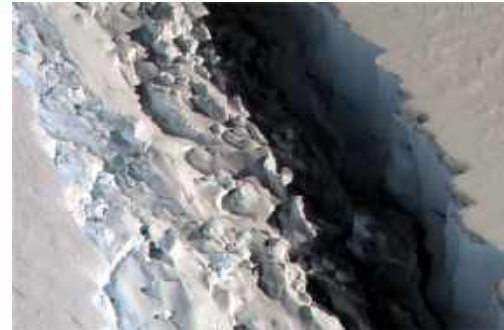
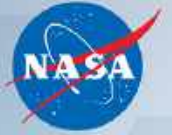


# SCIENCE

National Aeronautics and  
Space Administration



## NASA Western Water Applications in Colorado River Basin: Engaging with Stakeholders to Create Solutions

**Catalina M. Oaida**

*Stakeholder Engagement Lead*

NASA Western Water Applications Office

Jet Propulsion Laboratory, California Institute of Technology

8 October 2020

SWEPSYM



# Outline

- NASA Applied Sciences Water Resources Program and Western Water Applications Office (WWAO) Overview
- Identifying water needs
- Making connections, building projects
- Transitioning from research to operations
- NASA WWAO Water Portal



# NASA Applied Sciences Water Resources Program



- Support the use of Earth observations in water resources management related to **water demand, supply, and quality**
- Innovative solutions to water resources issues in partnership with stakeholders

USING EARTH OBSERVATIONS TO SOLVE OUR PLANET'S MOST PRESSING ISSUES.

[ ABOUT THE PROGRAM ]

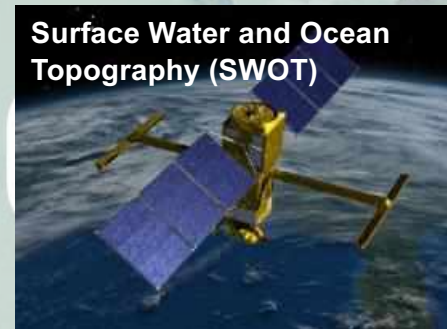
**In The Next Decade NASA Is Leading An Outpouring Of Freshwater Information From Space**

NASA-ISRO SAR (NISAR)



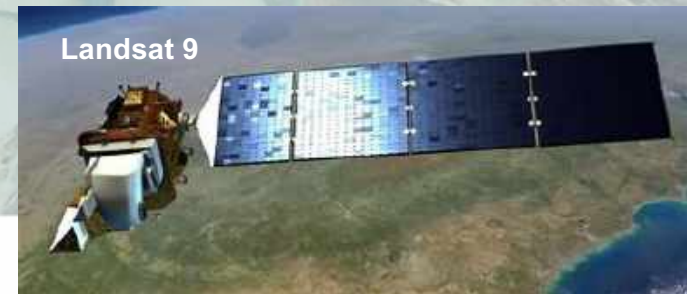
Launch Target Date – May 2022

Surface Water and Ocean Topography (SWOT)



Launch Target Date: Feb 2022

Landsat 9



Launch Target Date: Sept 2021

<https://appliedsciences.nasa.gov/programs/water-resources-program>





# NASA Applied Sciences Water Resources

In the field of water resources, Earth observations can help us:

- Improve efficiency and accuracy of freshwater availability
- Better predict freshwater availability, especially under- and over-supply events
- Optimize basin-level water management for long-term sustainability (e.g. reservoir storage and infrastructure planning information)
- Better understand water use to efficiently manage water allocations, including improving irrigation management strategies
- Protect human health and environment by providing water quality indicators



Image credit: By William Croyle, California Department of Water Resources - California Department of Water Resources - [https://scontent.fmuc2-1.fna.fbcdn.net/v/t1.0-9/16730609\\_10154430795287449\\_8360716524217440974\\_n.jpg?oh=297cbb5f045032a9da809b7919bc071b&oe=59331622](https://scontent.fmuc2-1.fna.fbcdn.net/v/t1.0-9/16730609_10154430795287449_8360716524217440974_n.jpg?oh=297cbb5f045032a9da809b7919bc071b&oe=59331622), Public Domain, <https://commons.wikimedia.org/w/index.php?curid=56253570>



Image credit: <https://solarpumps.com/articles/2017/solar-irrigation-for-your-farm>



Image cderit: <https://modernfarmer.com/2014/09/heres-drought-solution-just-stop-watering-crops/>



Image credit: <https://www.nal.usda.gov/waic/water-quality>



# NASA Applied Sciences Water Resources

## HOW?

- Exploring technology and capabilities
- Connecting the science to the decision makers
- Increasing access to information

## THE PILLARS OF THE NASA APPLIED SCIENCES WATER RESOURCES PROGRAM

### Portfolio of Applied Research Projects

- Support individual applied research that may include capacity building and transfer of technology or information to decision-making entities

### Western Water Application Office

- Stakeholder engagement
  - Basin assessments
- Private company engagement
  - Transfer of technology

### Program Activities

- Contribute to Interagency and International Working Groups
- Engage with private and public entities to amplify benefits of EO





# NASA Western Water Applications Office

NASA Jet Propulsion Laboratory  
California Institute of Technology



ABOUT PROGRAMS NEWS & INSIGHT RESOURCES CONNECT WITH US

Our mission is to improve how water is managed in the arid western U.S. by getting NASA research, data and technology into the hands of water managers and decision makers.

WWAO develops strategic partnerships with water managers, identifies pressing water issues and delivers solutions to those issues based on NASA capabilities.

## WWAO Model

Building Partnerships to Help Answer Questions Like...

- When will my snowpack melt and how much inflow will I get?
- Over the past X years, how many times did an algal bloom form near my intake? How has the frequency, duration changed?
- How can I optimize irrigation and fertilizer application?

WWAO pursues **needs** driven approach to develop and fund projects using remote sensing data, research, and technology.

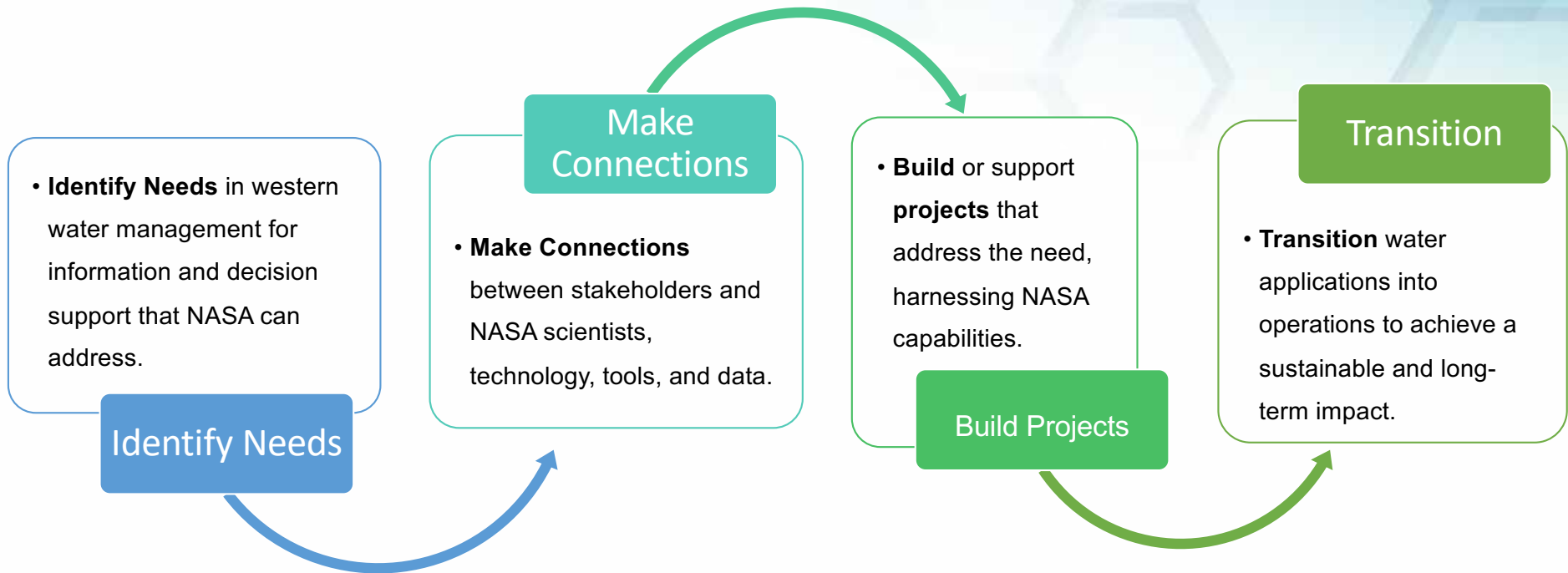
NASA Western Water Applications Office

Tools for managing a precious resource

<https://wwao.jpl.nasa.gov/>



# WWAO's mission is to improve how water is managed by getting NASA data, technology and tools to water managers and decision makers.



Work with partners for sustainable impact.

# 1. Identify Needs



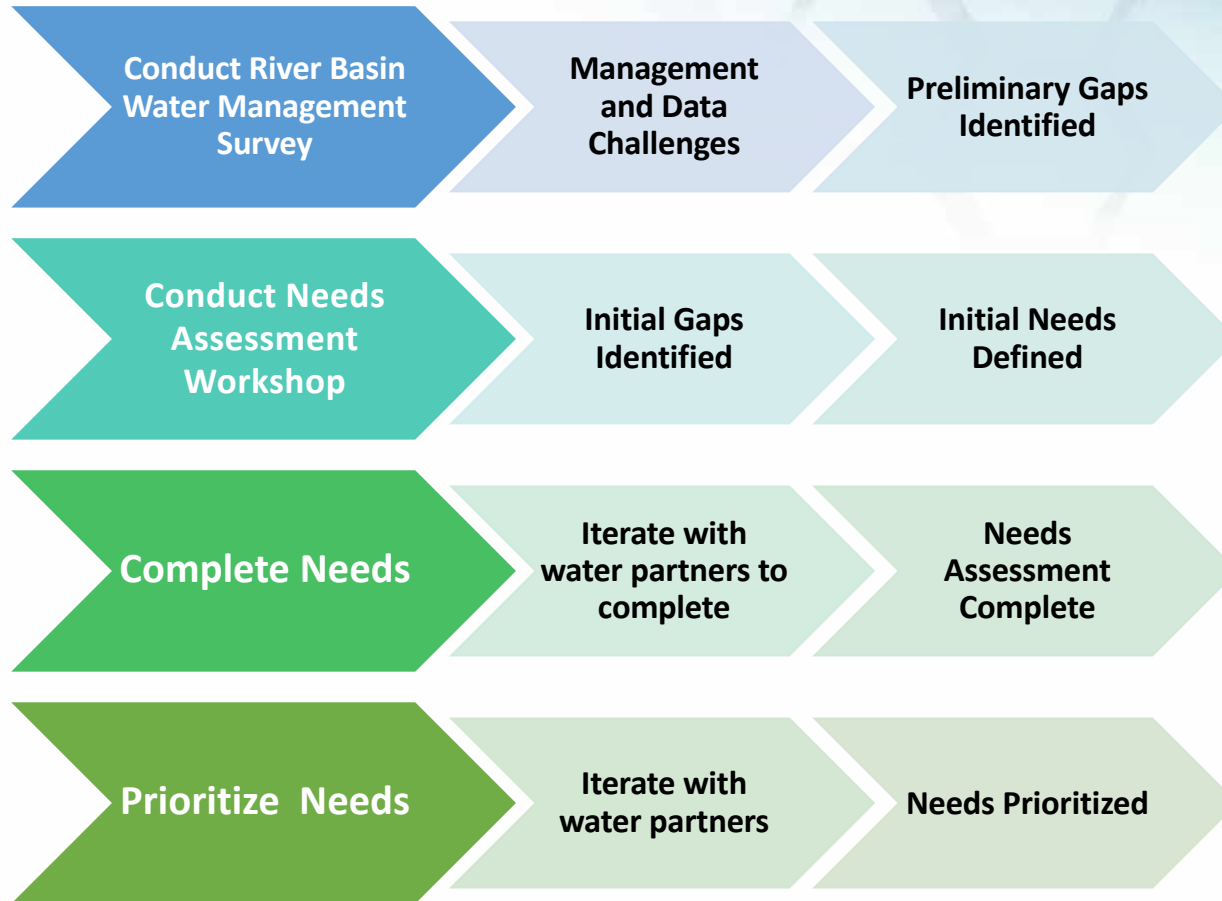
# Understanding Needs

- WWAO has conducted Needs Assessment Workshops for **Colorado** and **Columbia** River Basin, and the Private Sector
- Identified dozens of needs spanning agriculture, water supply, water quality and watershed health
- Plans to conduct similar assessments of **Rio Grande**, **Missouri** and **Arkansas-Red** Basins to identify highest priority needs
- Needs are now made available to community on **WWAO Water Portal**



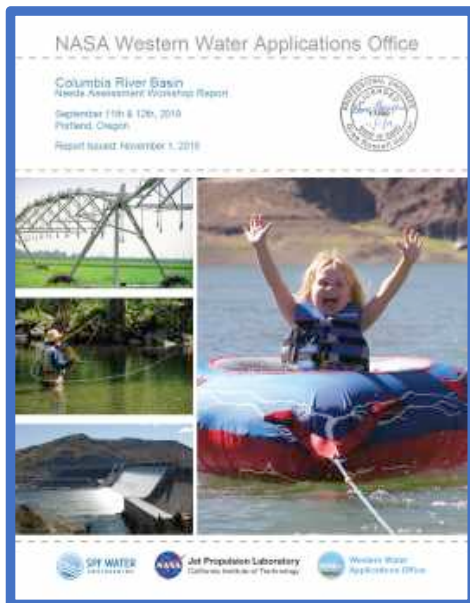


# River Basin Needs Identification & Assessment Process





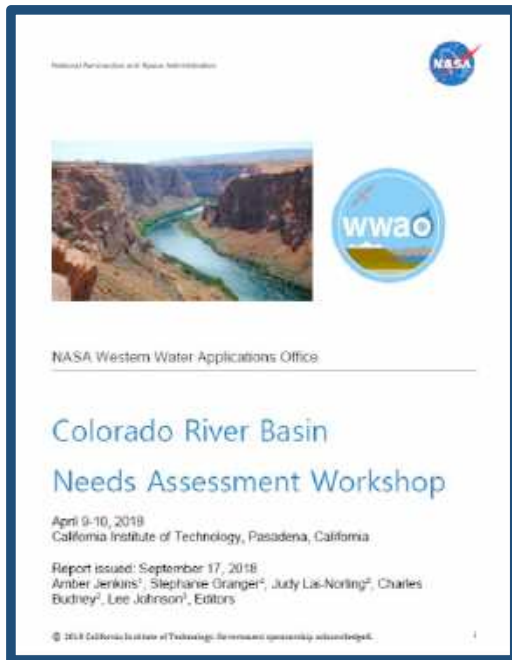
# 2019 Columbia River Basin Needs Assessment



Agriculture	Water Quality	Water Supply	Watershed Health
Crop Mapping	Cyanobacteria	Evapotranspiration	Habitat Management
Evapotranspiration/ Consumptive Use	Stream Temperature	Groundwater Recharge & Storage	Land Use & Land Cover
Irrigation Management & Scheduling	Turbidity	Snow Water Equivalent	Surface and Groundwater Interaction
		Streamflow Monitoring	Stream Temperature Dynamics



# 2018 Colorado River Basin Needs Assessment Priority Needs



Water Resources Category	Use Case
<b>Snow Properties and Processes</b>	Improved Forecasts of Snowpack, Runoff, Water Demand, Evapotranspiration
<b>Water Supply Forecasting (&lt; 1 year period)</b>	Streamflow Predictions at Sub-Basin Scales
<b>Evapotranspiration (ET) over Land and Water</b>	Consumptive Use for Calculating Water Budgets
	Reservoir Evaporation
<b>Crops and Agriculture Properties and Processes</b>	Crop Mapping
	Crop Monitoring
<b>Irrigation Types and Methods</b>	Irrigation Management
	Irrigation Mapping
<b>Groundwater Characterization</b>	Augmenting Groundwater Quantification
<b>Extreme Event Prediction and Impact Assessment</b>	Mitigation of Wildfire Impacts on Watershed Supply
	Augmentation of State-Level Drought Planning and Response
	Drought Planning and Response at the State Level
<b>Water Supply Forecasting (≥ 24-month period)</b>	Predicting Changes in the Sierra Nevada or Rocky Mountain Snowline, Snowpack Distribution, and Streamflow Forecasts



## **2. Making Connections & Building Projects**



In  
Implementation

# High-Resolution Drought Assessment for the Colorado Climate Center

## Motivation

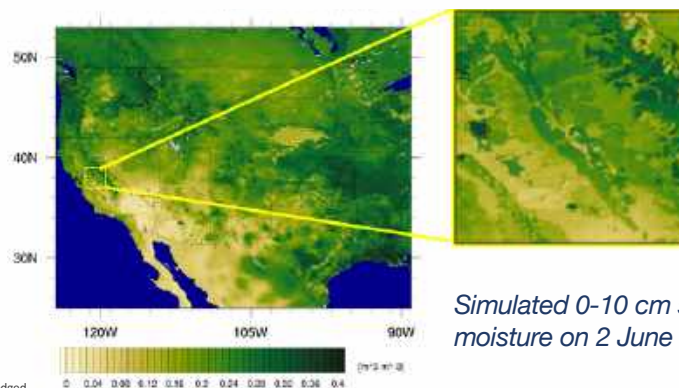
- **Drought monitoring with Colorado Climate Center**
  - Colorado Climate Center provides weekly updates to the United States Drought Monitor (USDM) for Colorado, New Mexico, Utah, Arizona, and Wyoming
  - Requires higher-resolution soil moisture, evaporative demand, evapotranspiration, snowpack, and irrigation estimates.
- **Groundwater recharge estimation with California State Water Resources Control Board**
  - Providing natural recharge estimates to support planning under Sustainable Groundwater Management Act (SGMA).

**Project Lead:** Matt Rodell  
(NASA Goddard)

**Partners:**  
Colorado Climate Center,  
California State Water  
Resources Control Board,  
and other state and local  
agencies.

**Capability:**  
High resolution drought  
assessment (soil moisture,  
evaporative demand, ET,  
snowpack, irrigation  
estimates)

**Applications:**  
Drought assessment



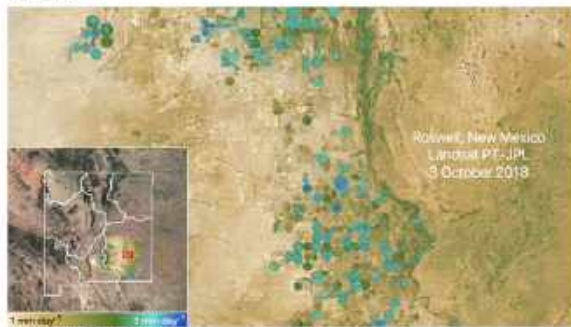
*Simulated 0-10 cm soil  
moisture on 2 June 2017.*



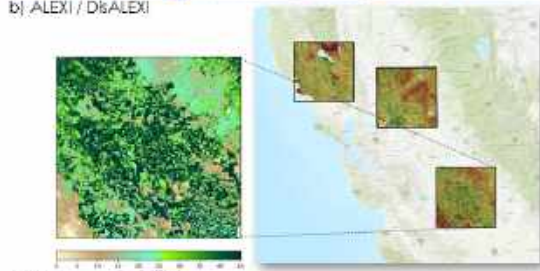
In  
Implementation

# Estimating Consumptive Use from Evapotranspiration in the Upper Colorado River Basin for the United States Bureau of Reclamation

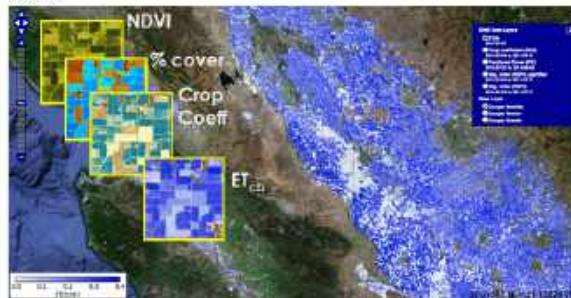
a) PT-JPL



b) ALEXI / DisALEXI



c) 51/MS



## Motivation

- The United States Bureau of Reclamation (USBR) is mandated to perform the accounting of consumptive use and loss for the Colorado River Basin.
- Currently, each state in the basin relies on what is reported by water-rights users. To verify these reports, unbiased estimates of consumptive use are needed.
- Water-rights planning, including emergency drought requirements and Indian Water Rights Settlements, in the Colorado River Basin is done at the state and federal levels.
- USBR would like to adopt a consistent methodology to be used at the USBR and potentially within four states in the Upper Colorado River Basin (UCRB).

**Project Lead:** Chris Hain (NASA Marshall)

**Partner:** Bureau of Reclamation

**Capability:** ensemble 30-m ET estimates between all available remote sensing methods.

**Applications:** estimate consumptive use in UCRB for reporting and long-term planning purposes.



In Progress

# Using Airborne Snow Observatory Snow Water Equivalent Products to Improve Runoff Forecasting

## Motivation

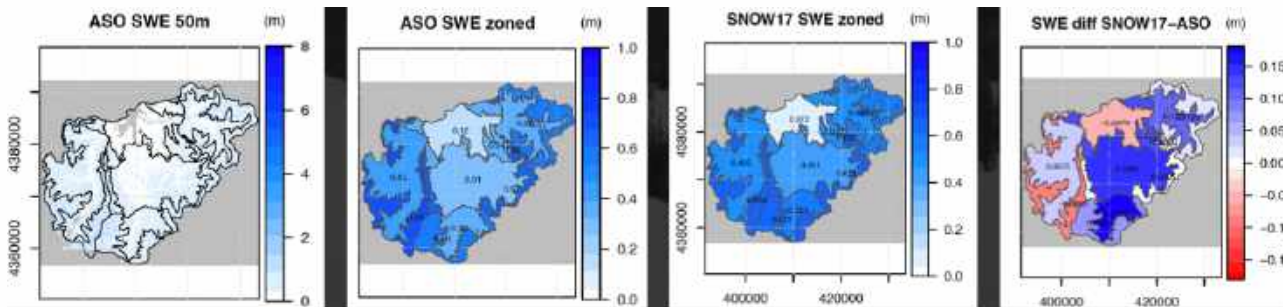
- Streamflow across the Western U.S. is predominantly snowmelt driven. Model SWE representation is a major source of uncertainty in current forecast models.
- Airborne Snow Observatory (ASO) data provides instantaneous SWE mapping in mountain terrain and are designed specifically for improving runoff estimates.
- NWS River Forecast Centers provide streamflow forecasts using combination of modeling and observations. However, there are logistical challenges to inserting new ASO data into operational procedures.

**Project Lead:** Kat Bormann (ASO, Inc., formerly of JPL)

**Project Partners:** Colorado River Basin Forecast Center (CBRFC), Southern Nevada Water Authority

**Capability:** Watershed-scale estimates of SWE at 50 m resolution derived from the product of snow depth observations at 3 m resolution and modeled snow density

**Application:** Derive tangible pathways for the quantitative use of ASO SWE products towards improved runoff forecasting using existing operational tools at the CBRFC





# 3. Transition Projects into Operations



# Eyes On The Earth

Transitioned

2 billion people rely on snowmelt for water. As the planet warms, water managers need to adapt to changing snow. NASA's Airborne Snow Observatory (ASO) – “*the most significant development in the history of snow surveys*” – is a powerful eye in the sky.



- With WWAO's help, ASO showed it can forecast snow water equivalent in mountain snowpack up to 98% accurately.
- As part of its **Research to Operations** program, WWAO determined a commercial spin-off for ASO was viable.
- In 2019, ASO Inc. was founded to transfer the NASA technology to commercial global operations. Its vision is to support sustainable water supplies by reaching every mountain system in the world.



# Navajo Drought Relief

In Transition

- WWAO's Drought Severity Evaluation Tool (DSET) delivers maps and trends of drought severity and precipitation in near-real-time.
- DSET was built by WWAO, the Navajo Nation Dept. of Water Resources, Climate Engine, and Desert Research Institute.
- Amber McCullum (NASA ARC/BAERI) and Carl McClellan (Navajo Nation Department of Water Resources) secured funding from the S.D. Bechtel, Jr. Foundation for **continued development** of the Drought Severity Evaluation Tool (DSET), as well as expansion of the partnership to use remotely sensed Evapotranspiration (ET) data from OpenET.
- This project will sustain the relationship with NASA and the Navajo Nation through the co-development of satellite-based water management tools, capacity building, an internship opportunity for a student within the Diné community, and continued transition to operations from NASA to the Navajo Nation.

Over 80% of homes on the Navajo Nation lack running water. Drought is common and pervasive. WWAO's new tool, with the help of data from space, is enabling Navajo managers to better respond to drought.



## Navajo Nation Drought Severity Evaluation Tool (DSET) USER GUIDE

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User Guide on WWAO Website

# Transition to Operations

- Developing “Business Cases” for NASA applications in water management
- Building a “Research to Operations” (R2O) community to facilitate transition of applications from NASA research to sustained operational use

WWAO will coordinate directly with partner programs in other federal agencies to understand specific near-term opportunities to improve the R2O process.

The workshop in 2021 will be focused on understanding how Congress and Federal Agencies develop priorities and secure resources for future innovation, and how NASA can build awareness of promising applications earlier in this process.



WWAO and the Western States Water Council, along with USGS and USBR plan to hold the 2<sup>nd</sup> Annual Research to Operations in Water Management Workshop” in **2021** (2020 workshop postponed due to COVID).





# WWAO's Water Portal - a Communication and Information Hub

## Goals for the Portal:

- Create connections between water **needs** and NASA **capabilities** to help solve water challenges.
- Provide a **valuable information portal** for (NASA) scientists, water managers, decision makers, agency program managers.
- Identify **common water priorities** across regions.
- Offer a place where users can **share their needs / capabilities**.

<https://wwao.jpl.nasa.gov/portal/>

# Thank you!

# Questions?

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**NASA Western Water Applications Office**  
Tools for managing a precious resource