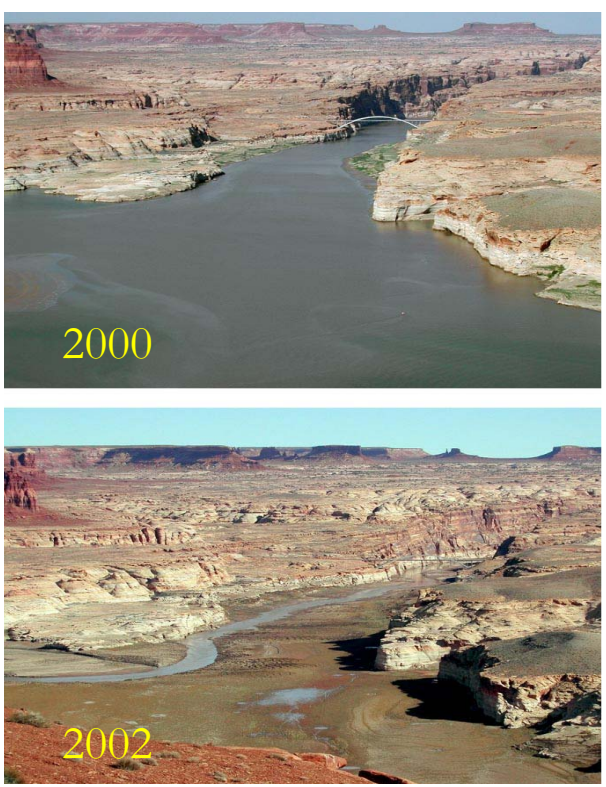
Enhancing Water Supply Reliability

An Interdisciplinary Project to Improve Predictive Capacity in the Colorado River Basin

Katharine Jacobs, Arizona Water Institute

WRRC Annual Conference

June, 2008



Courtesy USGS

Water Sustainability
The University of Arizona

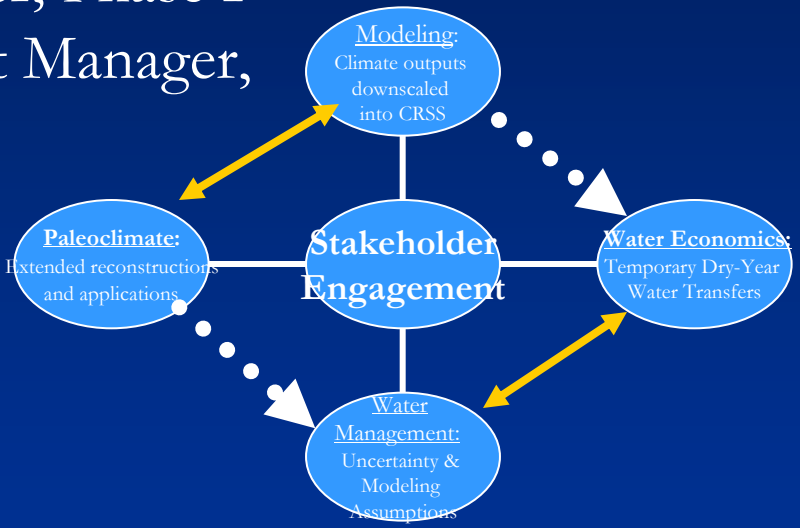
Water Resources Research Center

U.S. Department of the Interior
Bureau of Reclamation

Arizona Water Institute

Interdisciplinary Team

- **Bonnie Colby**, Agricultural and Resource Economics
  - Katie Pittenger, Lana Jones
- **Kathy Jacobs**, AZ Water Institute; SAHRA, WRRC
  - Dustin Garrick, Project Manager, Phase I
  - Rosalind Bark-Hodgins, Project Manager, Phase II
- **David Meko**, Tree Ring Lab
  - Scott St. George
  - Kiyomi Morino
- **Bart Nijssen**, 3 Tier Group, formerly Hydrology and WR
  - Laura Lindenmayer
- **Peter Troch**, Hydrology
  - Matt Switanek



Affiliated investigators

Andy Wood, University of Washington

Connie Woodhouse, UA Dept of Geography

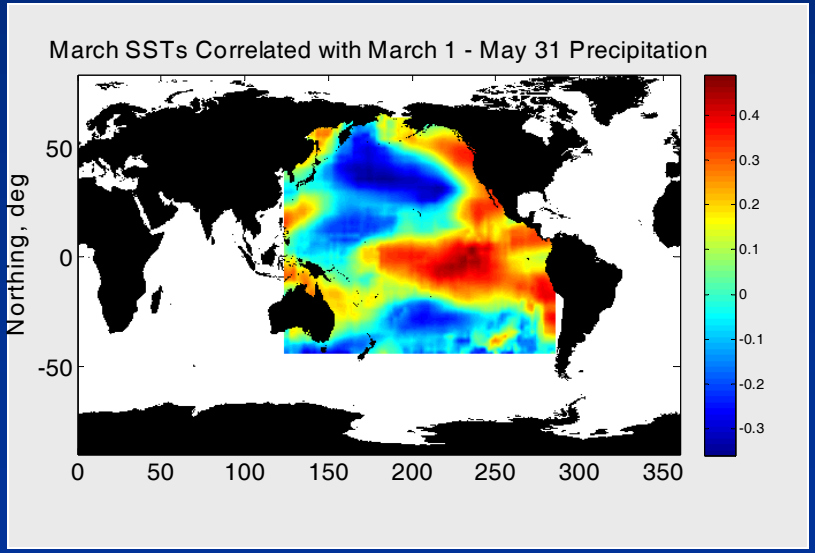
Project Objectives – Phase II

1. ***Develop*** new applications and recommendations for improved use of paleoclimate data, climate forecasts, and climate change predictions in Reclamation modeling and planning
2. ***Evaluate*** economic tradeoffs and distributional consequences across water use sectors and other stakeholders of options to firm supply reliability
3. ***Engage*** with other research groups and key stakeholders to tailor research foci (particularly on the enhancing predictive capacity in the 1-3 year time frame)
4. ***Support*** the EIS process and ongoing Reclamation operational needs

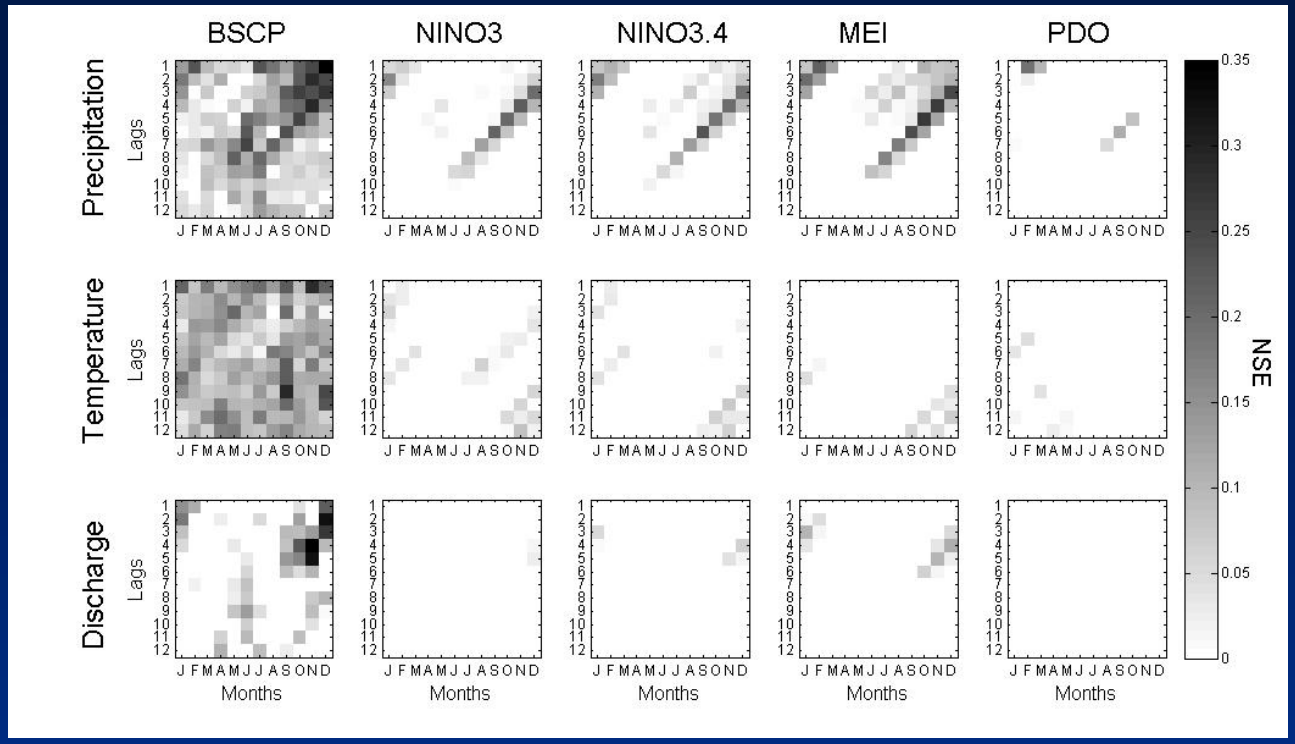
Hydrology Component: Basin-Specific Climate Prediction

- Seasonal predictions commonly conditioned by climate indices, e.g., NINO3 and PDO.
- Here, statistical relationships between sea surface temperatures (SSTs) and the Little Colorado River basin's hydroclimate are located throughout the year and at varying time lags.
- The SSTs from these regions of highest correlation are used as predictors.

BSCP's are closer to the historical record in the Little Colorado than hindcasts using standard climate indices as predictors.



Matt Switanek
(Peter Troch)

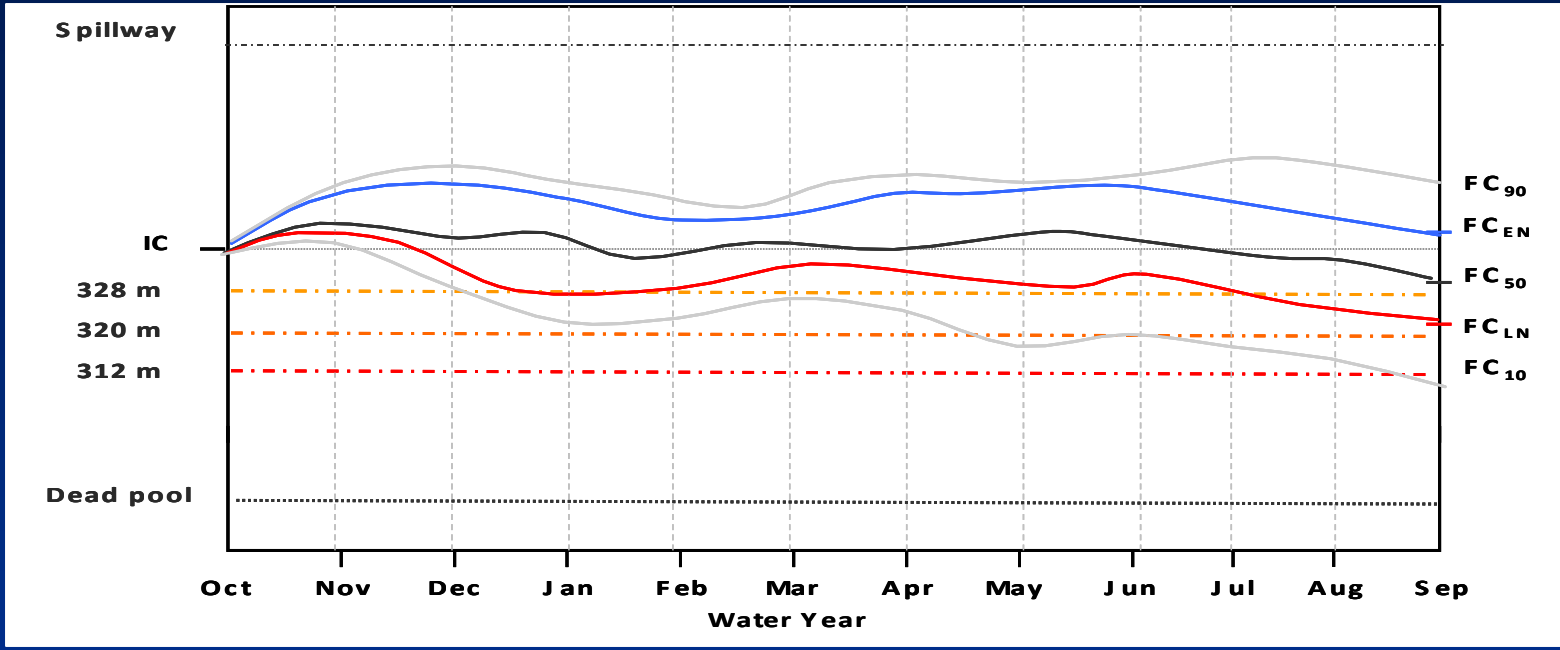


Basin-Specific Climate Prediction

Matt Switanek (Peter Troch)

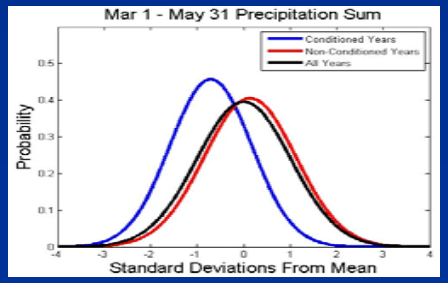
Nash-Sutcliffe model efficiency. The darker the shading, the more skillful the hindcasts are in comparison to the hydroclimatic mean.

Potential for improved system modeling and forecasts using ENSO or other conditioning.



Ensemble Streamflow Predictions with Initial Reservoir Conditions (IC) and Final Reservoir Conditions (FC): Current Practice (FC_{50}), ENSO-conditioned (FC_{EN} and FC_{LN}), 10th and 90th Percentiles (FC_{90} and FC_{10})

(Peter Troch)



The **paleoclimatology component:**

Tree-ring reconstructions can be used to understand past variability, allowing consideration of potential future frequency, duration and severity of system-wide droughts.

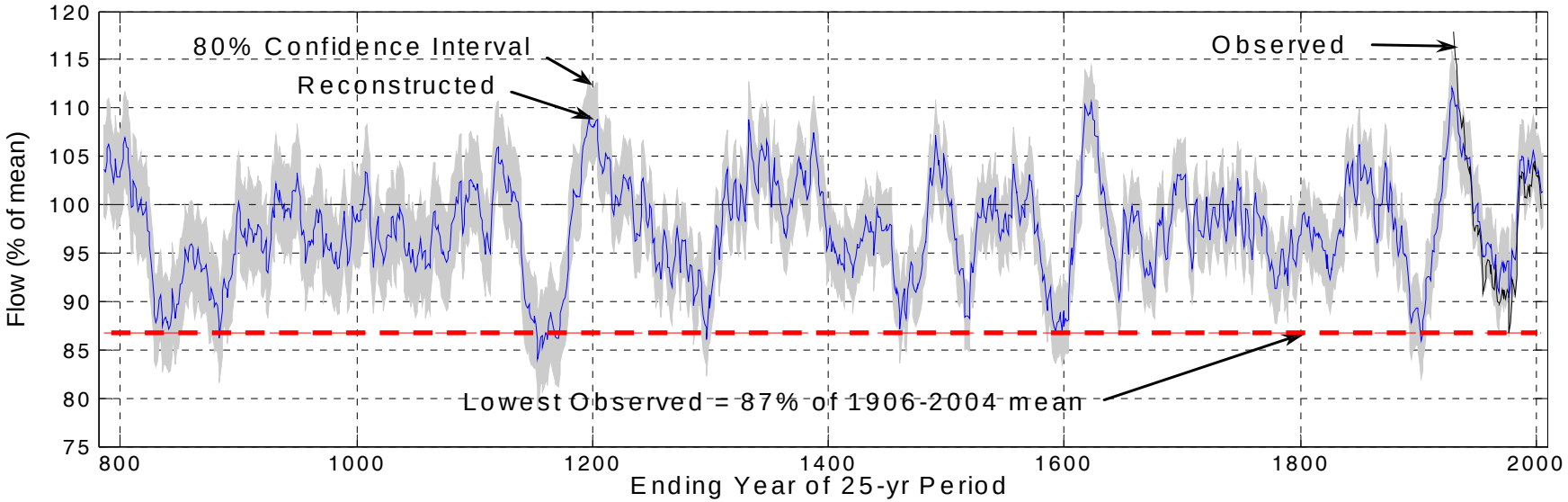
Tree-ring scientists are extending the tree-ring record further back in time by utilizing tree-ring information in remnant wood…

(Meko et al., 2007) have extended the reconstructed stream flow record for the Colorado River back to AD 762

Temporal Extension--Lee Ferry Record

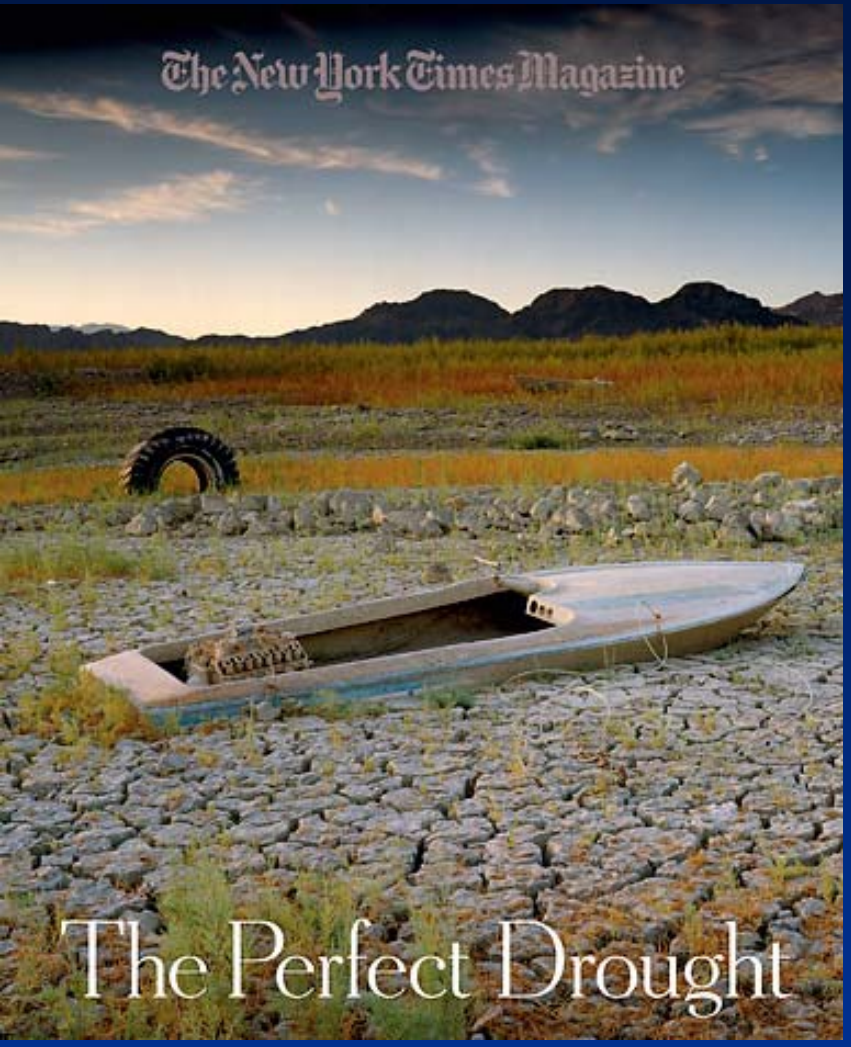
The A.D. 762 extension shows unusually persistent drought in Medieval period, with most severe conditions centered on A.D. 1150

- 25-year mean flow averaged 83% of modern gaged mean
- 13 straight years with below normal flow
- No very-high-flow years for an extended (62-yr) period



Reconstruction Smoothed as 25-yr Running Mean

Meko et al. (2007), "Medieval drought in the Upper Colorado River Basin", Geophysical Res. Letters, May 24, 2007



Goals for Temporary Transfers:

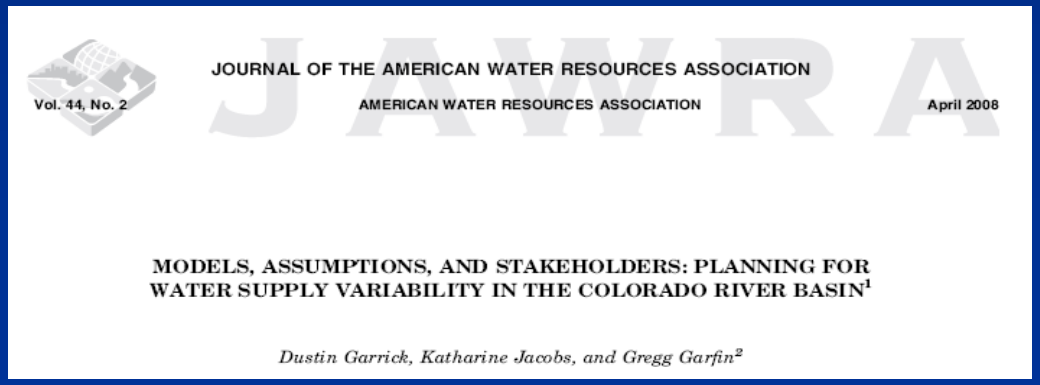
- **Address dry year needs**
- **Provide adequate lead time to irrigators**
- **Benefit the lessor and lessee**
- **Preserve the local agricultural economy**
- **Reduce third party negative impacts**

The **economics component** of the project investigates temporary, voluntary dry year water transfers that can be utilized by municipalities and others to provide water supply reliability.

Forbearance might also be used for system conservation i.e. to replace bypass flows currently lost to the Ciénega de Santa Clara.

The **water management component** of the project focuses on priorities articulated during the stakeholder-interaction phase of the project.

- Water managers and stakeholders requested more information on the uncertainty inherent in Reclamation models,
- Evaluations of modeling assumptions,
- Assistance with development of EIS for Shortage Guidelines and Reservoir Operations


JOURNAL OF THE AMERICAN WATER RESOURCES ASSOCIATION

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MODELS, ASSUMPTIONS, AND STAKEHOLDERS: PLANNING FOR WATER SUPPLY VARIABILITY IN THE COLORADO RIVER BASIN[1]

Dustin Garrick, Katharine Jacobs, and Gregg Garfin[2]

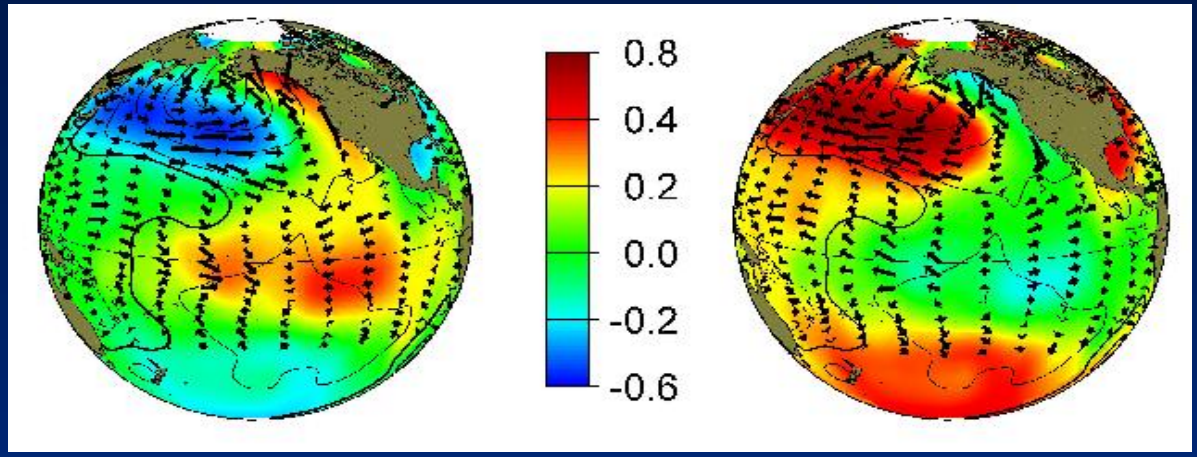

Stuck in the mud on the Colorado
Bonnie Colby

Interdisciplinary questions:

- Assess the forbearance water requirements for droughts of different magnitudes, durations, etc., based on paleo chronologies and identify alternative dry year options structures to respond;
- Assess the costs under different structures for mitigating the shortage deficits caused by these droughts;
- Using the current drought as a starting place, evaluate which forbearance approaches would be the most cost efficient.

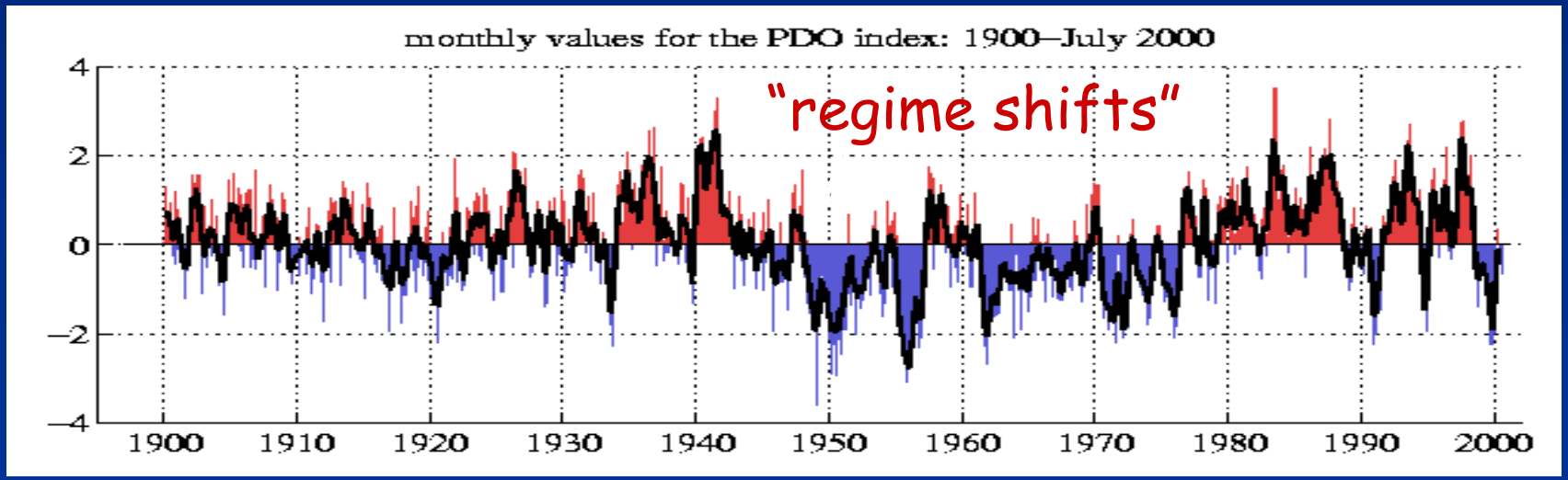
Decadal Predictions Workshop – March, 2007

Warm Phase



Cool Phase

Monthly Values for the PDO Index, 1900-2000

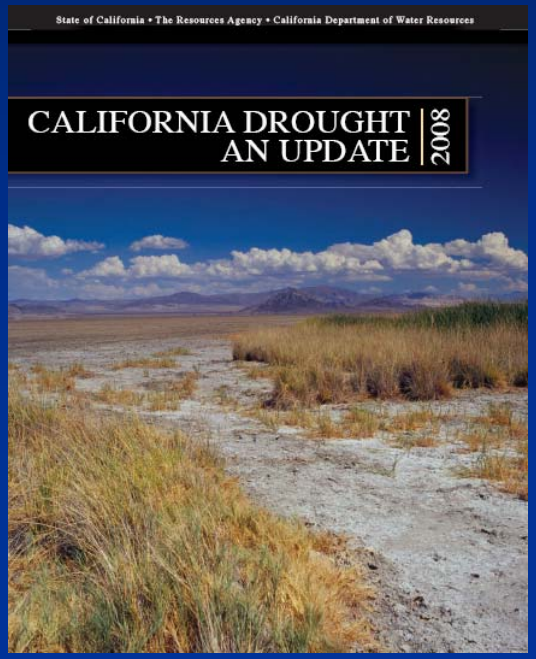


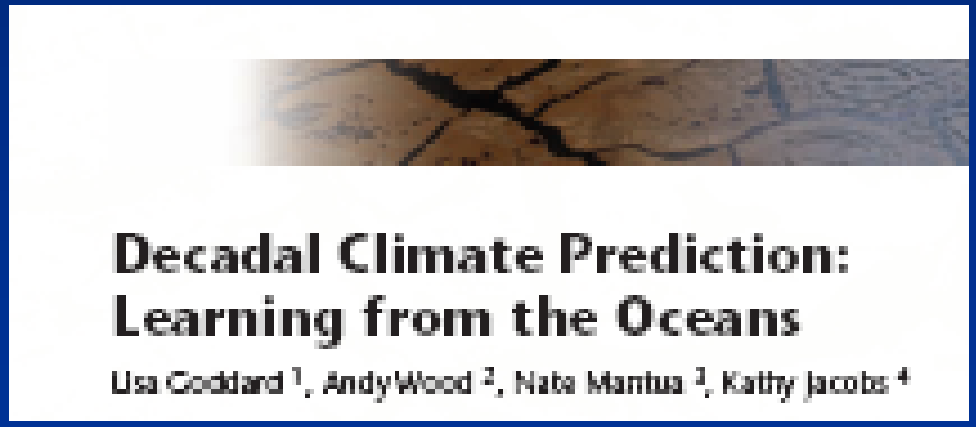
Pacific Decadal Oscillation

Courtesy of Nate Mantua

Observations

- Not understanding decadal variability is a major obstacle to improving ENSO predictions and to identifying impacts of global warming.
- It is valuable to predict tendencies over long periods even if the skill is relatively low.



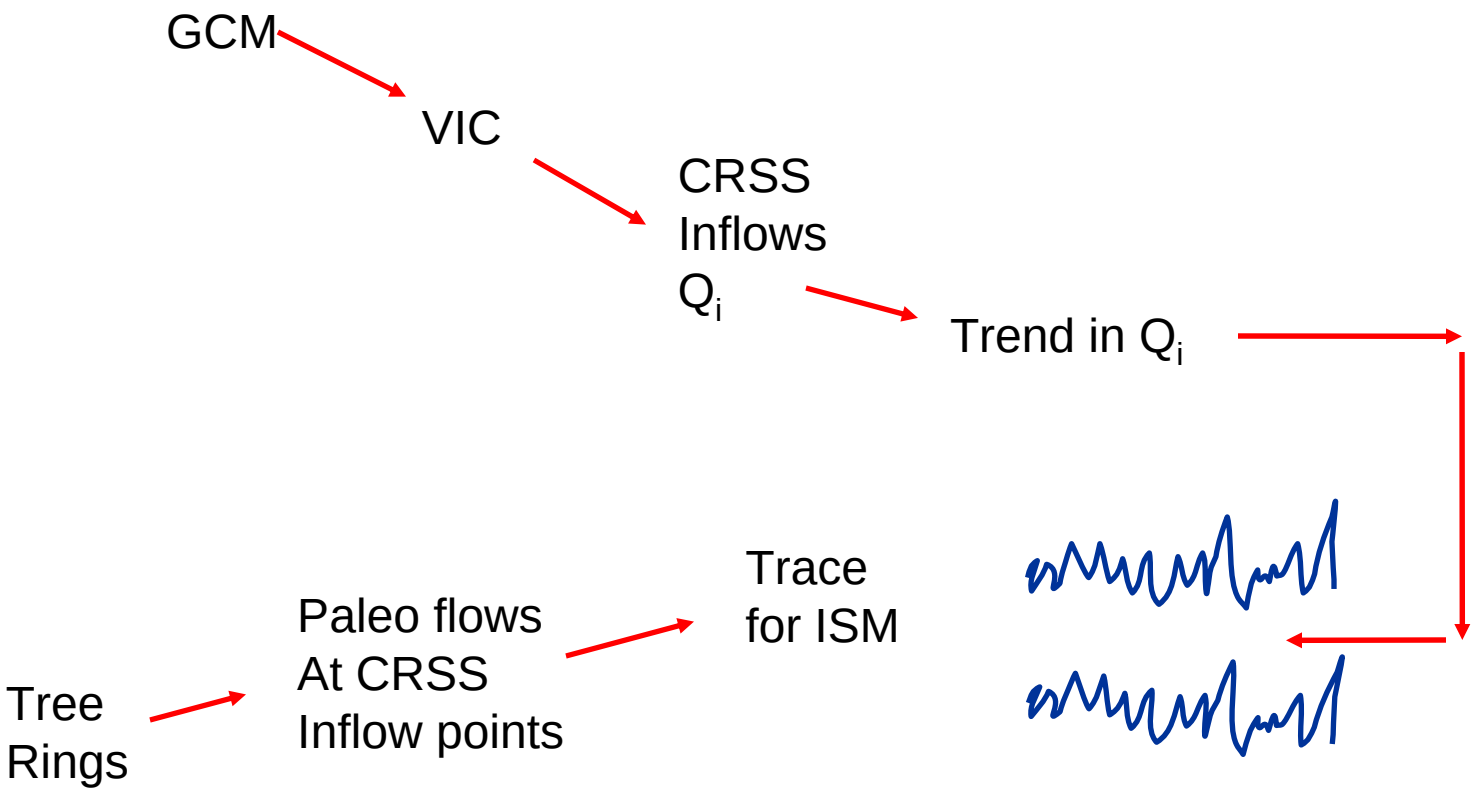


Decadal Climate Research Agenda

- Need to identify the observational priorities for supporting a decadal prediction system.
- Need to evaluate the mechanisms of persistence: cloud feedbacks, equatorial upwelling, etc.
- Can we quantify the amplitude of the anthropogenic signal vs. natural variability?
- What will the impacts of warming be on ENSO?
- Which mechanisms drive the impacts that key users care about (water managers, fisheries, fire managers)?

How can expected climate change be considered?

Dave Meko

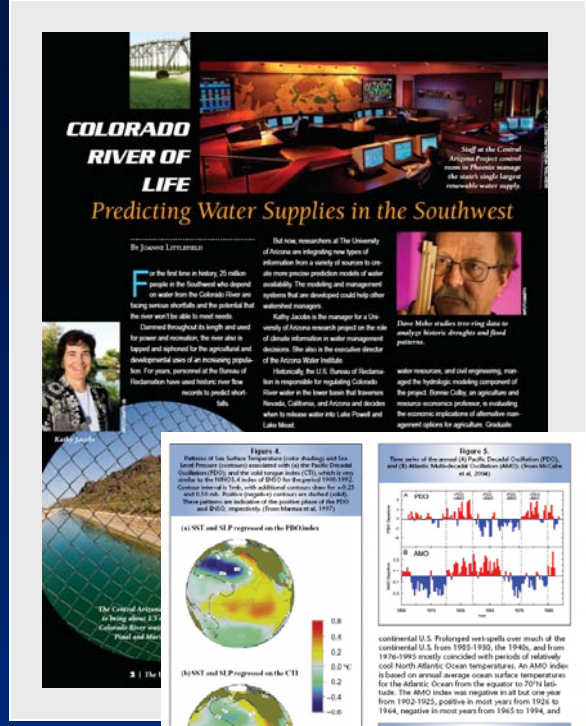


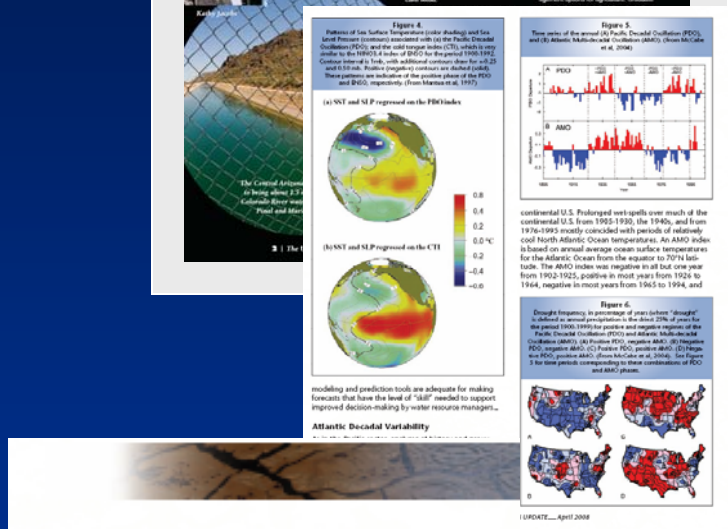
Reclamation Planning model - Paleo inputs to CRSS, defining the depth and duration of drought, preparing to overlay climate change on paleo records

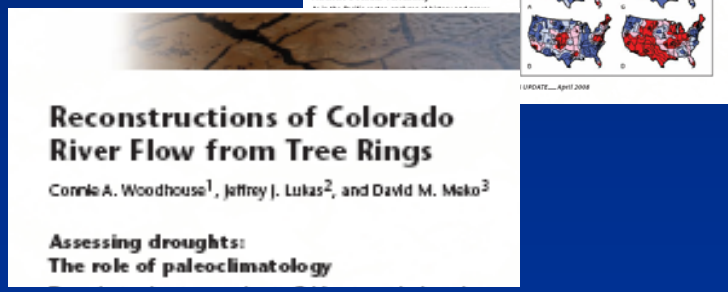
Project Publications - Outcomes

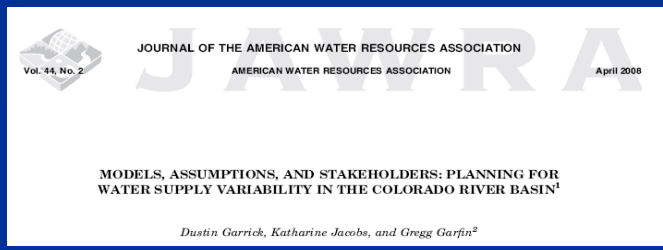
- 15 presentations at AGU, AHS, TRIF forum, project integration meetings, NOAA Climate Conference
- 15 publications
- 6 Posters
- Decadal Predictions Workshop - Seattle
- 8 e-newsletters
- 6 + media reports (tree ring studies, UA Research Report)
- 5 Master's theses, 8 grad students (to date)
- Support for Shortage Guidelines EIS
- Web Portal:

http://ag.arizona.edu/AZWATER/EWSR



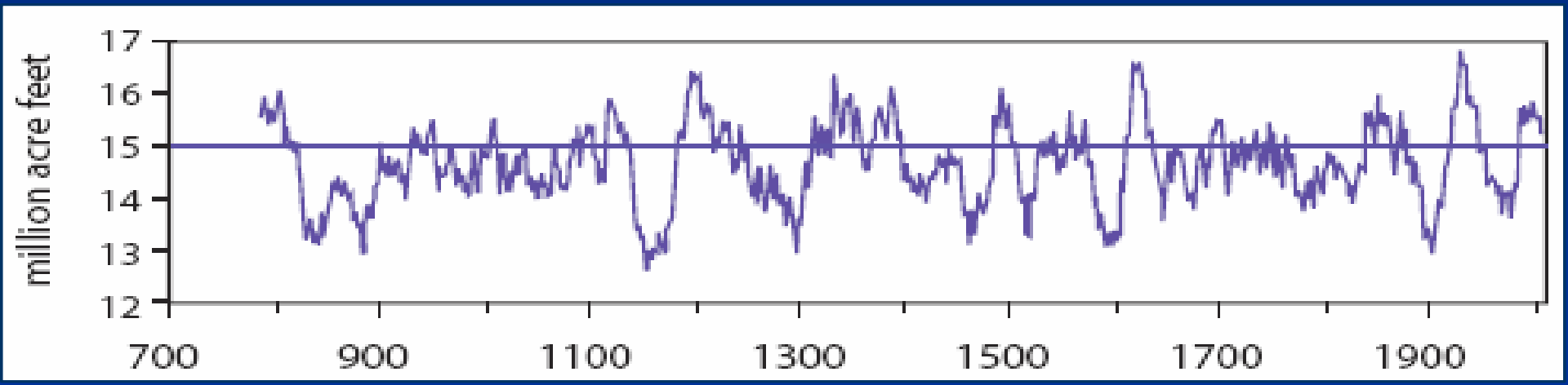






Thanks~!

This is the only period over the entire 1200+ year record to have below-normal streamflow for more than 10 consecutive years. The longest stretch of consecutively drier-than-average years in the instrumental period (since 1906) is five years…



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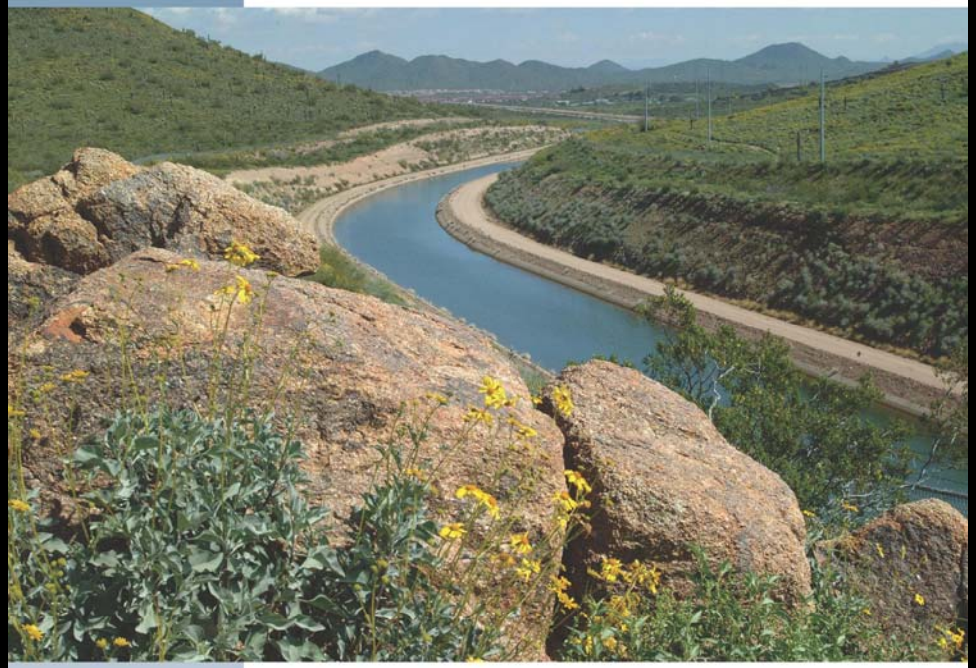

The Importance of the Colorado River to Arizona's Future

June 24, 2008
Phoenix, Arizona

Water Resources Research Center
The University of Arizona

CAP
CENTRAL ARIZONA PROJECT

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