

Assessing multi-year predictability of Colorado River water supply using a drift-free decadal climate prediction system

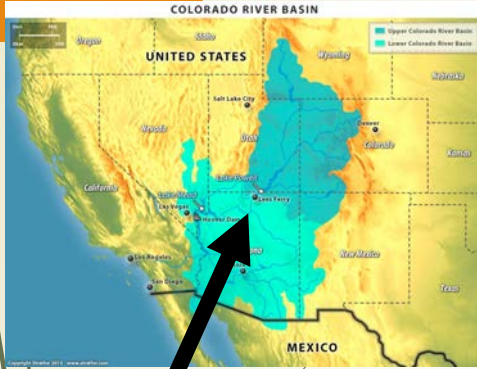
Yoshi Chikamoto¹ (Yoshi.Chikamoto@usu.edu)

Simon Wang¹, Robert Gillies^{1,2}, Matt Yost¹ & Larissa Yocom³

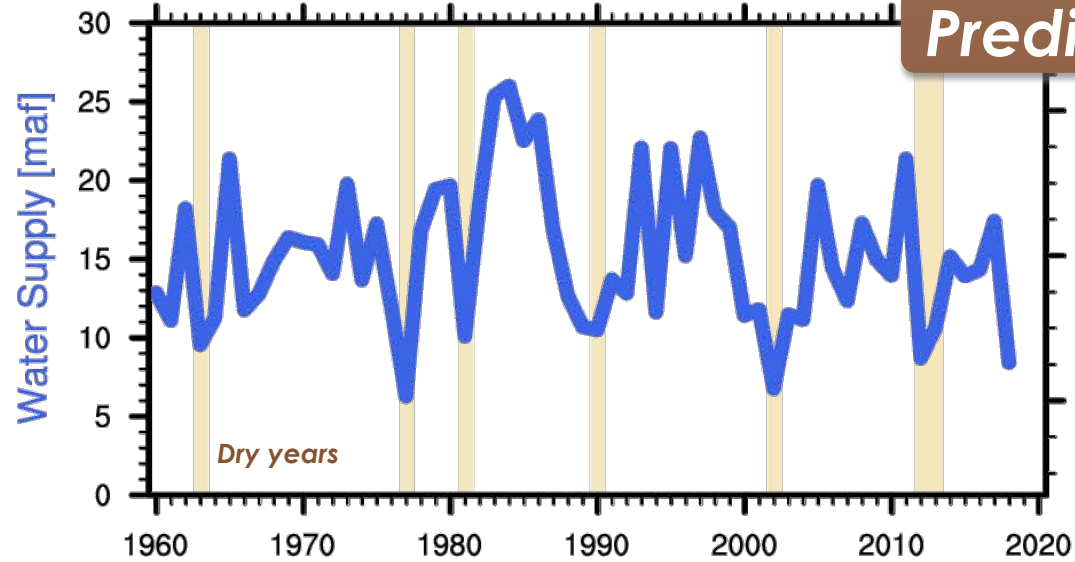


¹Department of Plants Soils & Climate
²Utah Climate Center
³Department of Wildland Resources

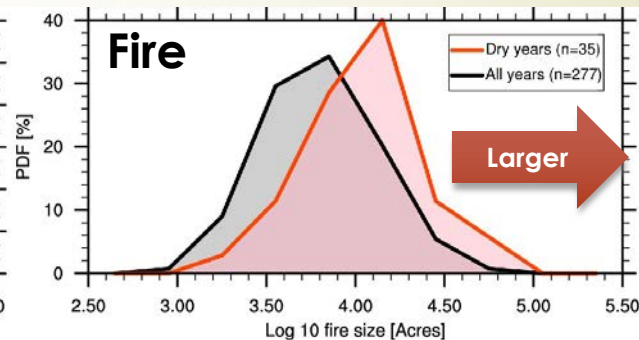
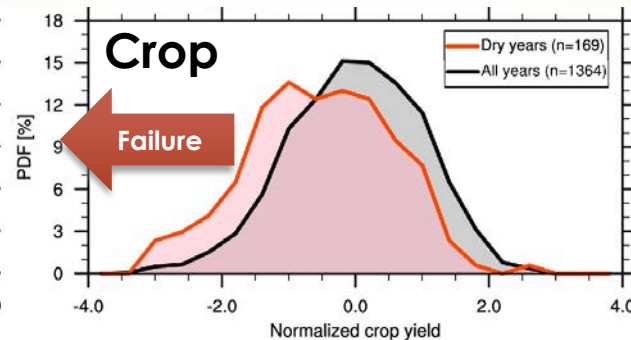
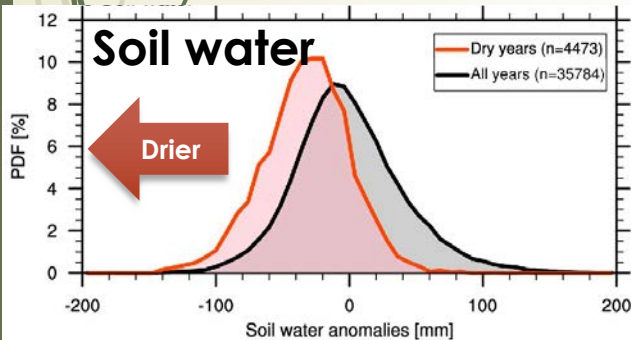
Colorado River water supply



**Natural Streamflow
at Lees Ferry, AZ**



Predictable?



Hypothesis: ocean-land synchronization

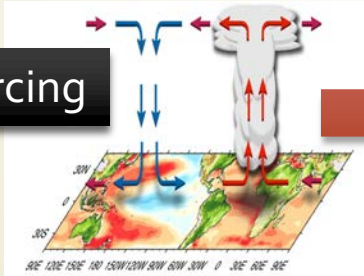
Weather disturbance



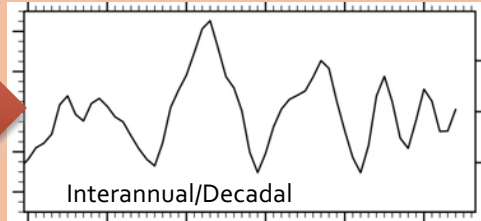
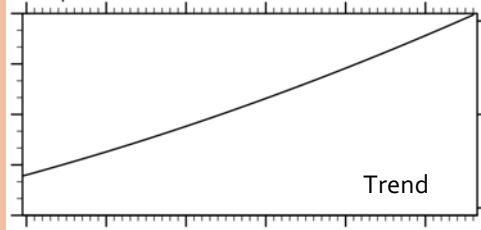
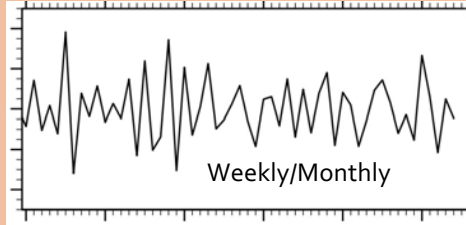
Radiative Forcing



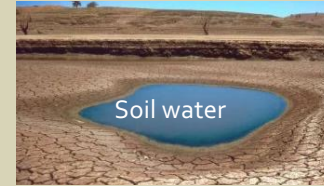
Ocean Forcing



Atmosphere



Land Process



Hypothesis: ocean-land synchronization

Weather d

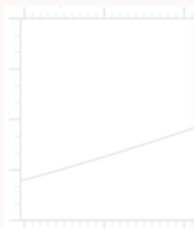
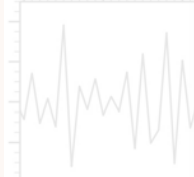
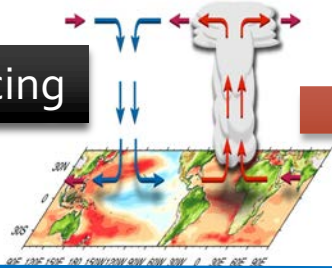
Filtering Effect



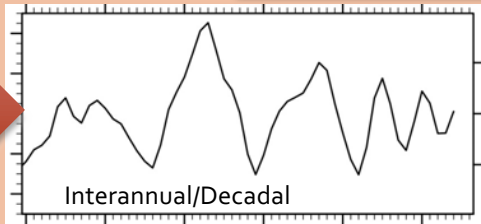
Radiative Forcing



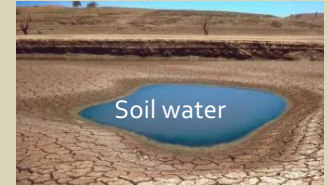
Ocean Forcing



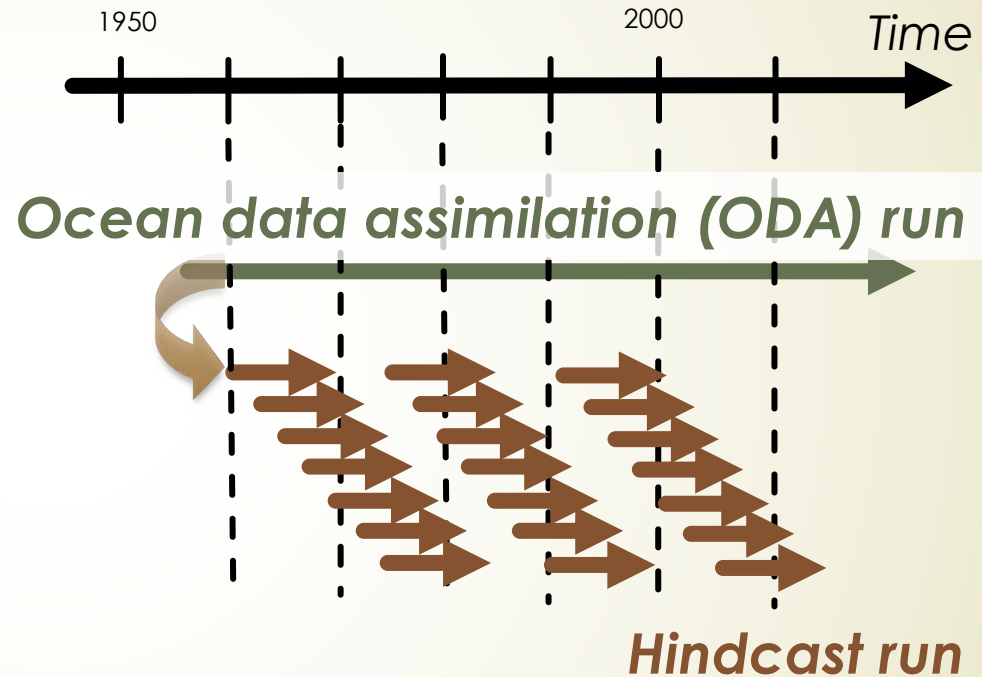
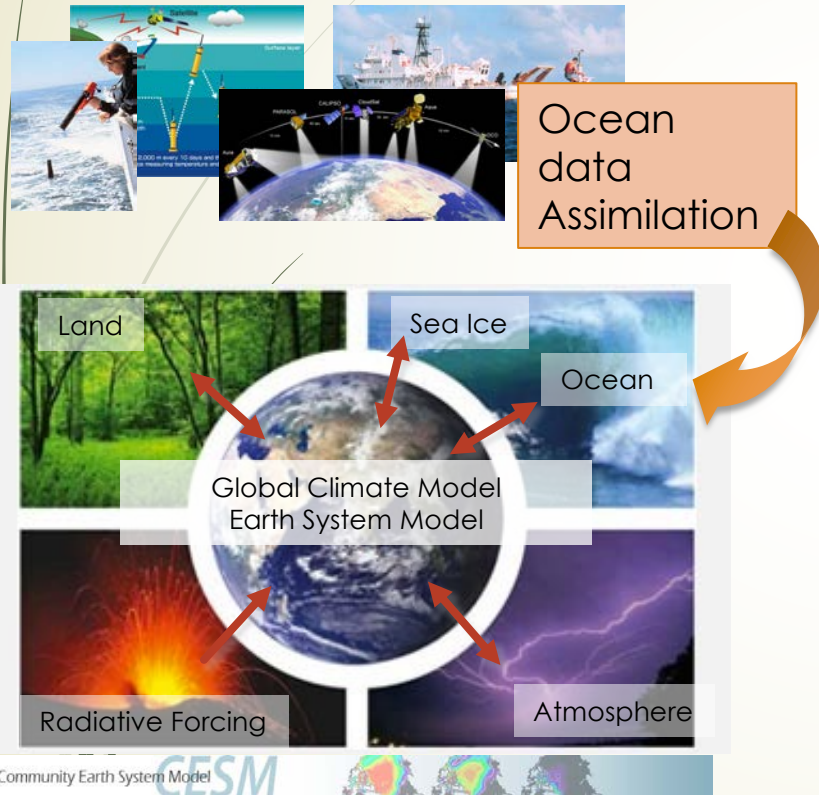
Ocean memory



Land Process



Decadal climate prediction approach

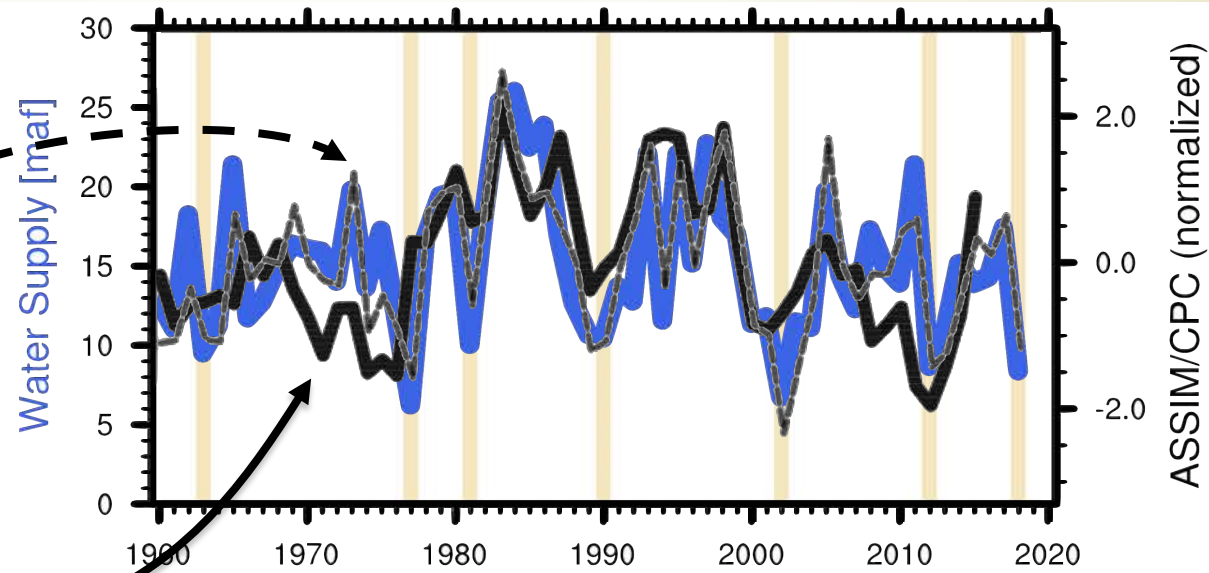
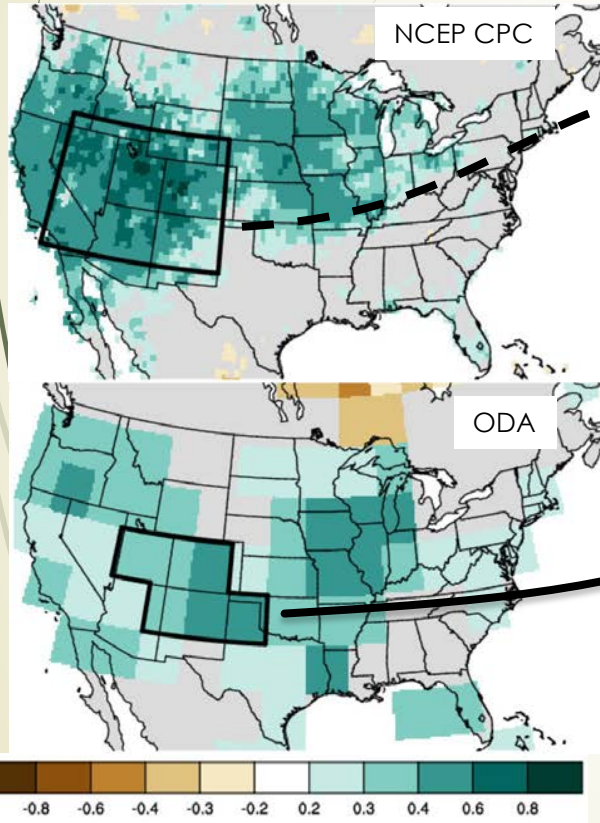


Each experiment has 10-member ensemble.

Chikamoto et al., (2019): A drift-free decadal climate prediction system for the Community Earth System Model, *J. Climate*.

Reconstruction of Colorado River water supply

Soil water anomalies



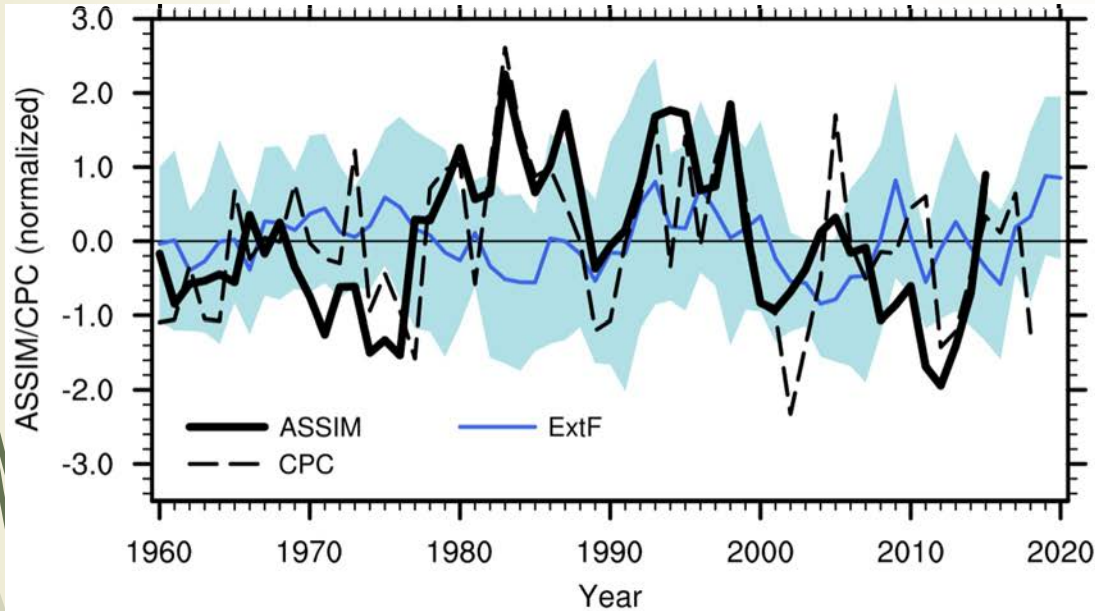
$$R(\text{Water supp vs CPC}) = 0.88$$

$$R(\text{Water supp vs ODA}) = 0.43$$

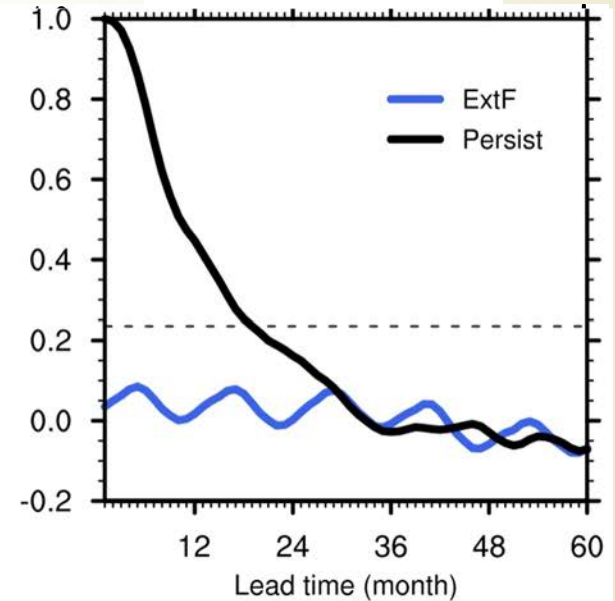
Ocean drives low-frequency streamflow variability

Predictability of Colorado River water supply

Reconstructed water supply



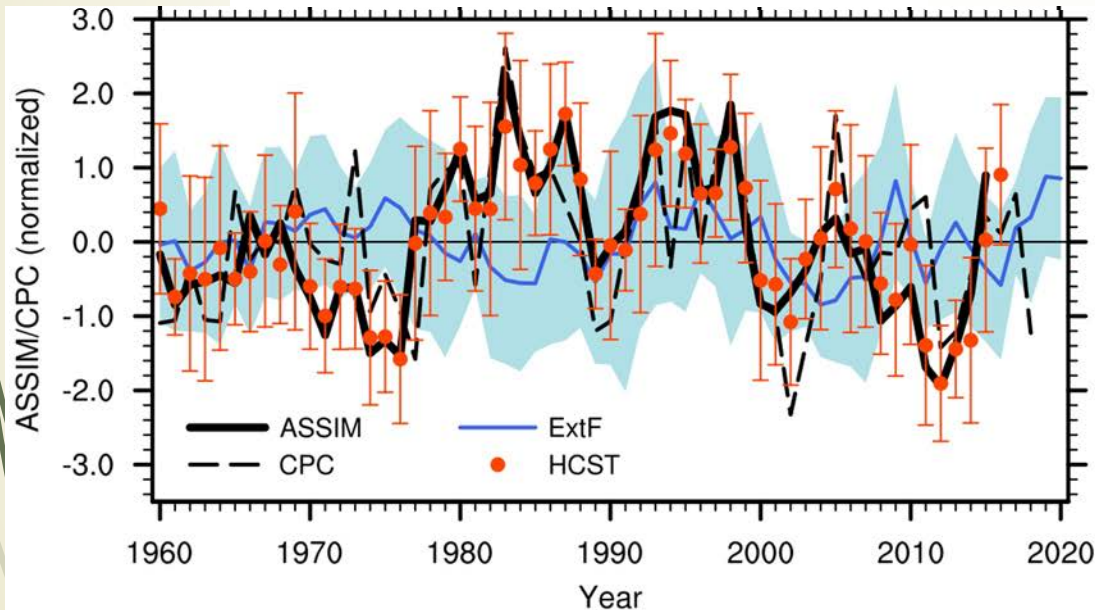
Predictive skill



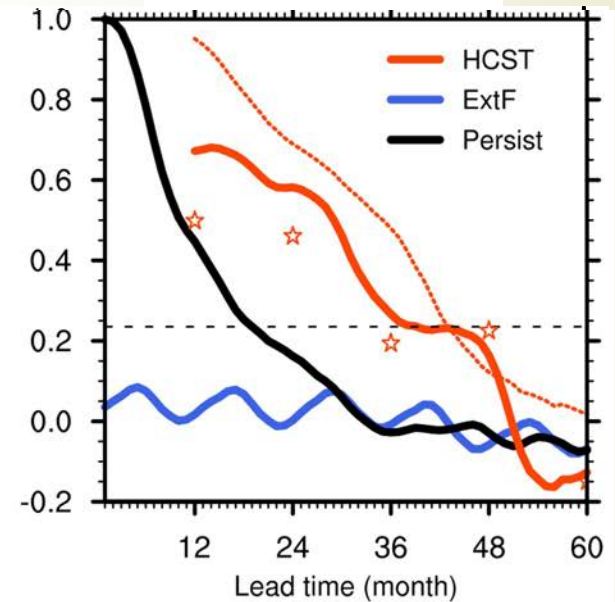
The global warming component is negligible for interannual-to-decadal water supply predictability

Predictability of Colorado River water supply

Reconstructed water supply

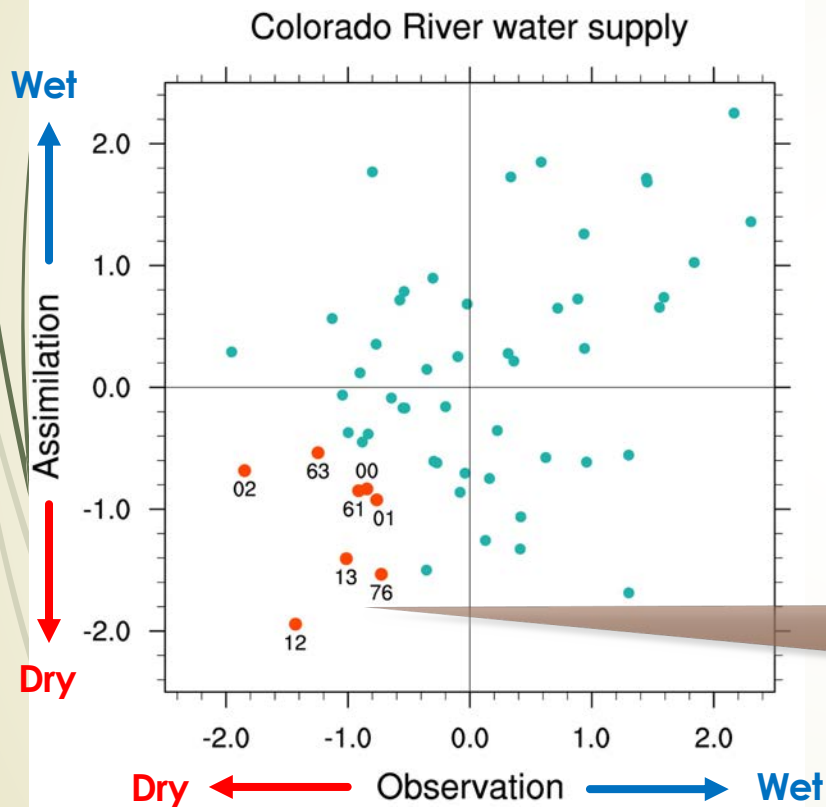


Predictive skill



The Colorado River water supply is predictable for several years!

Ocean memory for drought prediction

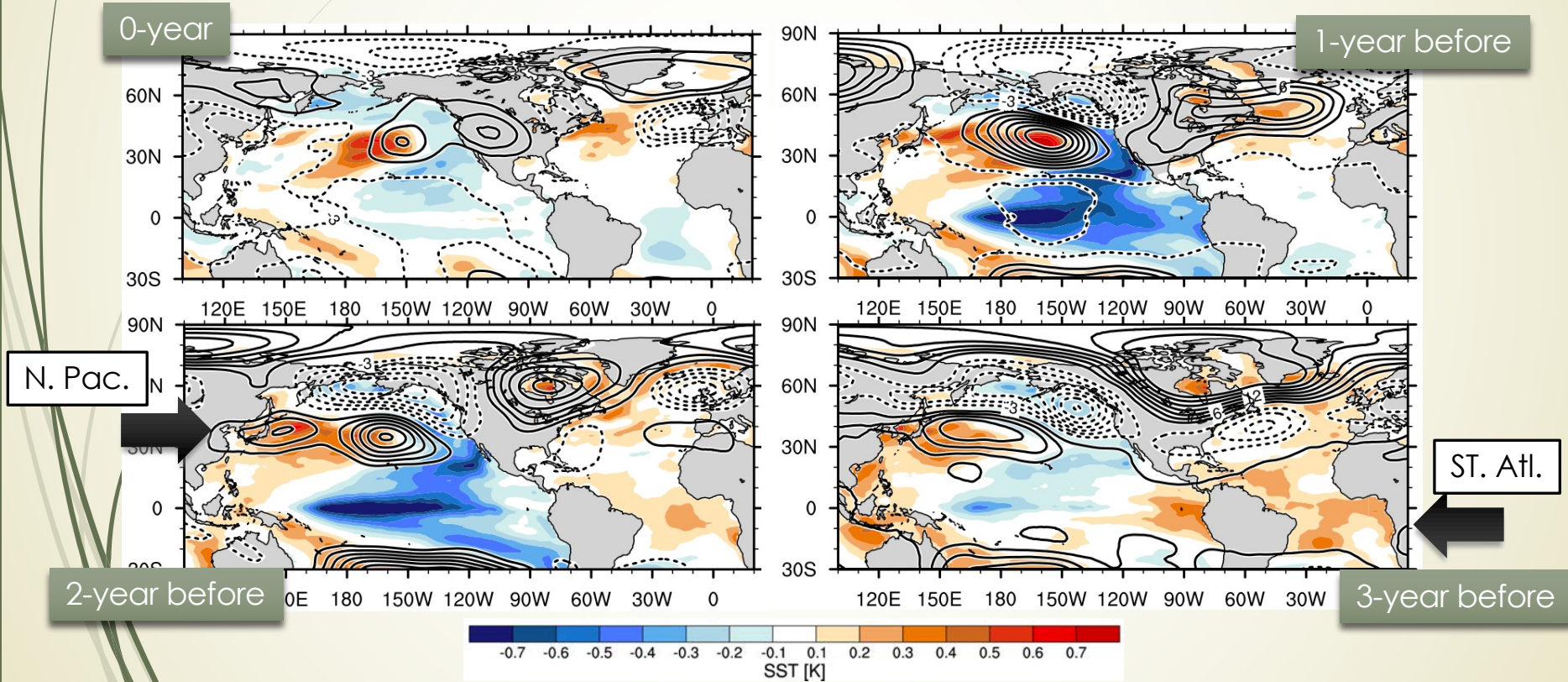


What ocean precursors are important to predict shortage of Colorado River water supply?

**Predictable
dry years**

Ocean-induced dry year composites

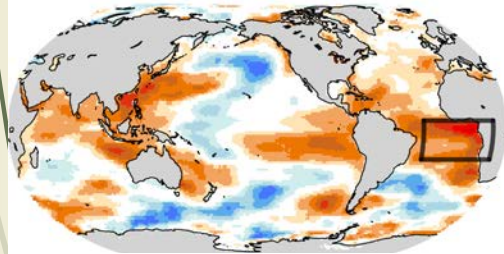
SST (shade) & Z500 anomalies (contour)



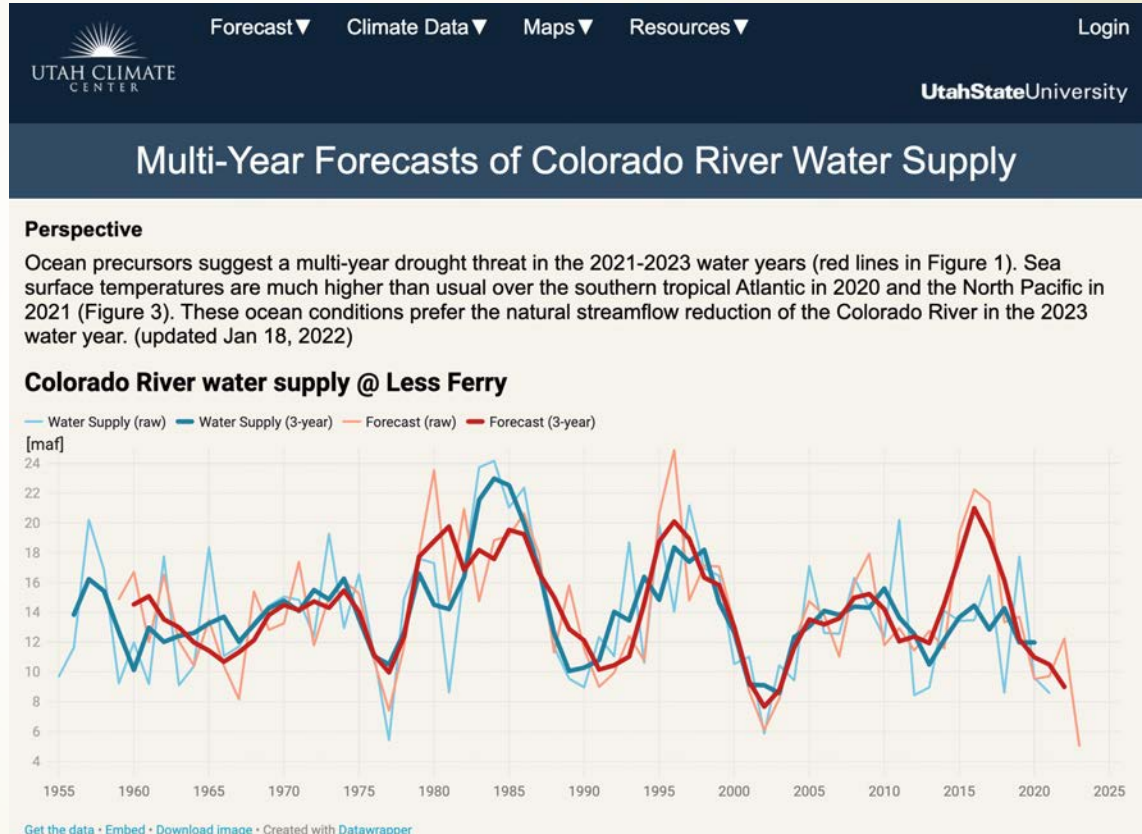
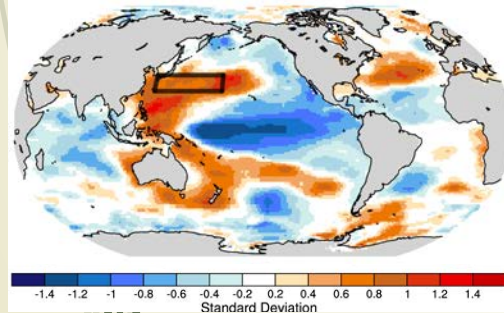
Operational forecast using ocean precursors

Monitoring

44-month ago



29-month ago



Decadal climate prediction efforts

	CESM-DPLE/SMYLE	Our study
Model config	~1° x 1°, 40 members	~3° x 3°, 10 members
Observation	Full field	Anomaly field (& ExtF adjustment)
Atmosphere	Uninitialized run	No observation (from ODA)
Land	Uninitialized run	No observation (from ODA)
Ocean	FOSI (wind stress & heat flux)	3D T&S in ORAS4 (from ODA)
Sea-ice	FOSI (wind stress & heat flux)	No observation (from ODA)

Model drift
Initialization shocks

They may have less impact for seasonal predictability but larger for decadal

There are many other factors!

FOSI: Forced Ocean Sea ice simulations
ODA: Ocean data assimilation run

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Colorado water supply

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Colorado River water supply is predictable on multi-year timescales owing to long-term ocean memory

Yoshimitsu Chikamoto [✉](#), S.-Y. Simon Wang, Matt Yost, Larissa Yocom & Robert R. Gillies

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CONTRIBUTOR

COMMS EARTH

BEHIND THE PAPER

Predicting prolonged drought in the Colorado River Basin

The Colorado River water supply is predictable for several years in advance by utilizing a state-of-the-art climate model, long-term ocean memories, atmospheric teleconnections, and land filtering effect.



Yoshi Chikamoto

Assistant Professor, Utah State University

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Yoshi Chikamoto

(Yoshi.Chikamoto@usu.edu)

