

Missouri River Basin Needs Assessment

Tools for Managing a Precious Resource

Thank you for joining us, we will begin promptly at 1:00 PM Central Time

**This meeting will be recorded*



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Missouri River Basin Needs Assessment

Tools for Managing a Precious Resource

Pre-Workshop Webinar | February 15, 2022

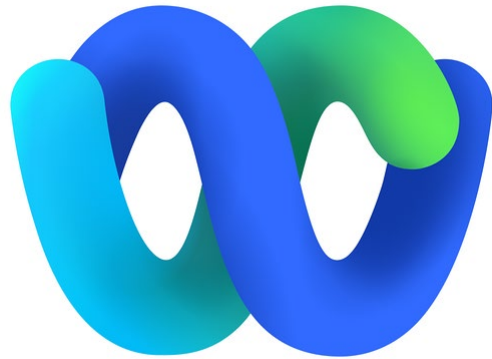
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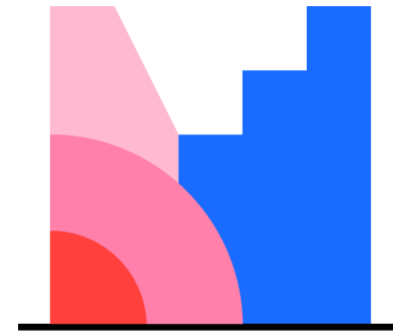
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Be Ready to Participate



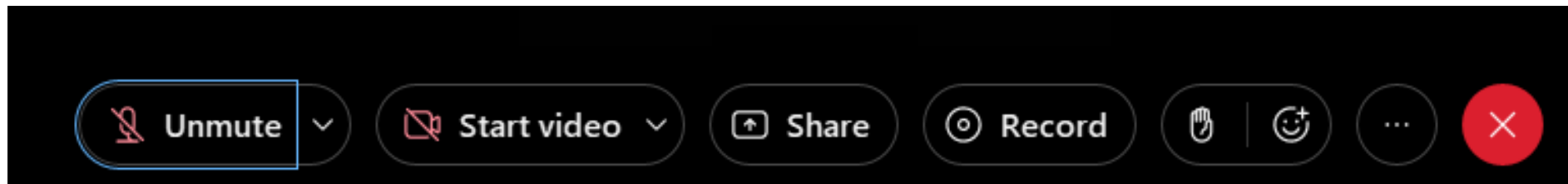
Use **WebEx** chat for questions



Have your phone or web browser ready – we'll use **Mentimeter** for live polling

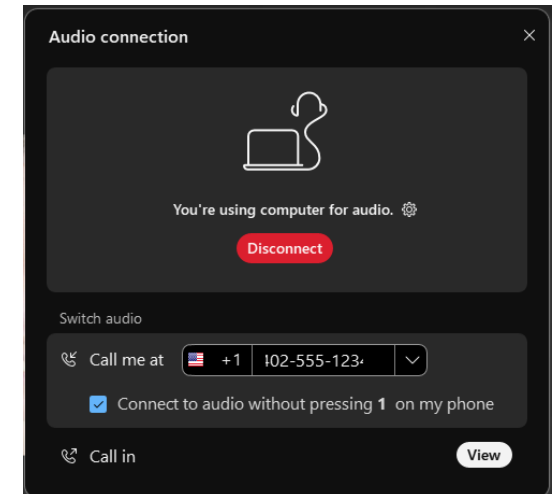
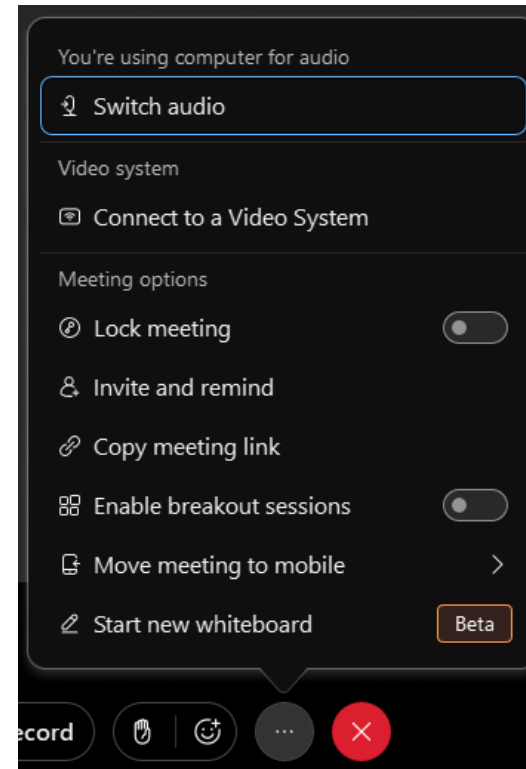
Rules of Engagement

- Please mute yourself during the presentation
 - There will be an open Q&A at the end of the presentation
- If you have technical difficulties, send a chat directly to Julie Molacek and she will help you troubleshoot.
- Turn off your cameras to help with bandwidth and connectivity



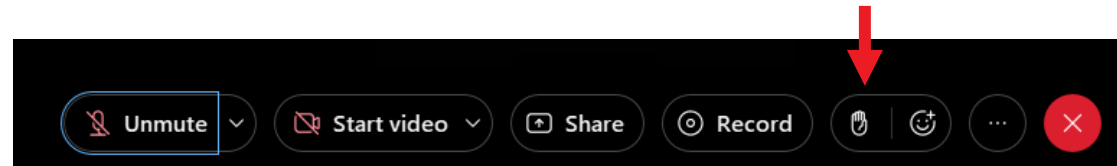
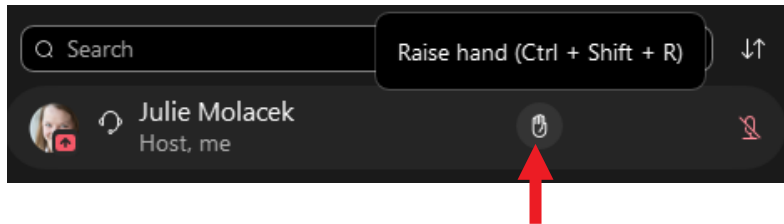
Rules of Engagement

- If you have trouble with audio, connect by phone:
 - Click the 3 dots at the bottom of the screen
 - Select “Switch audio”
 - Select “call me at” or “call in”



If You Have Questions During Presentation

- Raise your hand by clicking the hand icon (next to your name or at the bottom of the screen)
 - Unmute yourself when addressed by the host.



- OR you can submit a question in the chat box at the bottom right-hand part of your screen, and a host will read your question aloud.

Today's Agenda

- Welcome & Introductions
- NASA Earth Science & Water
- WWAO Background
- Research & Application Examples
- WWAO Needs Assessment / Basin Survey
- Use Case Definition & Samples
- From Use Cases to Useful Products
- Q & A

Welcome & Introductions



Who Are You?

Please type your name and organization in the chat box. We'd love to know who all we have on the call today!



**What's your name?
Where do you work?**

Project Team

Consultant Team (HDR)



Kristen
Veldhouse



Julie Molacek



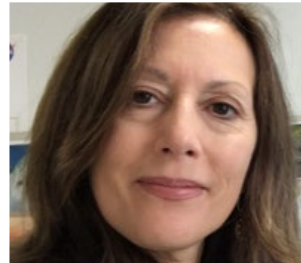
John Engel

Project Team

NASA Western Water Applications Office (WWAO) Staff



Indrani
Graczyk



Sharon Ray



Stephanie
Granger



Amber
Jenkins



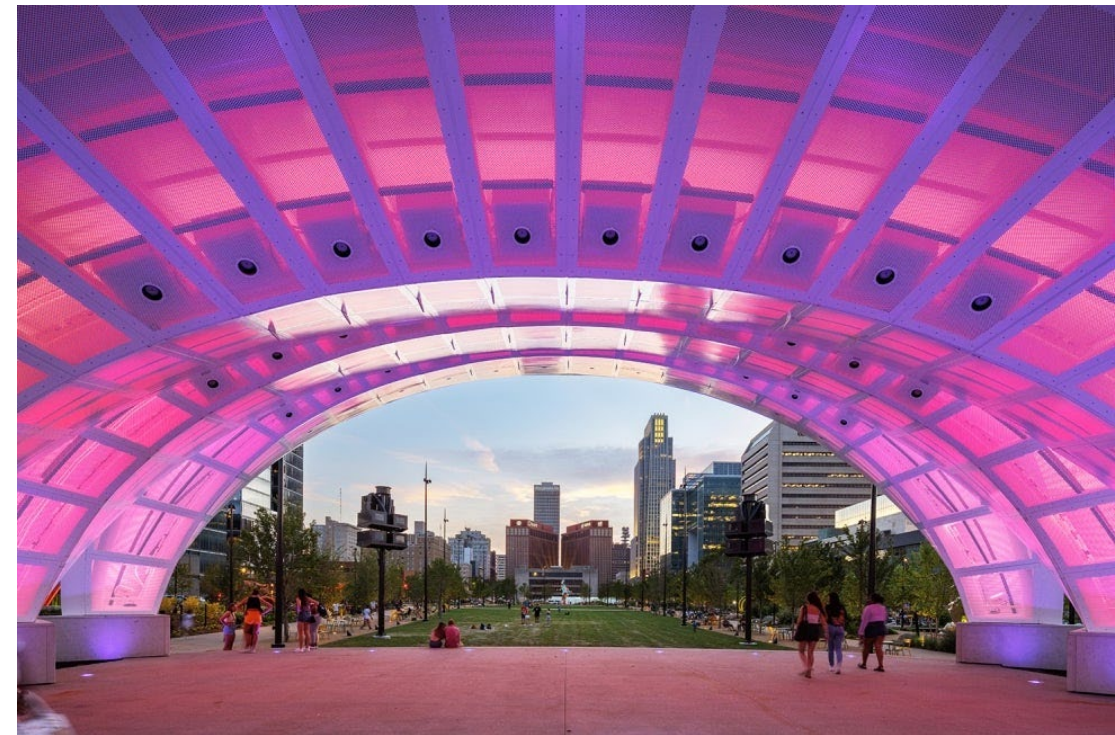
Amber
McCullum

WWAO Missouri River Basin Needs Assessment Workshop

(March 14 – 16, 2023 in Omaha, Nebraska)

Workshop Goals:

- **Identify opportunities** where remote-sensing data could complement existing systems and facilitate key water-management decisions
- Discuss **data needs and information gaps** in the Missouri River Basin
- **Identify ways** in which NASA may be able to assist in meeting these needs
- Develop **use-case scenarios** for the Missouri River Basin



NASA Earth Science & Water





EARTH FLEET

INVEST/CUBESATS

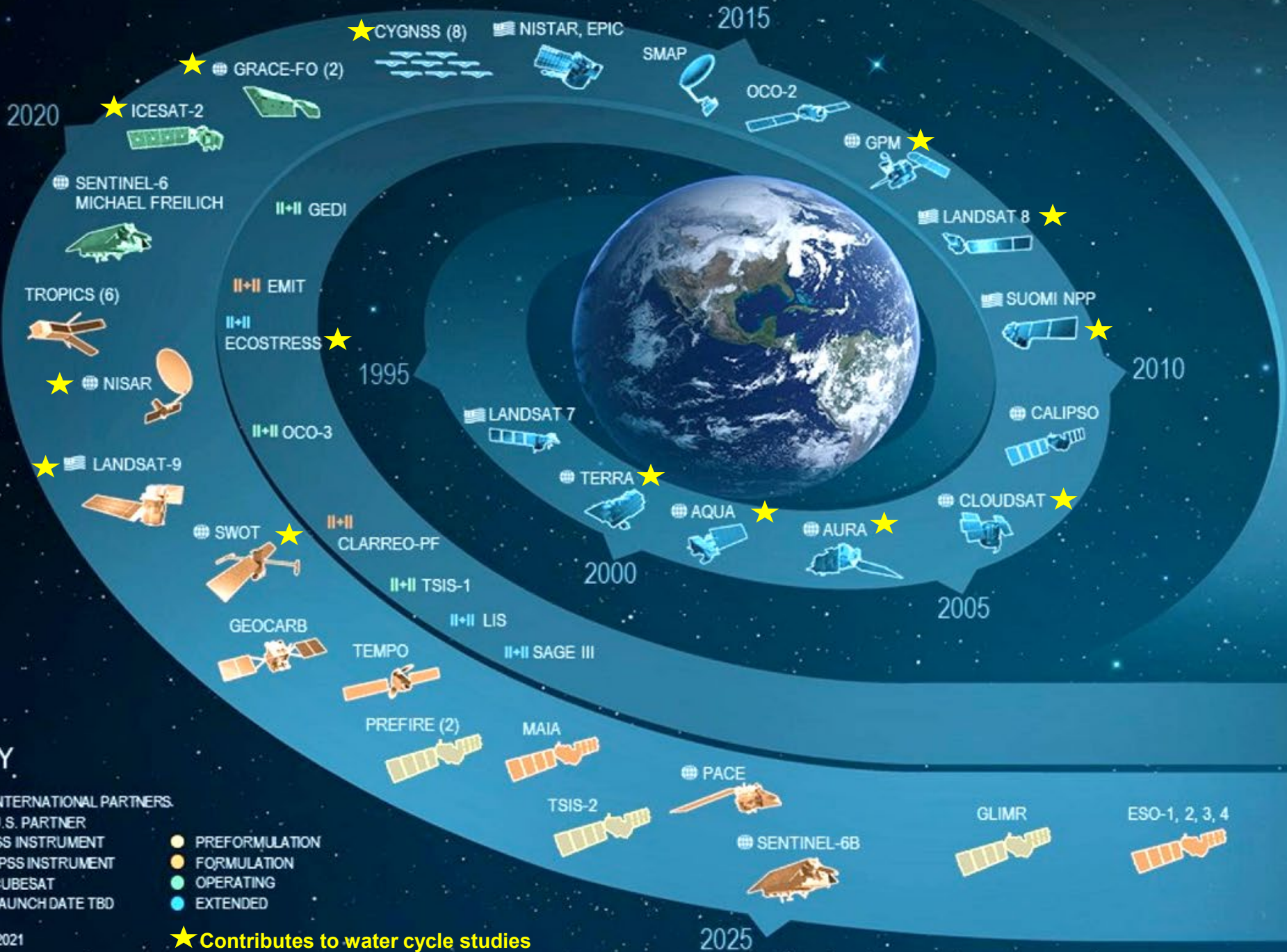
- TEMPEST-D 2021
- CSIM-FD 2023
- HARP 2022
- CIRIS 2023
- CTIM* 2022
- HYTI* 2022
- SNOOPI* 2022
- NACHOS* 2022
- NACHOS2* 2022

JPSS INSTRUMENTS

- OMPS-LIMB 2022
- LIBERA 2027

ISS INSTRUMENTS

MISSIONS

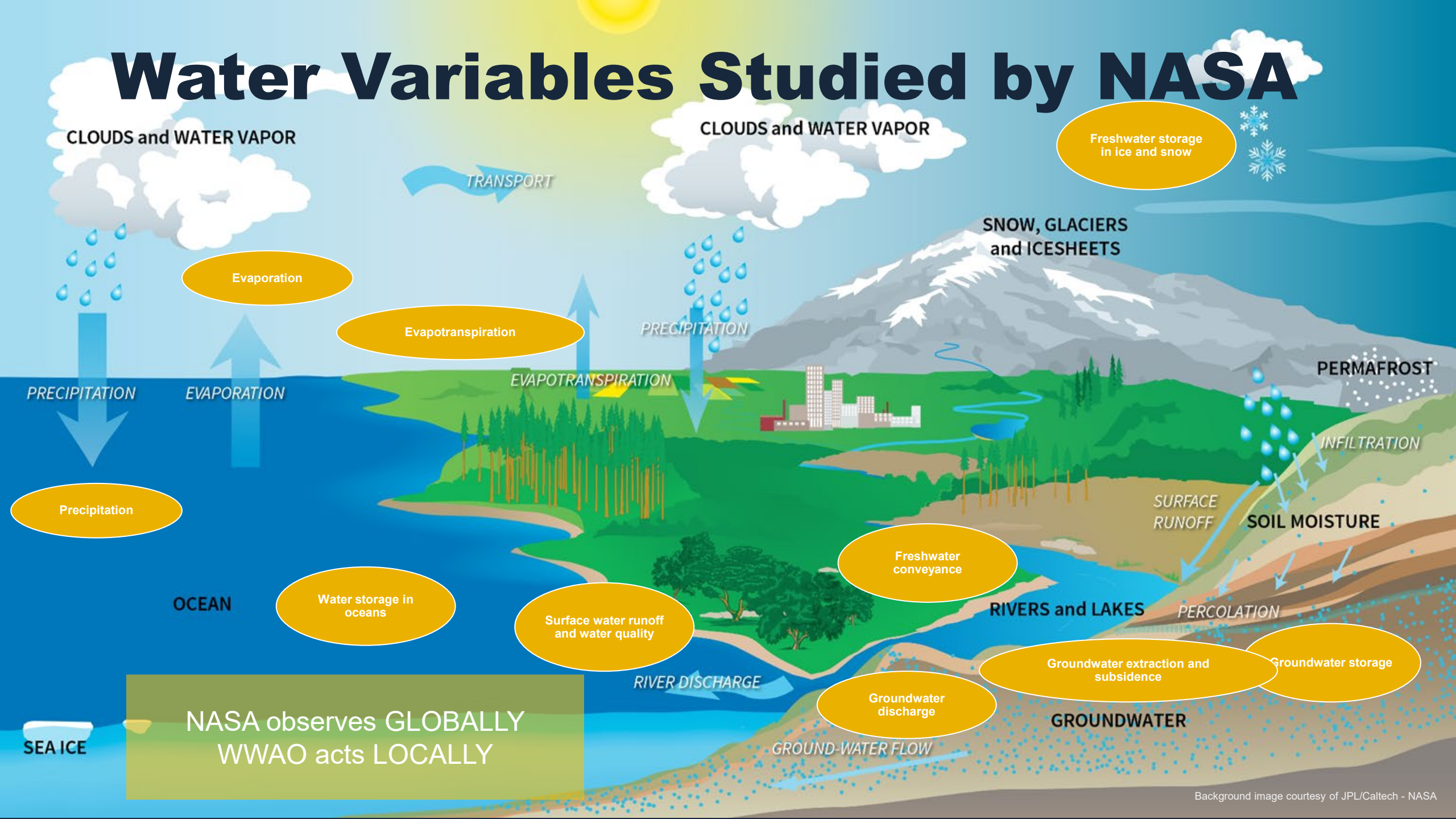


KEY

- INTERNATIONAL PARTNERS.
- U.S. PARTNER
- ISS INSTRUMENT
- JPSS INSTRUMENT
- CUBESAT
- LAUNCH DATE TBD
- PREFORMULATION
- FORMULATION
- OPERATING
- EXTENDED

★ **Contributes to water cycle studies**

Water Variables Studied by NASA

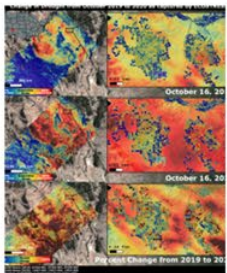


NASA observes GLOBALLY
WWAO acts LOCALLY

NASA Capabilities for Water Resources Management

- Evapotranspiration (ET)
- Snow (SWE, depth, cover, albedo)
- Forecasting & Precipitation
- Land Subsidence & Infrastructure Modeling
- Agriculture
- Water Quality
- Land Use
- Groundwater

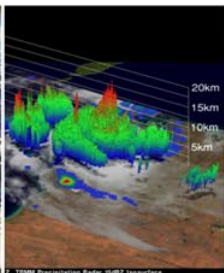
Capabilities examples (not comprehensive)



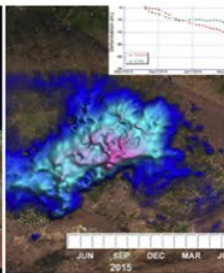
Evapotranspiration
ECOSTRESS, OpenET, SIMS



Snow
Airborne Snow Observatory



Forecasting & Precipitation
GPM, TRMM



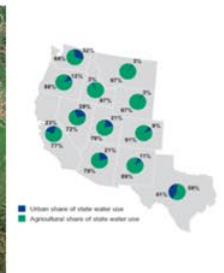
Land Subsidence
UAVSAR



Agriculture
Crop-CASMA



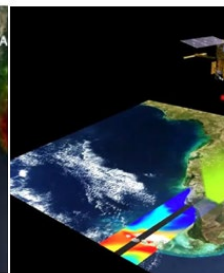
Water Quality
Estimate water quality constituents in CA Bay-Delta



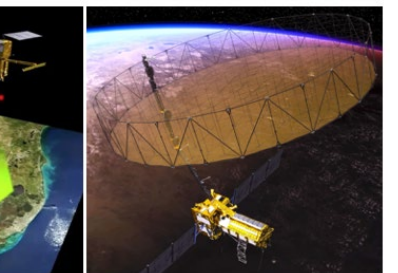
Land Use
Fallowed land mapping



Groundwater
GRACE/GRACE-FO



Surface Water
Ocean Topography
SWOT



Natural Processes, Resources & Hazards
NISAR

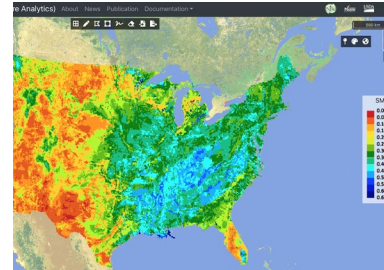
WWAO Background



WWAO – NASA's Western Water Applications Office

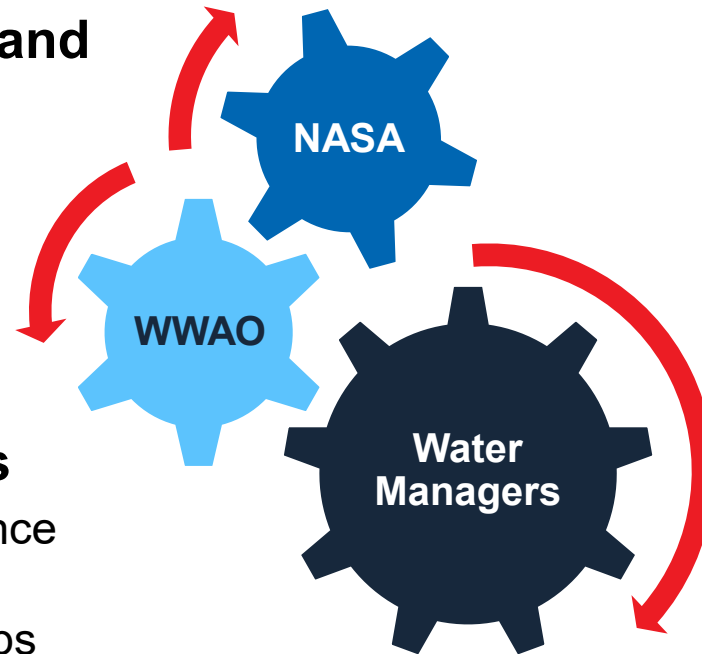
Tools for managing a scarce resource

- WWAO is a local western NASA program office to support Western U.S. water managers in putting NASA data to work
- **WWAO's mission:** To improve how water is managed by getting NASA data, technology, tools into the hands of western water managers



WWAO – NASA’s Western Water Applications Office

- **WWAO connects stakeholders with NASA scientists, technology, tools, and data**
 - Develop custom solutions through applications projects
 - Assist with application transition into operations
- **Innovate approaches to project development and stakeholder needs**
 - Leverage decades of investment in science and technology across NASA
 - Develop and maintain lasting relationships with western water managers through a western NASA office



WWAO Process

- 1 - **Identifying Needs** for which NASA’s unique capabilities can have an impact
- 2 - **Making Connections** between stakeholders and NASA
- 3 - **Transition** water applications into operations to achieve a sustainable and long-term impact

WWAO Model

Build partnerships to help answer questions such as:

- How can I optimize my irrigation application?
- When will my snowpack melt and how much inflow will I get?

WWAO pursues a NEEDS-DRIVEN strategy to develop and fund projects that utilize remote sensing data, research, and technology

Outcomes

Engagement



3 major needs assessments completed

6 western basins / watersheds studied

51 Use Cases documented

150+ participants in workshops / surveys

Projects



4 award rounds

16 completed projects

5 active projects

~30 project partners

4 Impact Assessments

20+ papers/articles on project results

Transition



3 capabilities transitioned

1 new company formed

1 Research to Operations Workshop

2 interagency Research to Operations publications

River Basin Approach

Conduct Water Management Studies and Needs Assessments for major western US basins

- Eight major basins in the western US, roughly west of the 100th meridian

4 x Basin Water Resources Management Studies completed

- Upper and Lower Colorado River Basin
- Columbia River Basin
- Rio Grande Basin
- Missouri River Basin



Research & Application Examples





Snow

Problem

Better snowpack information is a common need across the Western U.S.:

- Runoff forecasting
- Streamflow forecasting
- Flood prediction
- Snow conditions (SWE, albedo, etc.)

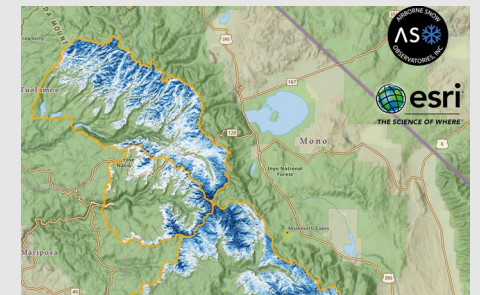
Solution

NASA's work in Snow Science has created multiple relevant capabilities:

- Airborne Snow Observatory (ASO)
- Snow Today data system (NSIDC)
- Satellite-based snow sensing for monitoring and forecasting (NRCS)
- Near real-time snowpack estimation from satellite data (CA DWR)

Value

- Established an operational pathway for remote sensing data to be used by the Colorado River Basin Forecast Center
- In 2020, ASO Inc., a NASA spinoff, delivered SWE estimates to California, Colorado and USBR
- As a private-sector entity, ASO Inc.'s outreach to Congress has led to funding bills for a DoI/USBR Snow Water Supply Forecasting Program
- Recommending ways to incorporate remotely sensed snow data into next-gen versions of NRCS operational tools to improve the accuracy of runoff forecasts





Drought

Problem

Drought continues to plague the West. Better information on drought conditions is a key need across the Western U.S. :

- Drought severity
- Drought indicators
- Short and long-term drought trends

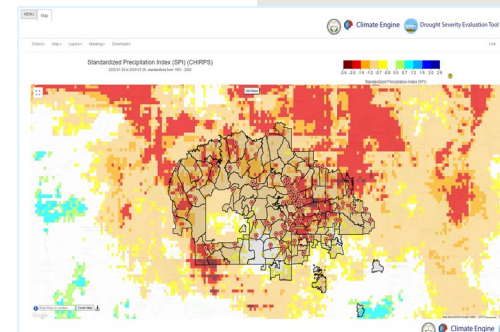
Solution

NASA's work in Drought Science has created multiple relevant capabilities:

- High-resolution drought indicators
- Drought severity tool
- Identification of drought-related groundwater changes

Value

- WWAO's Drought Severity Tool (DSET) is helping the Navajo Nation allocate emergency relief when drought hits
- After significant training and support, the Navajo Nation is taking operational responsibility for DSET
- WWAO's Western Land Data Assimilation System will feed finer-grained drought data into the Colorado Climate Center's weekly drought reports
- VIRGO – New NASA California groundwater tool will support sustainable groundwater management





Agriculture

Problem

As agriculture can be the largest consumer of water in the West, methods to measure and manage agricultural water are of great interest:

- Irrigation Management
- Soil Moisture
- Land-Use Tracking

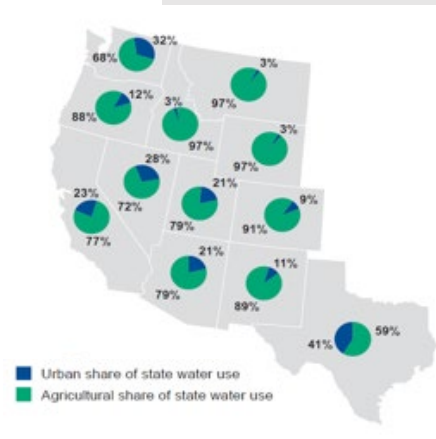
Solution

NASA's observations enable several new decision-support tools for agricultural water management:

- Satellite-Based Irrigation Management
- Soil Moisture Maps
- Fallowed Land Mapping

Value

- WWAO's Crop-CASMA Soil Moisture App delivers field-scale soil wetness to USDA NASS, pinpointing water availability and informing crop operations
- With WWAO's help, NASA satellite data have been incorporated into the CropManage tool to improve irrigation management
- Thanks to WWAO, CA, WA & NV can do Satellite Mapping of Fallowed Land on-demand, tracking drought-hit agricultural land at a monthly timestep





Evapotranspiration

Problem

Field-Scale Evapotranspiration Data is a prevalent need for Western water managers for a range of decisions:

- Verification of water rights
- Monitoring water use

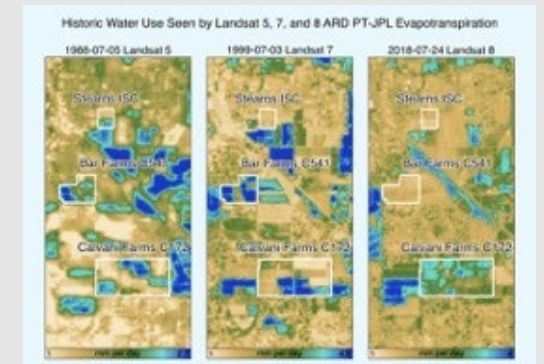
Solution

NASA has supported several approaches to estimate ET from satellite data:

- ALEXI / DisALEXI (with USDA)
- METRIC (with U. of Idaho and UNL)
- PT-JPL
- SEBAL (via international partners)
- SIMS
- SSEBOP (with USGS)

Value

- WWAO's Operational Evapotranspiration Visualizer enables the New Mexico State Engineer's Office to make more informed decisions on water-rights transfers
- WWAO's Intercomparison Study of Satellite ET Models with the U.S. Bureau of Reclamation delivered insights into which models are best suited to particular environmental conditions
- OpenET, an effort supported by NASA and philanthropic foundations to make satellite ET data available online, is a potential platform for transition to operations
- WWAO's tool to quantify water use through ET on irrigated lands across the Columbia River Basin is making data available via OpenET

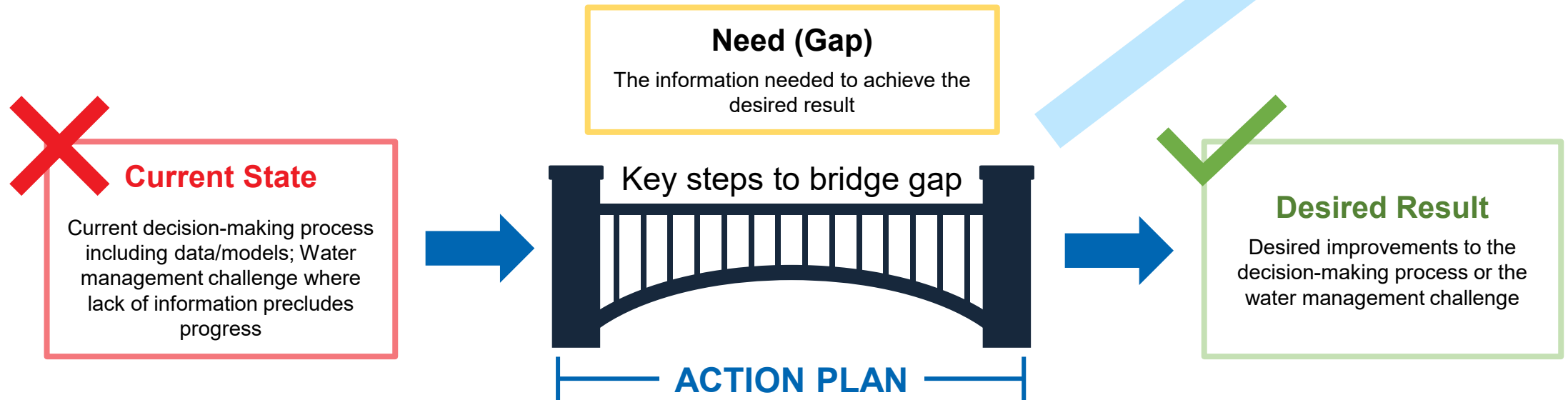


WWAO Needs Assessment / Basin Survey



What is a Need (Gap)?

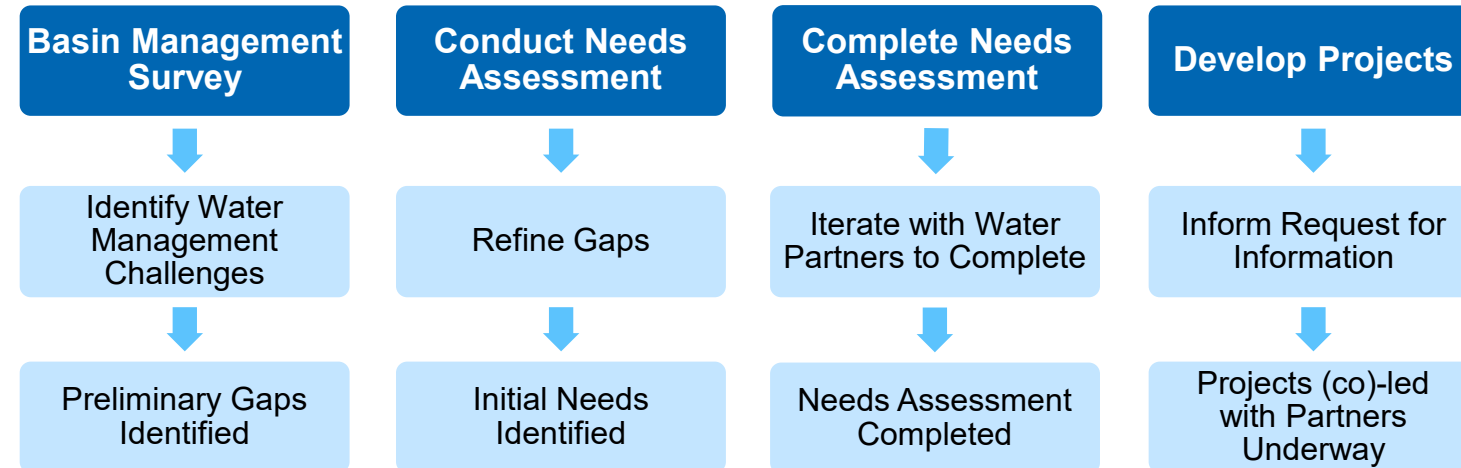
- A need is a **gap in water information**, or an **opportunity to improve upon an existing information source**
- If the need is addressed, it would lead to a **meaningful improvement** in a specific **water management decision making process**



Basin Needs Assessments

Needs Assessment

Multi-part process of identifying and understanding water resources gaps (needs) in the Western U.S.



Example of River Basin Needs

Water Resources Category	Needs
Snow Properties and Processes	Improved Forecasts of Snowpack, Runoff, Water Demand, Evapotranspiration
Water Supply Forecasting (< 1 year period)	Timely streamflow predictions at sub-basin level (WWAO)/Improving performance of streamflow predictions where snow data are sparse or non-existent (WG)
	Historical baseline of soil moisture in the CO River Basin (WG)
	Exploration of rain on snow dynamics (WG)
Evapotranspiration (ET) over Land and Water	Consumptive Use for Calculating Water Budget
	Reservoir Evaporation
	Consumptive Use of the Headwaters of the Colorado River (WG)
Crops and Agriculture Properties and Processes	Crop Mapping
	Crop Monitoring
Irrigation Types and Methods	Irrigation Management
	Irrigation Mapping
Groundwater Characterization	Augmenting Groundwater Quantification
Extreme Events Predictions and Impacts	Mitigation of Wildfire Impacts on Watershed Supply
	Augmentation of State-Level Drought Planning and Response
	Drought Planning and Response at the State Level
Water Supply Forecasting (≥ 24-month period)	Predicting Changes in the Sierra Nevada or Rocky Mountain Snowline, Snowpack Distribution, and Streamflow Forecasts

Missouri River Basin Survey

About the survey

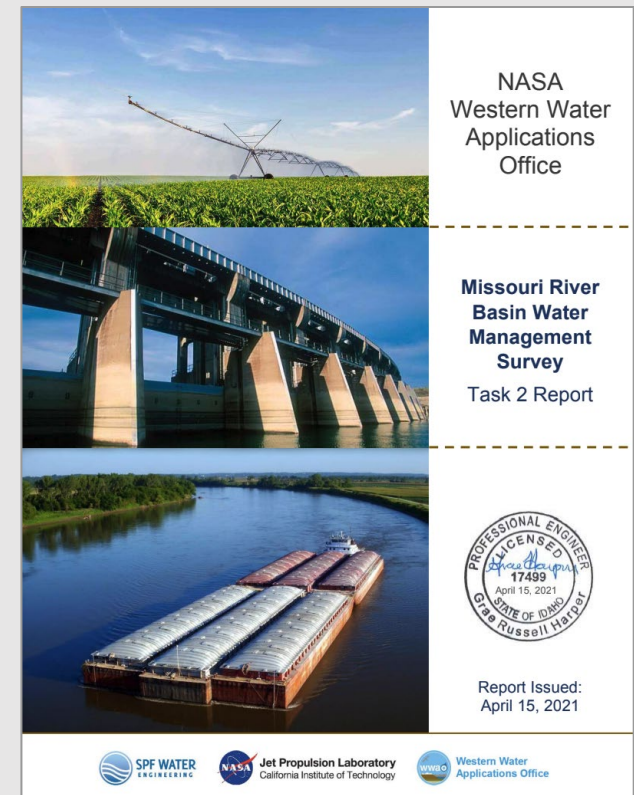
- WWAO contracted with SPF Water Engineering (HQ in Omaha)
- Surveyed entities with water interests across Missouri River Basin

Interview goals

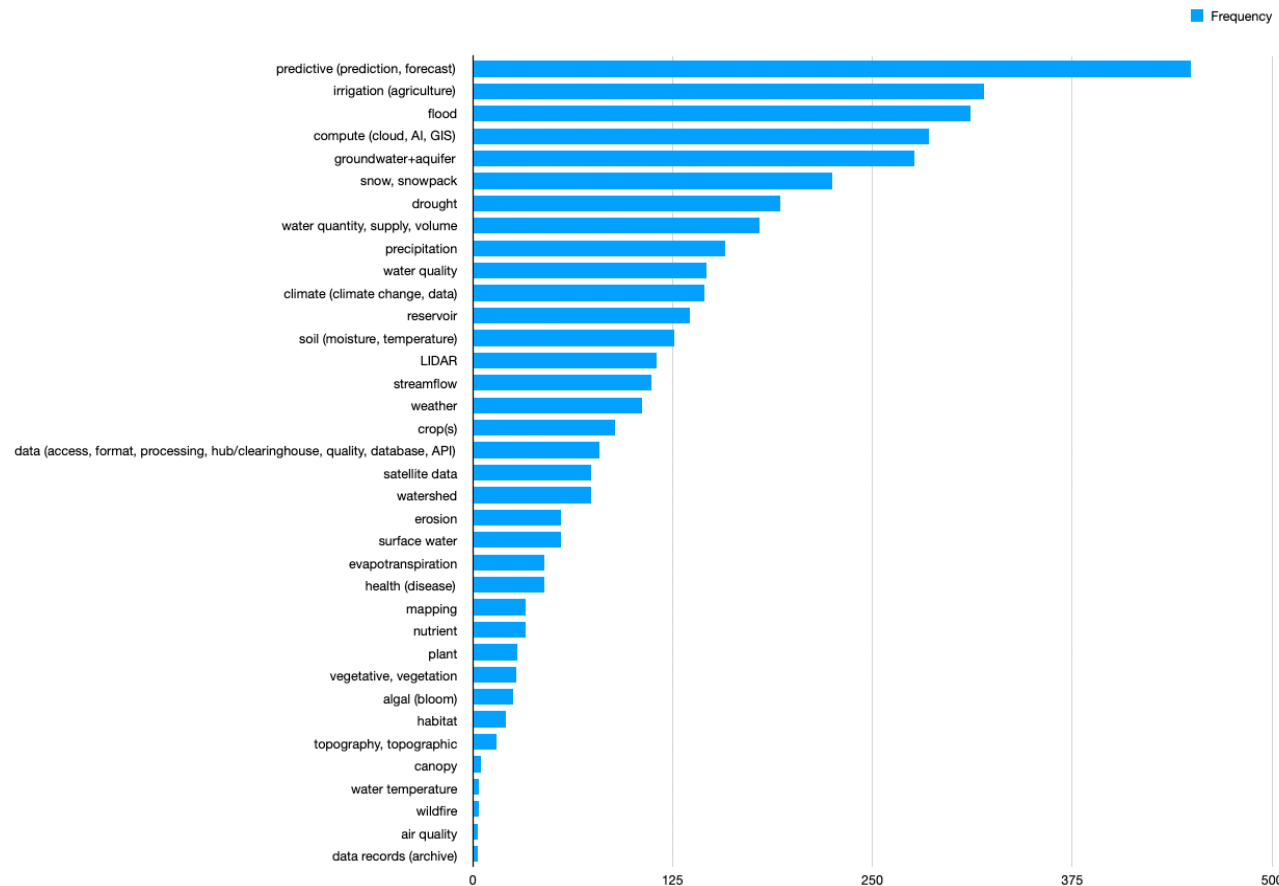
- Establish greater understanding
- How remotely sensed information is currently used to support water related decision making
- Set stage for potential future collaborative efforts between WWAO and Basin stakeholders

Survey provided insights

- How remote-sensing data is used and biggest water related issues



Missouri River Basin Survey – Frequency of Topics Mentioned



Top 8 Topics Mentioned

- Predictive (prediction, forecast)
- Irrigation (agriculture)
- Flood
- Compute (cloud, AI, GIS)
- Groundwater, aquifer
- Snowpack
- Drought
- Water Supply

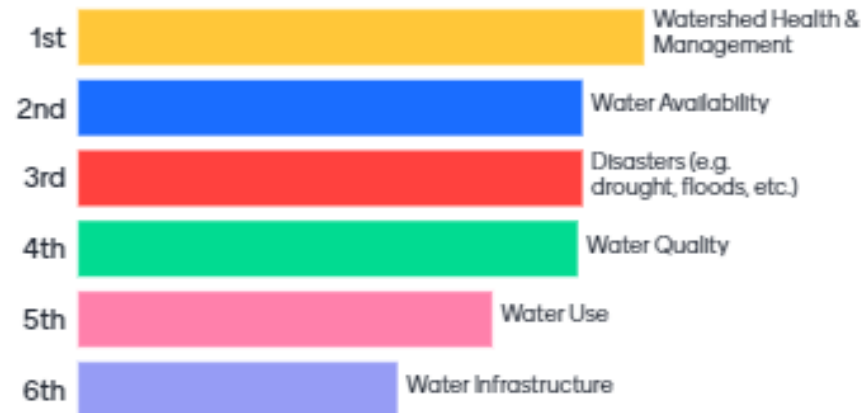
Live Polling Exercise

Go to www.menti.com and use the code
4298 3093 to access the poll.

Live Polling Exercise Results

What water management topics are you most concerned about? Please rank the options below.

Mentimeter



Live Polling Exercise

Let's discuss the results of the poll.

Use Case Definition & Samples



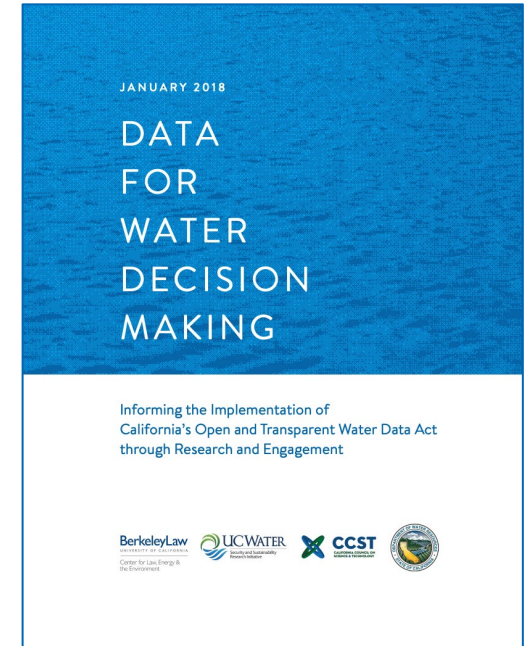
WWAO's Application of Use Cases

WWAO use cases are:

- A way to describe Missouri River Basin water decision making needs from an expert perspective

WWAO use cases will:

- Assess water resources needs with enough detail to develop projects and initiatives
- Communicate those needs to the WWAO and the NASA community of scientists and programs



Cantor, A.; Kiparsky, M.; Kennedy, R.; Hubbard, S.; Bales, R.; Pecharroman, L. C., et al. (2018). *Data for Water Decision Making: Informing the Implementation of California's Open and Transparent Water Data Act through Research and Engagement*. UC Berkeley; Berkeley Law. Retrieved from <https://escholarship.org/uc/item/9x62x0g2>.

Use Case Template

	Use Case Title	Descriptive Title Here, e.g. improved ET for Groundwater Management
Must Haves	Current State or Water Management Challenge	Describe the current decision making process and the data and models used to support decision making, or the water management challenge where lack of information is precluding progress.
	Desired Result	Describe desired improvements to the decision making process or the water management challenge described above.
	Need/Gap	Describe the information needed to achieve the desired result (e.g., consumptive use, snow water equivalent, streamflow, vegetation health, etc). Note: needs should be agnostic to specific solutions.
	Information requirements	To the extent possible, describe the required characteristics of the data needed to improve the decision, e.g., spatial resolution, temporal resolution, accuracy, latency, and data formats. Include necessary modifications to existing models.
	Partner Potential	Identify the primary organization that would partner with WWAO to develop/implement a potential project to address the need (should it be selected). Provide name(s) and contact information. Primary partner: <Contact Info/Phone number here> Other interested parties: <Contact info and phone numbers>
Supports Needs Prioritization by WWAO	Description/Decision Context	Describe the decision to be made, how the decision is made, and who makes the decision with as much detail as possible, including information about what data are used to inform the decision making process and who is currently responsible for producing and/or interpreting the data.
	Obstacles to addressing the need	Describe obstacles (e.g., technical, institutional, cultural, financial, etc) to addressing the need.
	Priority (MI, VI, I)	Provide a rough estimate of the priority of the need as MI, VI, or I. If possible, briefly describe your rationale for the prioritization. MI—Most Important —Refers to Needs that are critical in order to sustain socio-economic and/or environmental viability of the Missouri River Basin. These are the highest priority needs that should be considered. VI—Very Important —Refers to Needs that, if addressed, would contribute substantially to advancing socio-economic and/or environmental viability of the Missouri River Basin, second only to MI. Every effort should be made to address these needs if resources are available or if they can be addressed opportunistically. I—Important —Refers to Needs of high value that should be addressed if resources allow.
Supports WWAO Project Development and Partnering	Current Workflow	Describe the flow of information from a set of inputs to models (as appropriate) to outputs (e.g., monthly reports, graphs, etc) that are used to make the decision.
	Potential Data Sources	Describe potential sources of information that are aligned with the data characteristics defined above.
	Participants	Describe the primary participants who are impacted by this need.

Sample Use Case Template (Gap Analysis)

	Use Case Title	Improved ET for Groundwater Management
Must Haves	Current State or Water Management Challenge	Information on evapotranspiration is expensive or difficult to obtain, creating a barrier to evaluation of options to stabilize groundwater levels.
	Desired Result	Cost-effective, field-scale information on evapotranspiration is available and used to develop improved water budgets and evaluate the feasibility of incentive-driven conservation programs to stabilize groundwater levels.
	Need/Gap	Field-scale information on evapotranspiration to support development of improved water budgets and evaluation of incentive-driven conservation programs in critically impacted basins.
	Information requirements	Field-scale (30 m), daily timestep, <3 month data latency; accuracy of +/- 15% or better
	Partner Potential	Main Participating Partner: State Water Agency Other Interested Parties: Federal and local entities responsible for groundwater stabilization
Supports Needs Prioritization by WWAO	Description/Decision Context	State water agency works with local partners to evaluate different strategies for improving management of groundwater resources. Monthly estimates of ET as GIS data from the Global Land Data Assimilation (GLDAS) are currently used to improve understanding of the groundwater flow regime for developing management strategies.
	Obstacles to addressing the need	Ground-based measurements are expensive and not scalable; limited staff time to generate data; data from consultants is expensive and accuracy is hard to assess
	Priority (MI, VI, I)	MI—Most Important
Supports WWAO Project Development and Partnering	Current Workflow	e.g. input from xyz sensor, model abc is run, analysis is completed, output presented in monthly report
	Potential Data Sources	Agrimet, Crop-coefficient based models, Landsat
	Participants	Main Participating Partner: State Water Agency Other Interested Parties: USDA

From Use Cases to Useful Products



What Happens After the Workshop?

1



Prepare Needs Assessment Report

3



Establish Partnerships

2



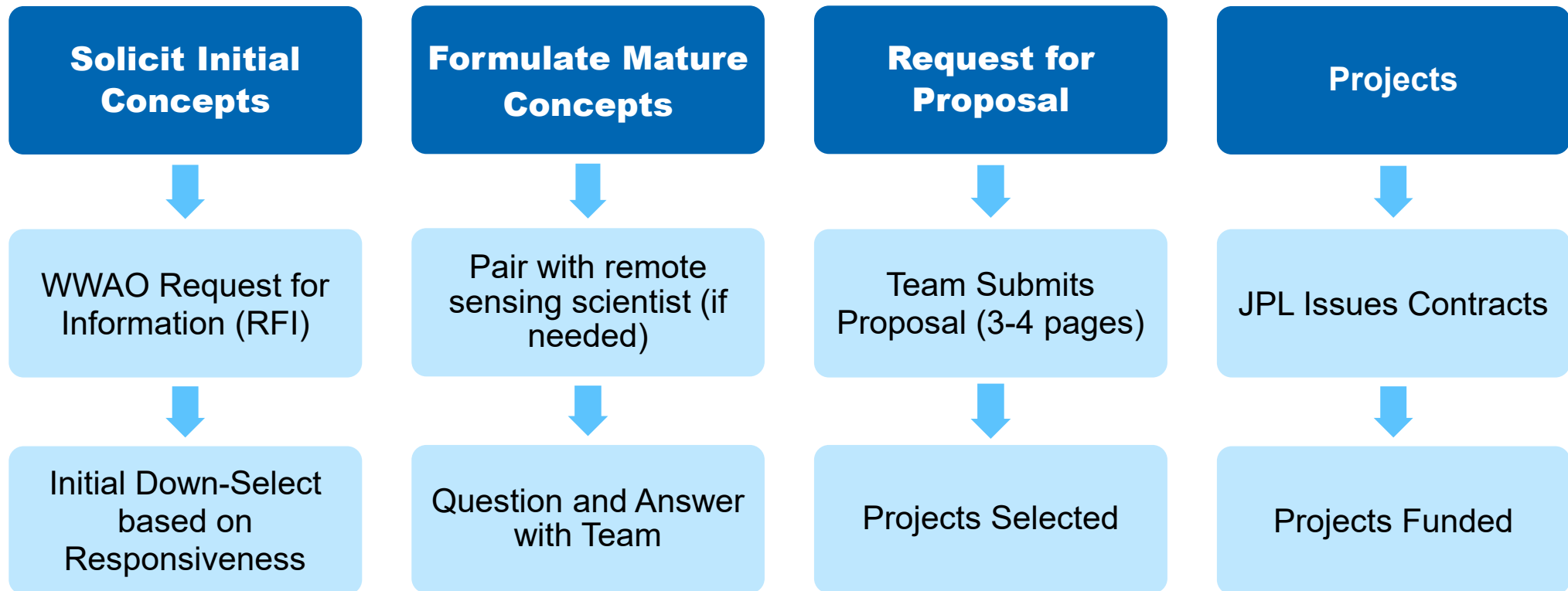
Develop projects using NASA data and technology

4



Advance capabilities and transition to operations

Project Formulation And Selection Process



Before the Workshop...

...consider what **YOUR** use cases might be.

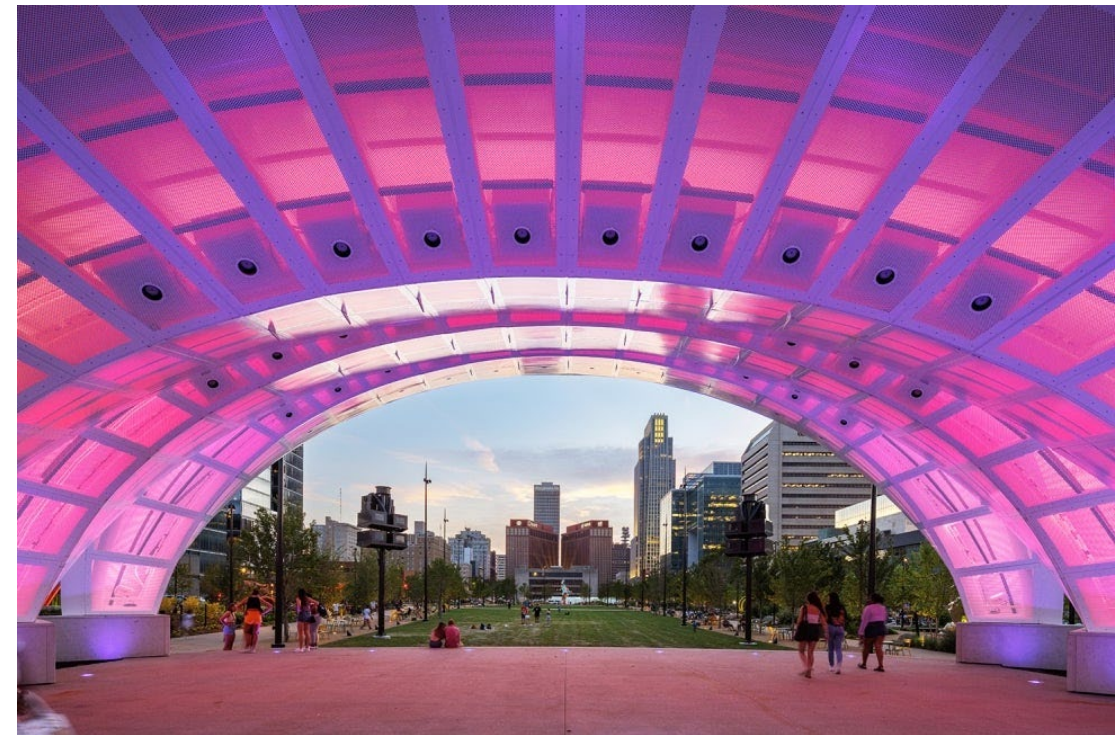
- We'll work to understand and capture your use cases at the WWAO Missouri River Basin Workshop in March.
- If you'd like to write down your use cases ahead of the workshop, you can find our Use Case Template on WWAO's Workshop web page at:

wwao.jpl.nasa.gov/resources/missouri-river-basin-workshop/

WWAO Missouri River Basin Needs Assessment Workshop

Workshop Goals:

- **Identify opportunities** where remote-sensing data could complement existing systems and facilitate key water-management decisions
- Discuss **data needs and information gaps** in the Missouri River Basin
- **Identify ways** in which NASA may be able to assist in meeting these needs
- Develop **use-case scenarios** for the Missouri River Basin



Workshop Details

Where:

- Omaha, Nebraska
- Marriott Downtown at the Capitol District

Dress:

- Business casual

When: **27 Days Away!**

- Tuesday, March 14
1:00 PM – 5:00 PM
- Wednesday, March 15
8:00 AM – 5:00 PM
- Thursday, March 16
8:00 AM – 11:00 AM

**All times are in Central Time*

Questions?



Thank You!

If you have questions prior to the workshop, reach out to:

Julie Molacek

julie.Molacek@hdrinc.com

(402) 399-1458

Missouri River Basin Management/Characterization Study: Summary of Issues & Challenges

About the study

- **Goal:** Capture cross-section of Basin
- 28 entities interviewed
 - Government entities, universities, water districts, multi-state coalitions, tribes, private sector

Biggest water related issues in the Basin:

- **Flood** prediction and emergency response
- Seasonal **snowpack** and its relation to freshwater availability
- **Drought** prediction and mitigation
- Response to change in **water supply** and demand
- Population growth and increased **water competition**
- Balance between the **environment and economy**

All participating stakeholders cited **climate change** as a major concern facing the Basin

Common challenges:

- Water Distribution and Management
 - Increasing difficulty in balancing appropriations for all the different water users in the Basin, especially irrigation and agricultural use.
- Climate Change
 - **Changes** in **snowpack** levels
 - Earlier and more **intense spring runoff** (shifting from snowpack to rainfall supplies)
 - **Transition from steady supply** melting snowpack to unpredictable, high volume/short timespan rainfall events that are hard to predict, capture and store.
 - **Earlier and shorter spring runoff** has increased magnitude of flood events and put a strain on emergency response.
- Habitat Degradation/Preservation
 - Includes spring runoff as well as land conversion and resulting habitat loss, urbanization, and changing water temperature and its effects on habitat.
- Flooding/Drought/Extreme Events