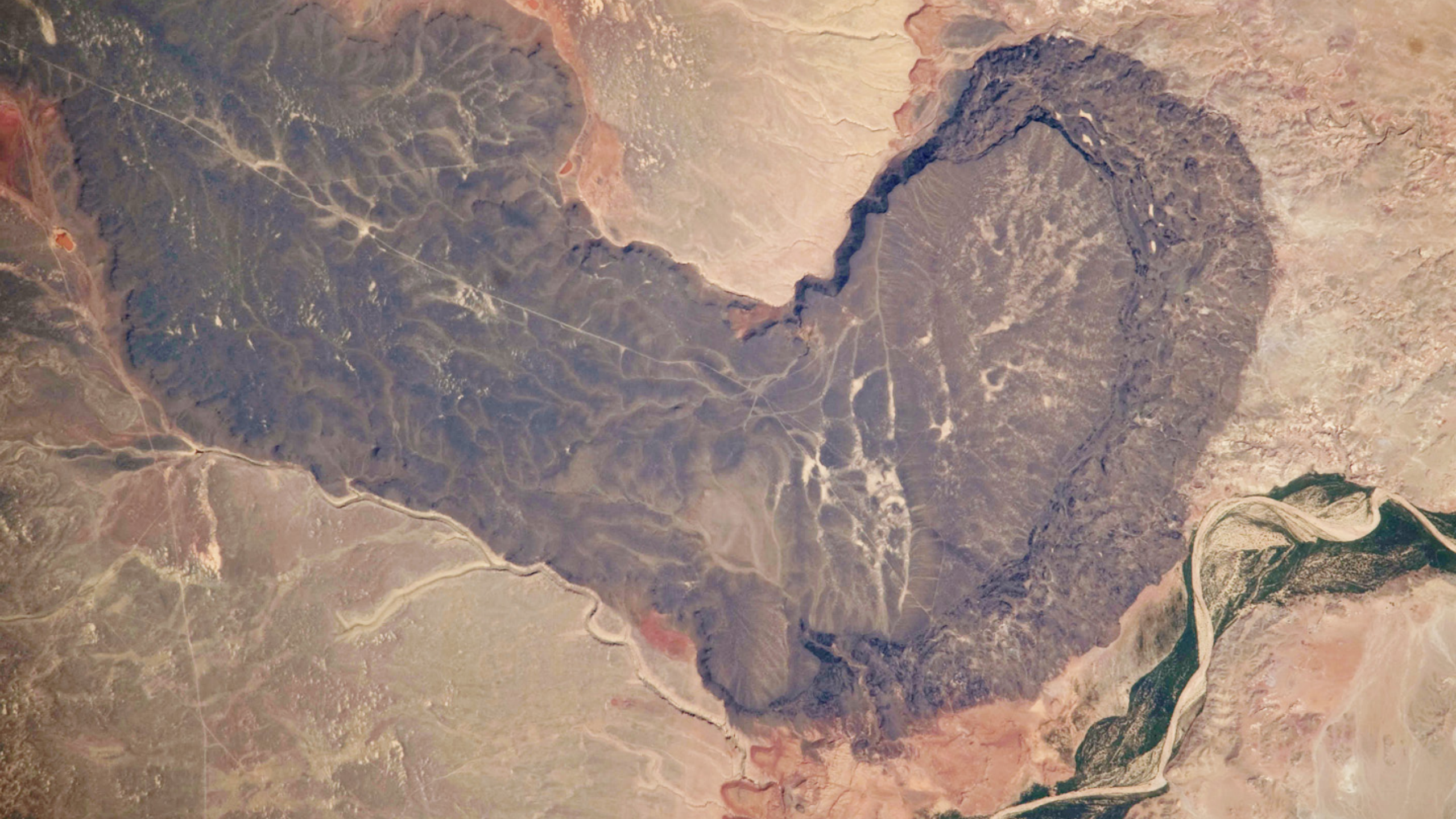
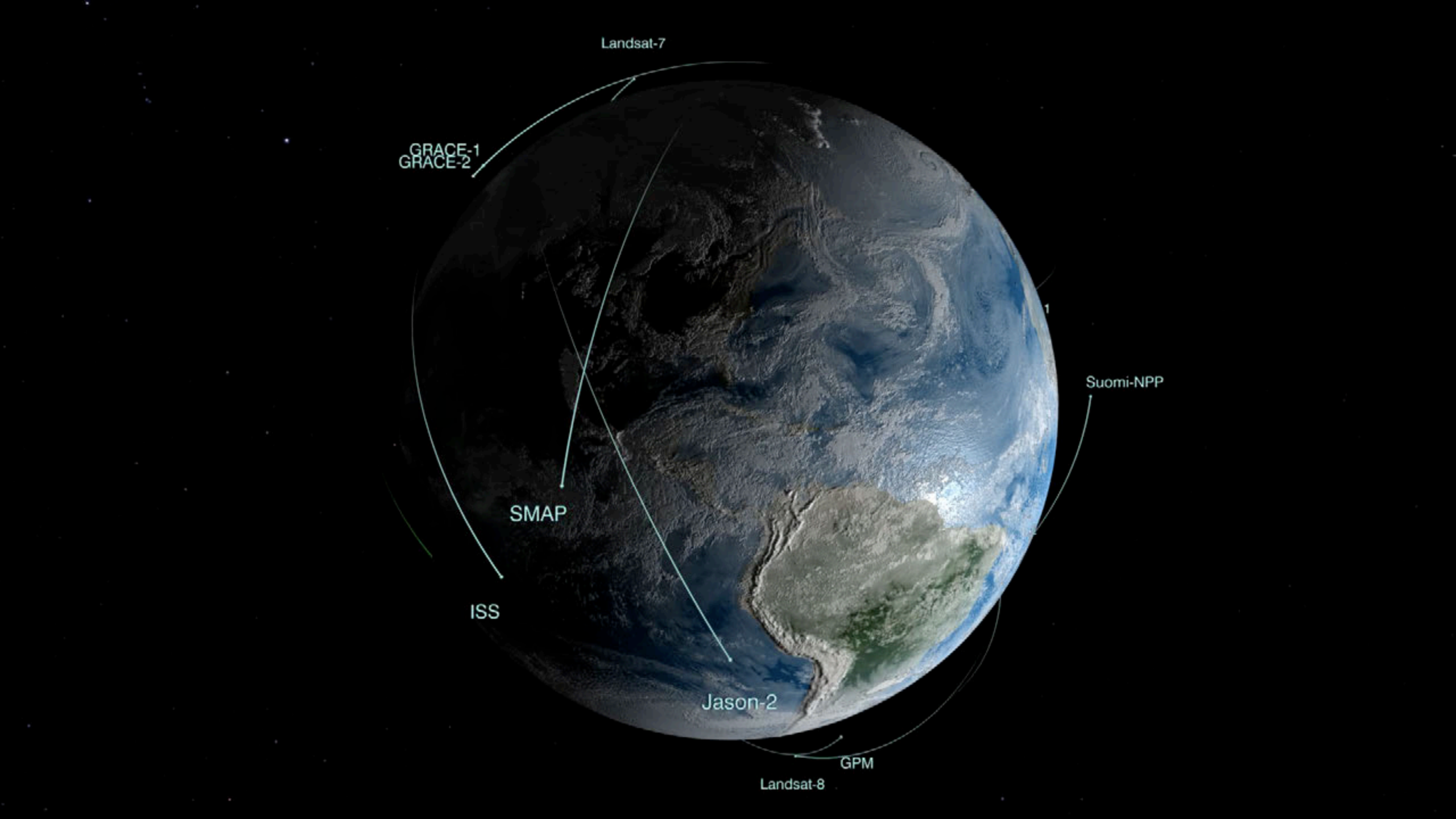
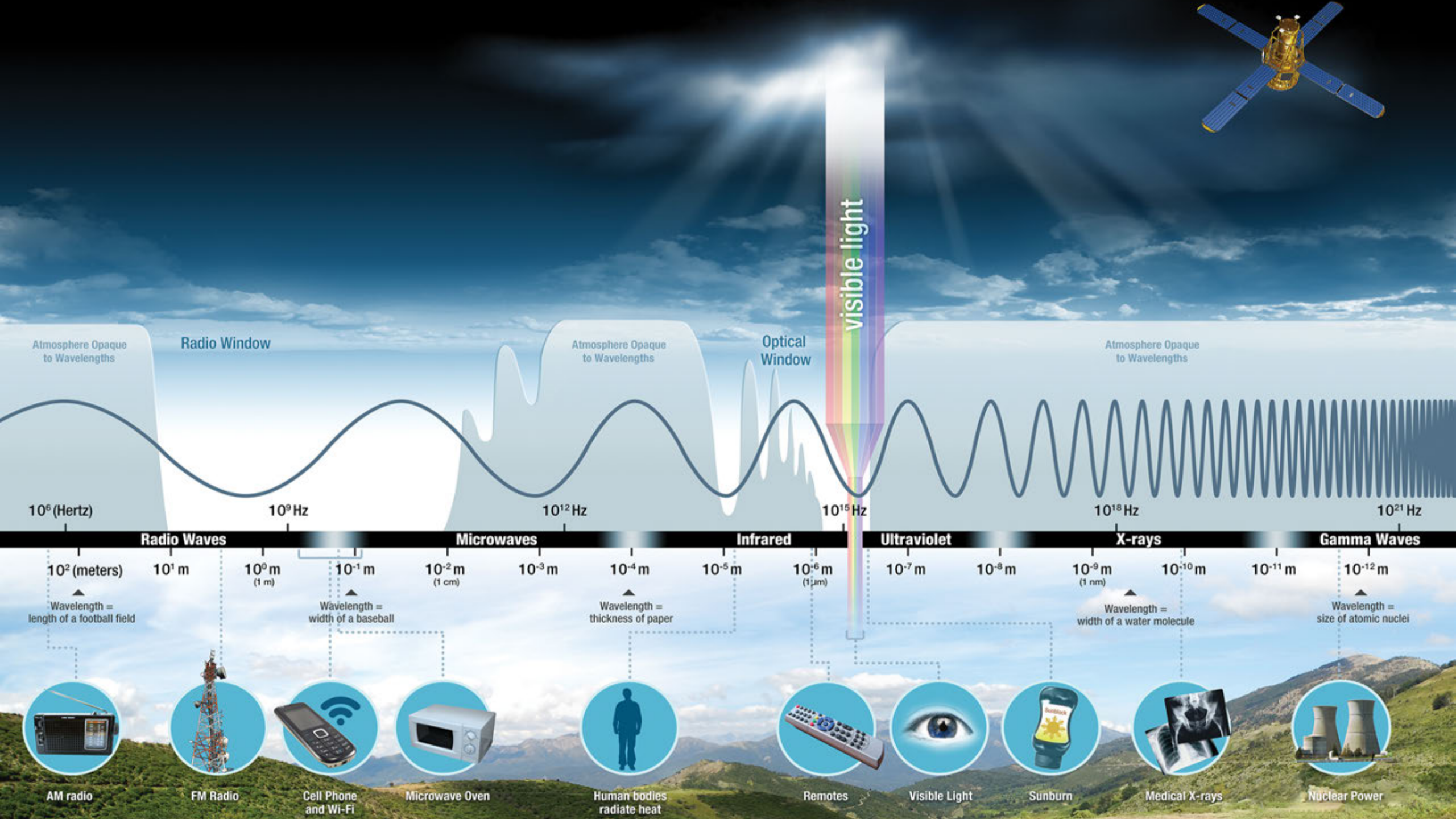
Collaborative Capacity Building and Sovereign Science with NASA and the Navajo Nation

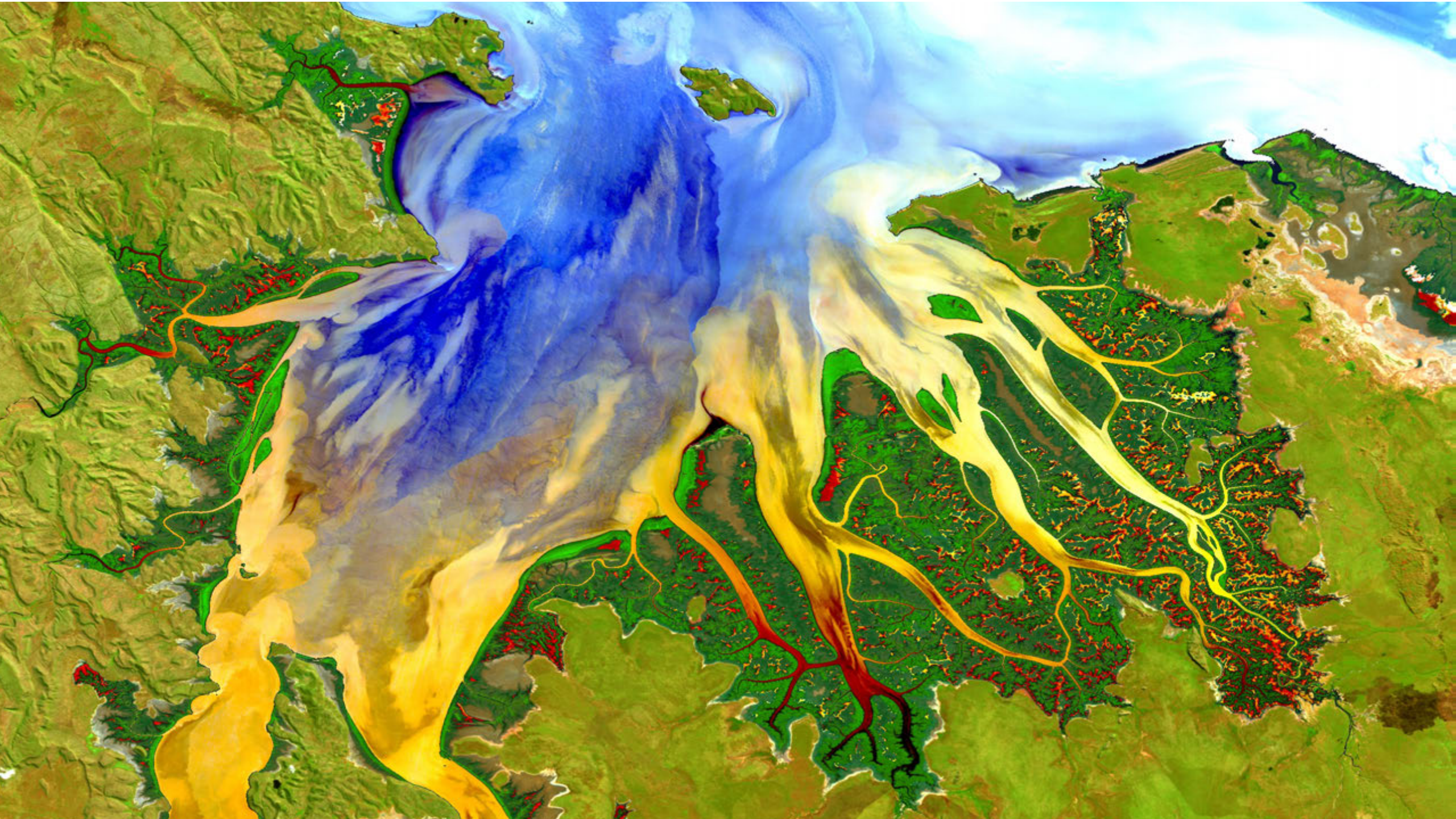
Amber McCullum, PhD (BAERI/NASA Ames Research Center
Nikki Tulley (University of Arizona)

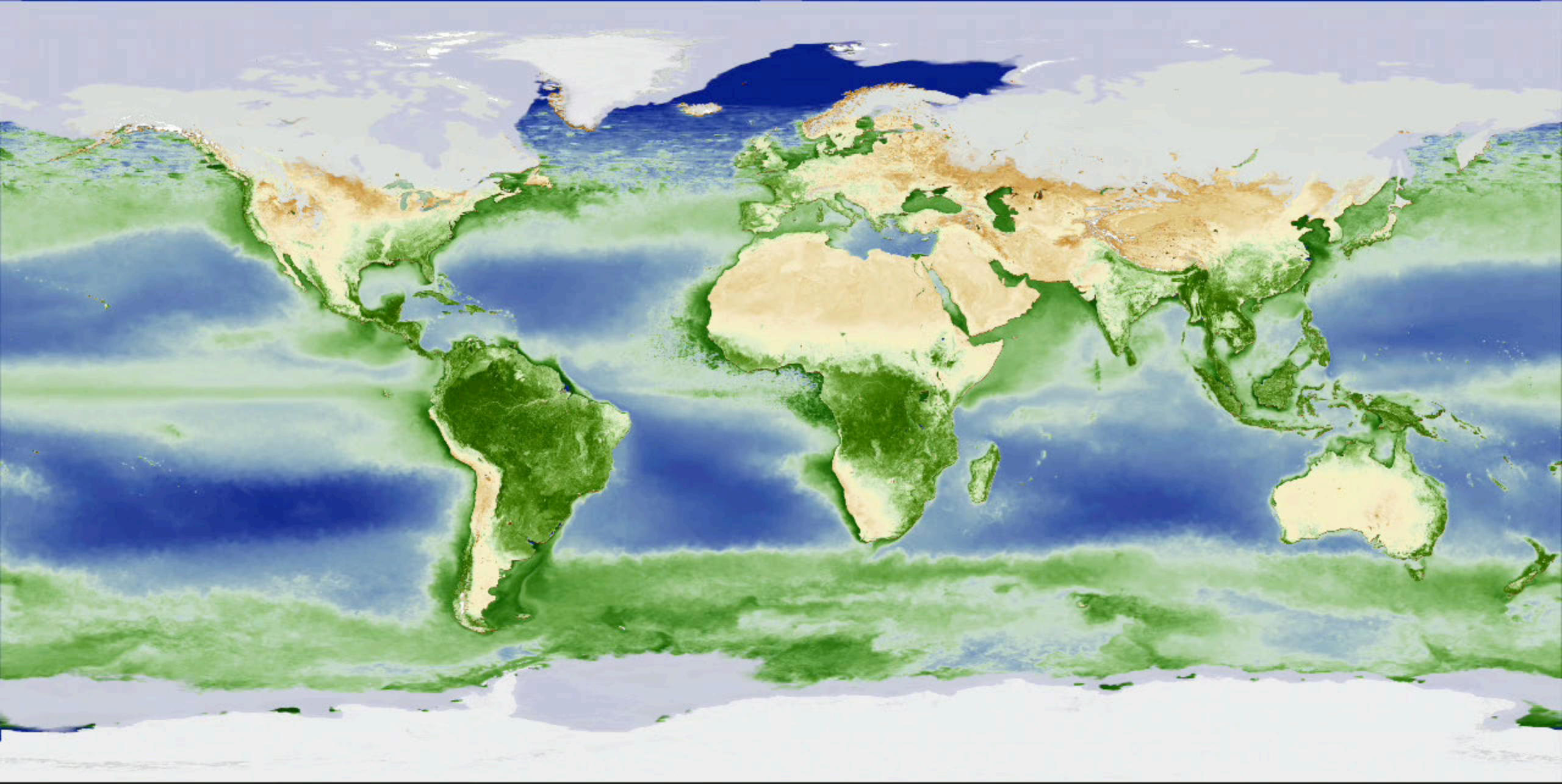
January 20, 2021
Water Resources Research Center Brown Bag




Landsat-7
GRACE-1
GRACE-2
SMAP
ISS
Jason-2
GPM
Landsat-8
Suomi-NPP


Atmosphere Opaque to Wavelengths
Radio Window
Atmosphere Opaque to Wavelengths
Optical Window
visible light
Atmosphere Opaque to Wavelengths
10⁶ (Hertz)
10⁹ Hz
10¹² Hz
10¹⁵ Hz
10¹⁸ Hz
10²¹ Hz
Radio Waves
Microwaves
Infrared
Ultraviolet
X-rays
Gamma Waves
10² (meters)
10¹ m
10⁰ m (1 m)
10⁻¹ m
10⁻² m (1 cm)
10⁻³ m
10⁻⁴ m
10⁻⁵ m
10⁻⁶ m (1 μm)
10⁻⁷ m
10⁻⁸ m
10⁻⁹ m (1 nm)
10⁻¹⁰ m
10⁻¹¹ m
10⁻¹² m
Wavelength = length of a football field
Wavelength = width of a baseball
Wavelength = thickness of paper
Wavelength = width of a water molecule
Wavelength = size of atomic nuclei
AM radio
FM Radio
Cell Phone and Wi-Fi
Microwave Oven
Human bodies radiate heat
Remotes
Visible Light
Sunburn
Medical X-rays
Nuclear Power




Jan
Dec
Land Vegetation (NDVI)
0.1
0.9
Ocean Chlorophyll Concentration (mg/m³)
0.01
0.1
1
10
20

NASA's Applied Sciences Program

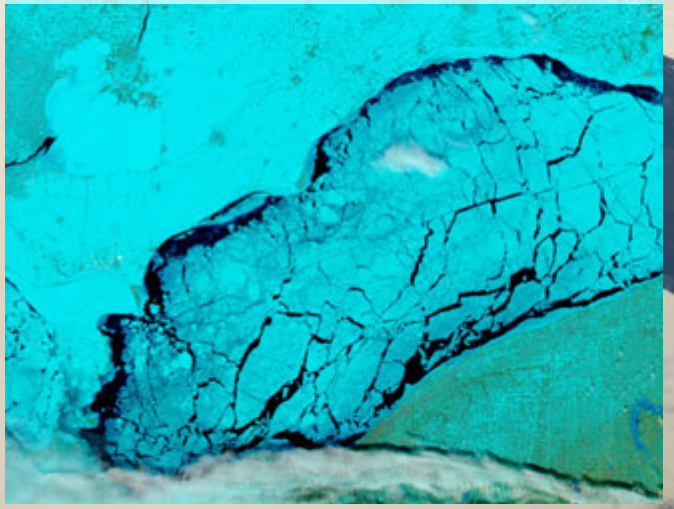
Ecological Forecasting

Disasters

Wildland Fires

Health and Air Quality

Water Resources



Capacity Building

Mapping Application for Penguin Populations and Projected Dynamics

http://www.penguinmap.com/

Snapshot Wisconsin

username | password

Login | Sign Up

Looks like

Pattern | Color | Horns | Tail | Build

Bear	Deer	Raccoon
Bobcat	Fox	Snowshoe Hare
Bird	Porcupine	Squirrel
Coyote	Rabbit	Wolf

How many | Behavior

Nothing here | Human | Finish

Tutorial | Clear Filters | ?

http://dnr.wi.gov/topic/research/projects/snapshot/

You should sign in!

Deer

Lightly built, whitetail deer are grayish brown to reddish brown in color. The underside of the tail is white. Adult males have antlers which curve forward and fork off a main branch. Young are reddish brown in color with white spots.

Often confused with Elk

Young

1 2 **3** 4 5 6+

Adult antlerless

1 2 3 4 5 6+

Adult antlered

1 2 3 4 5 6+

Adult head not visible

1 2 3 4 5 6+

Behavior

Vigilant Moving **Foraging** Resting Interacting Camera stare

Cancel **Identify**

No animals present

NASA's Capacity Building Program

SERVIR

ARSET

DEVELOP

Indigenous Peoples Initiative

Capacity Building: SERVIR

A joint NASA-USAID network, SERVIR works in partnership with leading regional organizations world-wide to help developing countries use information provided by Earth observing satellites and geospatial technologies for managing climate risks and land use.

https://www.servirglobal.net/

Connecting Space to Village

Capacity Building: ARSET

- Promotes efforts to discover and demonstrate innovative and practical applications of Earth Observations
- 4 application areas:
  - Air Quality
  - Disasters
  - Eco
  - Water Resources
- Seeks to increase the use of Earth science in decision-making through training for:
  - policy makers
  - environmental managers
  - other professionals in the public and private sector

Helping Professionals Solve Problems Including…

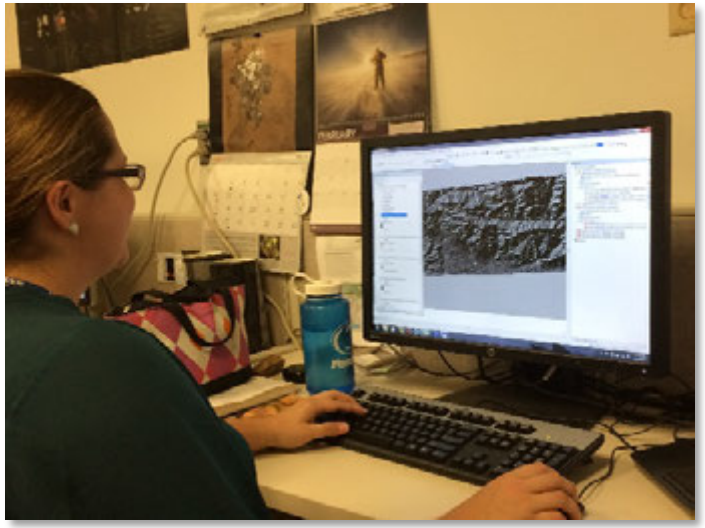
https://arset.gsfc.nasa.gov/

Capacity Building: DEVELOP

DEVELOP: addresses environmental and public policy issues by conducting interdisciplinary feasibility projects that apply the lens of NASA Earth observations to community concerns around the globe.

https://develop.larc.nasa.gov/

Individuals + Earth Observations + Institutions

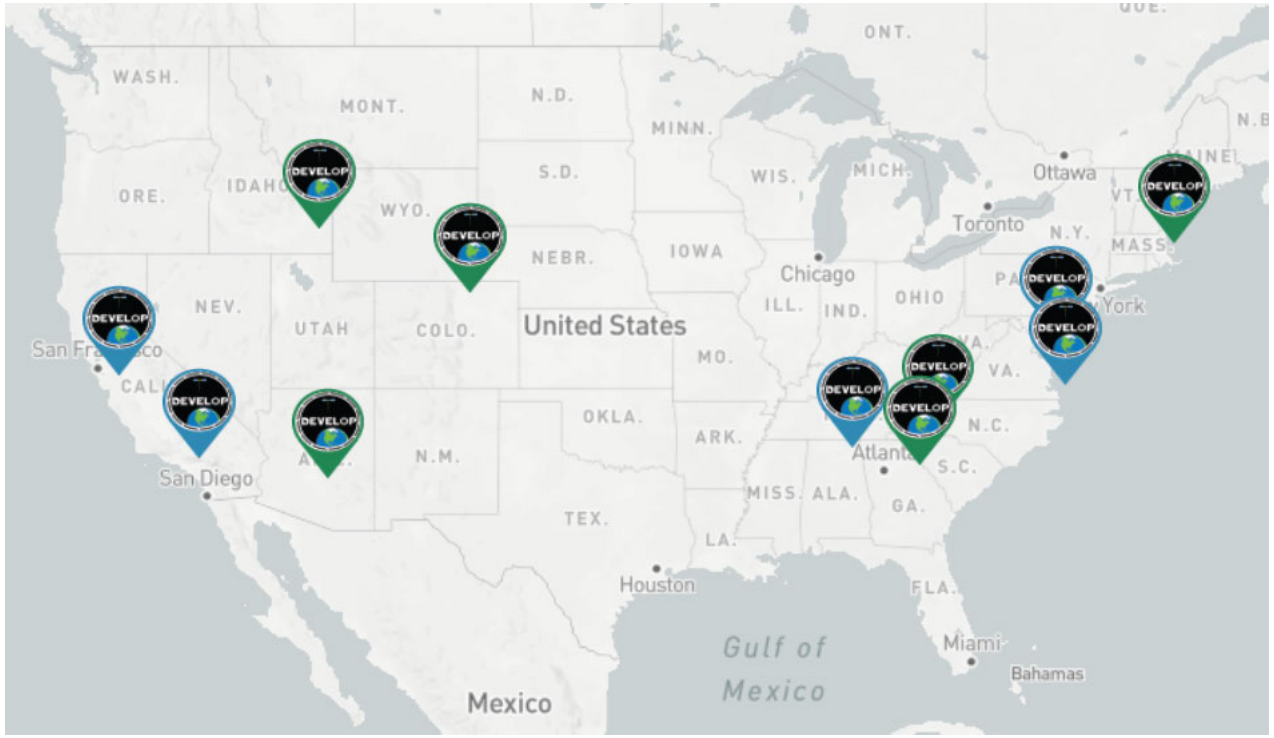


Apply for DEVELOP

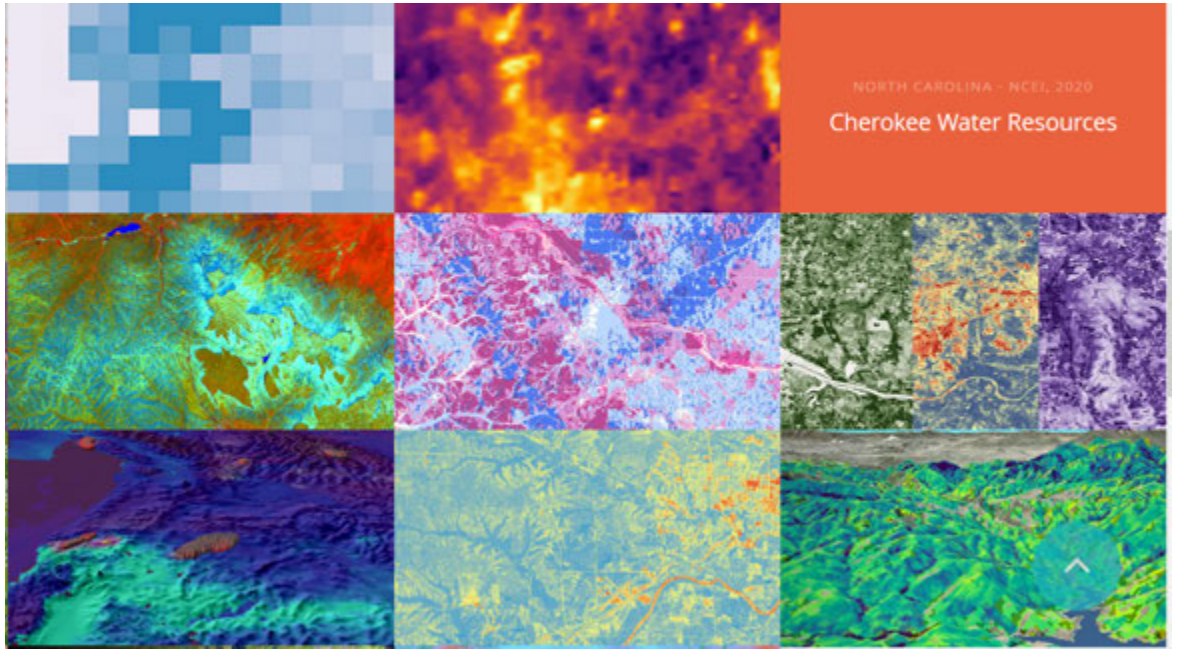
Summer 2021 Application Window: Jan 18 – Feb 26th, 2021

https://develop.larc.nasa.gov/apply.php

DEVELOP Locations

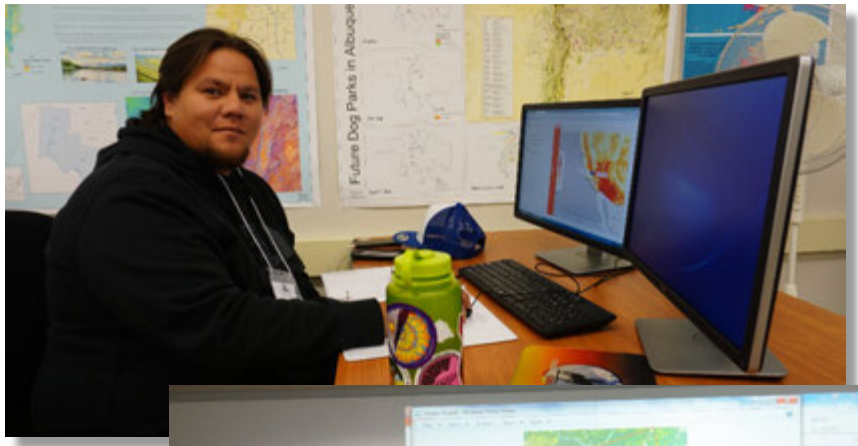


Projects: Water Resources, Health and Air Quality, Disasters, Land Mgmt, and more!



Capacity Building: IPI

Indigenous Peoples Initiative: In-person remote sensing training, place-based approaches, community engagement, all focused around Indigenous Knowledge systems




COMMUNITY ENGAGEMENT
Engaging with Indigenous Communities through tribally-focused conferences and meetings with regional governmental agencies, Climate Science Centers, and universities.
PLACE-BASED APPROACHES
Integrating traditional ecological knowledge towards natural resource/natural element management and conservation.
INDIGENOUS KNOWLEDGE SYSTEMS
Partnering with tribes, government agencies, and affiliated groups to develop technical remote sensing workshops and trainings applied to specific regions and/or thematic areas.
TECHNICAL WORKSHOPS

IPI: Community Engagement

IPI: Group on Earth Observations (GEO) Indigenous Alliance

First Indigenous-led session at the GEO Ministerial Summit
Canberra, Australia, November 2019

GEO Indigenous Summit
Online, December 2019

https://www.earthobservations.org/indigenoussummit2020.php

IPI: Remote Sensing Trainings


Northwest Indian College, Bellingham, WA


Sault Ste. Marie, MI

We co-develop place-based, in-person training workshops focused on content relevant to Indigenous lands and territories


Southwest Indian Polytechnic Institute, Albuquerque, NM


Denver, CO

Wk 1: Intro to Remote Sensing & NASA Data

Download Week 1 materials here

Tuesday, October 6th

Session 1 recording

- Introduction to the Navajo Nation
- Lecture: Introduction to remote sensing
- Exercise 1: Investigating color in a satellite image

Complete assignment for exercise 1 here (required for CEUs)

Thursday, October 8th

Session 2 recording

- Exercise 2: Accessing and downloading data
- Lecture: Vegetation indices
- Exercise 3: Vegetation indices

Complete assignment for exercise 2 and 3 here (requir CEUs)

Wk 2: Land Cover Classification

Download Week 2 materials here

Tuesday, October 13th

Session 3 recording

- Introduction to the Sault Ste Marie Band of Chippewa Indians
- Lecture: Land cover classification
- Exercise 4: Unsupervised classification

Complete assignment for exercise 4 here

Thursday, October 15th

Session 4 recording

- Exercise 5: Supervised classification
- Lecture: Accuracy assessment
- Exercise 6: Accuracy assessment

Complete assignment for exercise 5 here

Complete assignment for exercise 6 here

Wk 3: Change Detection & Time Series

Download Week 3 materials here

Tuesday, October 20th

Session 5 recording

- Introduction to the Rosebud Sioux Tribe
- Lecture: Overview of change detection
- Exercise 7: Change detection

Complete assignment for exercise 7 here

Thursday, October 22nd

Session 6 recording

- Lecture: Time series analysis
- Exercise 8: Time series analysis

Complete assignment for exercise 8 here

Wk 4: Remote Sensing Webtools

Download Week 4 materials here

Tuesday, October 27th

Session 7 recording

- Introduction to the Samish Indian Nation and the Tulalip Tribes
- Lecture: Webtools for remote sensing
- Exercise 9: Climate Engine and the Drought Severity Evaluation Tool (DSET)
- Exercise 10: FIRMS Active Fire Mapper and Worldview

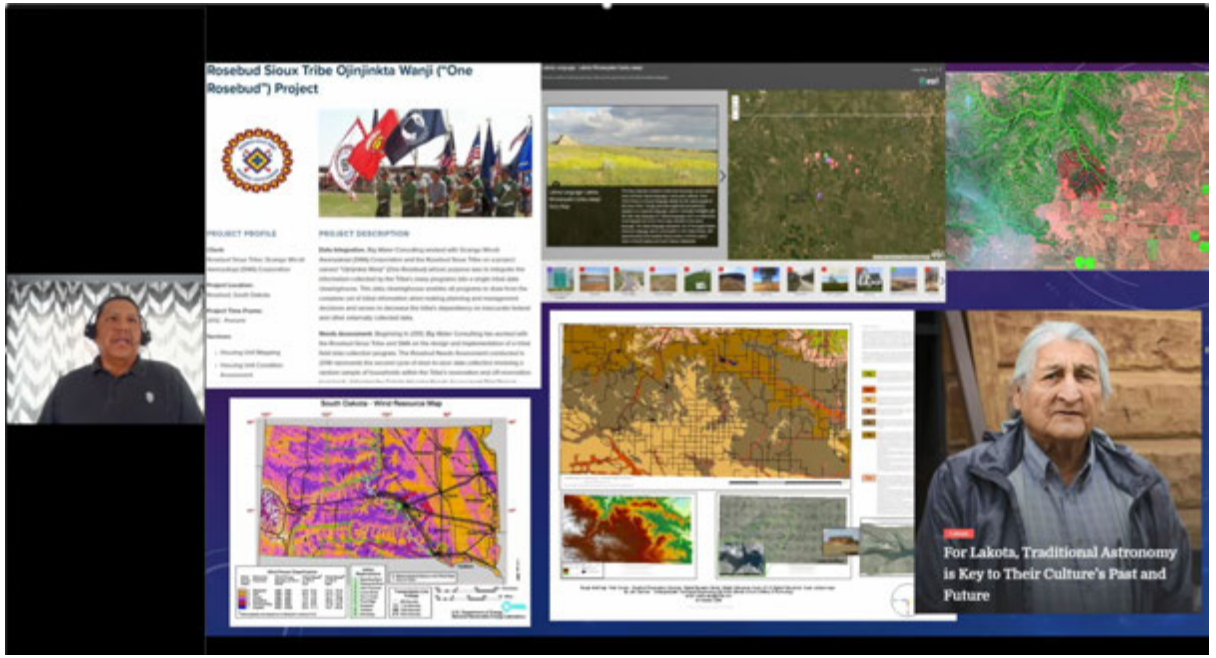
Thursday, October 29th

Session 8 recording

- Exercise 11: Global Forest Watch
- Course Summary and Feedback

Complete assignment for exercise 11 here


Navajo Nation Drought Severity Evaluation Tool
Introductory Video
A NASA Western Water Applications Office (WWAO) funded project.


Rosebud Sioux Tribe Ojinjinkta Wanji ("One Rosebud") Project
For Lakota, Traditional Astronomy is Key to Their Culture's Past and Future


LANDCOVER DATA APPLICATIONS IN TRIBAL WILDLIFE MANAGEMENT
Sault Ste. Marie Tribe of Chippewa Indians – Wildlife Program


Pepperwood Extent
GIS continued

CAPACITY BUILDING AS EMPOWERMENT

INDIGENOUS MAPPING WORKSHOP

The Firelight Group and its partners are proud to present the largest international geospatial conference for Indigenous Nations and organizations on Indigenous-led geospatial research

OUR STORY | WORKSHOPS

https://www.indigenousmaps.com/

Future Engagement Opportunities

Inter-American Academy of Geosciences & Applications

https://academy.amerigeoss.org/

- Engaging with Indigenous Peoples Training (Feb 2021)
- Geospatial Technology for Indigenous People (Spring/Summer 2021)

AmeriGEO
Earth Observations for the Americas

Drought Severity Evaluation Tool

A collaboration of Sovereignty and Science for the Navajo Nation

Project Team:
Amber McCullum (BAERI/NASA Ames Research Center)
Carlee McClellan (NN DWR)
Justin Huntington (DRI)
Britta Daudert (DRI)
Nikki Tulley (University of Arizona)

DSET Website Link
https://app.climateengine.org/dset

Drought Severity Evaluation Tool

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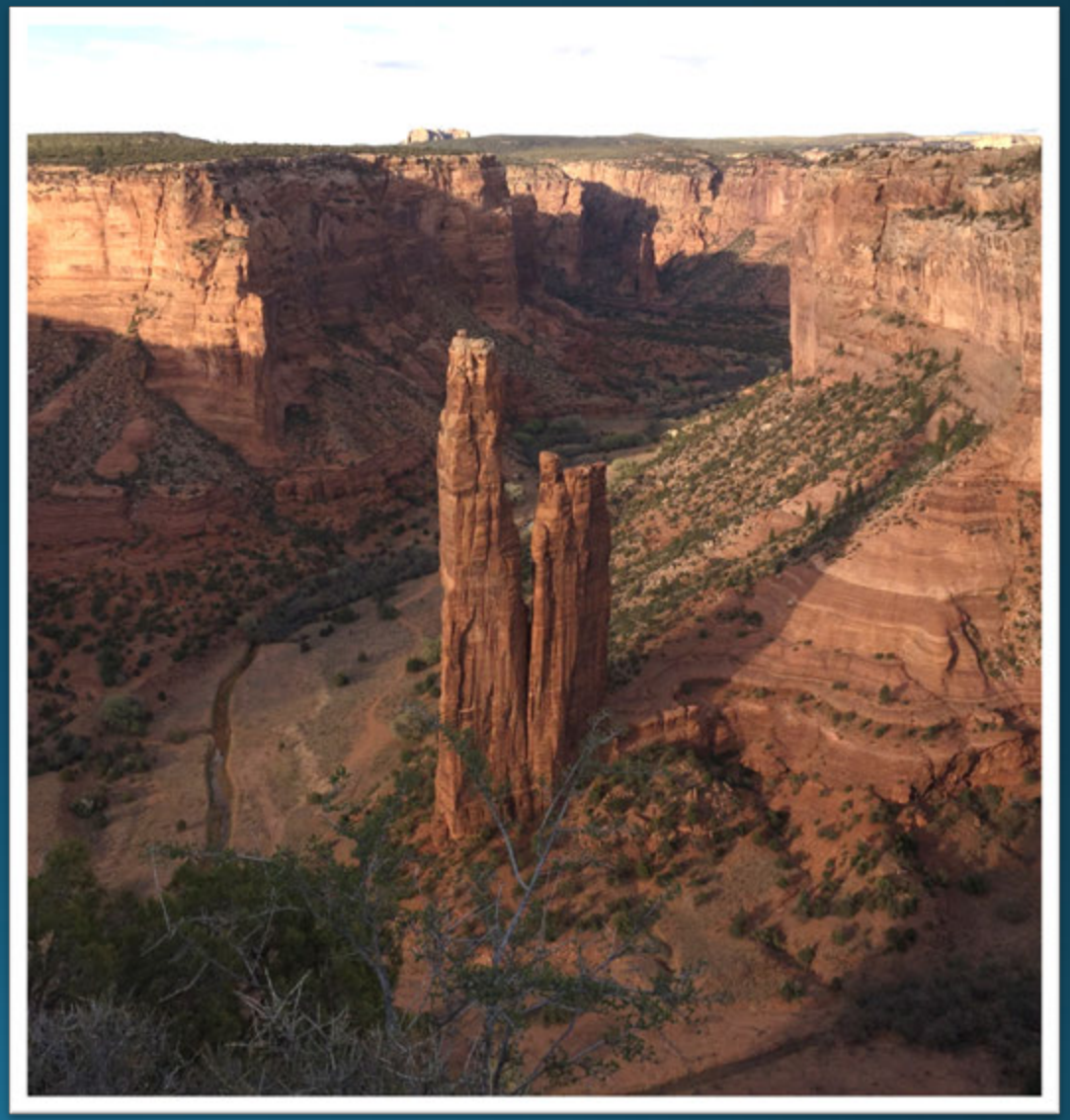


Improve NNDWR drought reporting through Earth Observations and *in-situ* data within a user-friendly web application

Space connection to Navajoland

- **Culture context of Indigenous relationship to land**
- **Preexisting knowledge system**
- **Communication mechanisms**


Navajo Nation Drought Severity Evaluation Tool
Introductory Video
DRI
Desert Research Institute
wwao
A NASA Western Water Applications Office (WWAO) funded project.

A view of the Navajo Nation

- 3 States
- 5 Agencies
- 110 Chapters
- Population ~200,000

Climate Engine

ABOUT TOOL DATA EXAMPLES TESTIMONIALS PUBS NEWS TEAM CONTACT

On-Demand Cloud Computing and Visualization of Climate and Remote Sensing Data

Analyze and interact with climate and earth observations for decision support related to drought, water use, agricultural, wildfire, and ecology

LAUNCH THE WEB APPLICATION

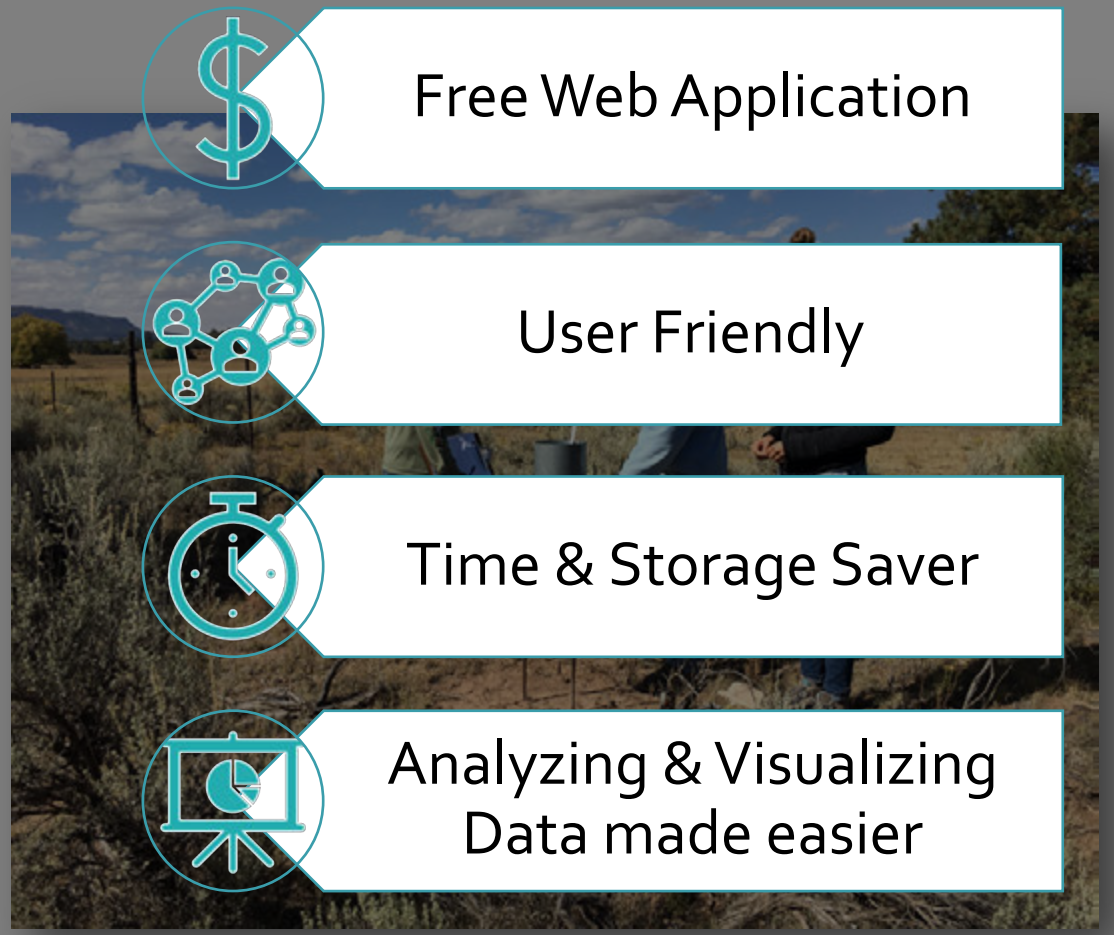
Drought Monitoring

Agriculture & Ecosystems

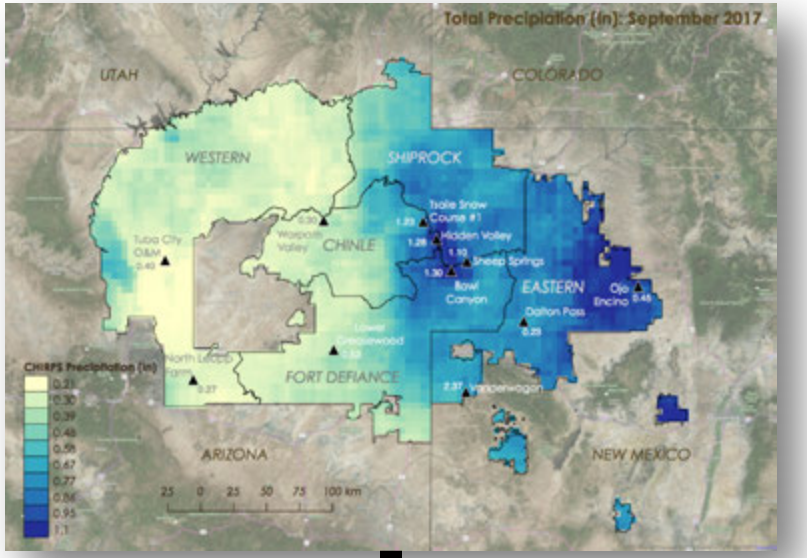
Wildfire

DSET Overview

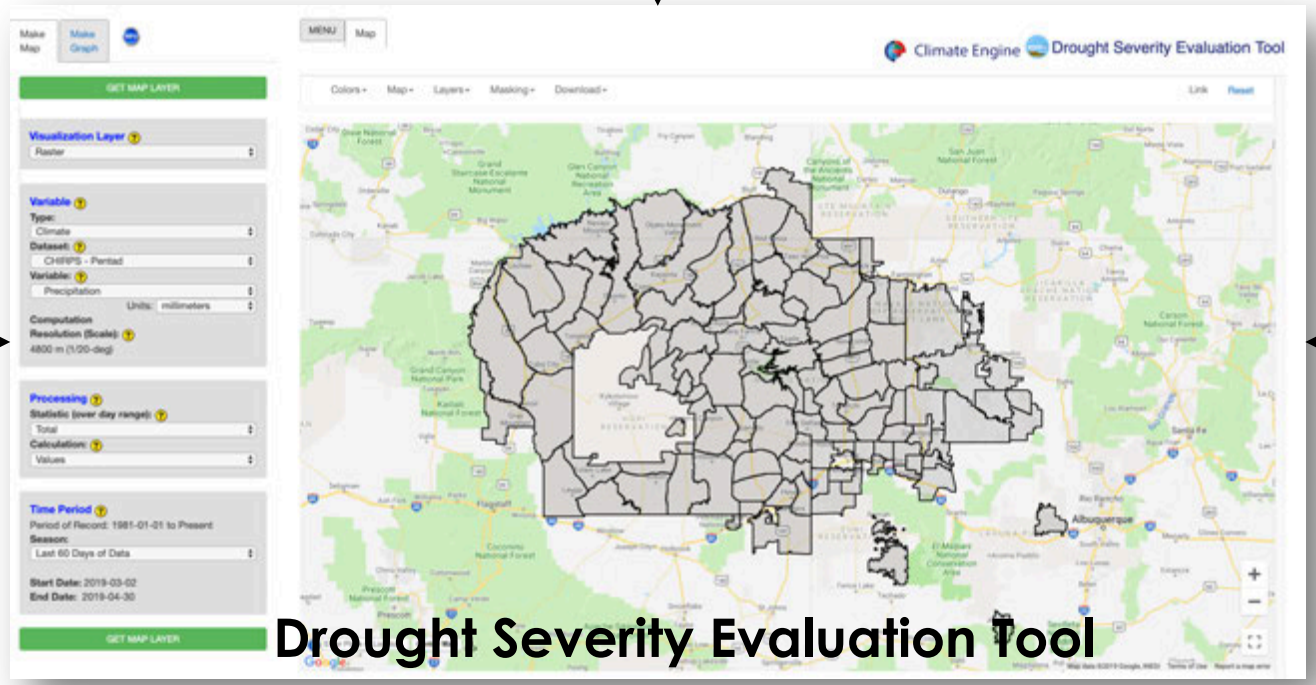
- NASA Western Water Applications Office (WWAO)
- Co-developed with the Navajo Nation Division of Water Resources (N.N. DWR), and the Desert Research Institute (DRI)



Navajo Rain Gauge Data

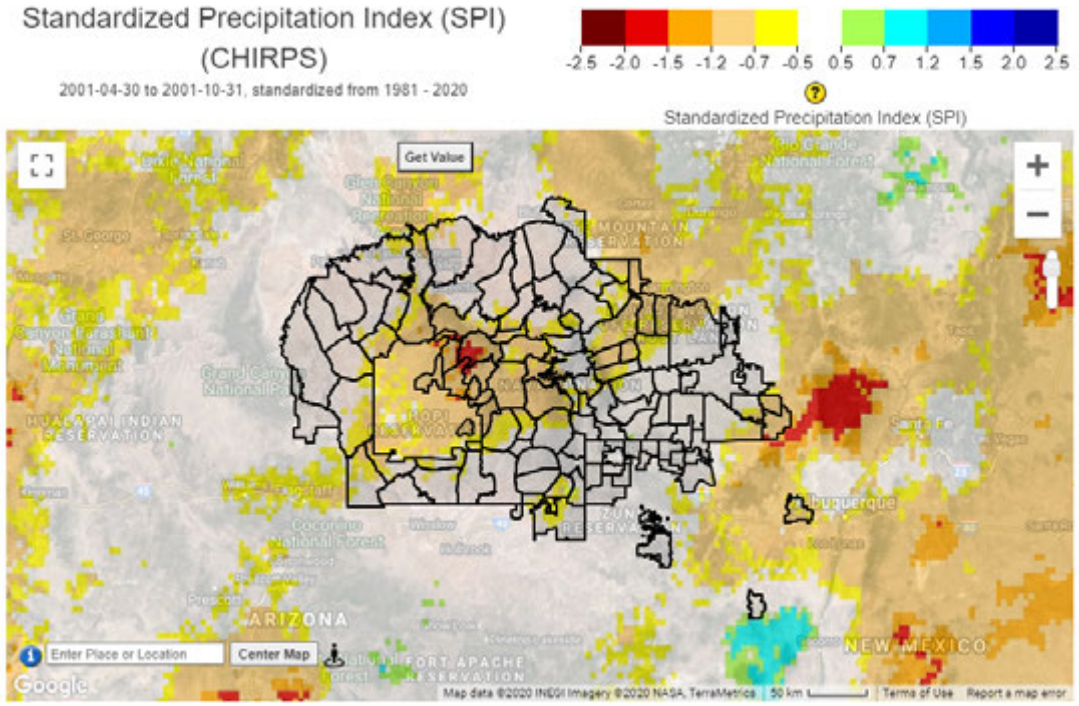


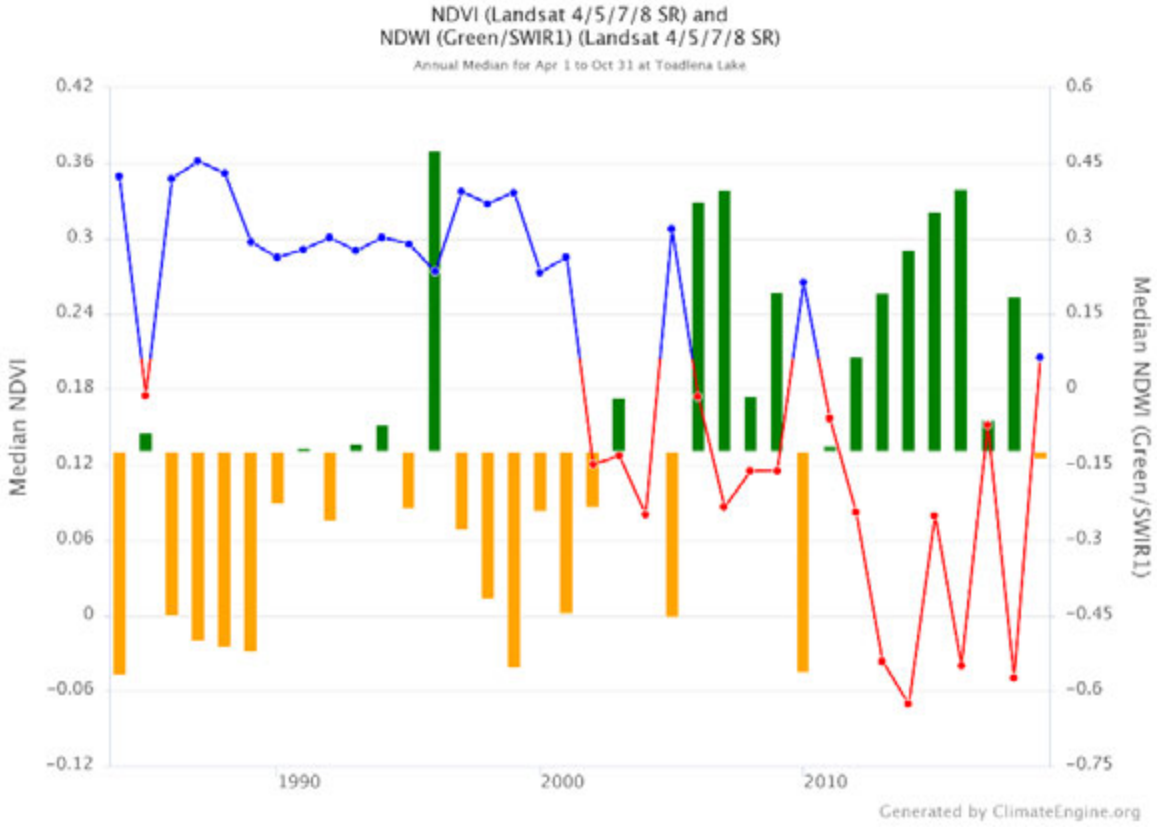
Modeled Data and Drought Indices



DSET Capabilities

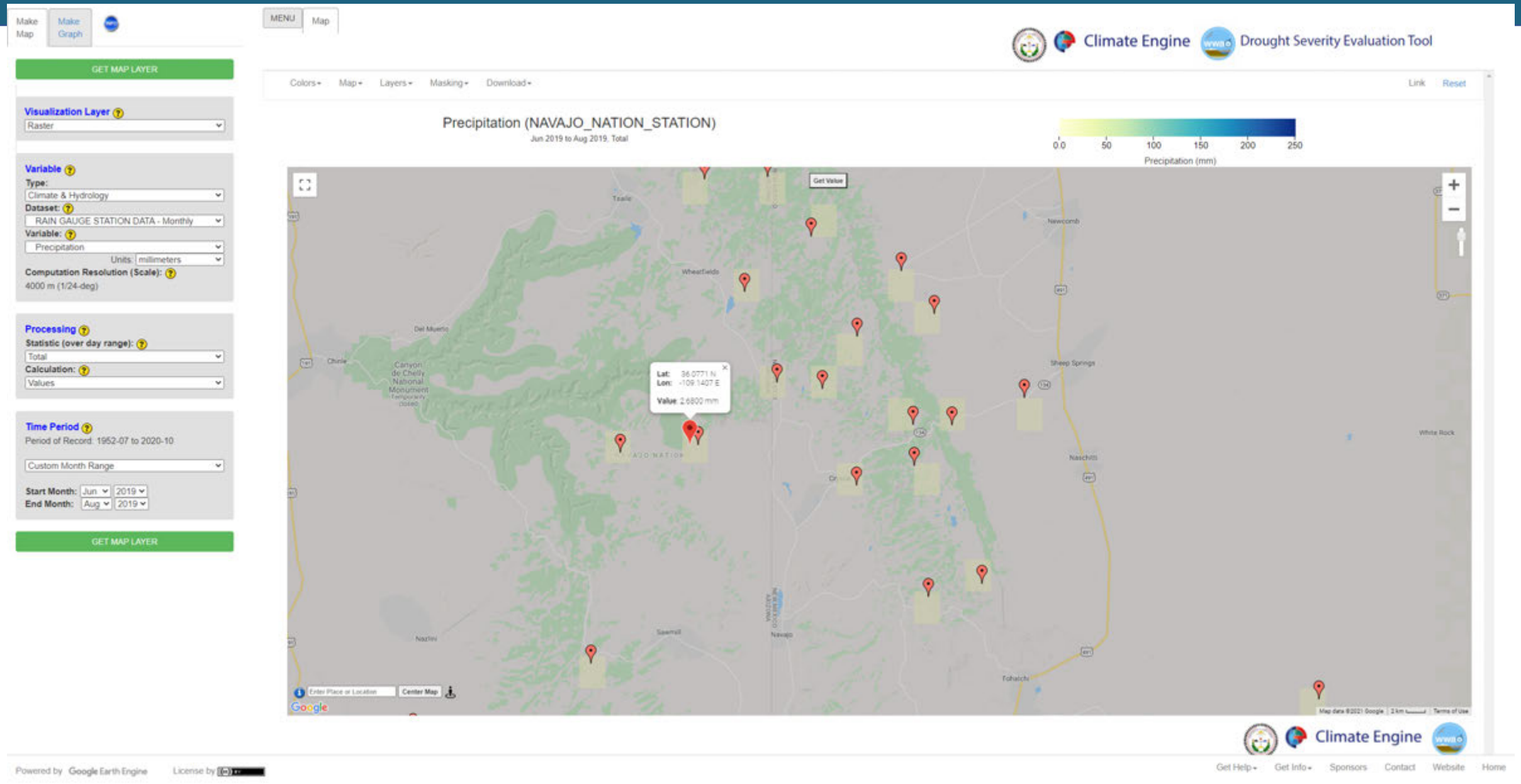
Easy to use interface



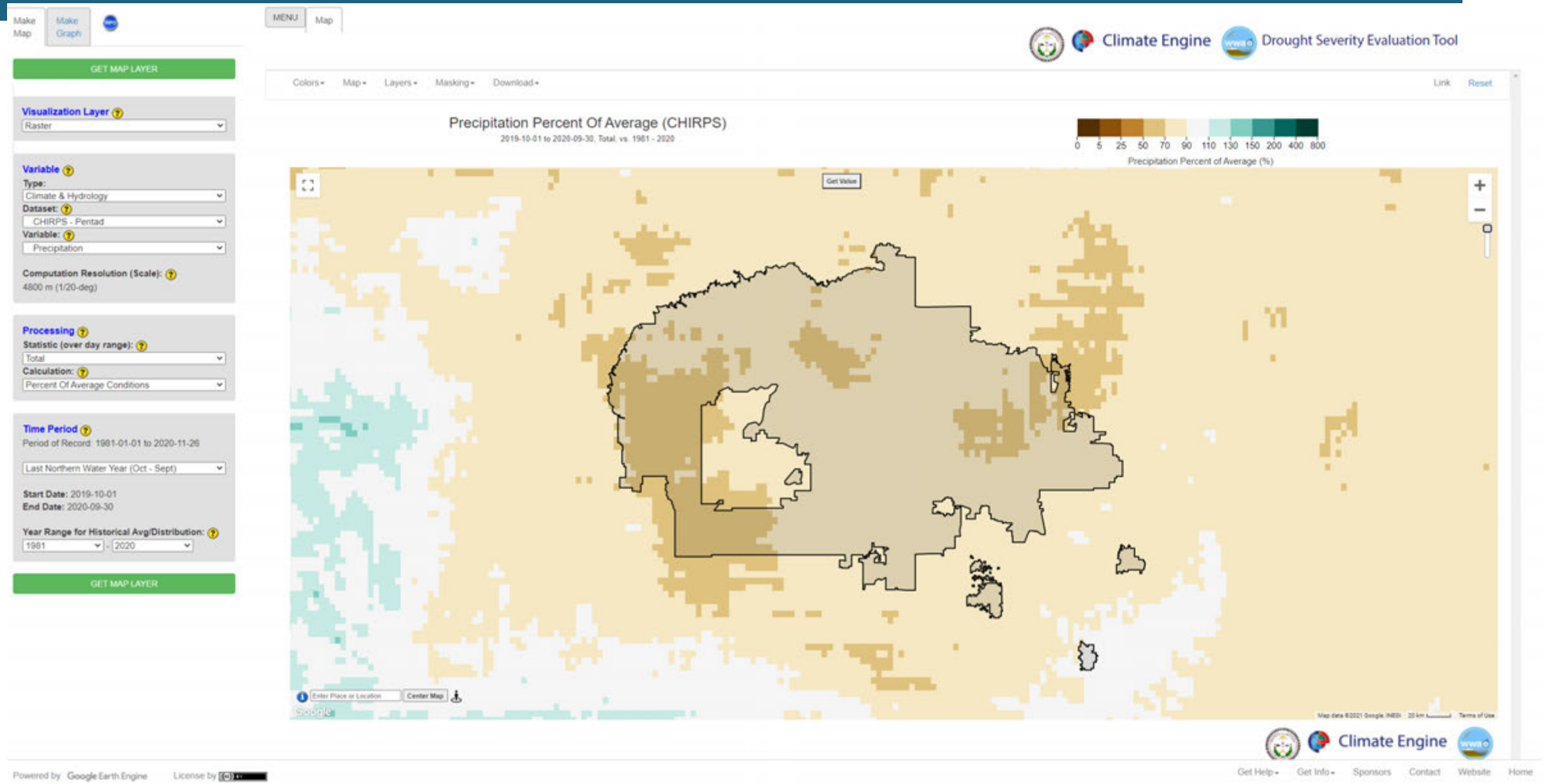


On-the-fly maps and times series

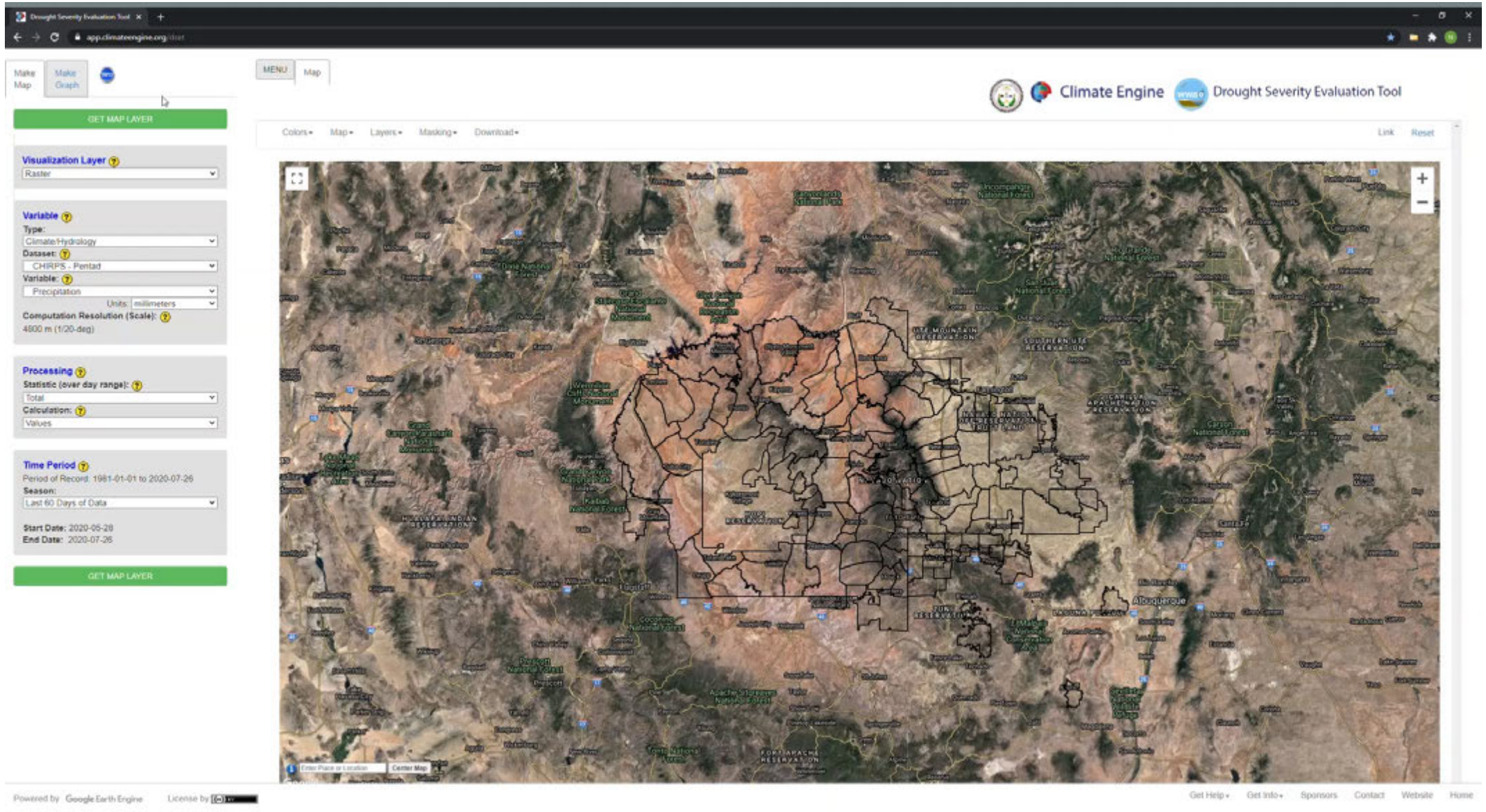
What were the rain gauge totals from the 2019 summer monsoon?



What was the precipitation percent of average last Northern Water Year?



DSET Drought Examples



NAVAJO TIMES

Monday
November 16, 2020
Last update: June 18 05:05 pm MST

:: MORE NEWS

Paying tribute: Honor Riders help code talker repair roof

Language education among hopes for $554M

50 Years Ago: Major

NEWS

Asáásyii Lake Fire grows to about 1,000 acres

By Alastair Lee Bitsoi and Terry Bowman
Navajo Times

NASCHITTI, N.M., June 16, 2014

After three days of charring approximately 1,000 acres, the Assayii Lake Fire has reached the summit of the Chuska Mountains and the inferno is moving in a northeastern direction toward the communities of Naschitti and Sheep Springs, N.M.

The fire will be categorized as a Type II National and State Level Fire, according to the Southwest Area Incident Management Team.

"I got scared," said Eleanor Largo, who had to evacuate

Make Map | Make Graph

GET MAP LAYER

Visualization Layer
Raster

Variable
Type: Remote Sensing
Dataset: MODIS Terra Daily
Variable: BAI (Burned Area Index)

Computation Resolution (Scale):
500 m

Processing
Statistic (over day range): Mean
Calculation: Values

Time Period
Period of Record: 2000-02-24 to 2020-08-20
Season: Custom Date Range

Start Date: 2014-05-10
End Date: 2014-08-10

GET MAP LAYER

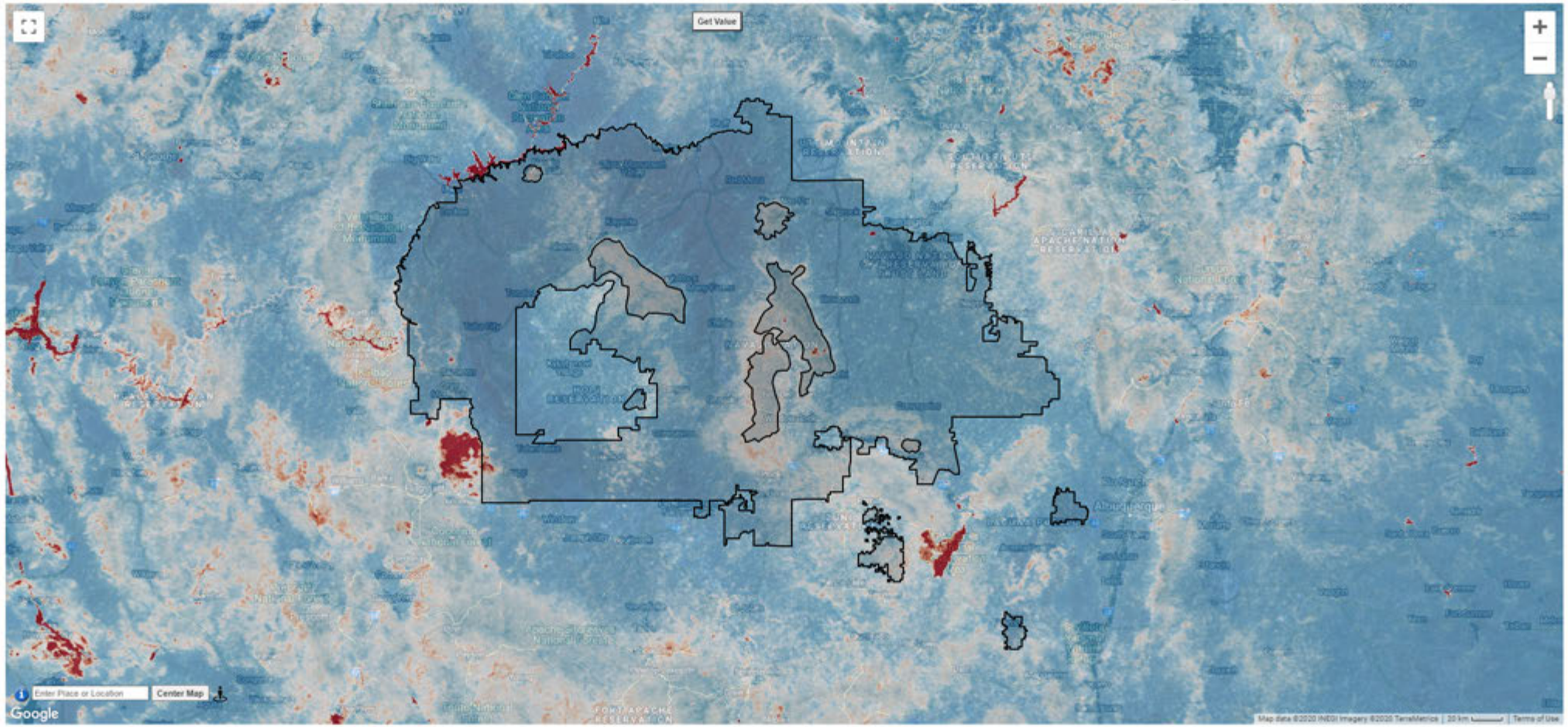
MENU | Map

Climate Engine | Drought Severity Evaluation Tool

Colors | Map | Layers | Masking | Download | Link | Reset

BAI (MODIS Terra Daily)
2014-05-10 to 2014-08-10, Mean

0.0 20 40 60 80 100
BAI



Climate Engine

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Make Map | Make Graph

GET TIME SERIES

Time Series Calculation:
Summary Time Series

Two Variable Analysis

Region:
Polygon

Variable 1 | Variable 2

Variable 2

Type:
Remote Sensing

Dataset:
Landsat 4/5/7/8 Surface Reflectance

Variable:
NDVI (Vegetation Index)

Computation Resolution: (Scale)
1000 m

Year Statistic:
Mean

Time Period
Period of Record: 1984-01-01 to 2020-08-03

Season:
Custom Day Range

Start Day: May 10
End Day: Aug 10
Year Range: 2000 to 2019

GET TIME SERIES

MENU | Map | Figure | Data

Climate Engine | Drought Severity Evaluation Tool

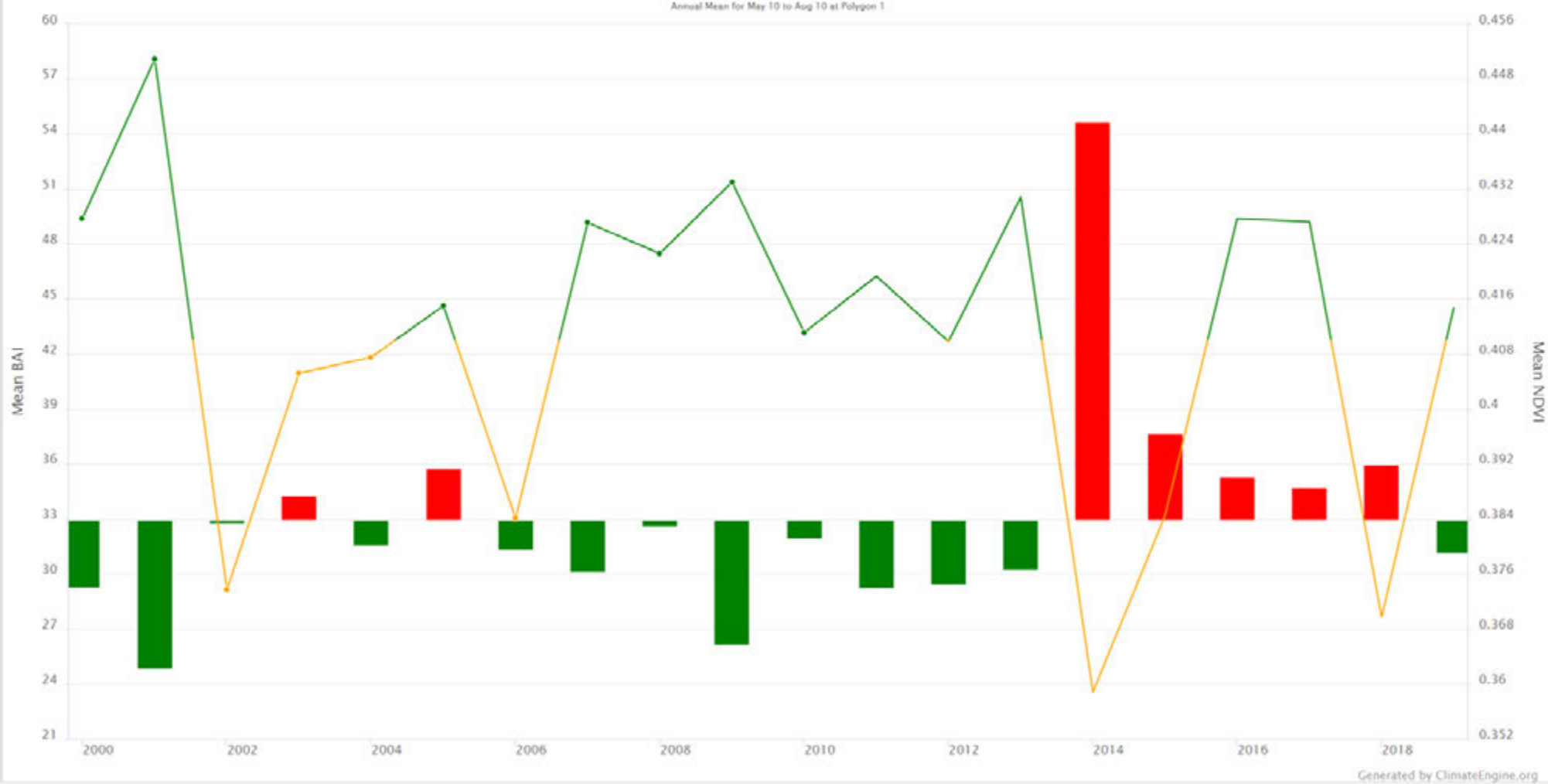
Graph | Statistics | Link | Reset

Deviations from 32.9 and 0.41

BAI (MODIS Terra Daily) and
NDVI (Landsat 4/5/7/8 SR)

Annual Mean for May 10 to Aug 10 at Polygon 1

Download



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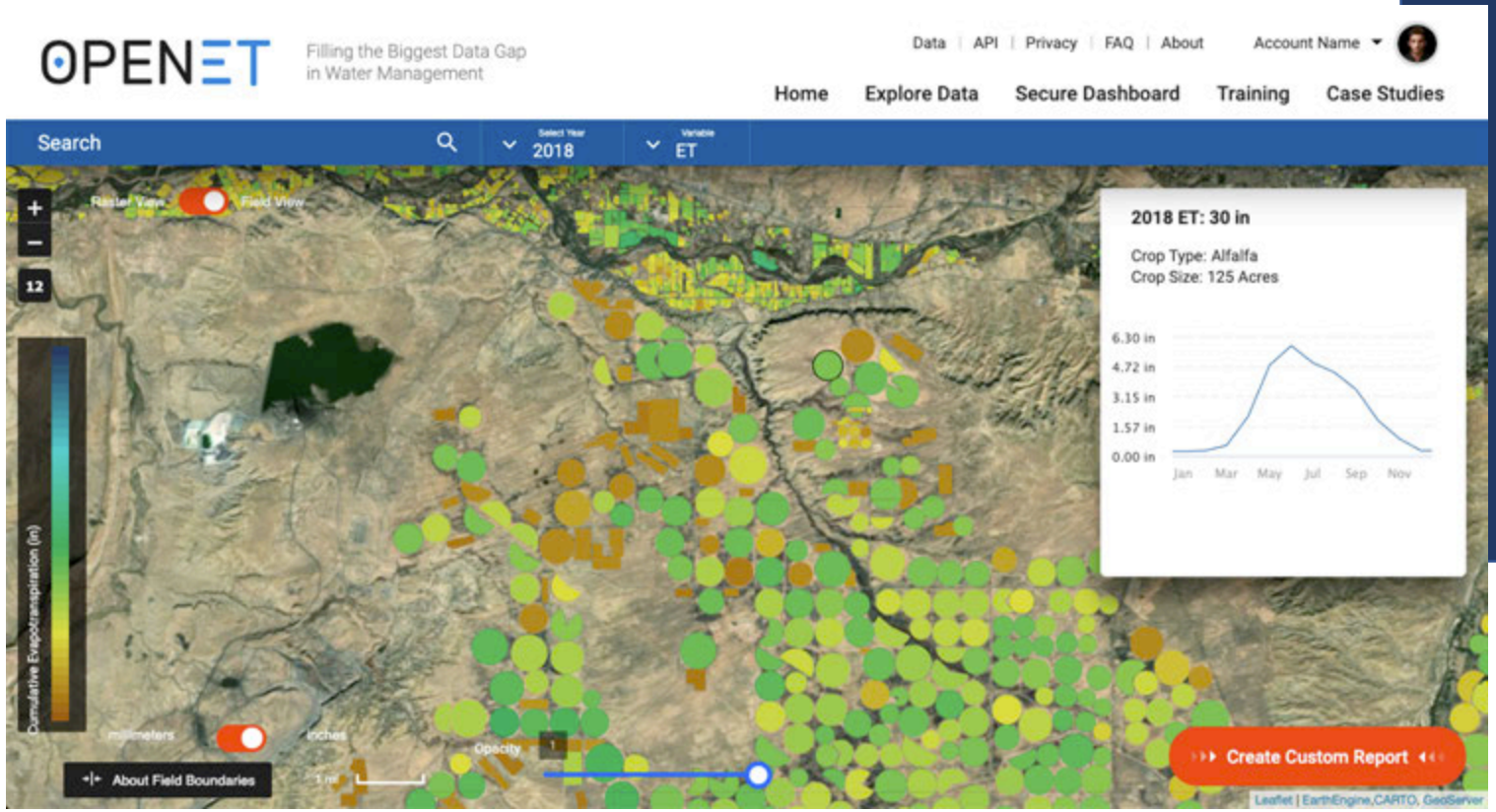
Partner-driven tools start with **relationships**

- April 2019: 2-Day hands-on training in Flagstaff, AZ
- Multiple Navajo Nation Natural Resources Departments
- Feedback/Discussion session

- Dec 2019: 1-Day hands-on training in Window Rock, AZ
- Focus on Department of Agriculture new personnel

Future Partnerships and Projects

OpenET Project Now Underway



Continued Work

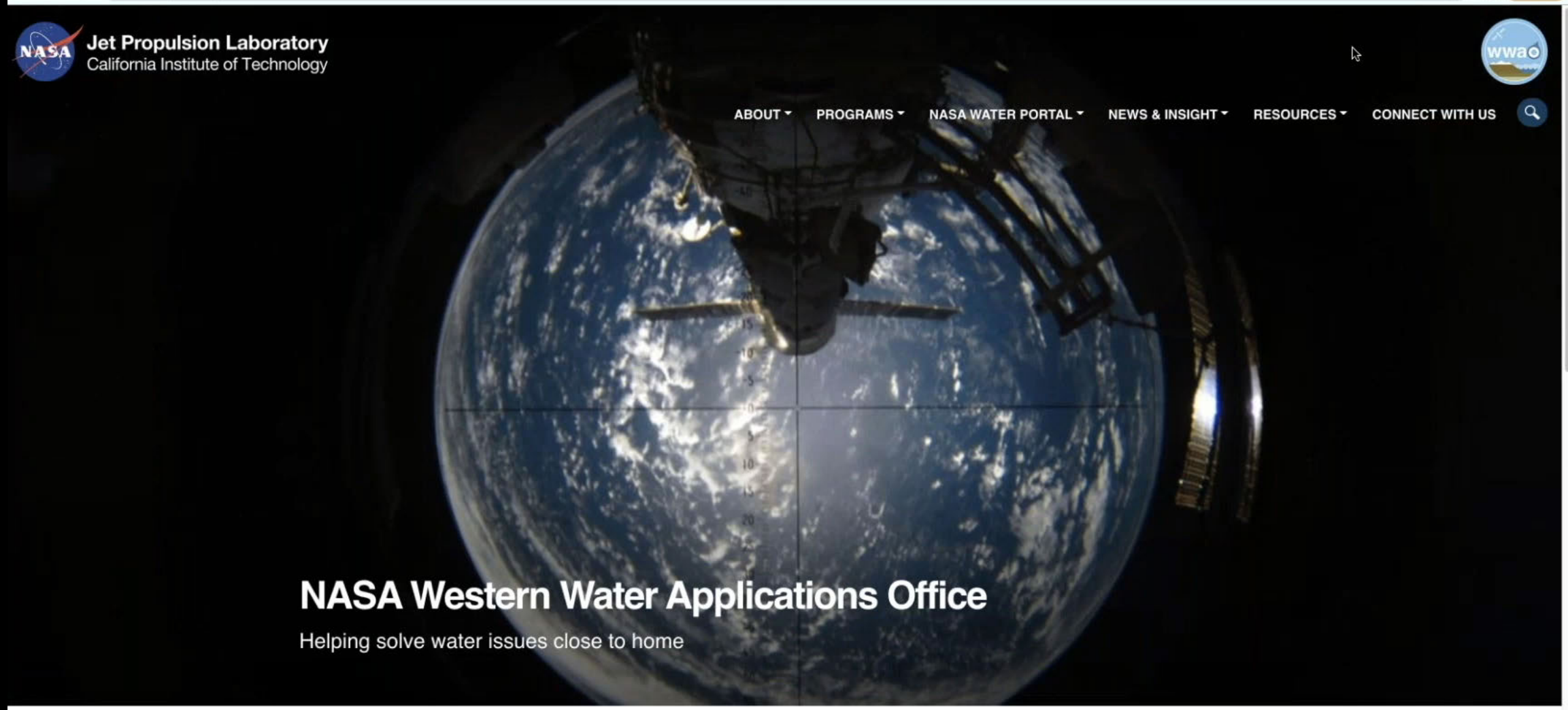
- DSET training
- OpenET case-study
- Partnerships with Dept. of Agriculture and/or NAPI
- Use of OpenET for consumptive water use estimates
- Student internships

Continue to strengthen relationships.

Thank You!

Amber McCullum, PhD
Amberjean.Mccullum@nasa.gov

Nikki Tulley, MWR
nikkitulley@email.arizona.edu



Welcome to NASA's Western Water Applications Office.

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

WWAO partners with water managers, identifies pressing water issues and delivers solutions to these issues based on NASA