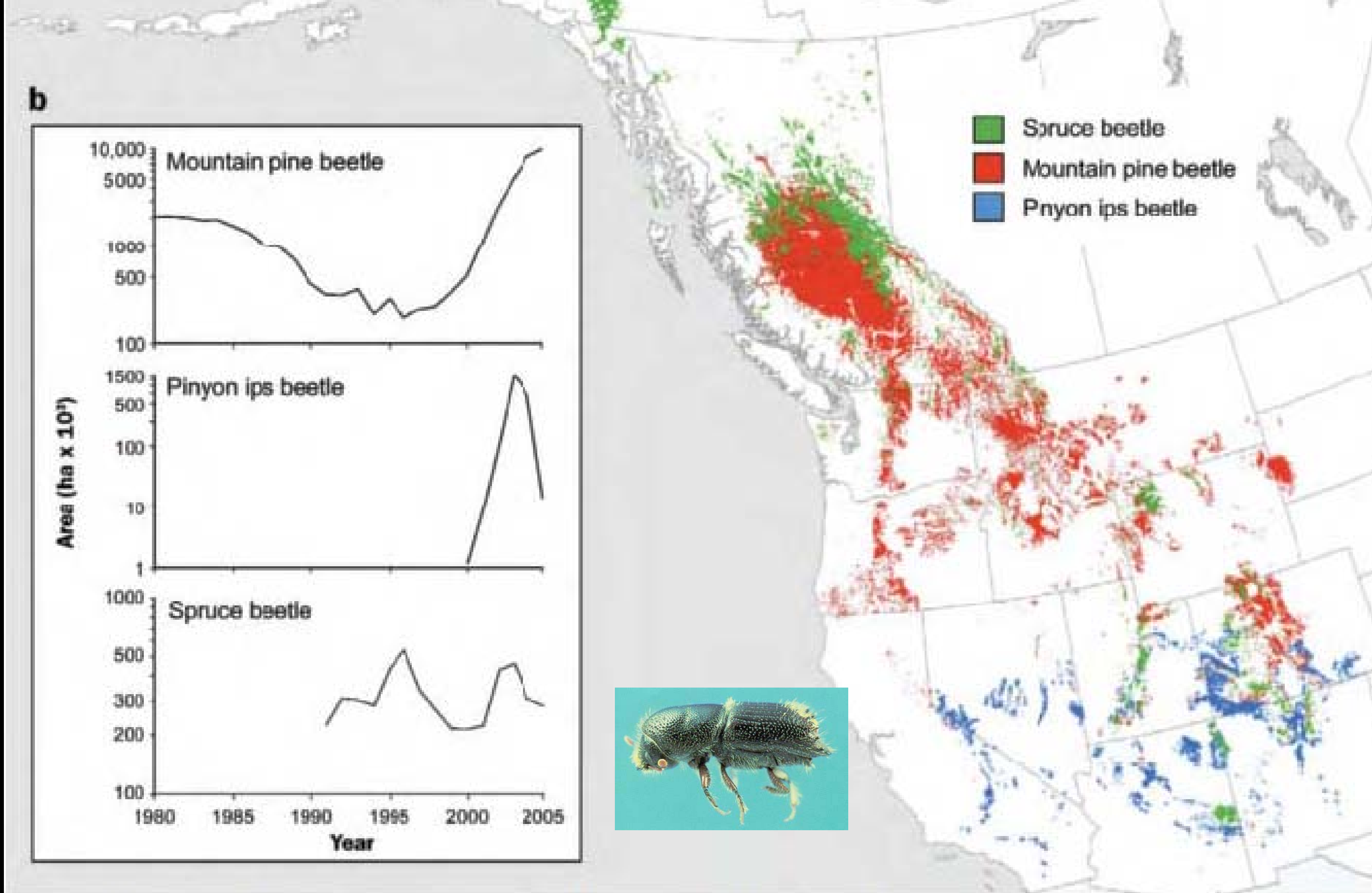


R. Seager (presented at WGA Drought Workshop, September, 2010) Check http://www.westgov.org for PDF

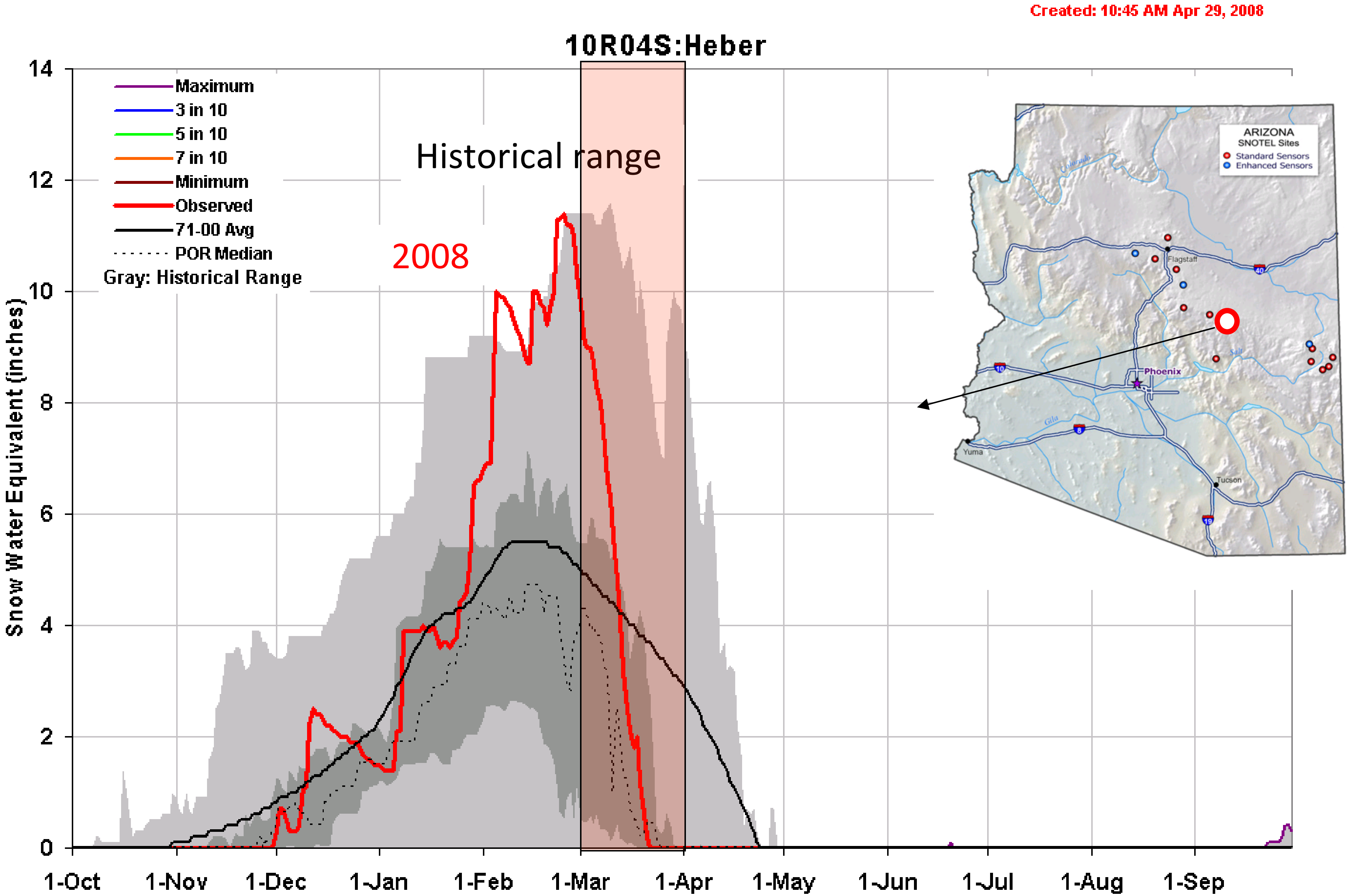

Massive pinyon pine dieback 2002-2004
UGA0949030
Near Flagstaff
N.S. Cobb



Breshears et al. 2005 – Proc. Nat. Acad. of Science



Courtesy of Craig Allen, USGS, Bandelier N.M.

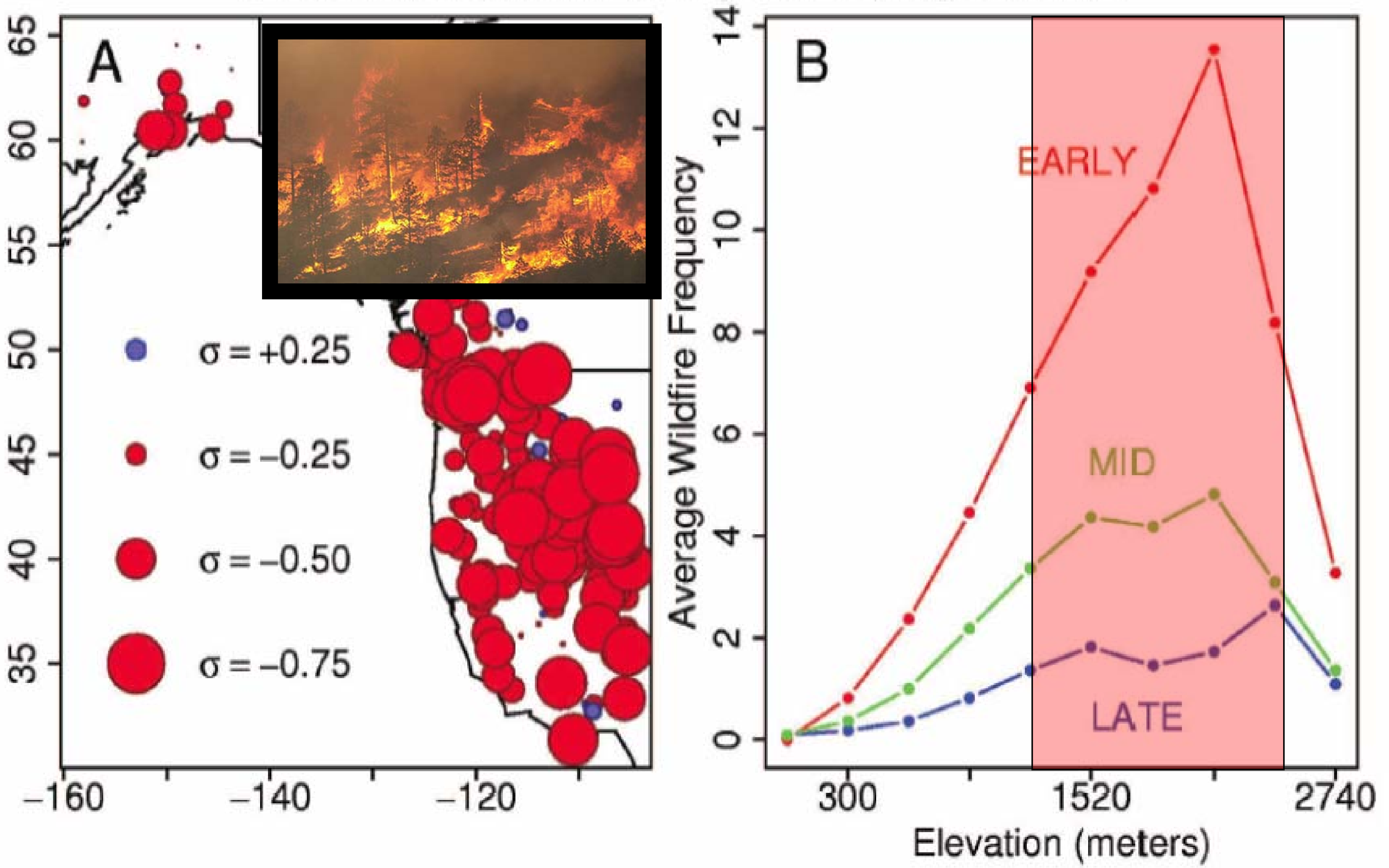


This is an automated product based on SNOTEL data, provisional data are subject to change.
This product combines the historical period of record data (**gray background**) with the recent daily data (**heavy red, left**) to project into the future (**colored lines, right**). This product does not consider climate information such as El Nino or short range weather forecasts and therefore should only be used as a seasonal planning tool. Contact Tom.Pagano@por.usda.gov 503 414 3010

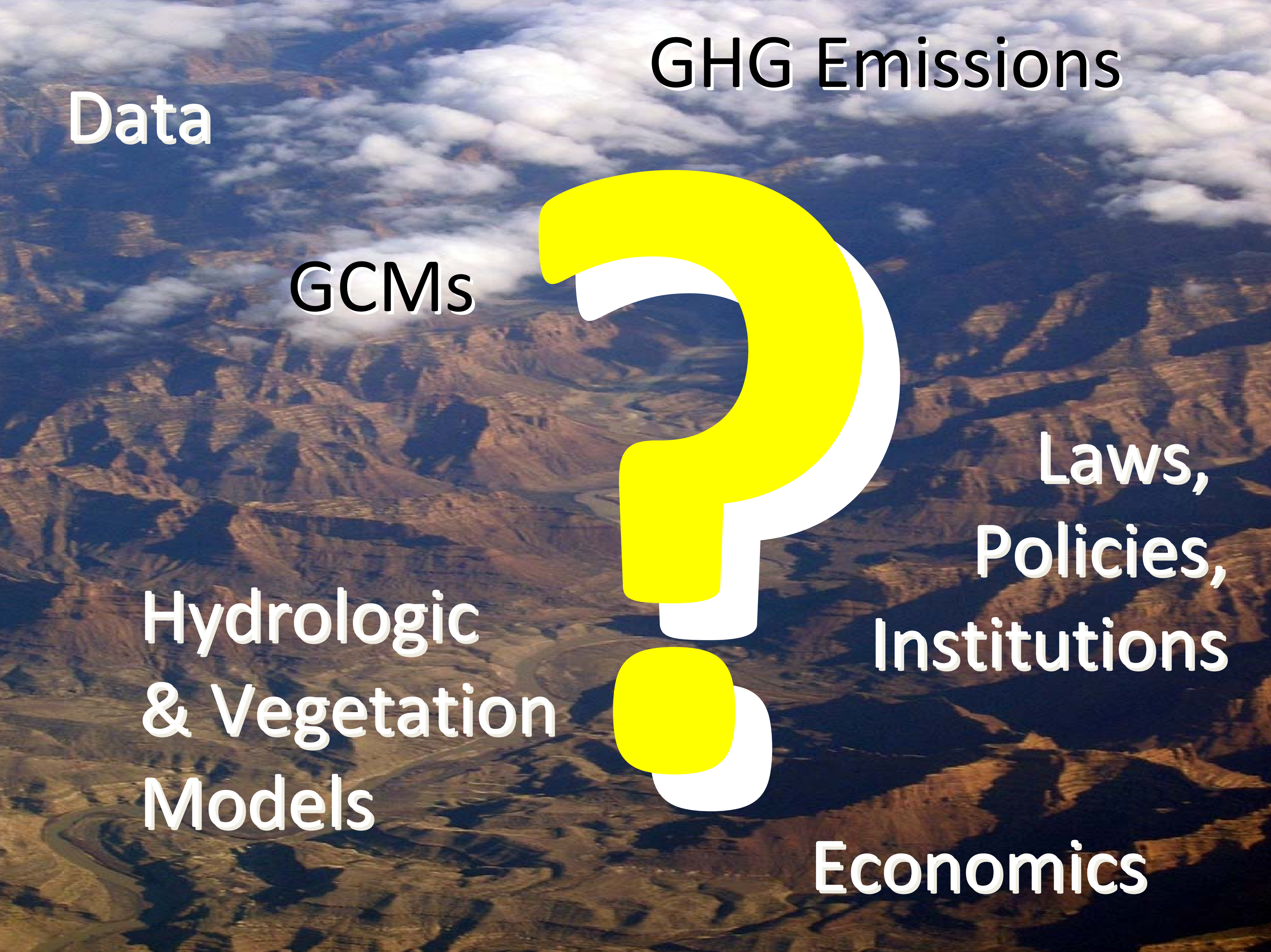
NRCS

ftp://ftp.wcc.nrcs.usda.gov/data/water/wcs/snow_proj

Forest Wildfire and the Timing of the Spring Snowmelt



Westerling et al., 2006 Science

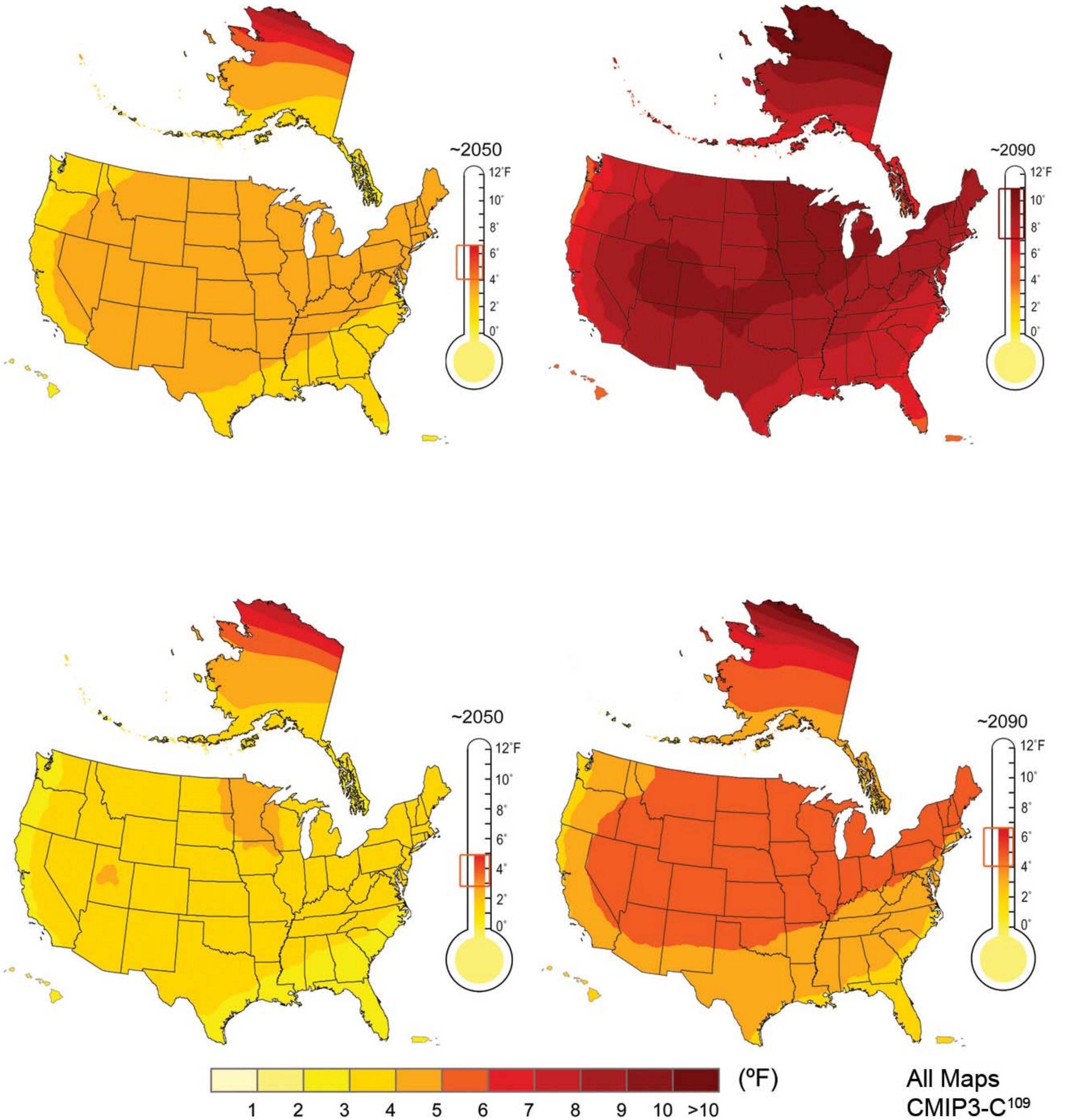

GHG Emissions
Data
GCMs
?
Laws,
Policies,
Institutions
Hydrologic
& Vegetation
Models
Economics

Hotter

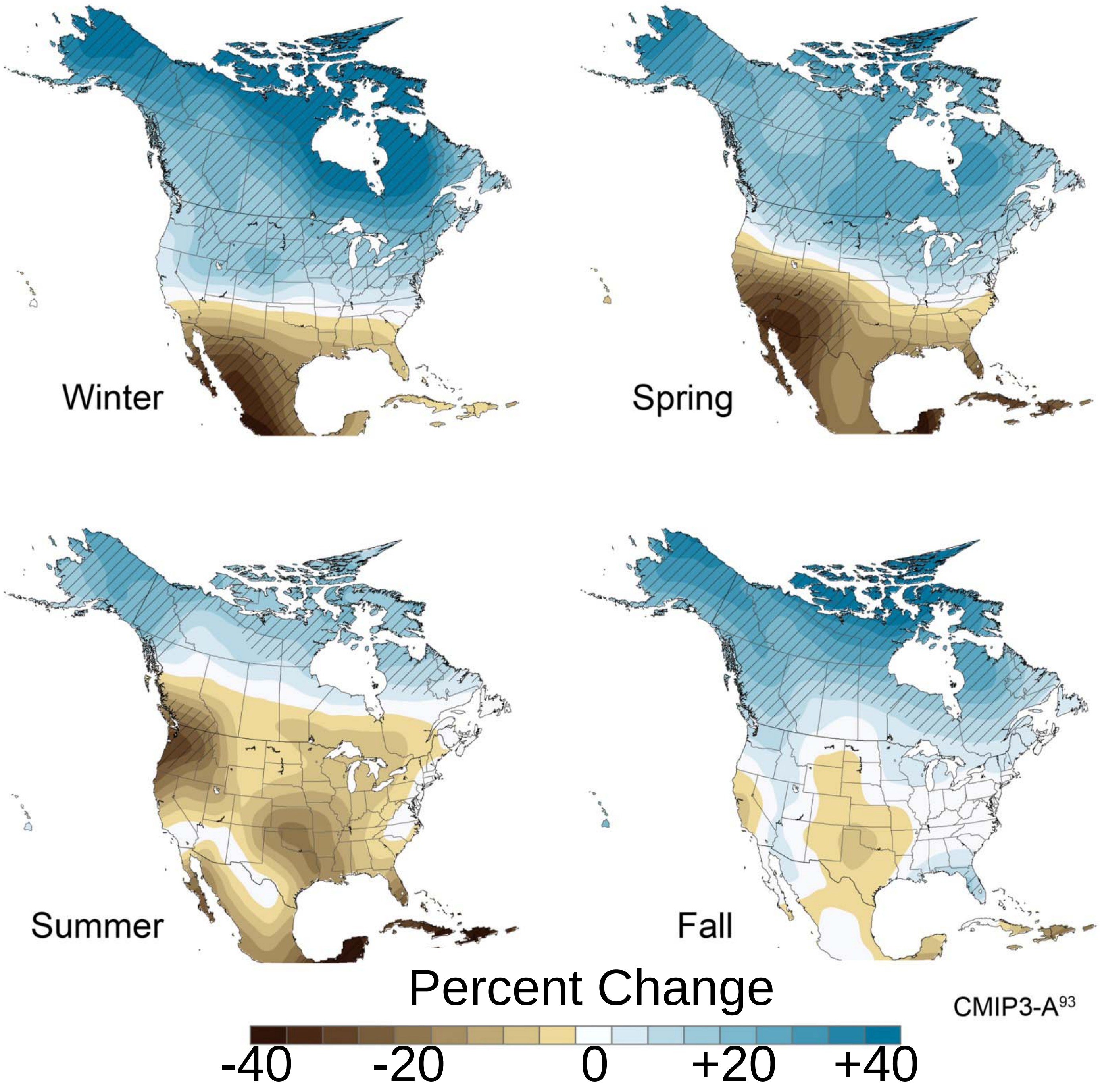
2040-2059 | 2080-2099

Higher Emissions Scenario

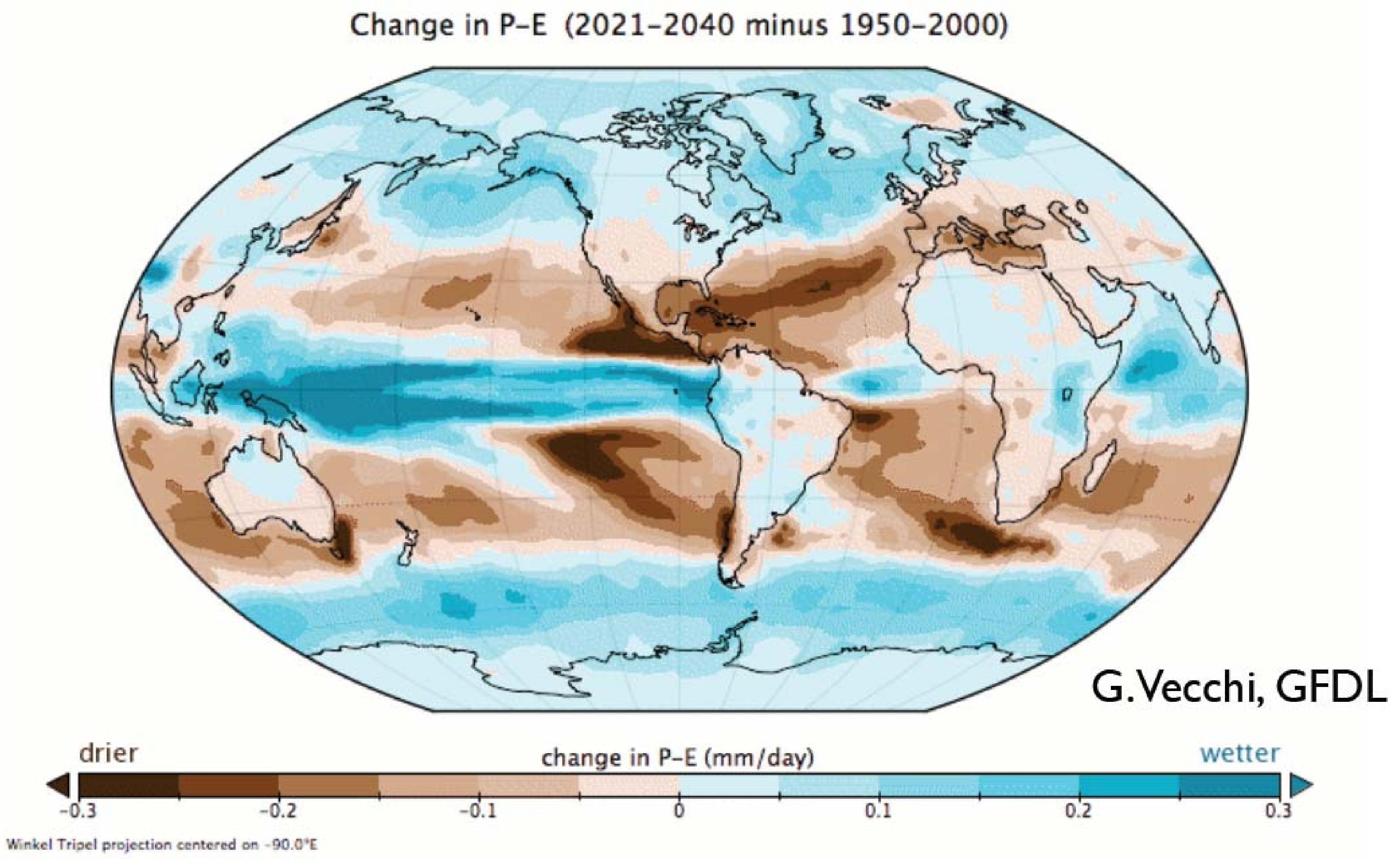
Lower Emissions Scenario



Drier



CCSP, 2008



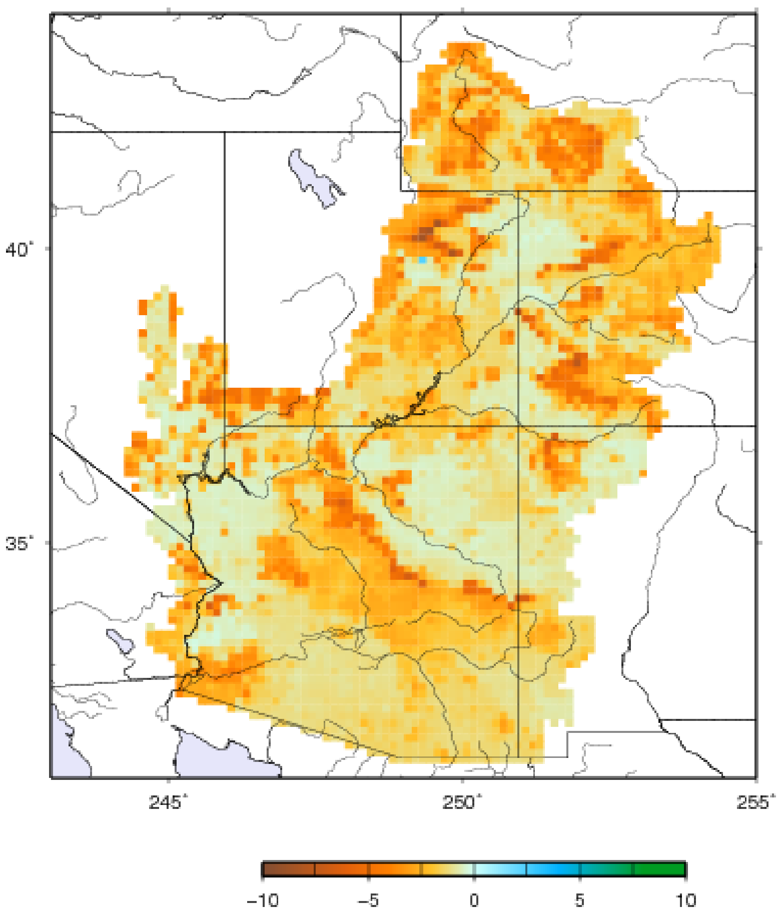
Seager, R., M. Ting, I. Held, Y. Kushir, J. Lu, and G. Vecchi, 2007: Model Projections of an Imminent Transition to a More Arid Climate in Southwestern North America. *Science, **316, 1181-1184.***

Analysis of Hydrologic Models

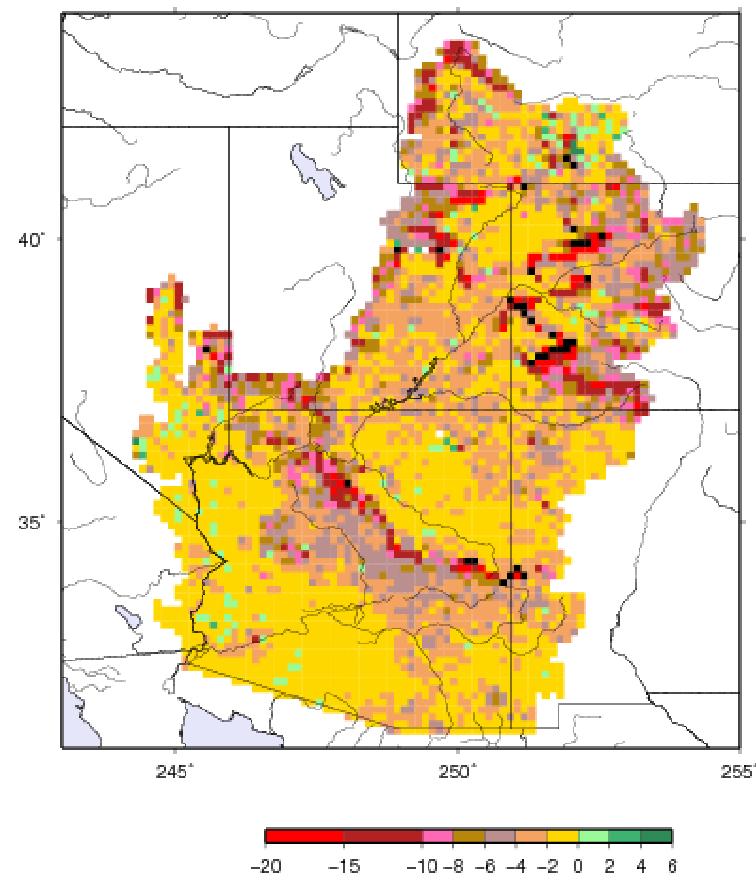
Climate Forcings	Land-surface Hydrologic Models	Measures
Historic Delta changes GCM scenarios	Variable Infiltration Capacity (VIC) McCabe 2-Layer Soil Water Balance Noah LSM Sacramento (SAC) Catchment LSM Community Land Model SAC operational others…	temp sensitivity = $\dfrac{\dfrac{Q_{ref+1} - Q_{ref}}{Q_{ref}}}{\text{deg C}}$ precip elasticity = $\dfrac{\dfrac{Q_{ref-1\%} - Q_{ref}}{Q_{ref}}}{\%}$

Elasticities

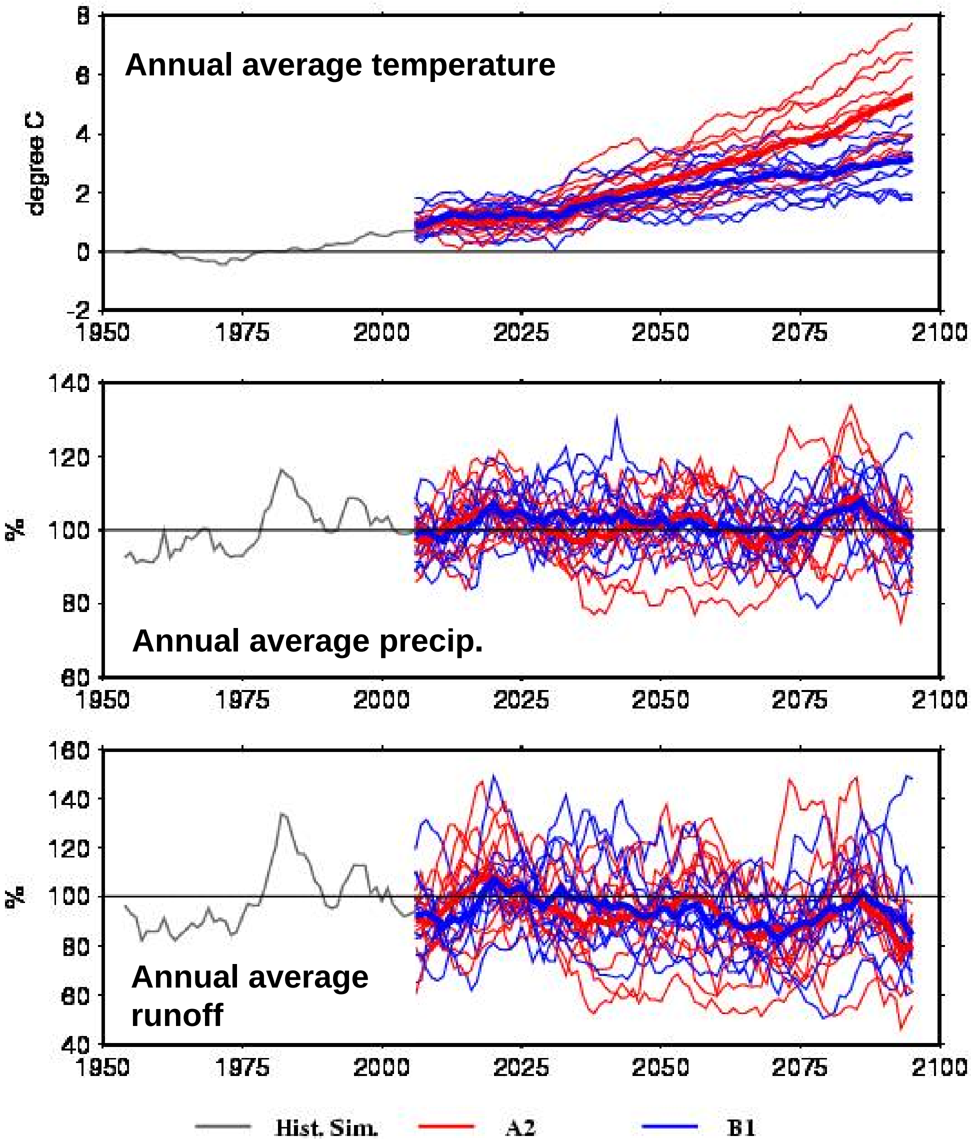
Precipitation



Temperature



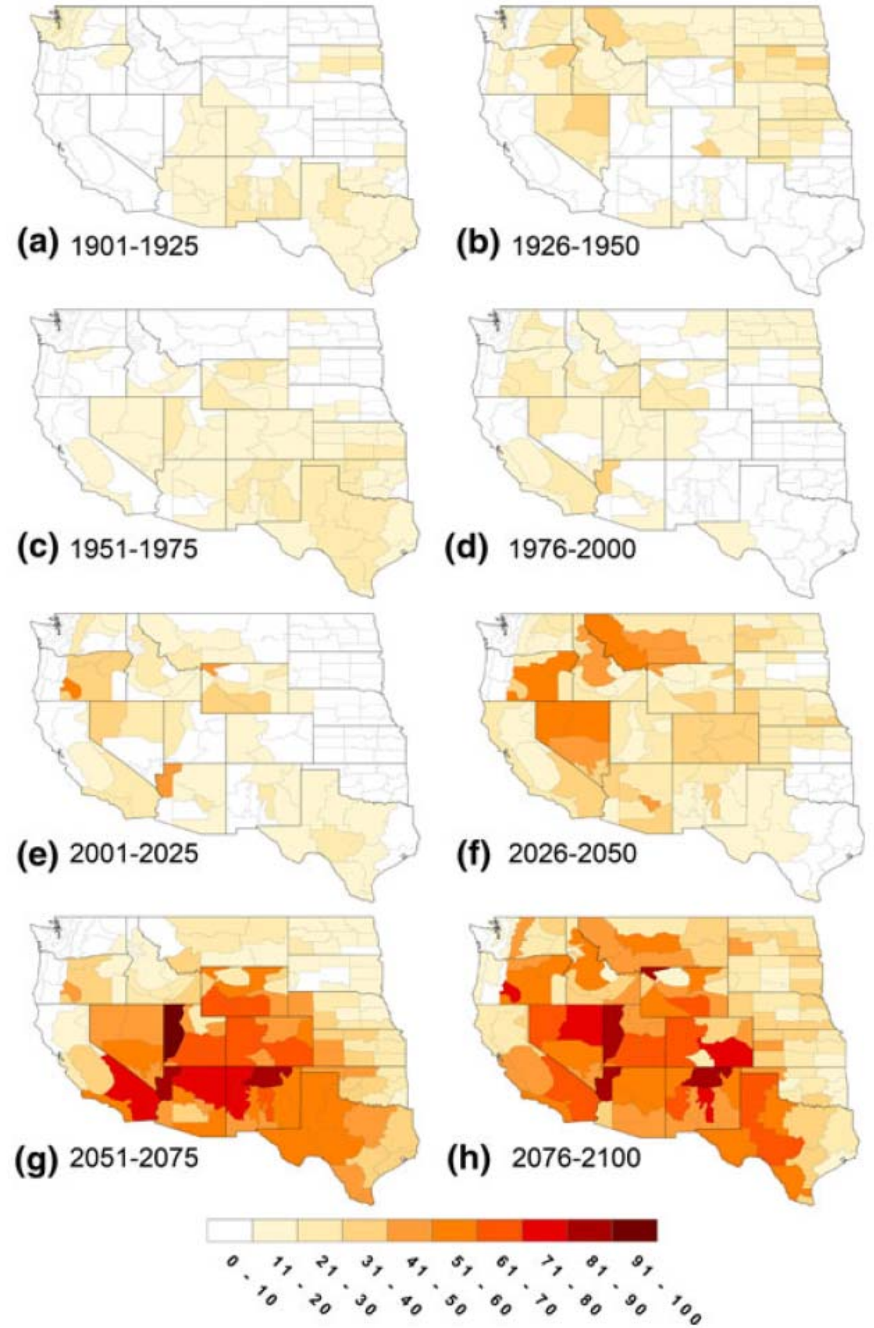
9-year running means expressed as departures from 1950-1999 means



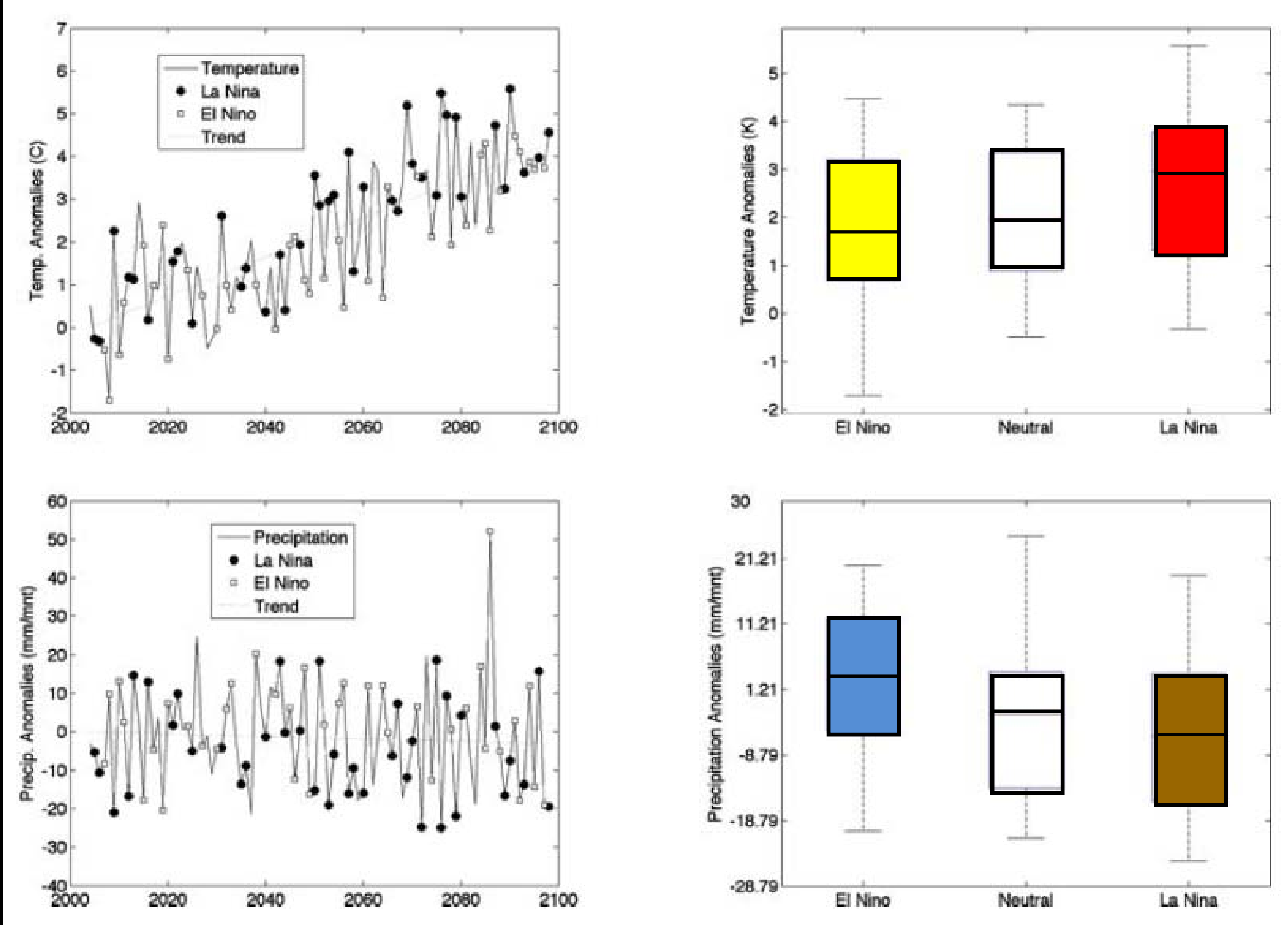
Christensen & Lettenmaier, 2006

Decreasing Runoff

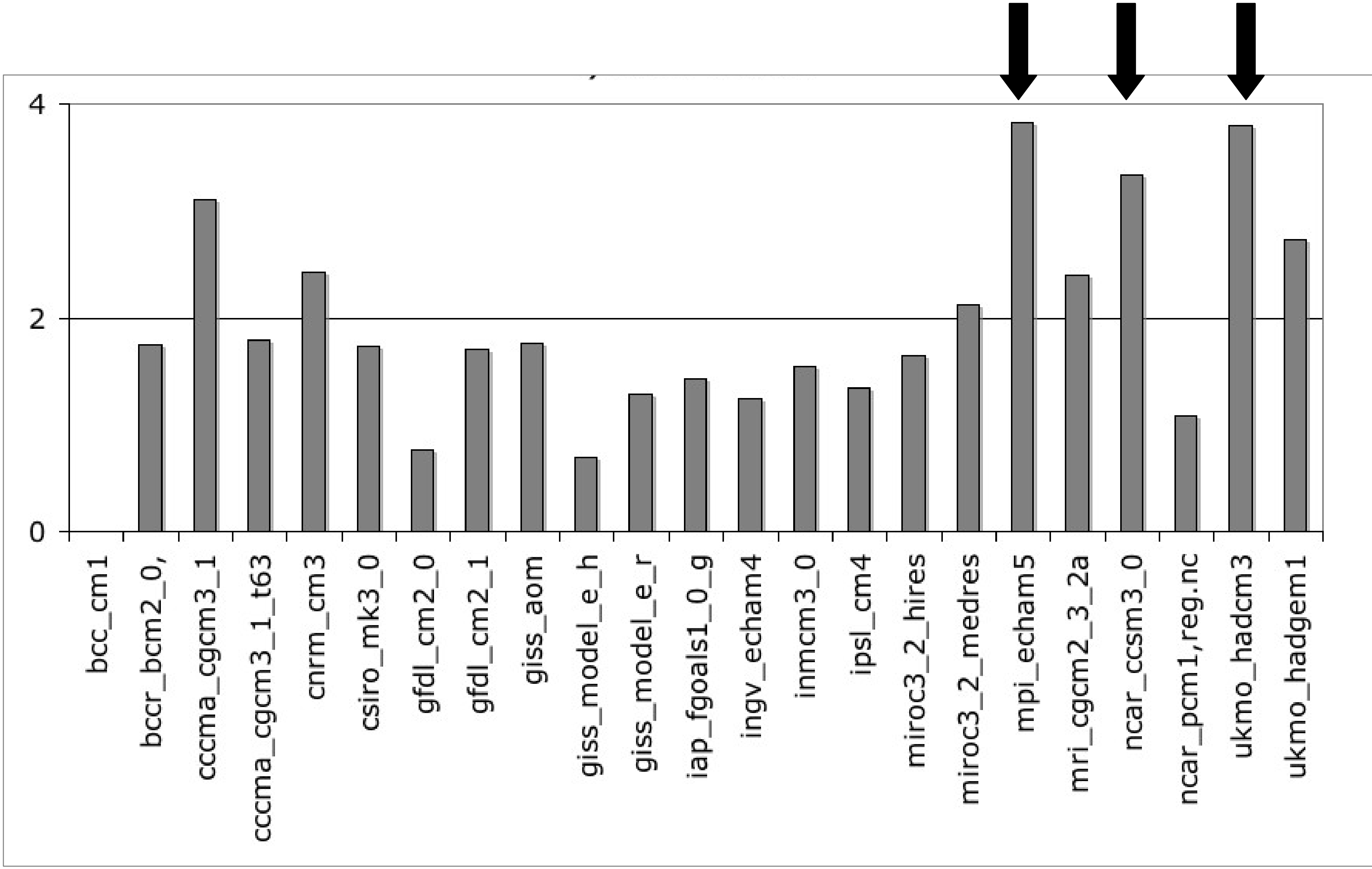
Percent of months in Severe drought (PDSI less than -3)



Gutzler and Robbins, 2010

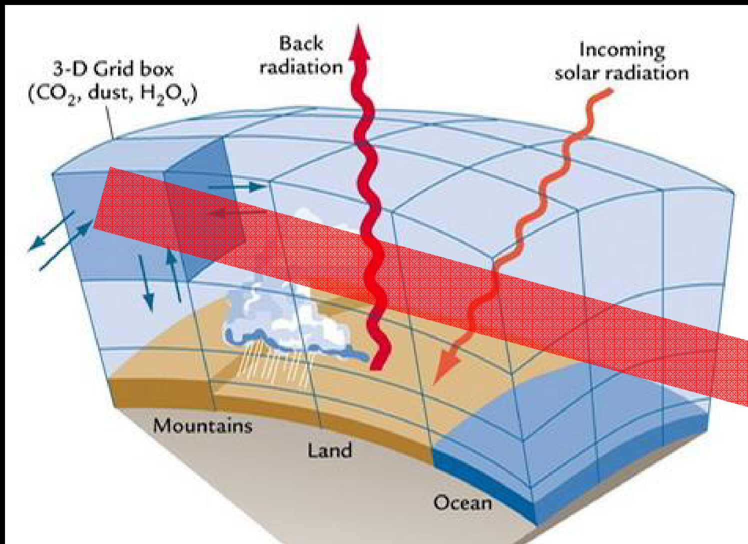


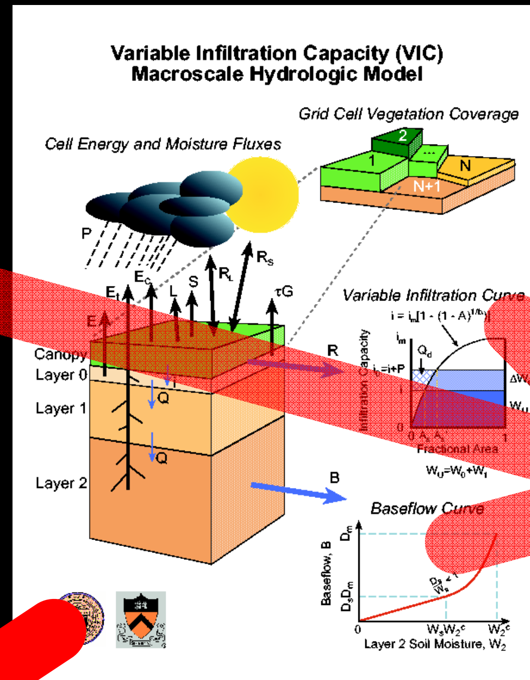
Dominguez, F., J. Cañon, and J. Valdes, 2010: IPCC-AR4 climate simulations for the Southwestern US: the importance of future ENSO projections. *Climatic Change*, ***99*****, *****499-514.***

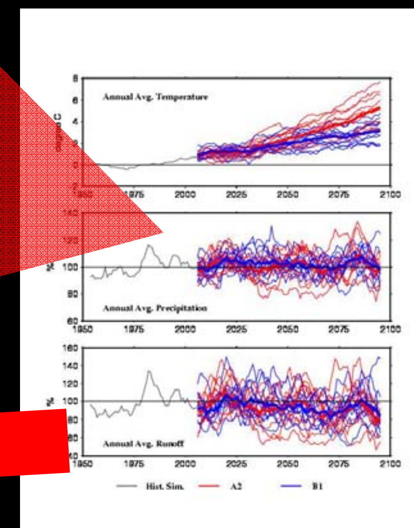


Dominguez, F., J. Cañon, and J. Valdes, 2010: IPCC-AR4 climate simulations for the Southwestern US: the importance of future ENSO projections. *Climatic Change*, ***99, 499-514.***

Methodology







There are basically two approaches to downscale coupled climate model projections :

Statistical Downscaling

These methods assume a relationship between large-scale atmospheric variables (predictors) and local climate variables (predictands).

- Pro : Cheap and computationally efficient.
- Pro : Can use many different scenarios, model runs.
- Pro : Easily transferable to other regions.

- Con : Requires long and reliable observation data.
- Con : Depends on choice of predictors.
- Con : Assumes stationarity of predictor-predictand relationship.
- Con : Cannot account for feedbacks.

Francina Dominguez et al., (UA)

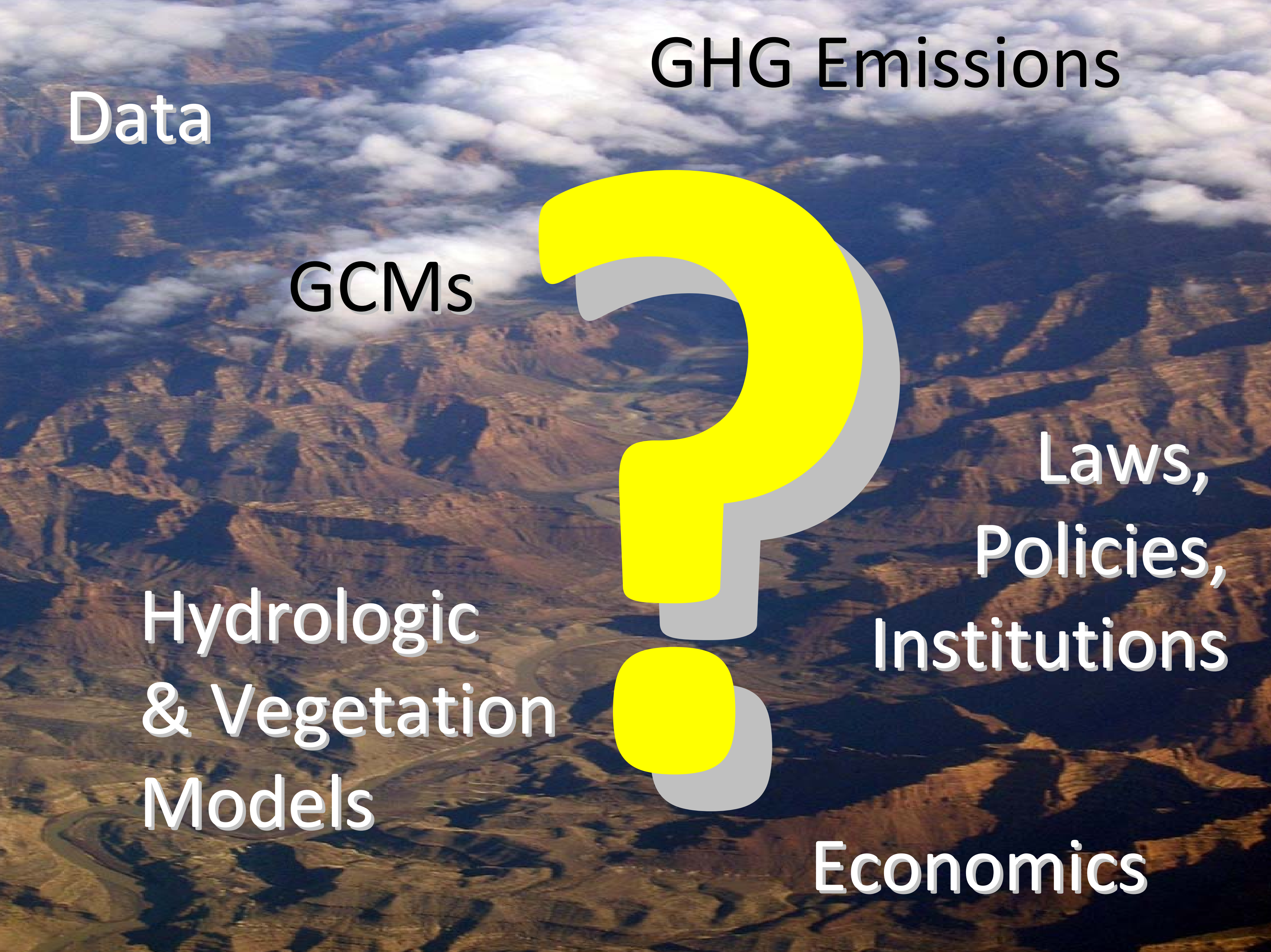
The second downscaling approach is dynamical downscaling.

Dynamical Downscaling

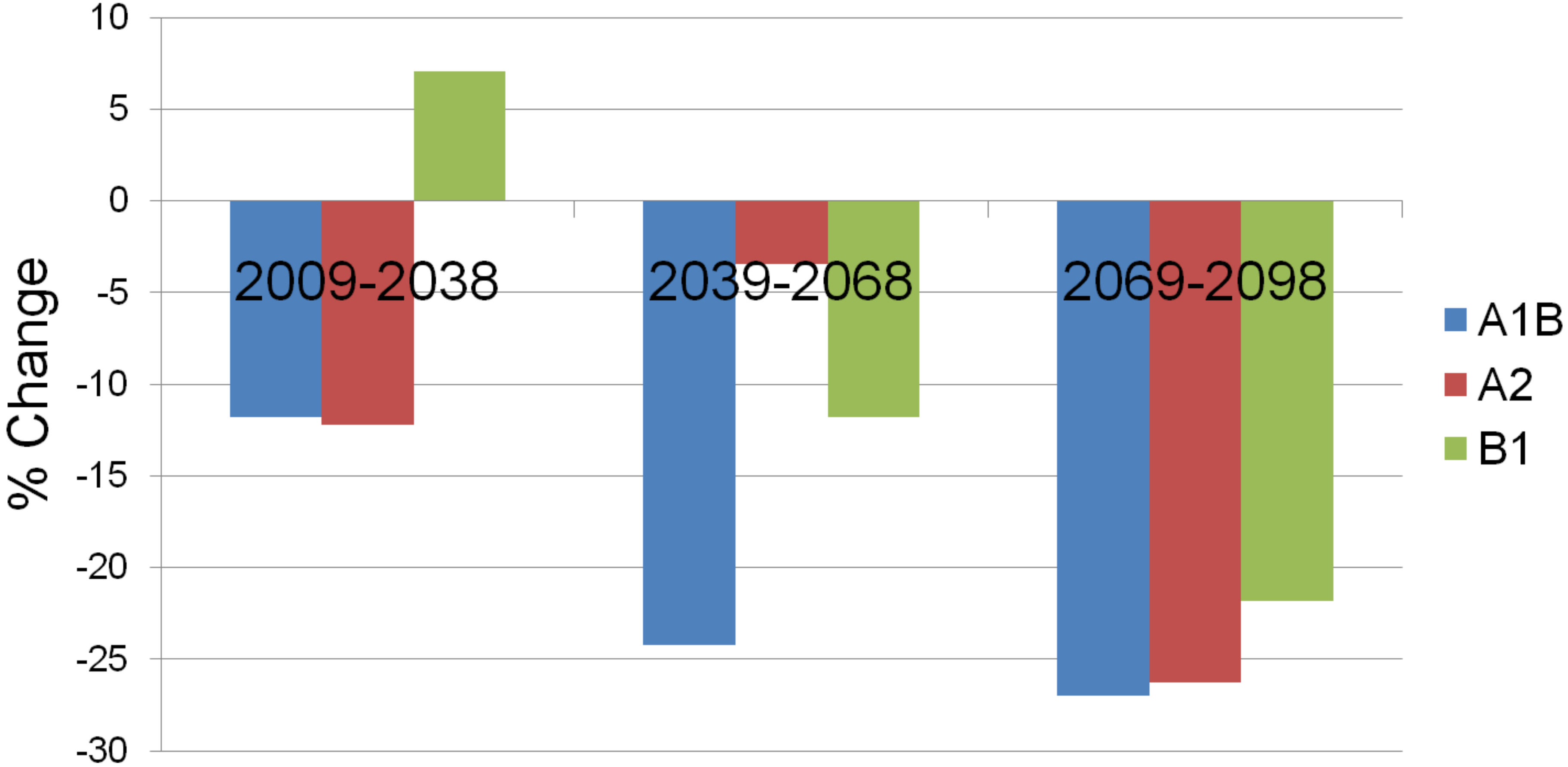
- Pro : Produces responses based on physically consistent processes.
- Pro : Captures feedbacks.
- Pro : Can model changes that have never been observed in historical record.
- Pro : Useful where topographic controls are important.

- Con : Requires significant computational power.
- Con : Limited amounts of models / runs / timescales.
- Con : Dependant on GCM boundary forcing.
- Con : Problems with drifting of large-scale climate.

Francina Dominguez et al., (UA)

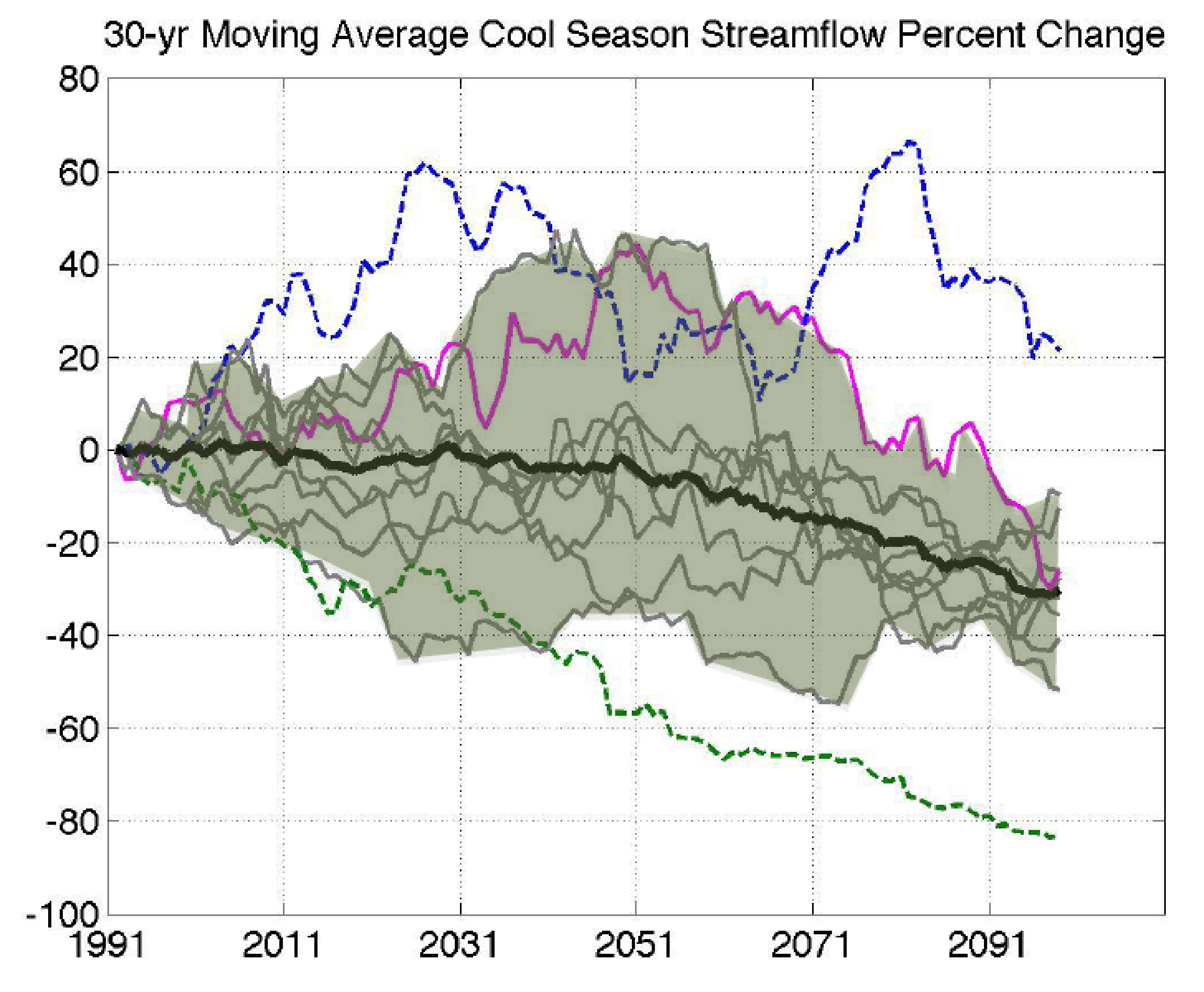

GHG Emissions
Data
GCMs
Laws,
Policies,
Institutions
Hydrologic
& Vegetation
Models
Economics

Change in Streamflow Volume

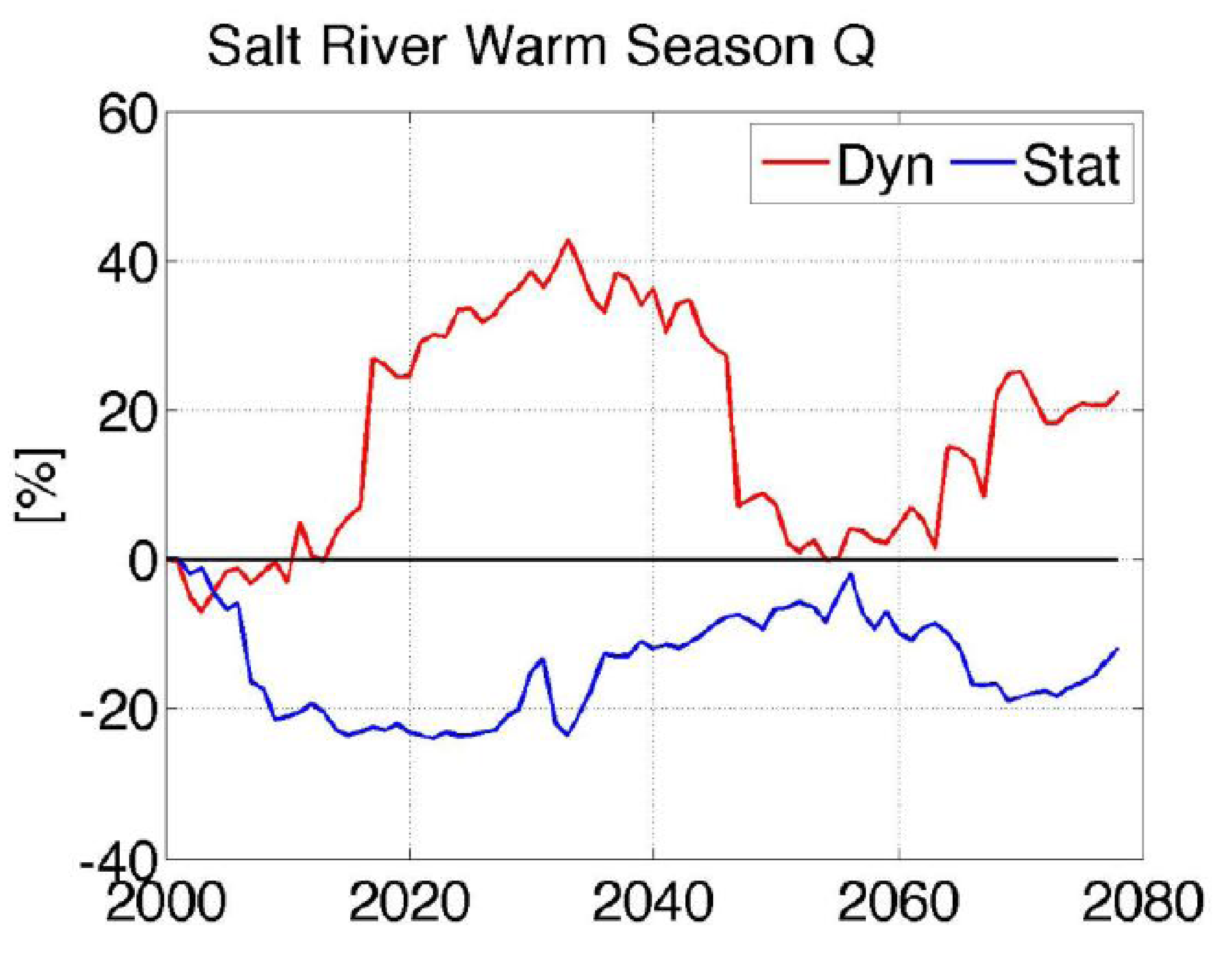


Salt River Basin

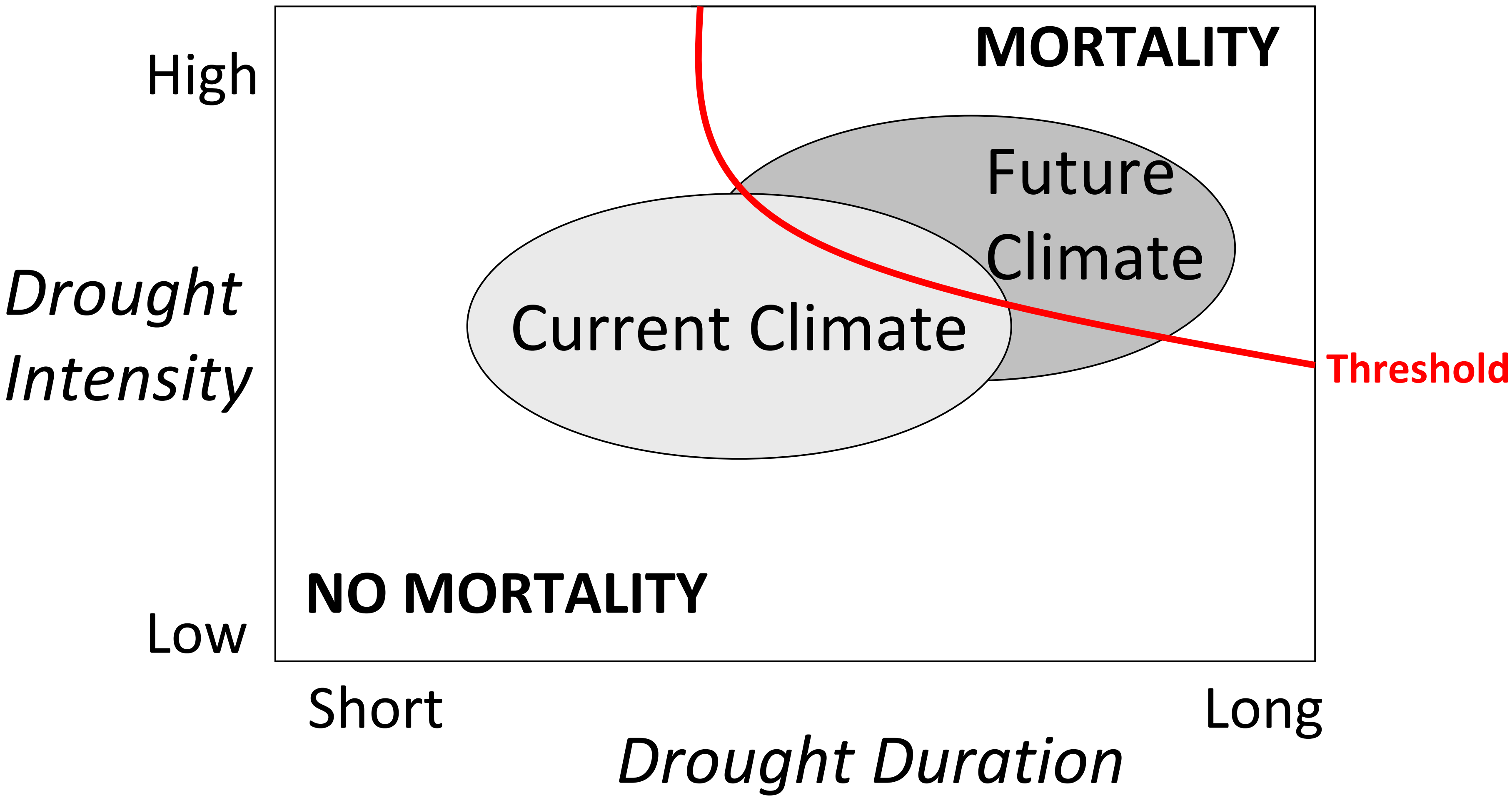
Rajagopal et al. 2010



Dominguez, Rajagopal, Castro, Troch, Demaria, Gupta, Durcik, Chang
University of Arizona

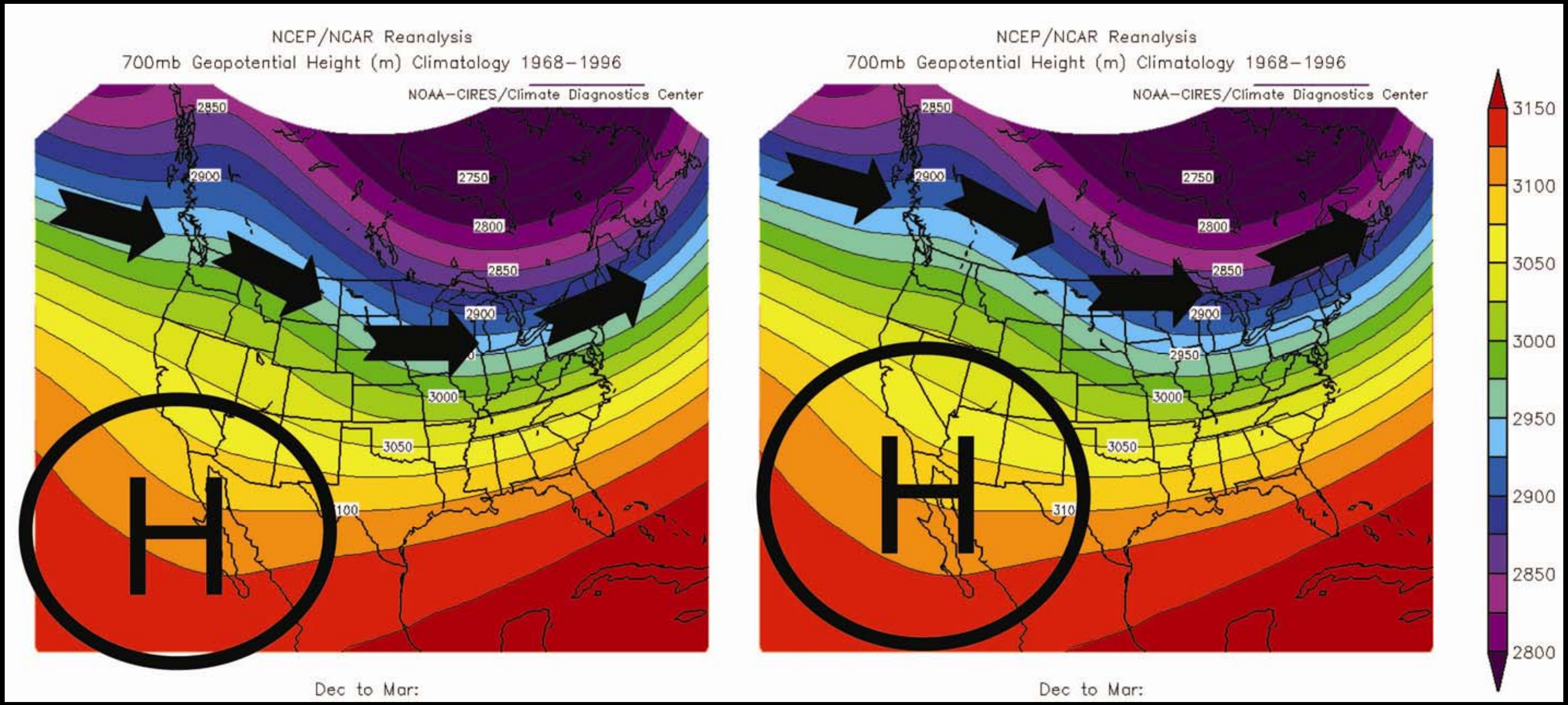


Dominguez, Rajagopal, Castro, Troch, Demaria, Gupta, Durcik, Chang
University of Arizona

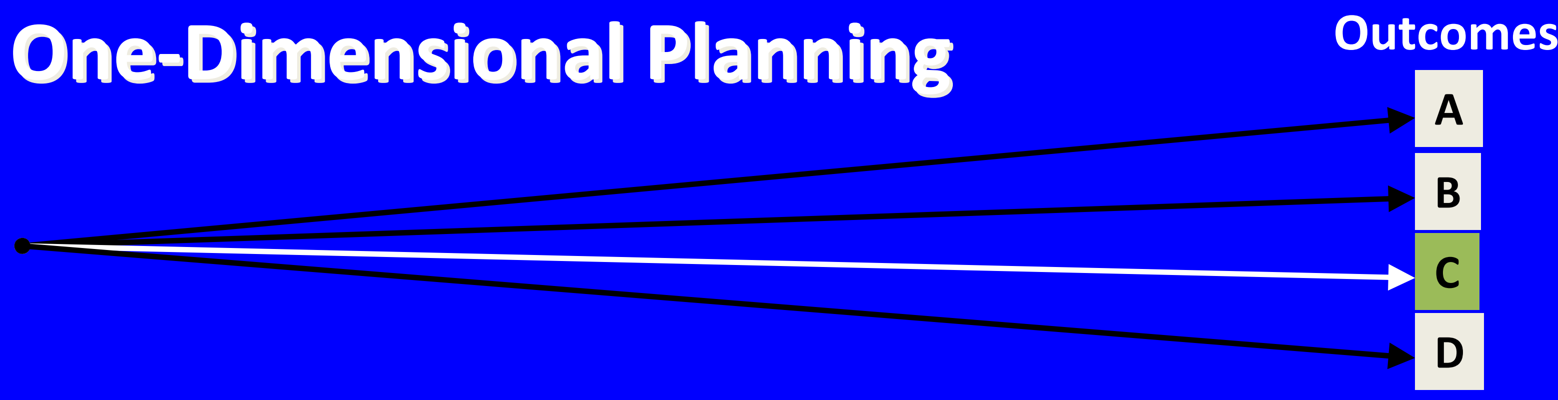

MORTALITY
High
Future
Climate
Drought
Intensity
Current Climate
Threshold
NO MORTALITY
Low
Short
Long
Drought Duration

Average Winter Jet Stream

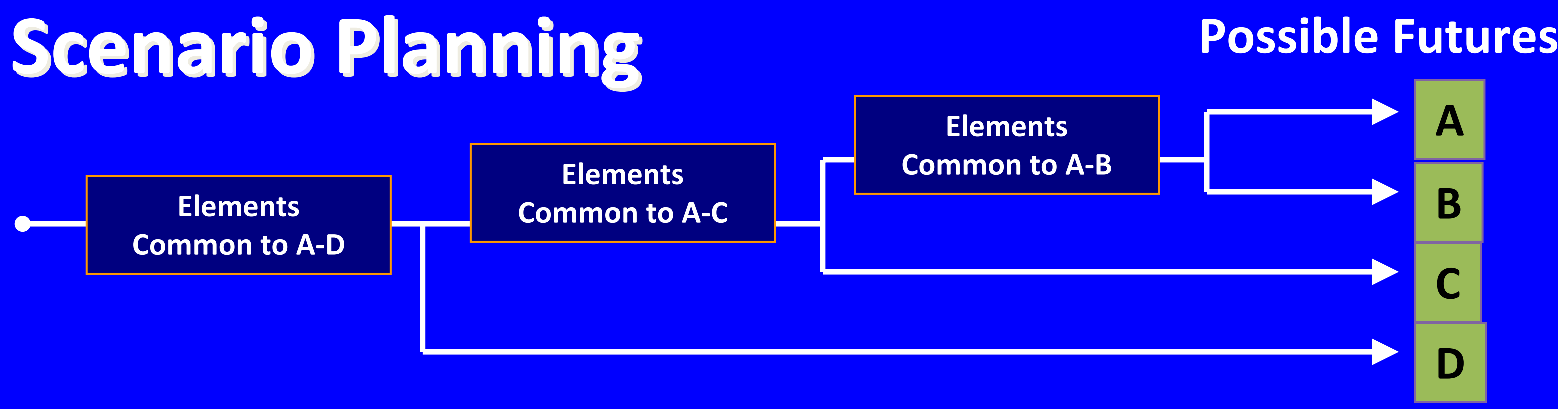
Climate Change Winter Jet Stream



One-Dimensional Planning



Scenario Planning

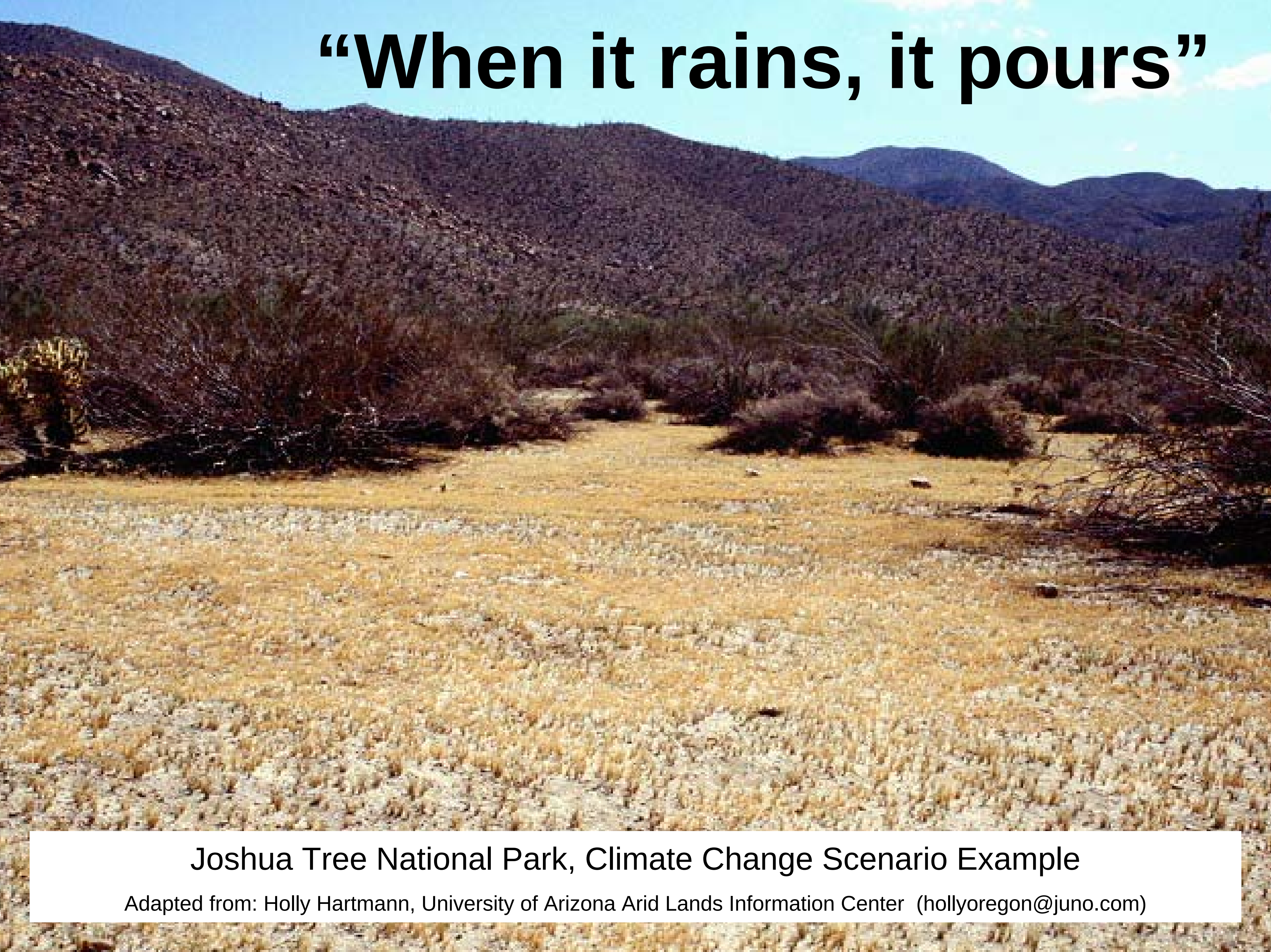


“Summer Soaker”

Joshua Tree National Park, Climate Change Scenario Example

Adapted from: Holly Hartmann, University of Arizona Arid Lands Information Center (hollyoregon@juno.com)

“When it rains, it pours”



Joshua Tree National Park, Climate Change Scenario Example

Adapted from: Holly Hartmann, University of Arizona Arid Lands Information Center (hollyoregon@juno.com)

“Dune”

Joshua Tree National Park, Climate Change Scenario Example

Adapted from: Holly Hartmann, University of Arizona Arid Lands Information Center (hollyoregon@juno.com)

State of the System (1999-2010)

WY	Unregulated inflow into Powell % of Average	Powell and Mead Storage maf	Powell and Mead % Capacity
1999	109	47.59	95
2000	62	43.38	86
2001	59	39.01	78
2002	25	31.56	63
2003	52	27.73	55
2004	49	23.11	46
2005	104	27.16	54
2006	71	25.80	51
2007	70	24.43	49
2008	102	26.52	53
2009	88	26.40	53
2010*	68	24.95	50

* Inflow based on latest CBRFC forecast; storage and percent capacity based on March 2010 24-Month Study

RECLAMATION

2007 Interim Guidelines

- Operations specified for full range of operation for Lake Powell and Lake Mead
- Strategy for shortages in the Lower Basin
- Mechanism in Lower Basin to encourage efficient and flexible use and management of Colorado River water (ICS)
- In place for an interim period (through 2026)

RECLAMATION

Lake Powell & Lake Mead Operational Diagrams and Current Conditions

Lake Powell		
Elevation (feet)	**Operation According to the Interim Guidelines**	**Live Storage (maf)[1]**
3,700	**Equalization Tier** Equalize, avoid spills or release 8.23 maf	24.3
3,636 - 3,666 (2008-2026)	**Upper Elevation Balancing Tier[3]** Release 8.23 maf; if Lake Mead < 1,075 feet, balance contents with a min/max release of 7.0 and 9.0 maf	15.5 - 19.3 (2008-2026)
3,612 3/21/11		12.97 3/21/11
3,575	**Mid-Elevation Release Tier** Release 7.48 maf; if Lake Mead < 1,025 feet, release 8.23 maf	9.5
3,525	**Lower Elevation Balancing Tier** Balance contents with a min/max release of 7.0 and 9.5 maf	5.9
3,490		4.0
3,370		0

Lake Mead		
Elevation (feet)	**Operation According to the Interim Guidelines**	**Live Storage (maf)[1]**
1,220	**Flood Control Surplus or Quantified Surplus Condition** Deliver > 7.5 maf	25.9
1,200 (approx.)[2]	**Domestic Surplus or ICS Surplus Condition** Deliver > 7.5 maf	22.9 (approx.)[2]
1,145	**Normal or ICS Surplus Condition** Deliver ≥ 7.5 maf	15.9
1,105		11.9
1,096 3/21/11		11.12 3/21/11
1,075	**Shortage Condition** Deliver 7.167[4] maf	9.4
1,050	**Shortage Condition** Deliver 7.083[5] maf	7.5
1,025	**Shortage Condition** Deliver 7.0[6] maf Further measures may be undertaken[7]	5.8
1,000		4.3
895		0

Diagram not to scale

[1] Acronym for million acre-feet

[2] This elevation is shown as approximate as it is determined each year by considering several factors including Lake Powell and Lake Mead storage, projected Upper Basin and Lower Basin demands, and an assumed inflow.

[3] Subject to April adjustments which may result in a release according to the Equalization Tier

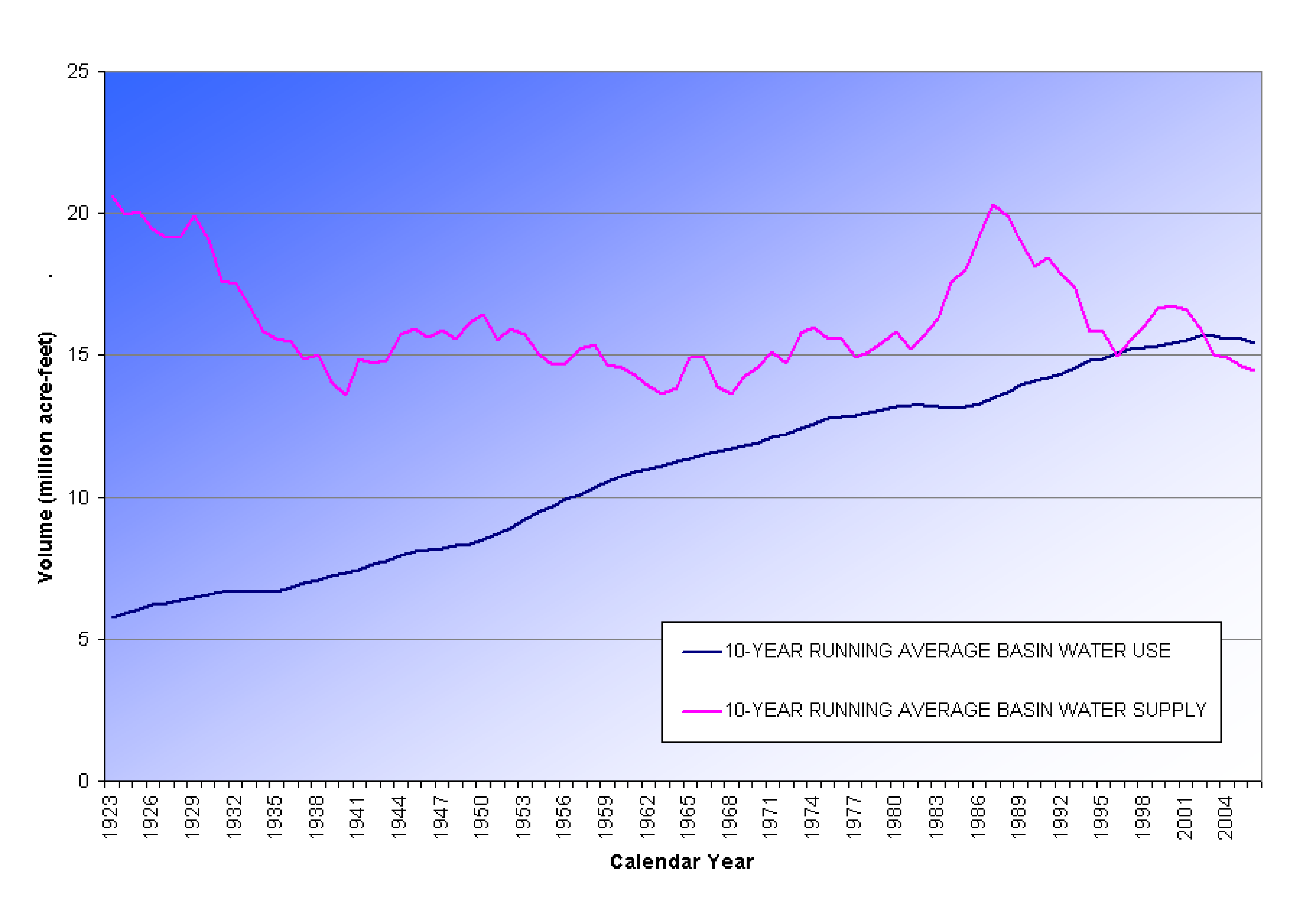
[4] Of which 2.48 maf is apportioned to Arizona, 4.4 maf to California, and 0.287 maf to Nevada

[5] Of which 2.40 maf is apportioned to Arizona, 4.4 maf to California, and 0.283 maf to Nevada

[6] Of which 2.32 maf is apportioned to Arizona, 4.4 maf to California, and 0.280 maf to Nevada

[7] Whenever Lake Mead is below elevation 1,025 feet, the Secretary shall consider whether hydrologic conditions together with anticipated deliveries to the Lower Division States and Mexico is likely to cause the elevation at Lake Mead to fall below 1,000 feet. Such consideration, in consultation with the Basin States, may result in the undertaking of further measures, consistent with applicable Federal law.

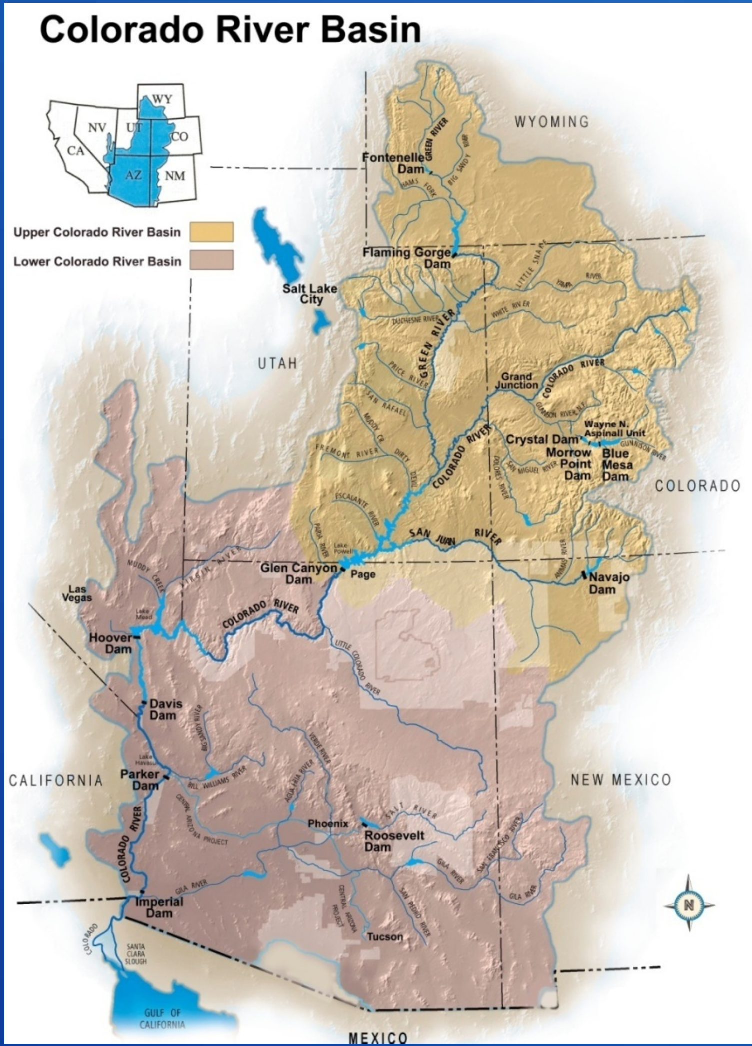
Colorado River Water Supply & Use



RECLAMATION

Colorado River Basin Study Objectives

- Define current and future imbalances in water supply and demand
- Assess the risks to all Basin resources
- Develop and evaluate adaptation and mitigation strategies



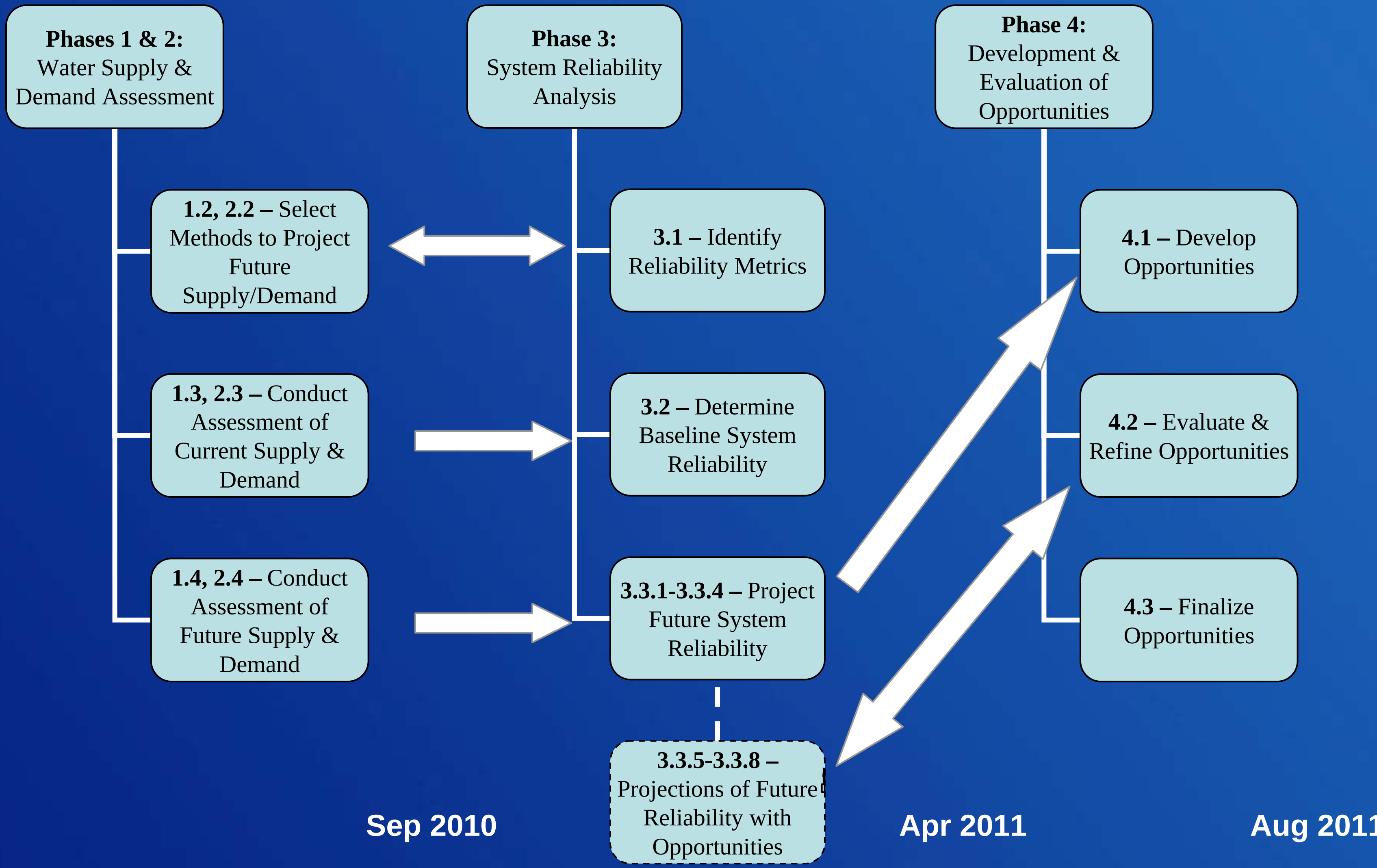
RECLAMATION

Cost-Share Partners

- Arizona Department of Water Resources
- (California) Six Agency Committee
- Colorado Water Conservation Board
- New Mexico Interstate Stream Commission
- Southern Nevada Water Authority
- Utah Division of Water Resources
- Wyoming State Engineer's Office
- Reclamation's Upper and Lower Colorado Regions

RECLAMATION

Study Phases



RECLAMATION

Timeline

Milestone	Deliverable Description
September 2010	Report describing findings from current and future water supply assessment
September 2010	Report describing findings from current and future water demand assessment
April 2011	Report describing findings from system reliability analysis
August 2011	Report describing findings of opportunities analysis
October 2011	Draft Study report and appendices available for review
December 2011	Final Study report and appendices complete

Public Involvement Plan (PIP)

- Goals:
  - Effectively provide, seek, receive, and consider information from all interested stakeholders
  - Promote further dialog regarding water supply-demand imbalances and potential solutions, particularly post-2026
- Approach:
  - Multi-faceted communication including website, email, points-of-contact, news releases, public meetings, and additional meetings with interested stakeholder groups
- All information received will be considered and feedback will be provided

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Colorado River Management Objectives



- Provide flood control and river regulation
- Provide water for consumptive use
- Generate hydropower
- Provide recreation
- Enhance and maintain ecosystem habitat
- Recover and protect endangered species

These objective are often in conflict

We seek equitable”balance of the objectives.


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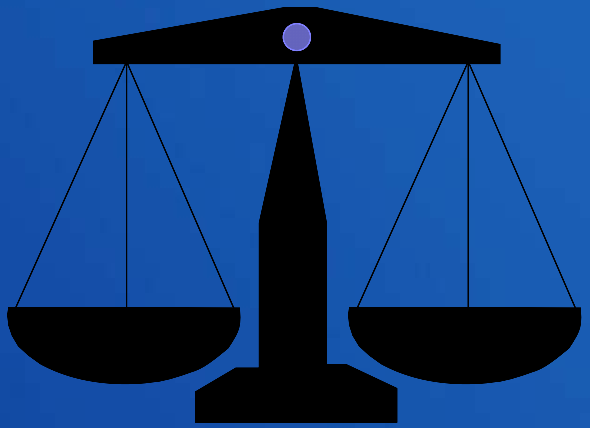
Considerations for Achieving an Equitable Balance in Decision-Making

- Legal and political constraints
- Stakeholder involvement
- Sound technical knowledge



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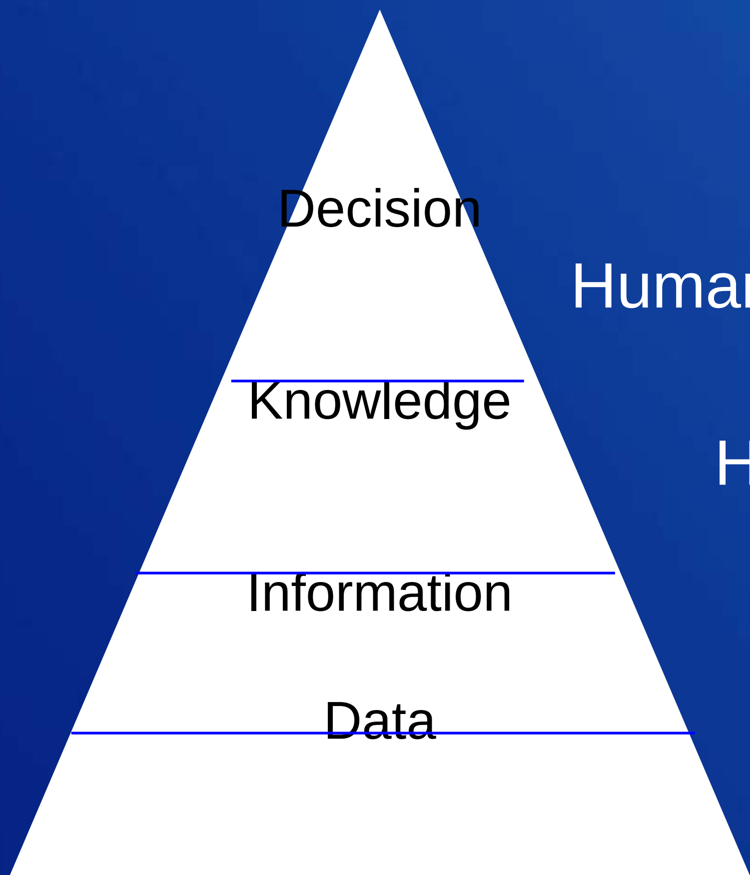
Role of Technical Data, Information, and Knowledge in Decision-Making



Human judgment incorporating other considerations

Human interpretation and intuition

Analysis and synthesis

Collection, QA/QC, processing

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