Application of the Community Land Model to explore levers of water sustainability in the American Southwest

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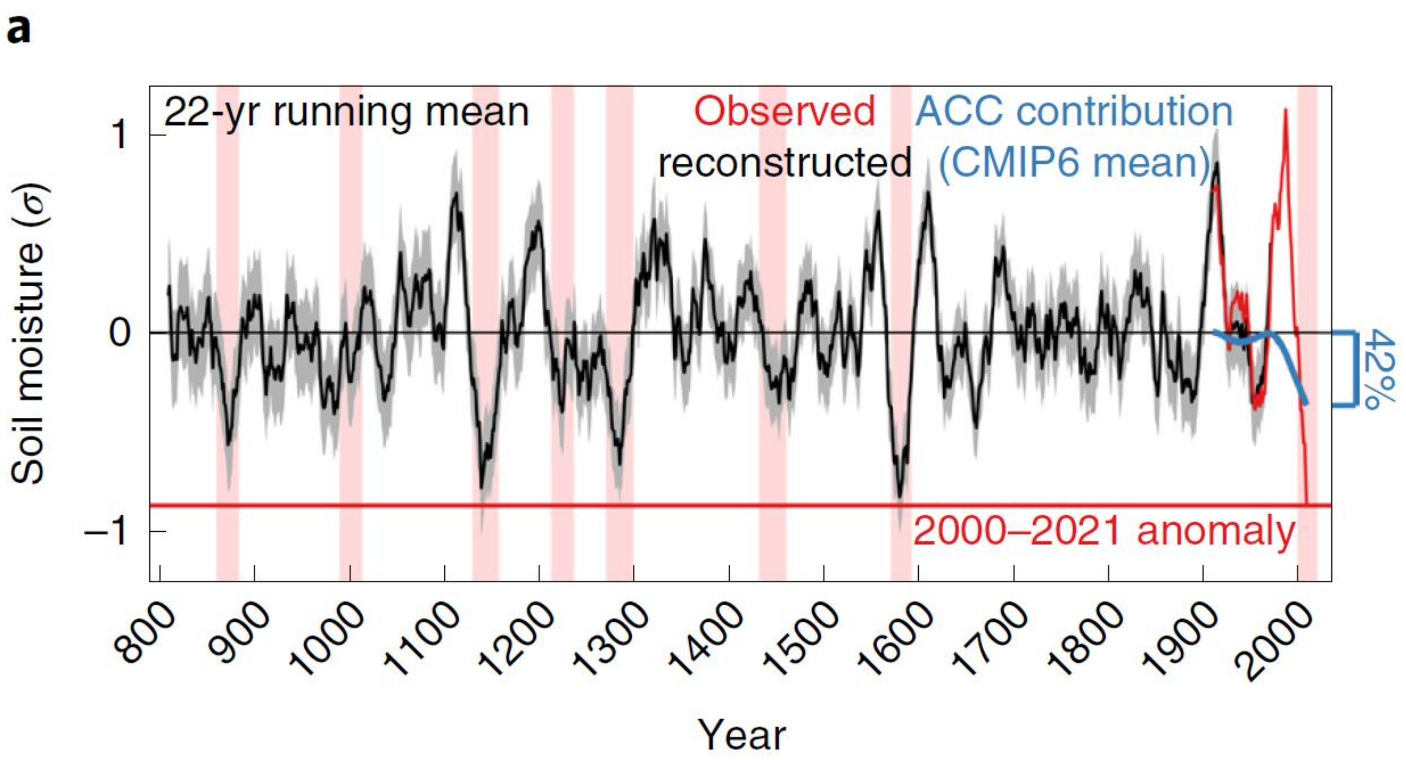
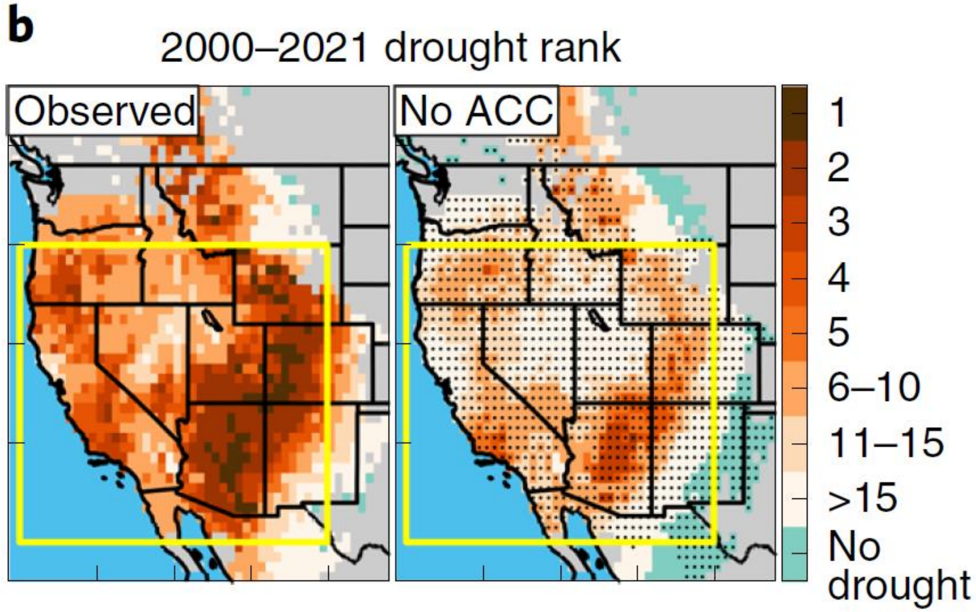
MICHIGAN STATE UNIVERSITY
National Science Foundation
WHERE DISCOVERIES BEGIN
University of Colorado Boulder

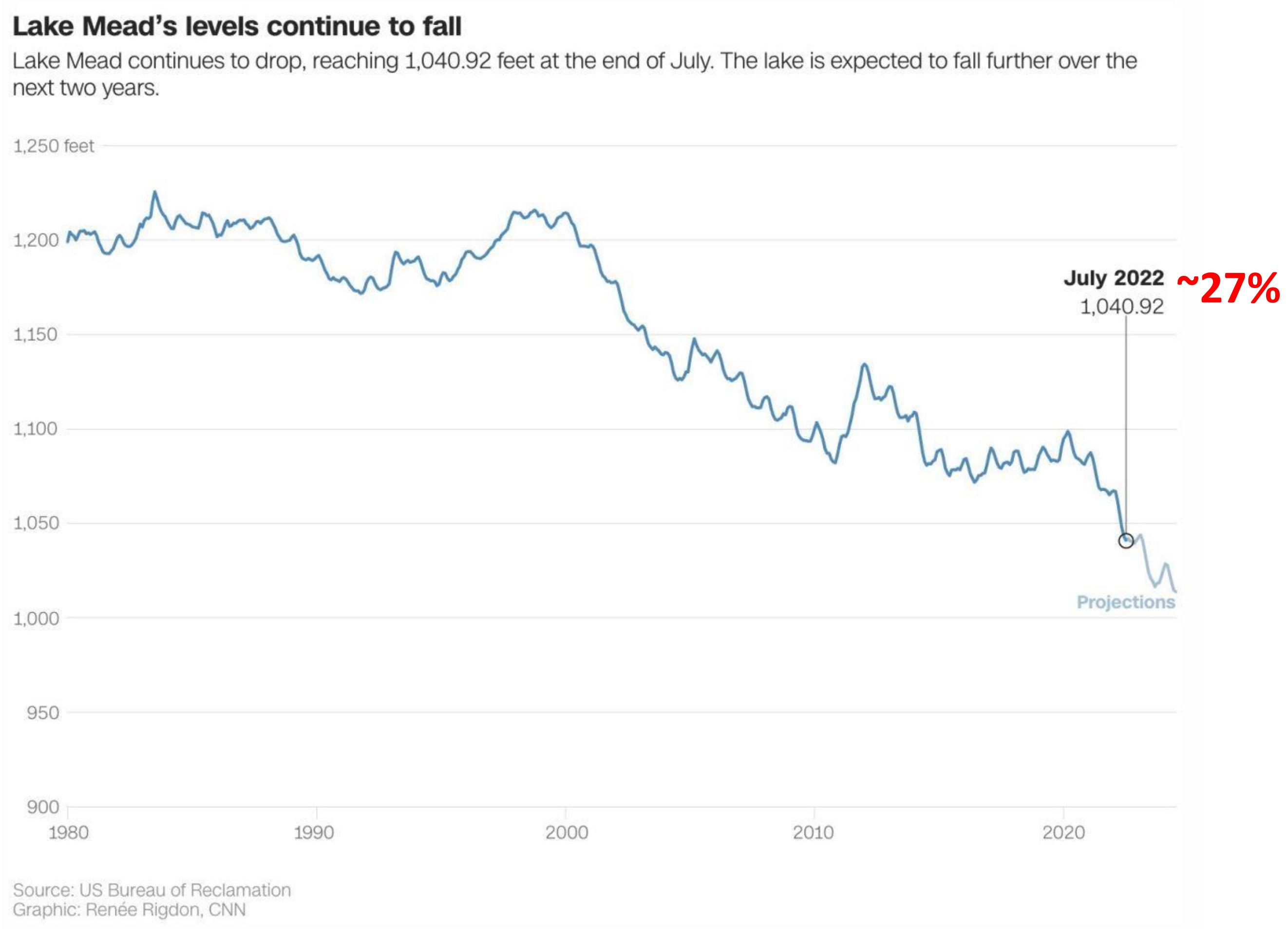
Unfolding water crisis



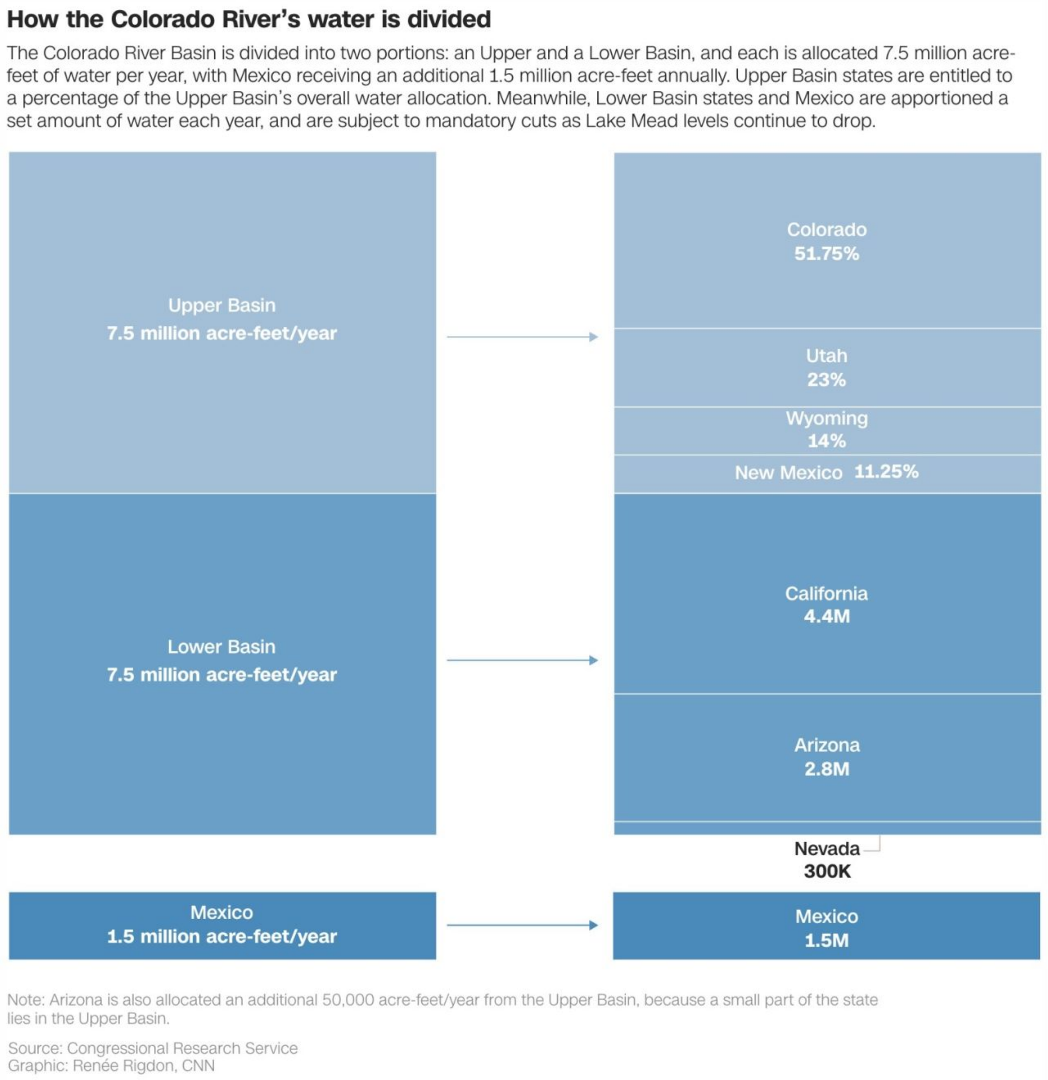


(Williams et al., 2022, Nature CC)

Unfolding water crisis



Unfolding water crisis



(1)

To what extent water demands will be met in the future?

(2)

What are alternative management strategies to mitigate the impact of water scarcity ?

Kickoff Workshop – Key themes

- **Land modeling :** Bringing the Community Land Model to decision making
- **Variability and aridification:** Can drought be considered a drought anymore or is it the new normal (aridification)? How will the hydrology look like with increasing variability and increasing aridity?
- **Uncertainty:** What is forcing us (our system) to be vulnerable?
- **Future scenarios:** Changes in demand due climate change (e.g., agriculture demand) instead of "*not enough water what to do*"
- **Pilot basins**

BUREAU OF RECLAMATION

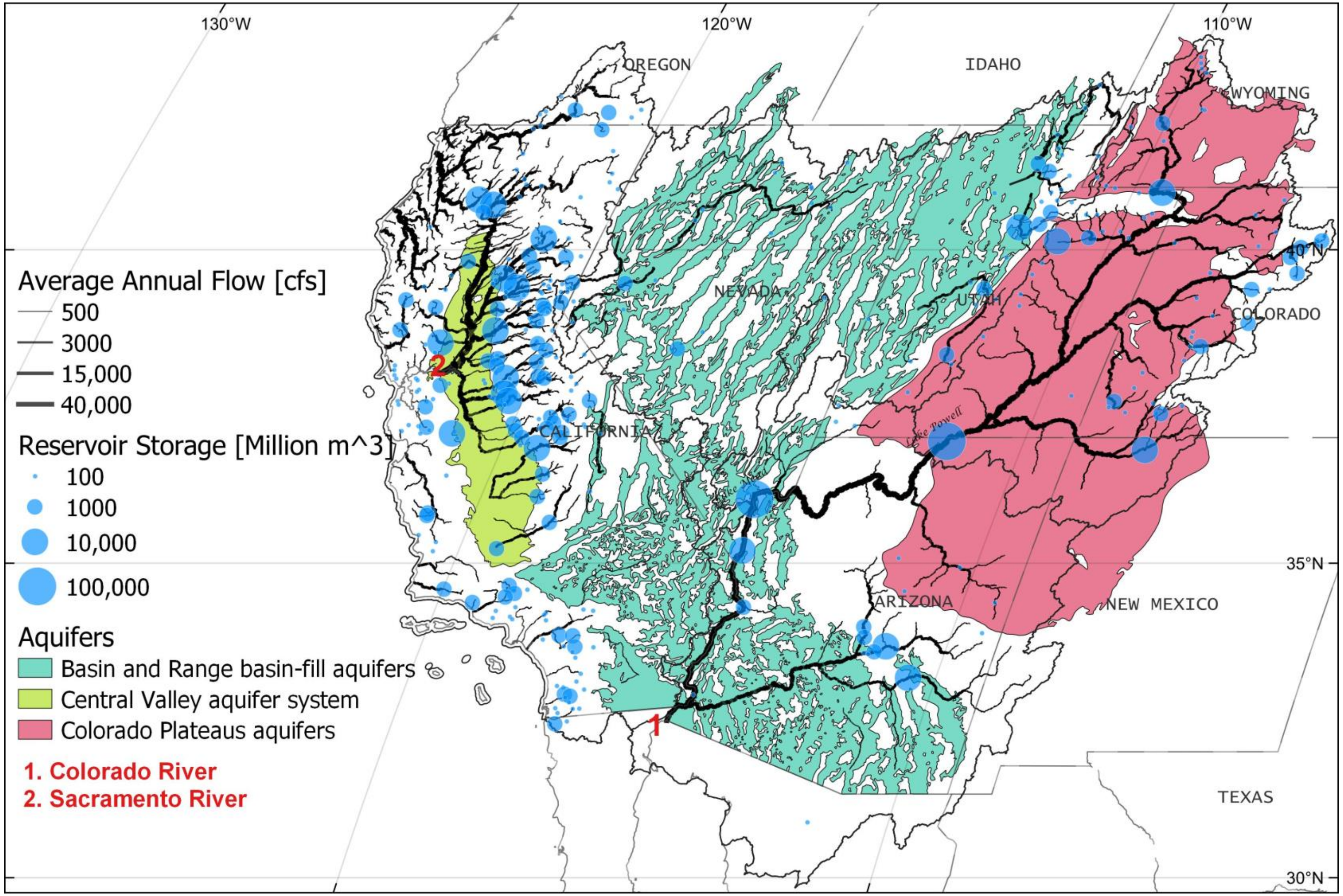
Office of the State Engineer Interstate Stream Commission

DENVER WATER

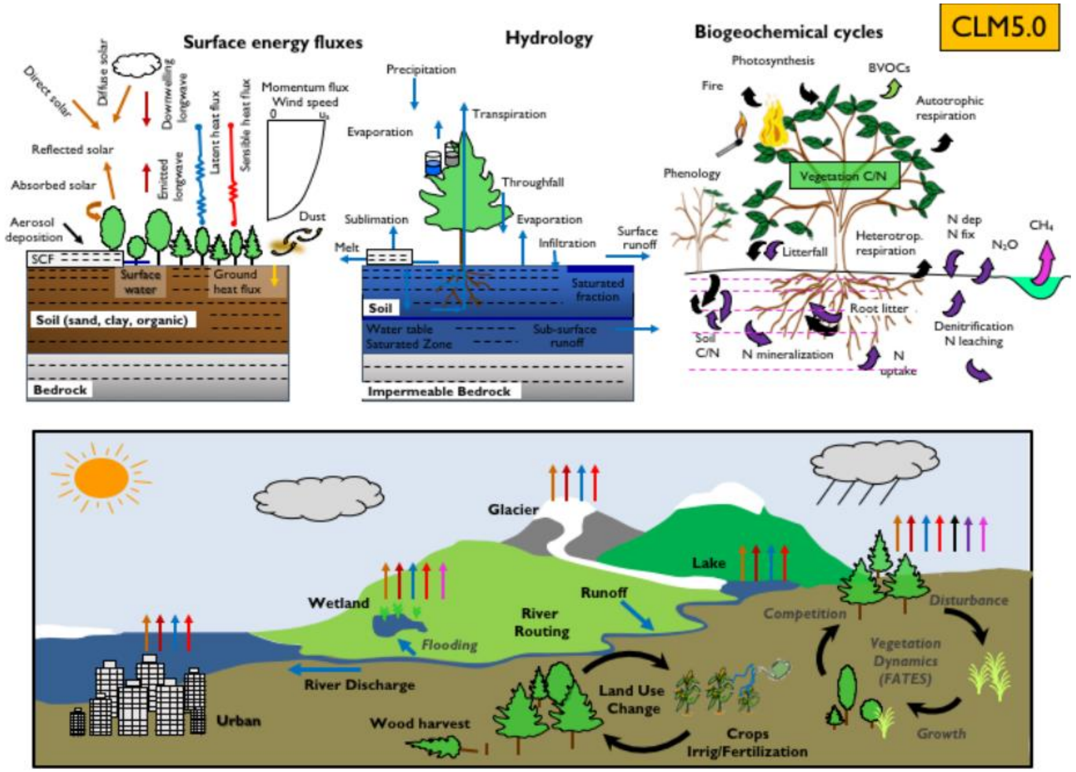
WWA

CALIFORNIA DATA EXCHANGE CENTER CALIFORNIA DEPARTMENT OF WATER RESOURCES

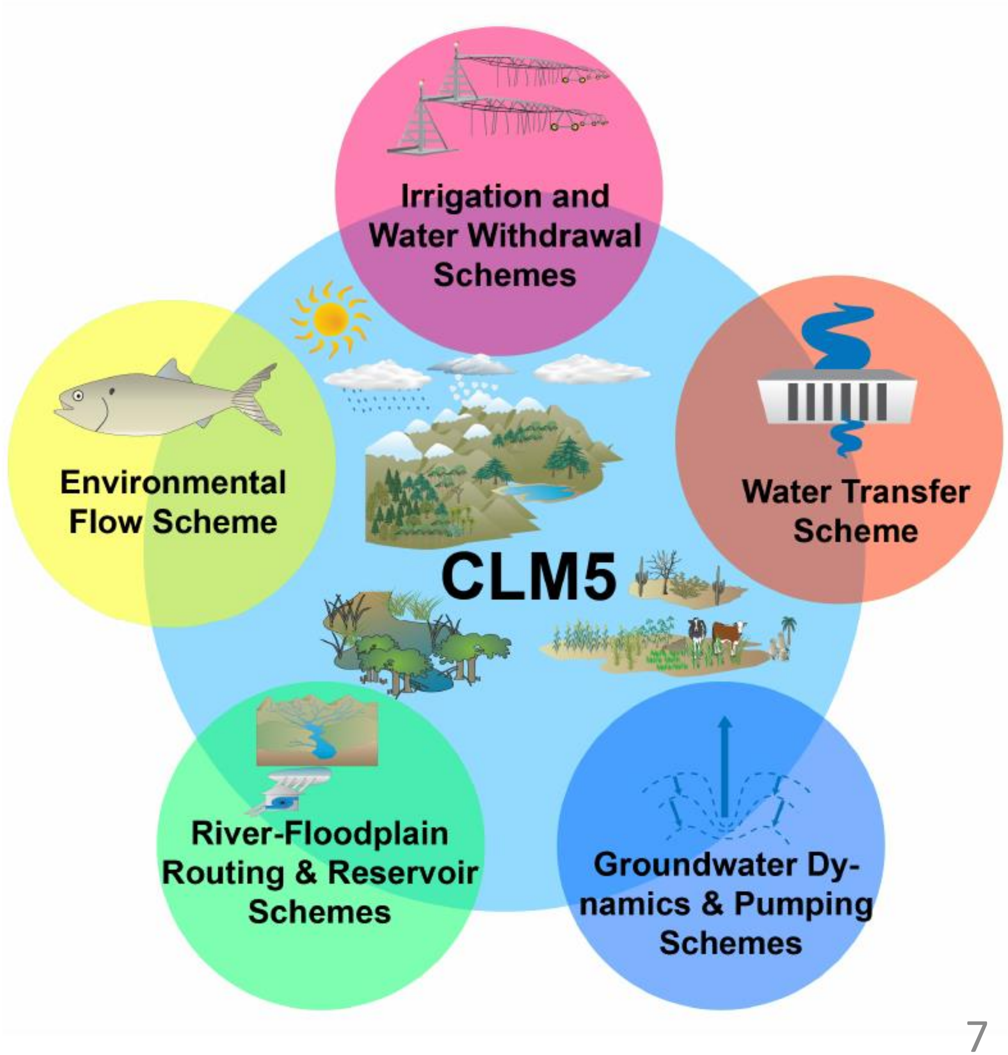
Southwestern US



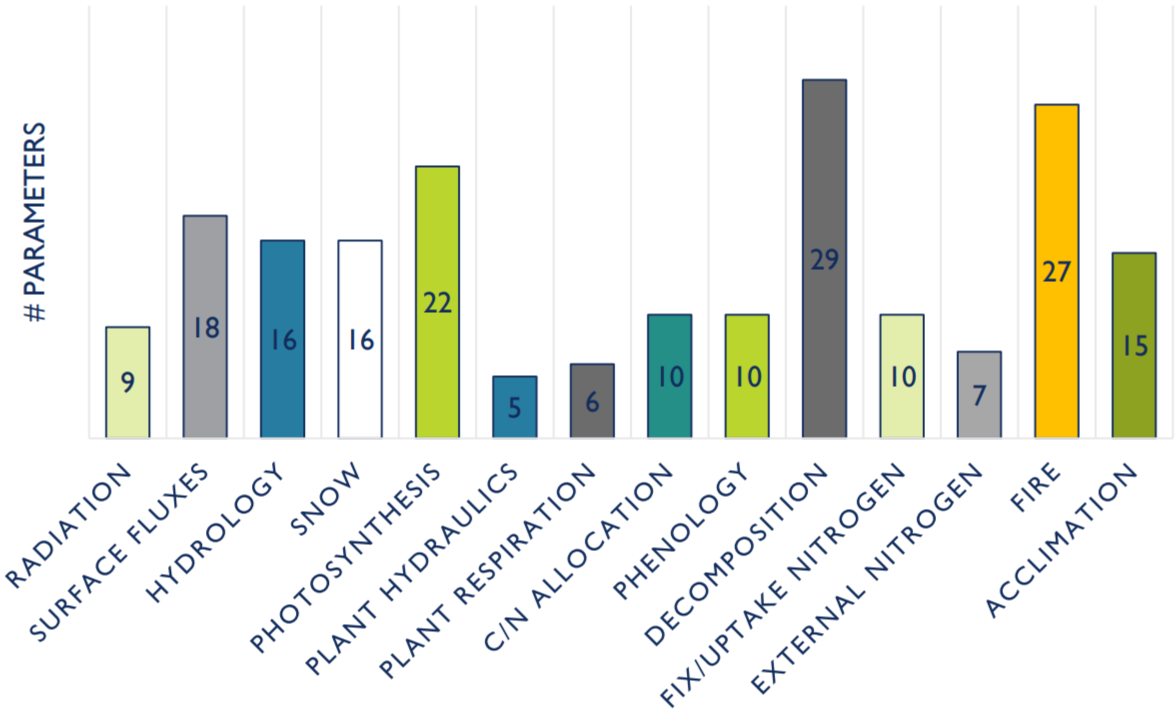
Community Land Model (CLM) version 5



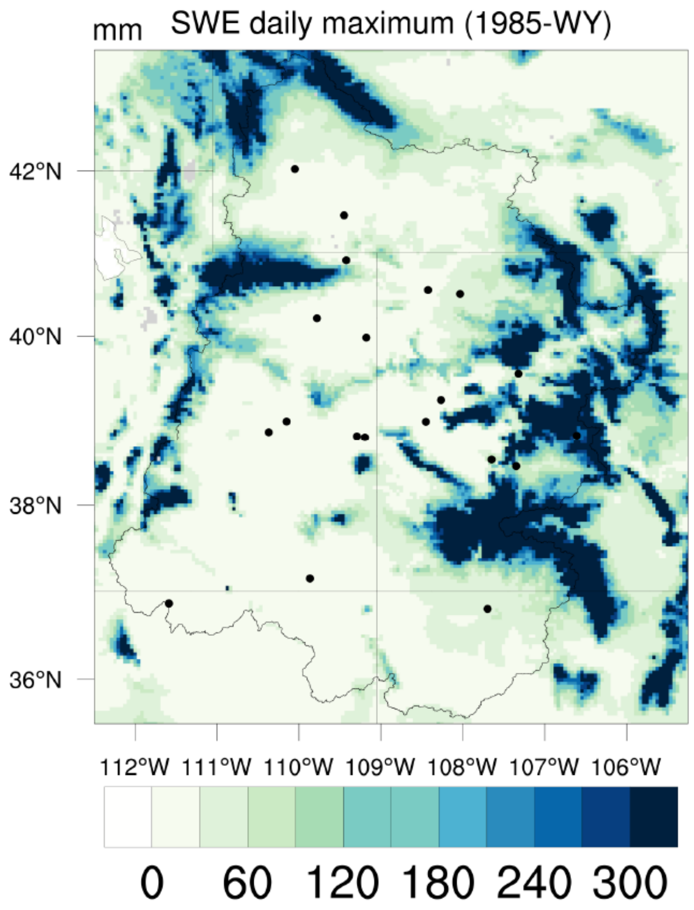
(Lawrence et al., 2019)



Model optimization

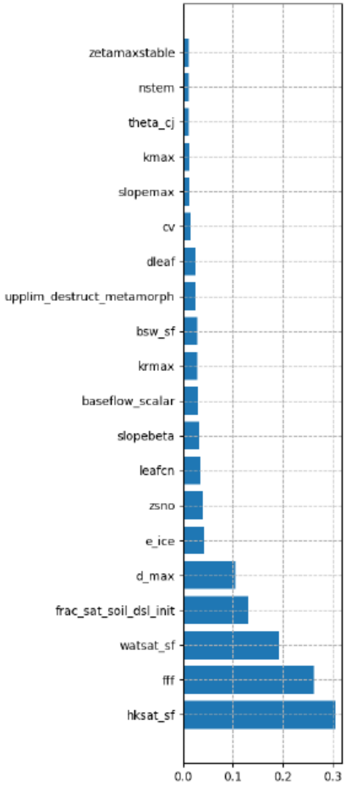


University of Arizona 4-km gridded SWE product



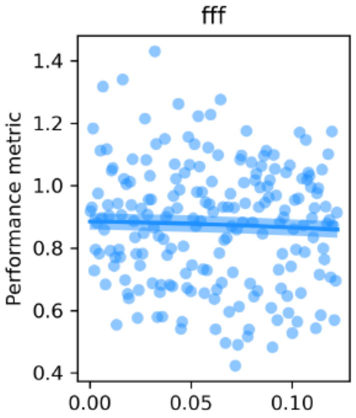
Model optimization

(1)
Identify sensitive parameters:
Perturbed Parameter Ensemble (PPE)

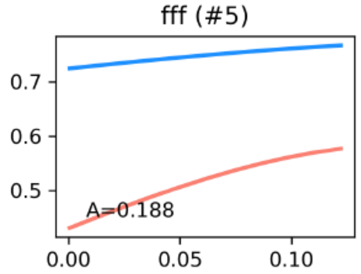


(2)
Perturb parameters & Calculate performance metrics

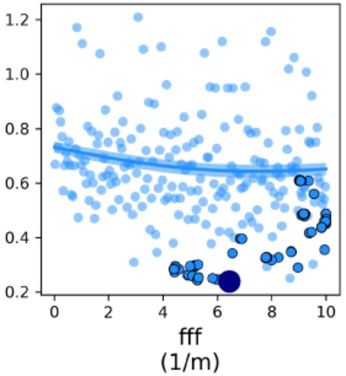
$\phi_Q,\ \phi_S$



(3)
Train a model performance metrics $\propto$ parameters



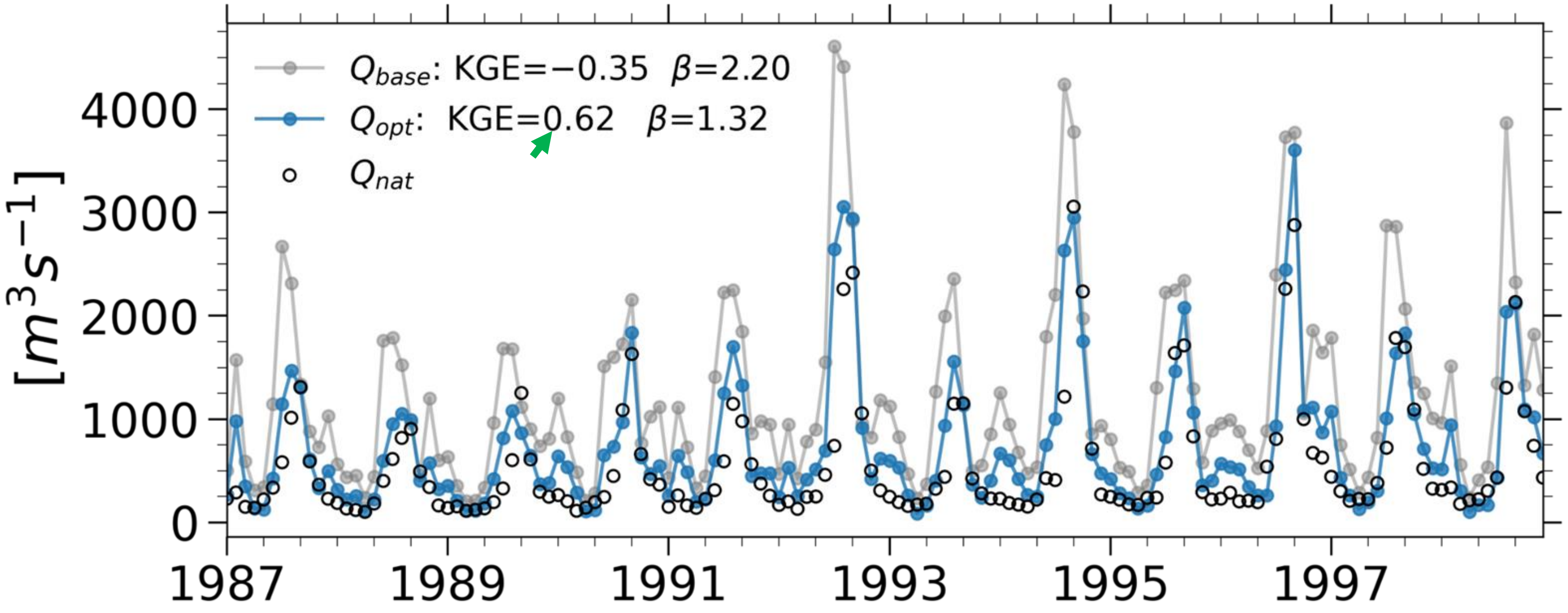
(4)
Predict optimal parameters set

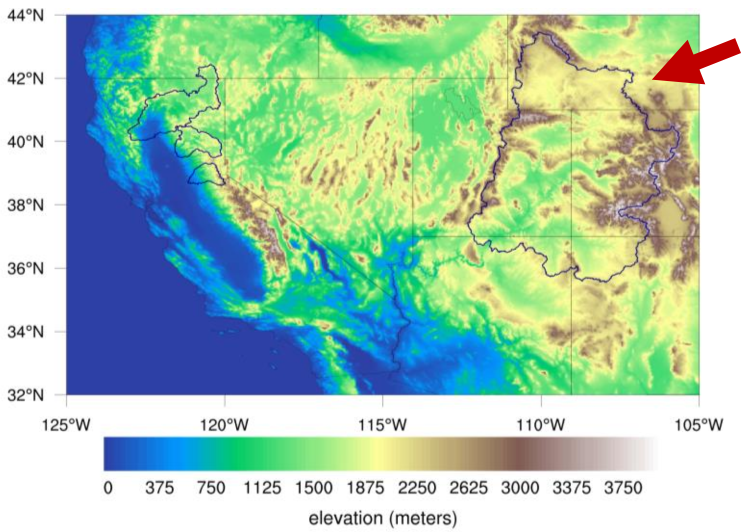


following *Cheng et al. (WRR under-review)*

Model predictability in Southwestern basins

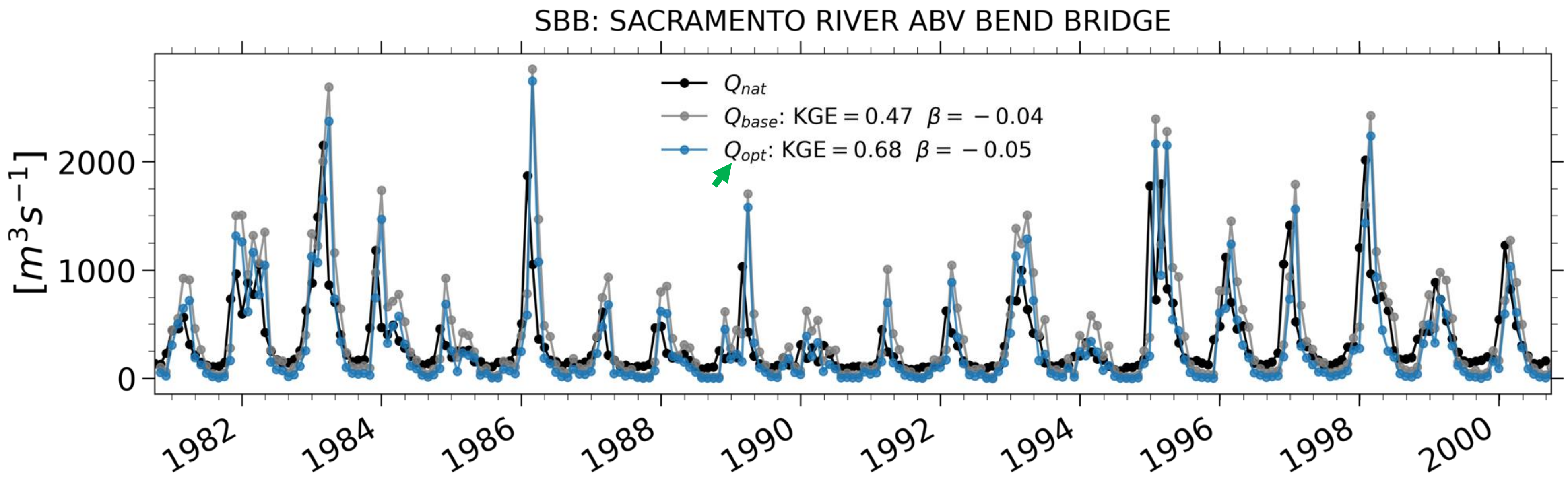
Colorado River at Lees Ferry

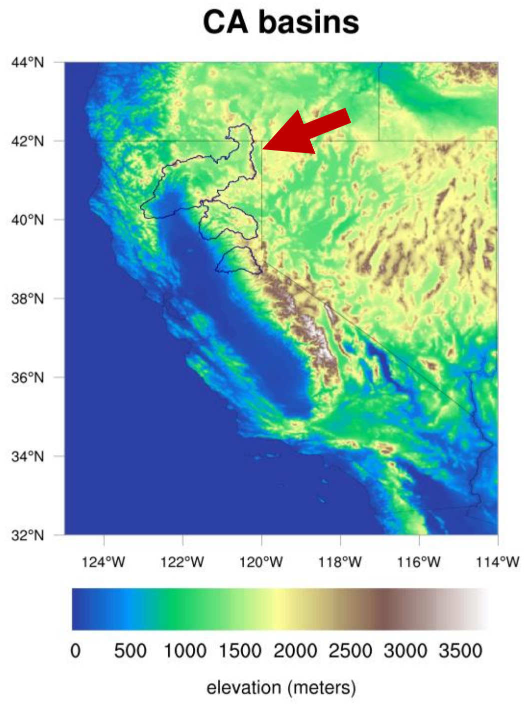




Model predictability in Southwestern basins

Sacramento River at Bend Bridge





Lever I
Natural water availability

Videos Source: Renée Rigdon and Daniel Wolfe, CNN

Lever I

Lever II

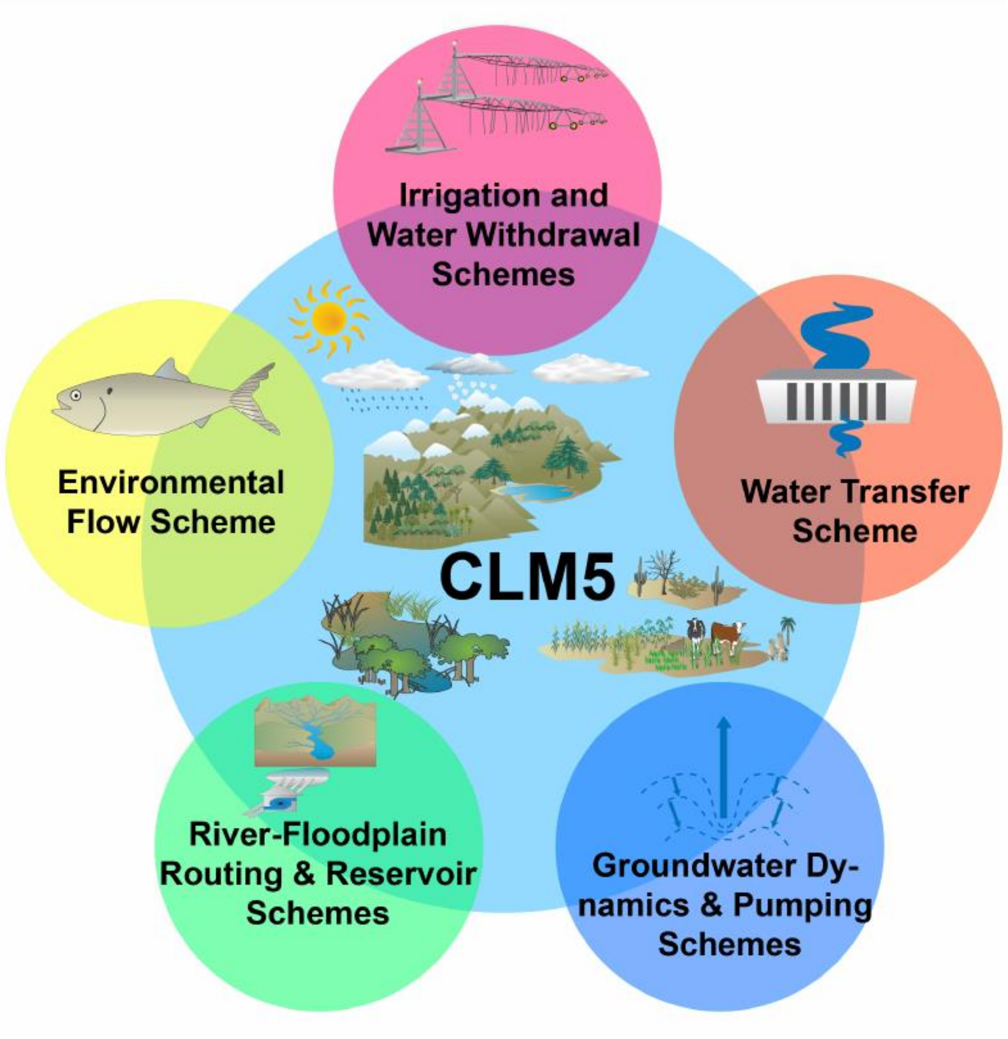
Lever II
Water demands

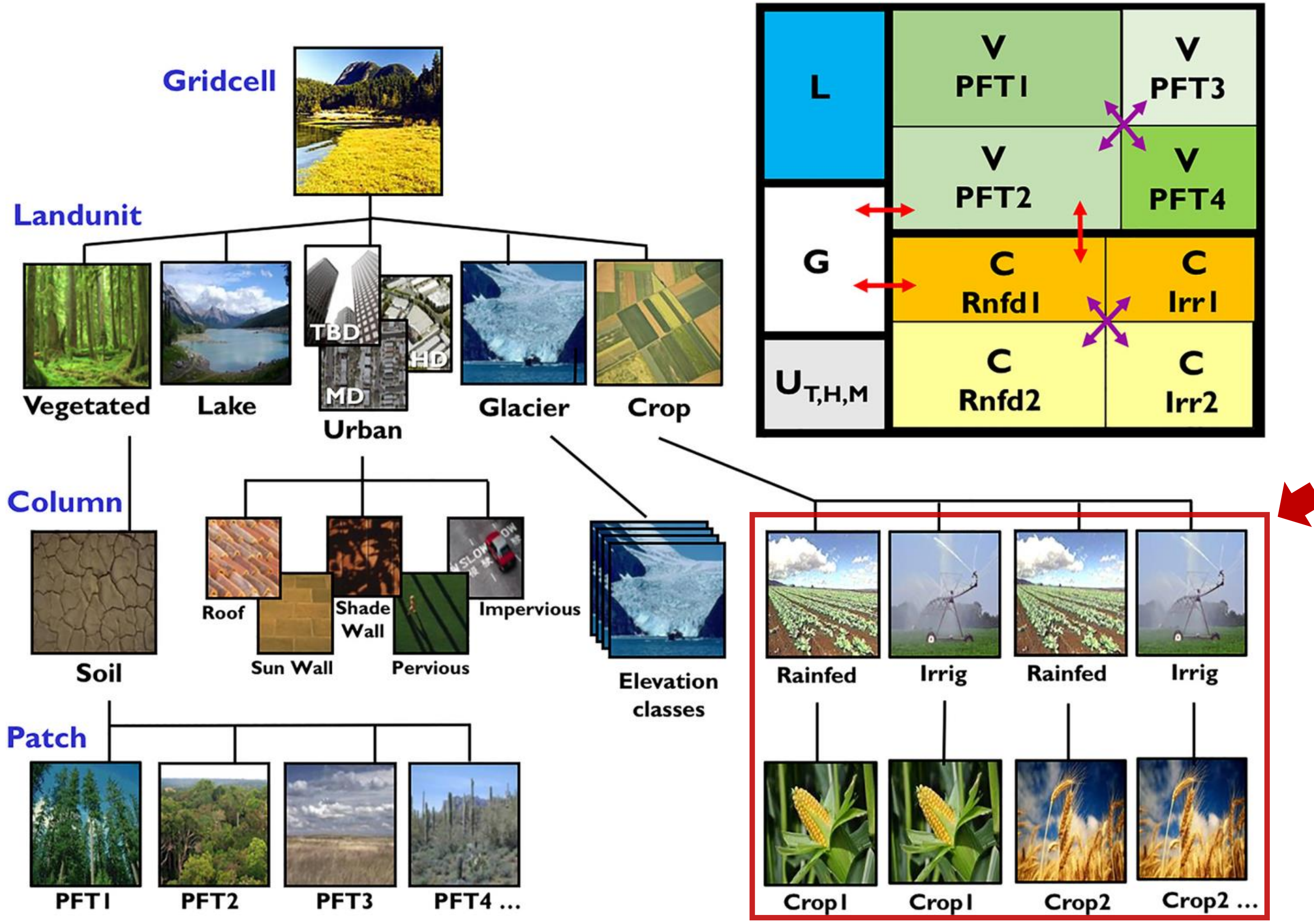
Videos Source: Renée Rigdon and Daniel Wolfe, CNN

Lever III
Reservoir Management

Videos Source: Renée Rigdon and Daniel Wolfe, CNN

Integrated modeling framework



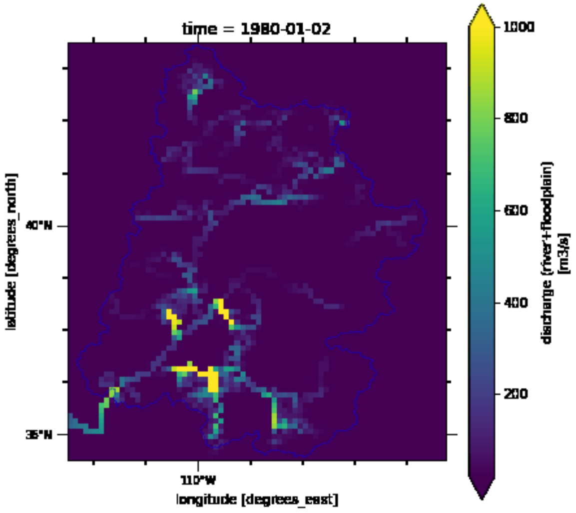


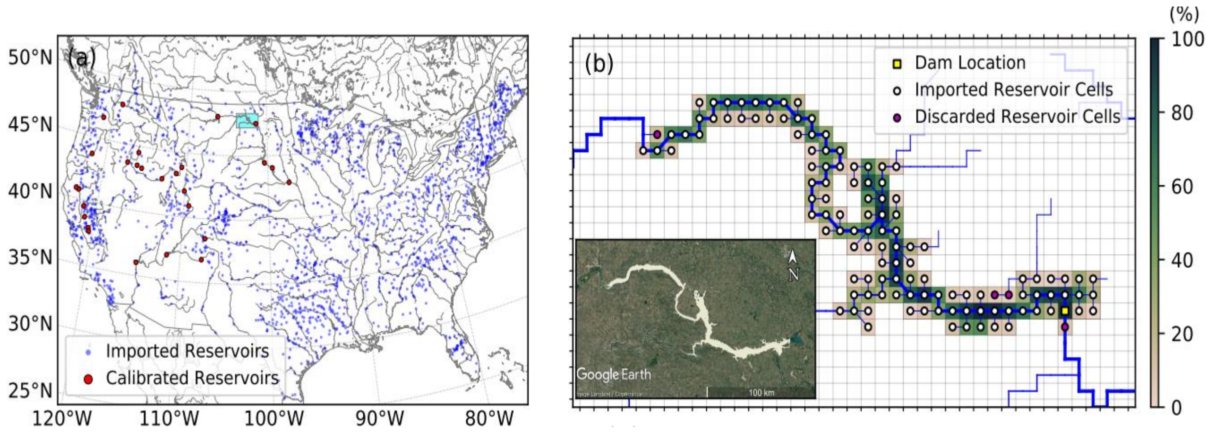
(Lawrence et al., 2019)

Integrated modeling framework

Community Land Model
(Natural river flow [m3/s])

River-Reservoir Model (CaMa-Flood)
(Yamazaki et al., 2011, Shine et al. 2019)





Conclusion

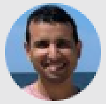
Task 1.
Reconstruct the natural and human-induced changes in the water cycle

Task 2.
Quantify the future changes in water supplies and demands

Collaborators
Workshops

Task 3.
Co-develop potential sustainability pathways considering tradeoffs between water use and environmental needs

Thank you!



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