



# **NASA Western Water Applications Office Overview**

*Accelerating the application of NASA observations and  
scientific analysis techniques to tangible, important, and  
timely water management problems*

**Southern California Water Dialogue**  
**2/28/2018**



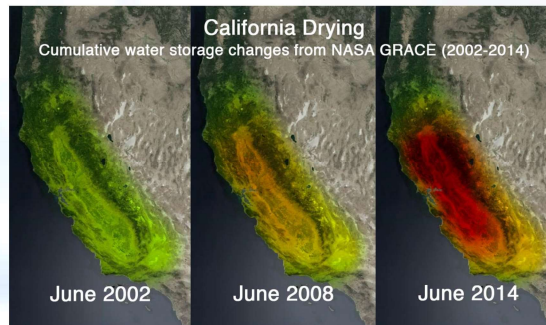
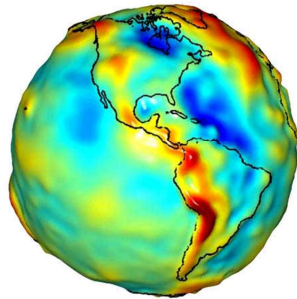
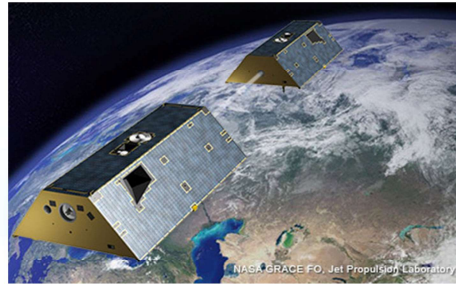
19 NASA Earth Observing Satellite Missions, many collaborations with other federal agencies such as USGS or NOAA, or international collaborations with JAXA (Japanese Aerospace Exploration Agency)

GRACE (Gravity Recovery and Climate Experiment) ended in October 2017 but GRACE-FO scheduled to launch 4/14/18 from Vandenberg AFB

# GRACE-FO Launching 2018



- Gravity Recovery and Climate Experiment (GRACE) mission active March 2002 – October 2017
- GRACE Follow-On (GRACE-FO) launching April 14, 2018 from Vandenberg AFB
- Twin satellites measuring Earth's gravity field anomalies



# NASA Airborne Science



# UAVSAR



- **UAVSAR:** Uninhabited Aerial Vehicle Synthetic Aperture Radar
- **Instrument:** L-band Synthetic Aperture Radar
- **Products:** Polarmetric (PolSAR) and interferometric (repeat-pass InSAR) products highlight features and show changes in the earth over time
- **Current Platform:** Gulfstream III with precision autopilot to fly same path within 5 m (16 ft)
- Also serves as a radar technology platform for future space-borne imaging radar missions such as NASA ISRO Synthetic Aperture Radar (NISAR) mission (expected launch 2020)



UAVSAR Sacramento Delta High Tide Flight Lines [https://uavsar.jpl.nasa.gov/cgi-bin/report.pl?planID=PLAN\\_11061#map](https://uavsar.jpl.nasa.gov/cgi-bin/report.pl?planID=PLAN_11061#map)

Flight Line detail: [https://uavsar.jpl.nasa.gov/cgi-bin/product.pl?jobName=SDelta\\_33502\\_11062\\_004\\_110829\\_L090\\_CX\\_01#data](https://uavsar.jpl.nasa.gov/cgi-bin/product.pl?jobName=SDelta_33502_11062_004_110829_L090_CX_01#data)

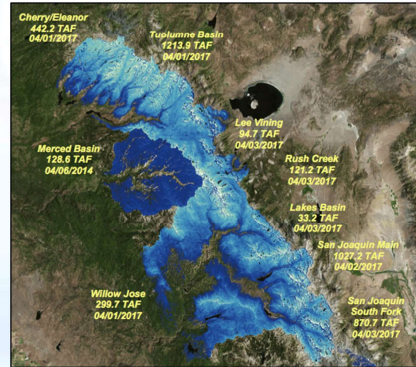
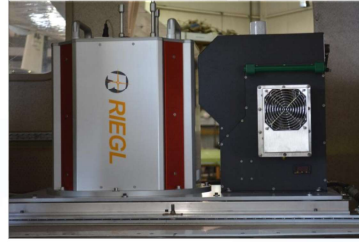




# Airborne Snow Observatory



- **ASO:** Airborne Snow Observatory
- **Instruments:** Near-Infrared Scanning Lidar, Multi-spectral Imaging Spectrometer
- **Products:** Basin-wide, spatially distributed measurements of snow depth, snow albedo, snow water equivalent
- **Platform:** King Air A90
- Regular flights in California & Colorado



UAVSAR Sacramento Delta High Tide Flight Lines [https://uavsar.jpl.nasa.gov/cgi-bin/report.pl?planID=PLAN\\_11061#map](https://uavsar.jpl.nasa.gov/cgi-bin/report.pl?planID=PLAN_11061#map)

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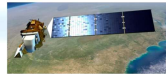
## NASA Capabilities for Water Resource Management



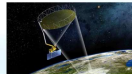
Topical Area	NASA Remote Sensing Instrument or Platform
Agriculture & Evapotranspiration (ET)	MODIS, Landsat, VIIRS, ECOSTRESS (2018), ASTER, SMAP, AIRS, HyTES
Snow (SWE, Depth, Cover, Albedo)	MODIS, ASO
Groundwater	UAVSAR, GRACE-FO, NISAR (2020)
Forecasting & Precipitation	SWOT (2020), JASON-2, JASON-3, AIRS, GPM, IceSat-2
Subsidence & Infrastructure Monitoring	UAVSAR, NISAR (2020)
Water Quality	MODIS, Landsat, VIIRS, AVIRIS, PRISM, HICO, HSI, PACE (2022)
Land Use	MODIS, Landsat, VIIRS



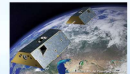
MODIS  
Instrument on  
Terra



Landsat 8



Soil Moisture  
Active Passive  
Mission (SMAP)



Gravity Recovery  
and Climate  
Experiment  
(GRACE Follow On)



Uninhabited Aerial  
Vehicle Synthetic  
Aperture Radar  
(UAVSAR)



Airborne Snow  
Observatory  
(ASO)





## **NASA Western Water Applications Office**

## WWAO: NASA's Western Water Applications Office

A local western office helping to inform water decisions with NASA data



### What is the WWAO?

An initiative from NASA's Earth Science Division, Applied Sciences Program to support Western US water management to put NASA data to work in making decisions.

### What Does the WWAO Do?

- Connect stakeholders with NASA scientists, technology, tools, and data.
- Develop custom solutions through applications projects.
- Assist application transition into operational state.

### Why the NASA-WWAO?

- Apply NASA's wealth of science, remote sensing data and expertise.
- Leverage decades of investment in science and technology.
- Develop and maintain lasting relationships with stakeholders.

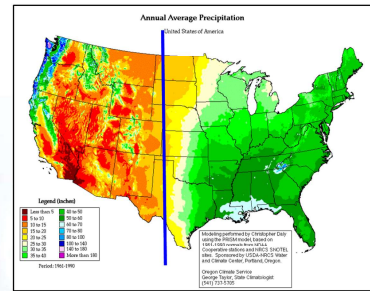


Figure 1 - A 30-year climatology of annual U.S. Precipitation. The red line denotes the 100<sup>th</sup> meridian. (Source: C. Daly, Oregon State University)

The Western United States is defined by the Department of Interior (DoI) as those states that are on or west of the 100<sup>th</sup> meridian and encompasses the states represented by the Western Governor's Association (WGA). It is roughly the divide between the "wet" east and the "dry" west

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Emphasize not trying to reinvent wheel or displace anyone

27 federal agencies that have a mandate related to water


We want to learn more bc we want to be sensitive to the mandates of our federal partners.

We want to work with agencies, not against

Focus on local, state, and Federal stakeholders and data users

## Stakeholder Engagement is Key to Success

- Engage
  - Concerted engagement with western water resources stakeholders
- Listen & Learn
  - What challenges are water managers facing?  
What are the information needs?
  - What are the decision making processes?
  - Is there potential for NASA capabilities to play a role?
  - What are the lessons learned by other organizations doing similar work?
- Inform
  - Introduce the WWAO to a broad range of water stakeholders



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Don't reinvent the wheel.

## Success Strategy

- The WWAO will maintain an awareness of Western water challenges and where NASA may have a unique ability to make an impact.
- Match “needs” to NASA capabilities.

- Develop and maintain “WWAO Core Capabilities”.
  - “Effective and sustained” stakeholder engagement.
  - Unique “application transition” support.

## WWAO plans to develop projects using a variety of approaches.

- Directed, “pull”, and innovative project development

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WWAO management and SEWG 33 stakeholder meetings throughout the year.

By meetings, we’ve invited folks to JPL for in-depth meetings, we held focused meetings at stakeholder institutions, we’ve presented at workshops, forums, meetings. DEWS, WSWC, ASCE...

Boundary orgs like USDM and DEWS

Ten Academic institutions throughout the U.S

Some basins may need more love and attention.

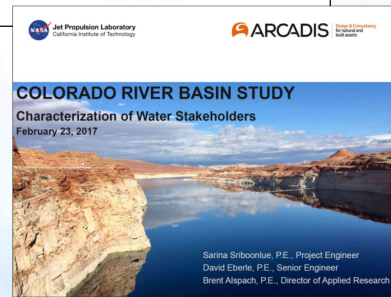
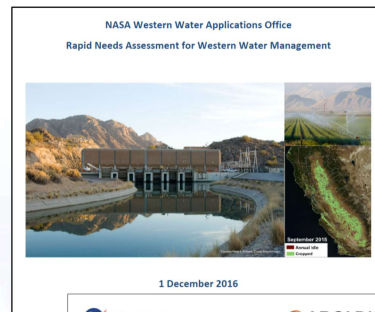
Extreme events are a big concern. What are the trends? Resources. CA big bucks, AK no bucks.

USDA, NOAA RISAs, CADWR, USGS, Marty Ralph,

# WWAO Community Activities



- **Needs Assessments:**
  - Goal: understand stakeholder needs and priorities
  - 2016 Rapid Needs Assessment with 22 member review panel from federal, state, and nonprofit agencies
  - 2018 Needs Assessment in early April, focus on Colorado River Basin
- **2018 Water Information Management System (WIMS) Workshop**
  - Partnership with Western States Water Council
  - Goal: understand WSWC member needs, priorities, and challenges regarding water data acquisition, use of cloud computing and big data
- **Basin Market Studies:**
  - Goal: characterize water stakeholders, current use of remote sensing data, challenges to adopting remote sensing data



<http://www.westernstateswater.org/upcoming-meetings/2018-water-information-management-systems-wims-workshop/>

Guiding Philosophy: Understanding decision needs & contexts is critical to project formulation & implementation.

**ACTION:** Conduct Rapid Needs Assessment and Colorado Basin Market Survey. Annual updates for other regions or topics.

**GUIDING PHILOSOPHY:** Long-term relationships with water management community are essential to develop trust.

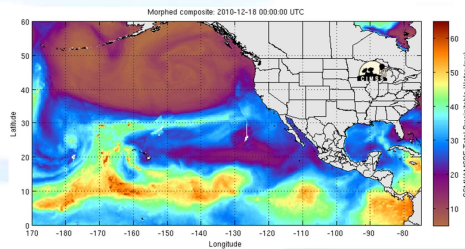
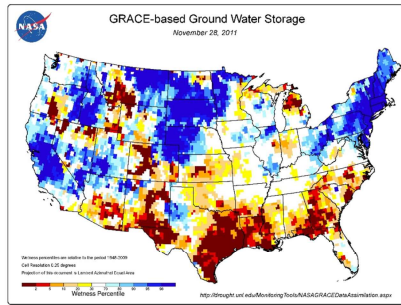
**ACTION:**

Develop and maintain sustained engagement

Assess outcomes and impacts



# Outcomes of the 2016 Needs Assessment



- Specific needs identified in the Needs Assessment:
  - Characterizing changing **rain/snow transitions** and high elevation **snow water content**
  - Improved **evaporation and evapotranspiration** information products
  - Real-time **soil moisture** monitoring
  - **Groundwater** inventories, capacity, inflow/outflow measurements
  - Improved **precipitation forecasting**, including atmospheric rivers

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Without the decision context we did not get to the level of specificity we needed to develop requirements.

What are the needs? Without preconceived notions. Trying desparately not to get to solutions.

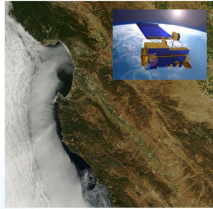
# WWAO Pilot Projects: Extent of Fallowed Lands in CA, NV, WA

**PROJECT TEAM:** NASA Ames Research Center, USGS, USDA National Ag. Statistics Service, California Dept. of Water Resources, NOAA, California State University Monterey Bay

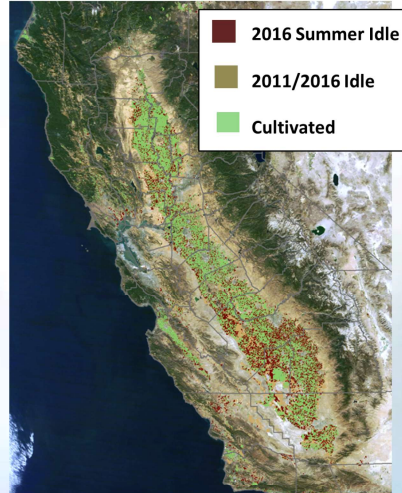
## Satellite Data



Landsat (TM / ETM+ / OLI)  
+SPOT, DMC, Sentinel-2A



Terra / Aqua (MODIS)  
250m / 15.5 acre  
Daily overpass



**Land Classification Neural Network Algorithms**

**Data Validation via USDA Data and Field Surveys**



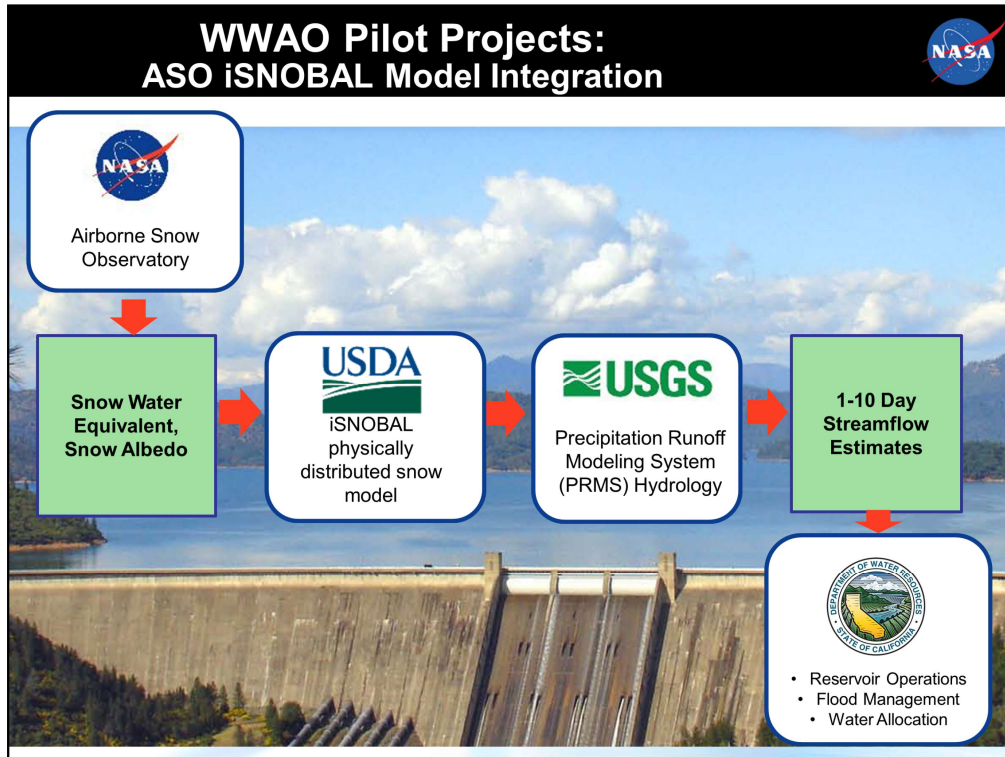
**Products: Maps and Summary Tables,  
Comparisons against Baseline Periods**

<https://nex.nasa.gov/nex/projects/1372/>



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CA program to fallow land during the drought. Needed a way to assess effectiveness of the program.



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Airborne Snow Observatory -

# Ways to work with WWAO



- How can my agency work with WWAO?
  - Participate in a WWAO Needs Assessment workshop
  - One-on-one meetings with the Stakeholder Engagement team
  - Develop WWAO project concepts in conjunction with the WWAO team

## WWAO Stakeholder Engagement Team

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