



Satellite-based Drought Reporting on the Navajo Nation

Carlee McClellan (NNDWR)

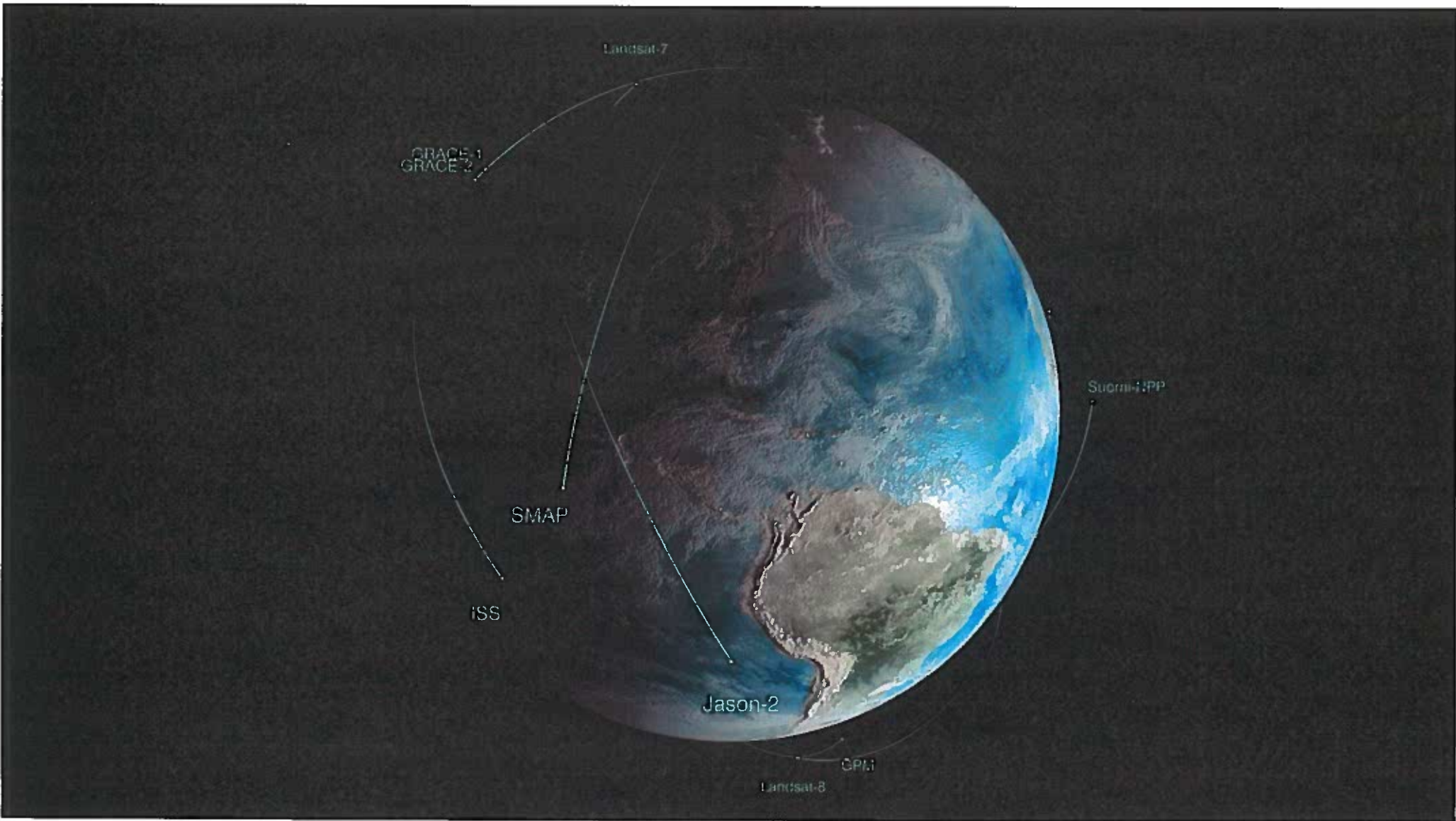
Dr. Amber McCullum, (Project Lead, NASA Ames Research Center/BAERI)

Britta Daudert (Desert Research Institute)

Justin Huntington (Desert Research Institute)

A satellite image of a coastal region, likely the Pacific Northwest, showing a coastline with a bay and a large river system. The land is covered in dense green forest. A semi-transparent rectangular box is overlaid on the image, containing the text "NASA's Applied Sciences Program".

NASA's Applied Sciences Program



NASA's Applied Sciences Program

Ecological Forecasting



Disasters



Wildland Fires



Health and Air Quality



Water Resources



Capacity Building



Indigenous Peoples Capacity Building Initiative

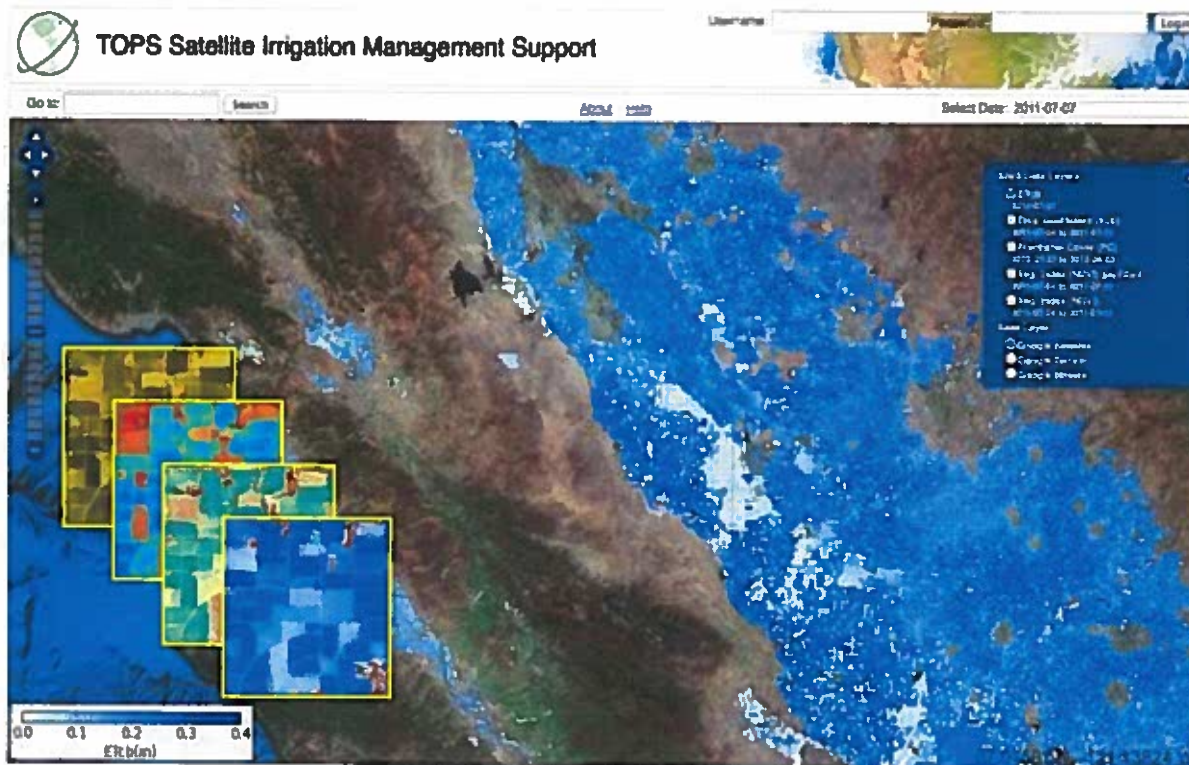


In-person remote sensing training, place-based approaches, community engagement, with the hope of incorporating Traditional Ecological Knowledge (TEK)

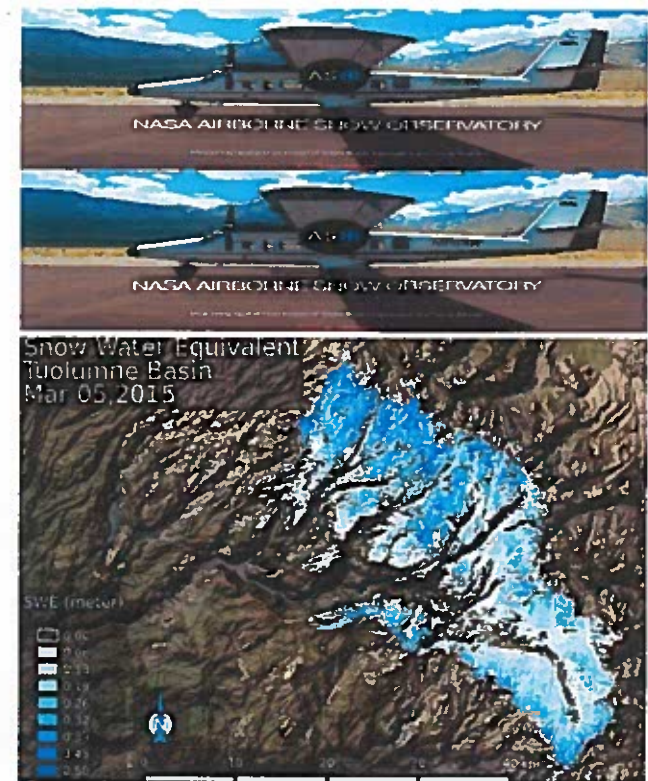




Water Resources



<http://ec2-54-196-147-232.compute-1.amazonaws.com/dgw/sims/>

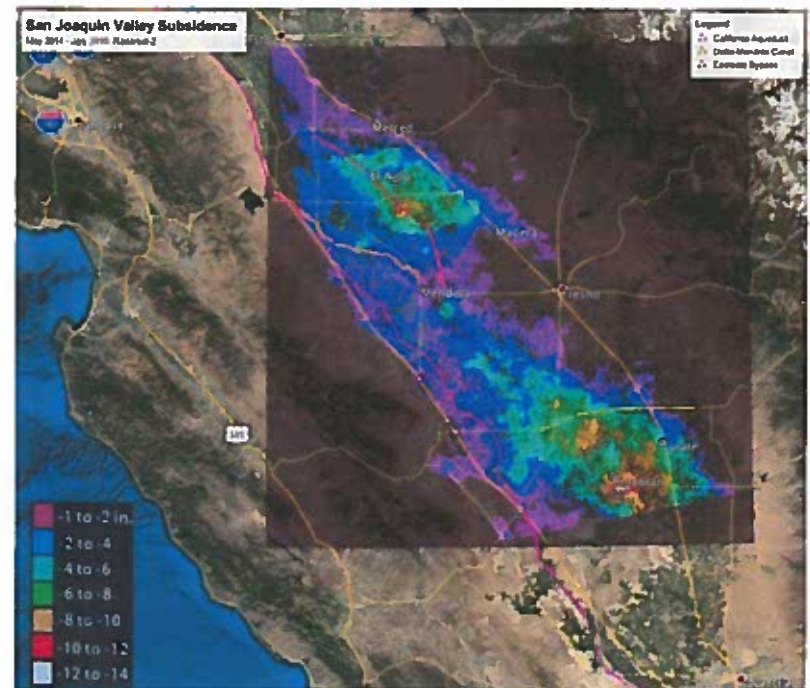
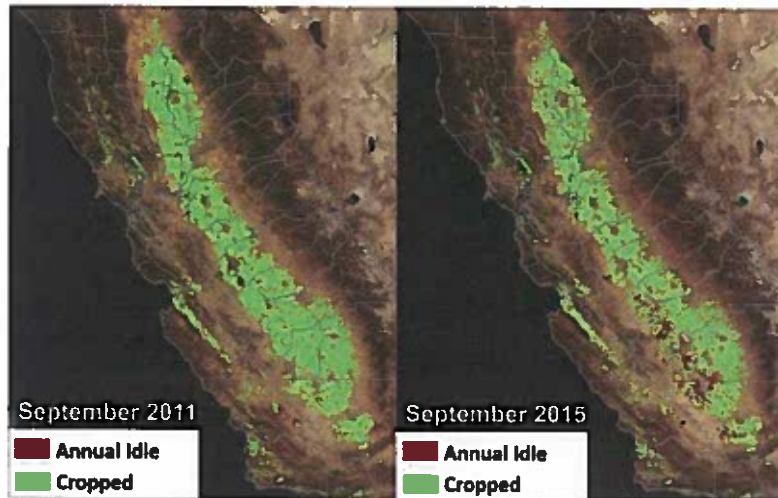


<https://aso.jpl.nasa.gov/>



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

Seeking project ideas and partner organizations!





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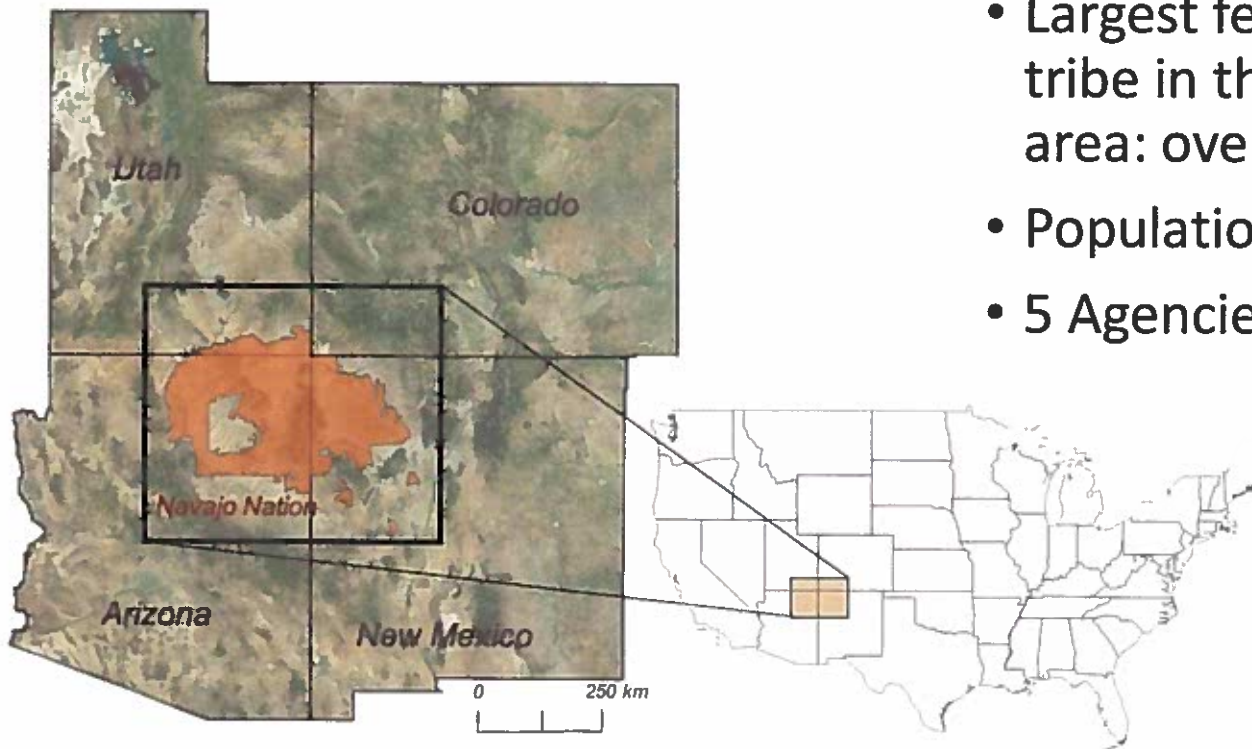
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The Navajo Nation



- Largest federally-recognized tribe in the United States in land area: over 70,000 km²
- Population of over 200,000
- 5 Agencies and 110 Chapters

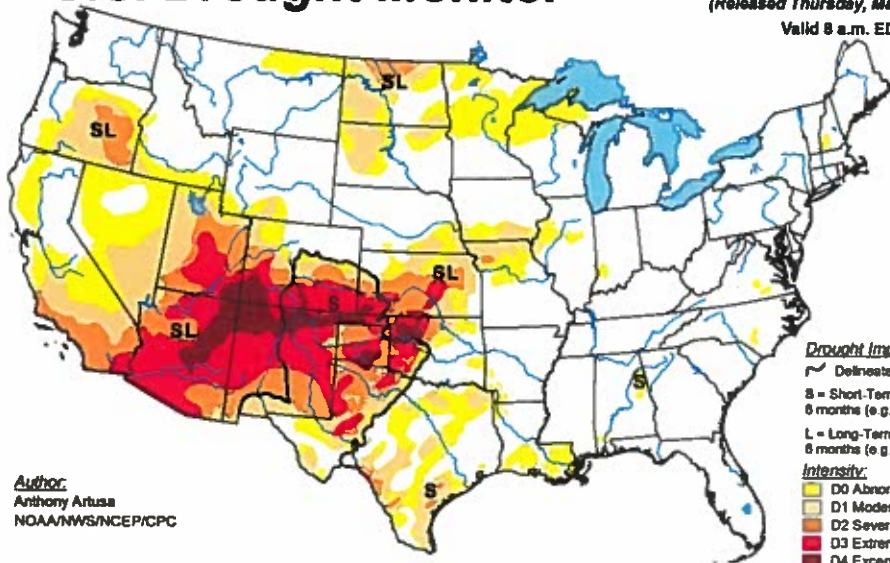


Drought on The Navajo Nation



U.S. Drought Monitor

May 29, 2018
 (Released Thursday, May 31, 2018)
 Valid 8 a.m. EDT



Drought Impact Types:
 ~ Delineates dominant impacts
 S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)
 L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

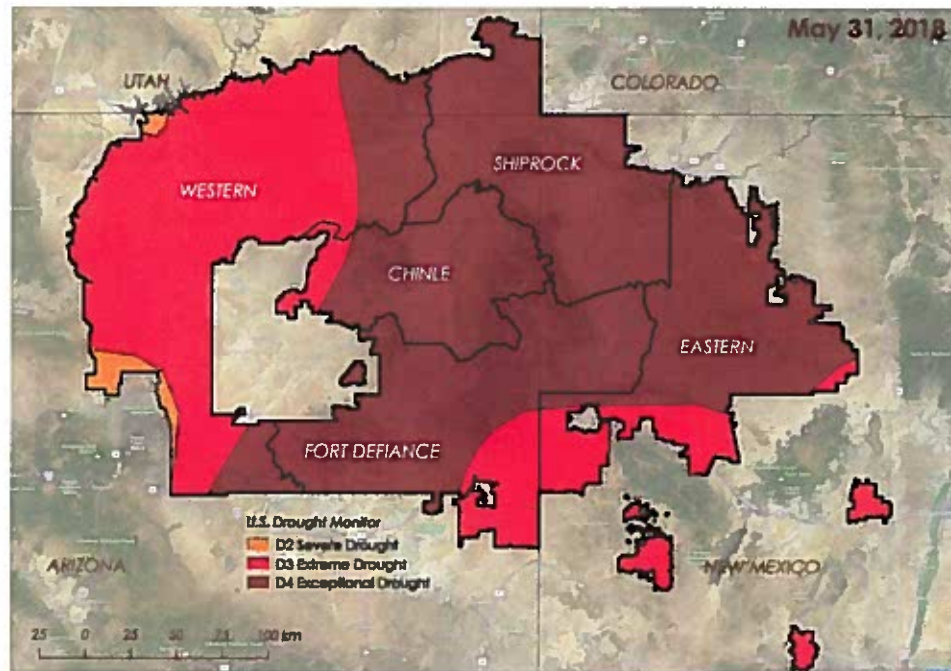
Intensity:
 D0 Abnormally Dry
 D1 Moderate Drought
 D2 Severe Drought
 D3 Extreme Drought
 D4 Exceptional Drought

Author:
 Anthony Artusa
 NOAA/NWS/NCEP/CPC



<http://droughtmonitor.unl.edu/>

The Navajo Nation: Prone to frequent and pervasive droughts



U.S. Drought Monitor
 D2 Severe Drought
 D3 Extreme Drought
 D4 Exceptional Drought

25 0 25 50 75 100 km

Climate and Hydrology



- Two wet seasons (winter, summer)
- Increasing precipitation variability
- Warming temperatures

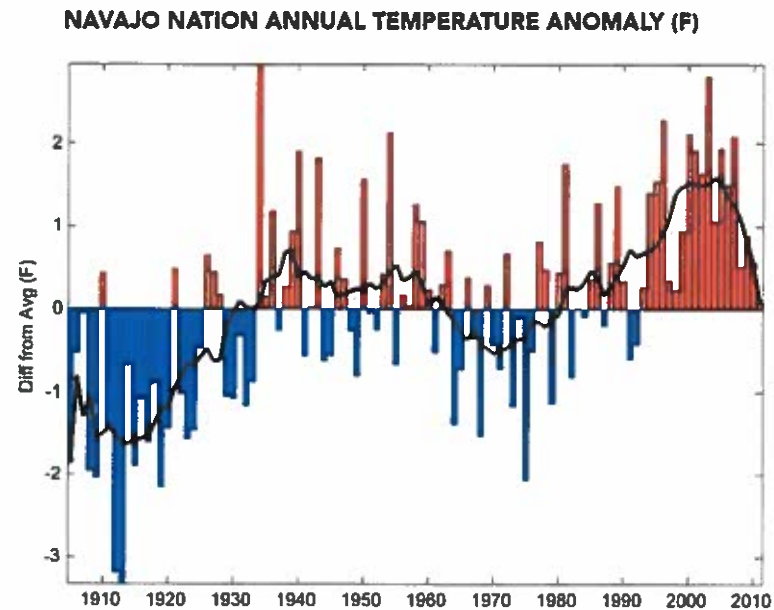
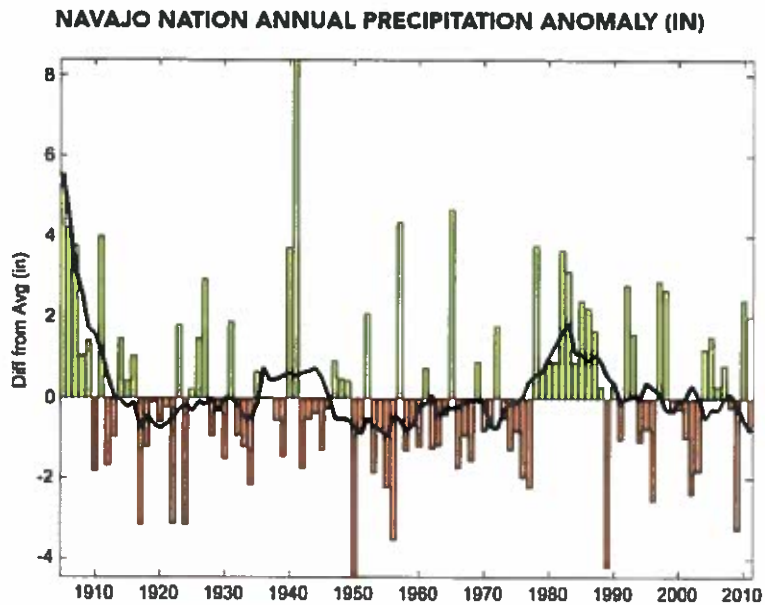


Figure credit:
Crimmins et.
al, 2013

Water Supply and Drought Reporting Challenges



- Low reliability and limited direct residential access to supply
 - 40-55% of homes lacking direct access to public water systems
 - Increased water hauling during dry periods
 - Mitigation efforts are resource intensive
- Limited precipitation and runoff data
- Coarse spatial resolution of regional drought indicators



Image credit: CBS News

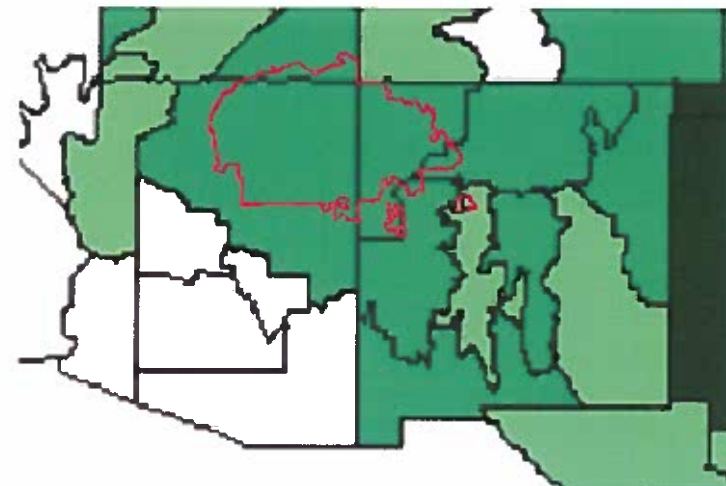


Image credit: Western Regional Climate Center (WRCC)

Project Goal



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

Decision-making context: More appropriate allocation of drought relief dollars to regions on the NN that have the greatest need

Drought Data Sources: NN Rain Gauge Data



- 85 rain gauge stations across the NN
- Precipitation measurements obtained on quasi-monthly basis

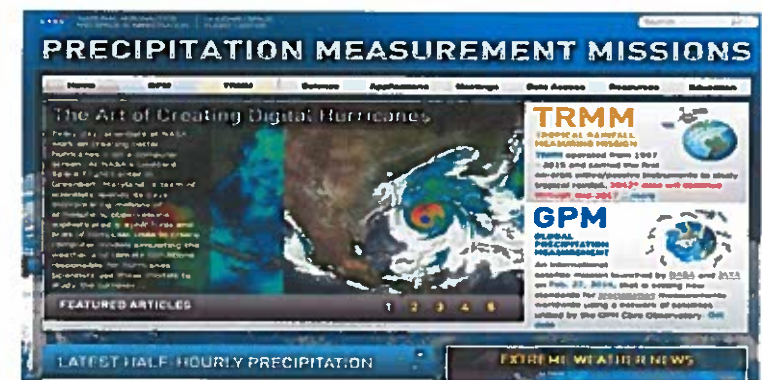
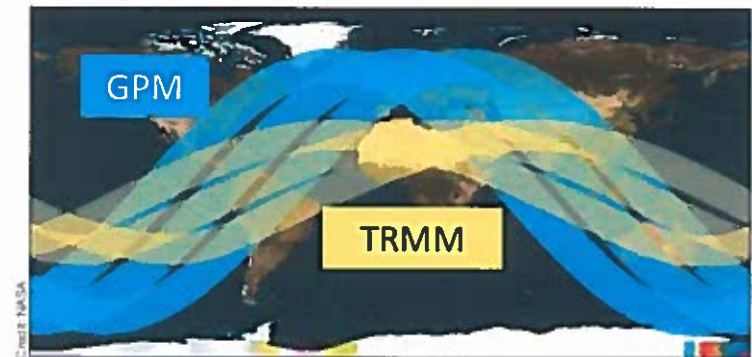
- Site visits by NNDWR personnel
 - 10-day window



Drought Data Sources: Remote-Sensing



- Tropical Rainfall Measuring Mission (TRMM) and Global Precipitation Mission (GPM)
 - NASA & JAXA (Japanese Space Agency) Joint Missions
 - TRMM: Nov 27, 1997 – Apr 15, 2015
 - GPM: Feb 27, 2014 – present
- Multi-satellite Precipitation data product (3B43)
 - TRMM and GPM
 - Monthly from 1998 – present at 0.25° (~22.5 km) resolution
- Integrated Multi-satellite Retrievals for GPM (IMERG)
 - Monthly from 2014 – present at 0.1° (~9km) resolution



Drought Data Sources: CHIRPS SPI



- The Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS) is an over 30-year quasi-global rainfall dataset
- Incorporates 0.05° resolution satellite imagery with *in-situ* station data to create gridded rainfall time series
- Standardized Precipitation Index (SPI):

Accumulated precipitation over months of interest

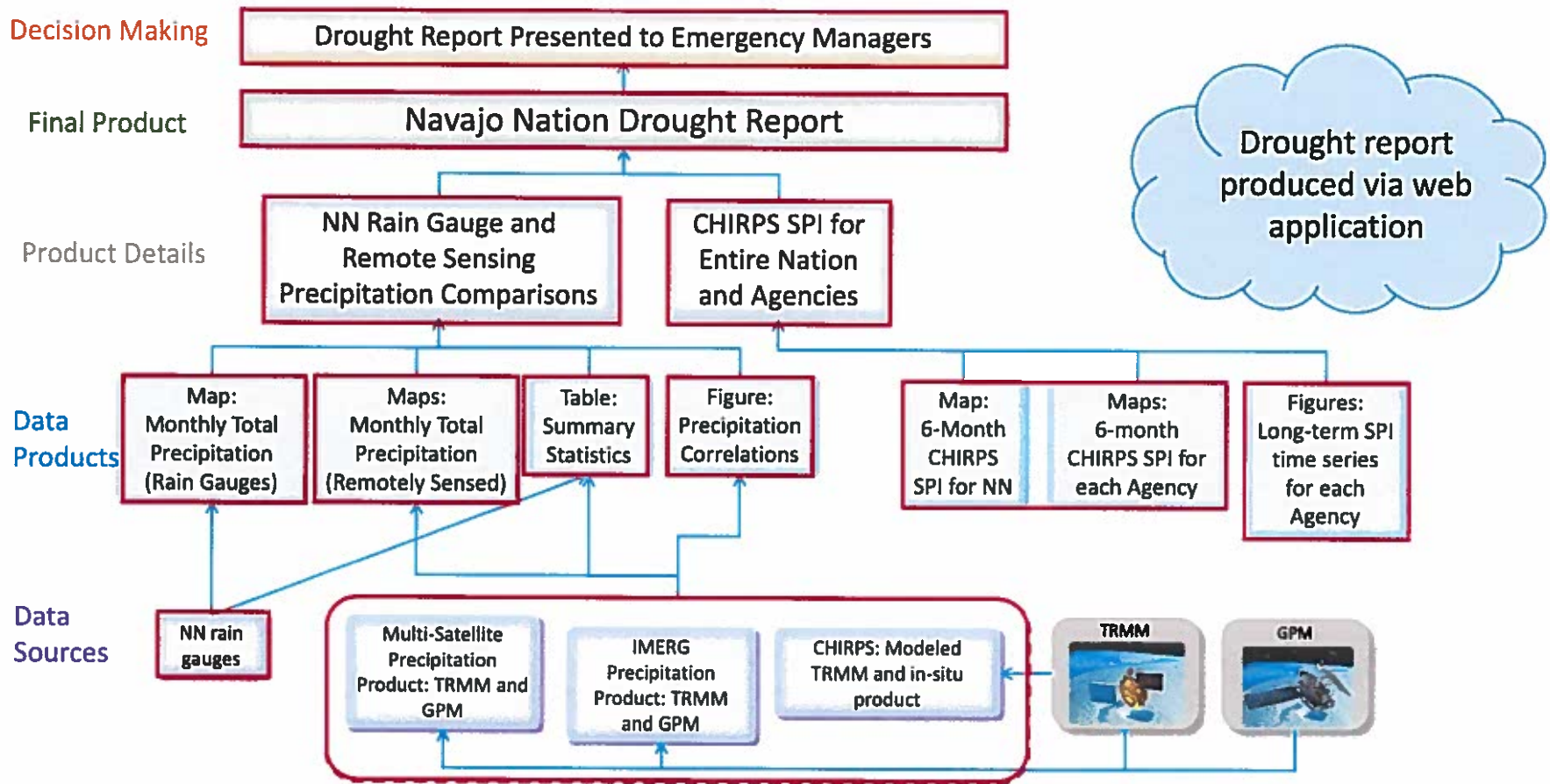
Historical average over months of interest

$$SPI = \frac{X_i - \bar{X}}{S}$$

Standard deviation

| SPI Value | Drought Intensity Interpretation |
|--------------|----------------------------------|
| -0.4 to 0.5 | Near Normal |
| -0.5 to -0.7 | Abnormally Dry |
| -0.8 to -1.2 | Moderate Drought |
| -1.3 to -1.5 | Severe Drought |
| -1.6 to -1.9 | Extreme Drought |
| ≤ -2.0 | Exceptional Drought |

Drought Severity Evaluation Tool (DSET)



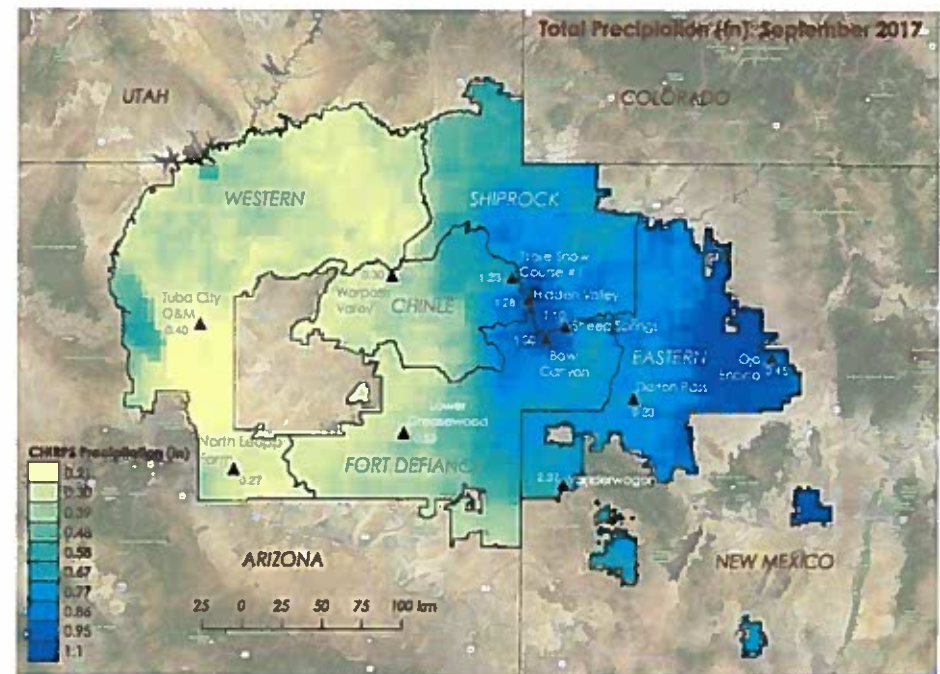
Step 1: Rain Gauge and CHIRPS Comparisons



- 11 NNDWR rain gauges
 - Down-selected based on record length, consistency, and location
 - Date Range: January 2011-December 2017



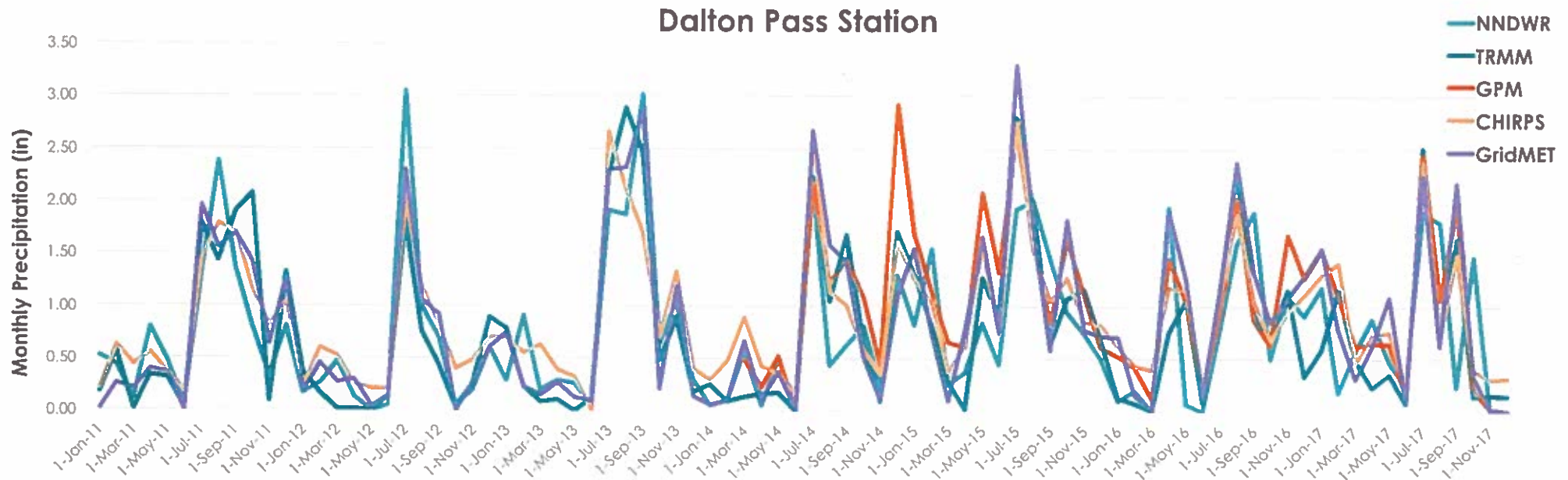
- Monthly total precipitation comparisons:
 - NNDWR rain gauges vs. CHIRPS (pixel location)
 - Agencies vs. CHIRPS (average totals for region)
 - Chapters vs. CHIRPS (average totals for region)



Step 1: Rain Gauge and CHIRPS Comparisons



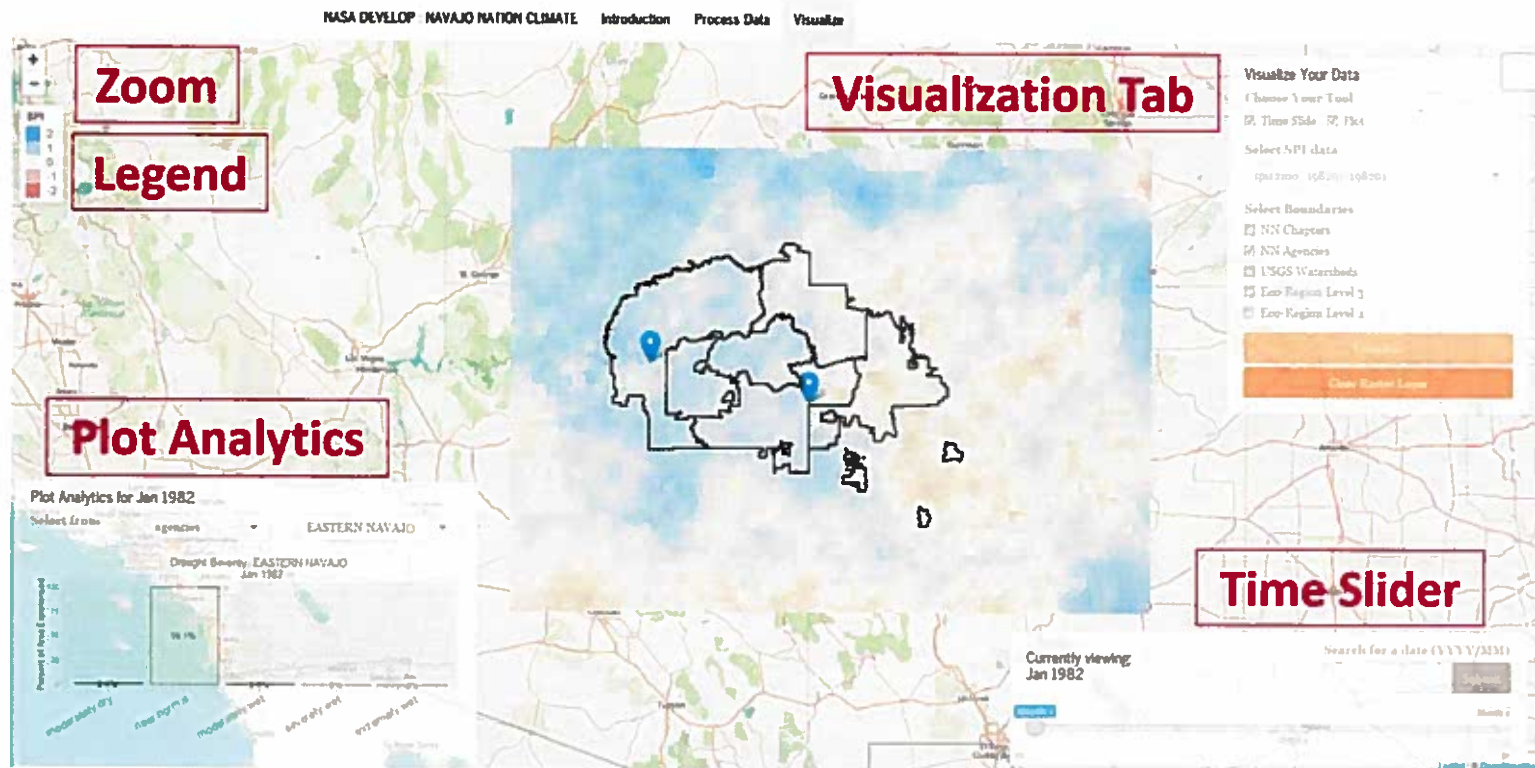
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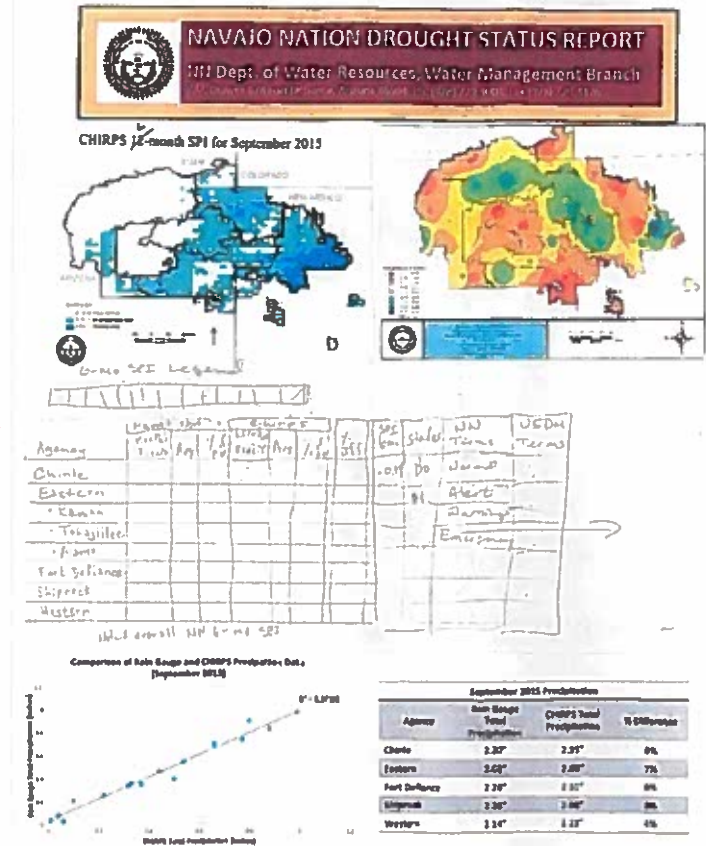
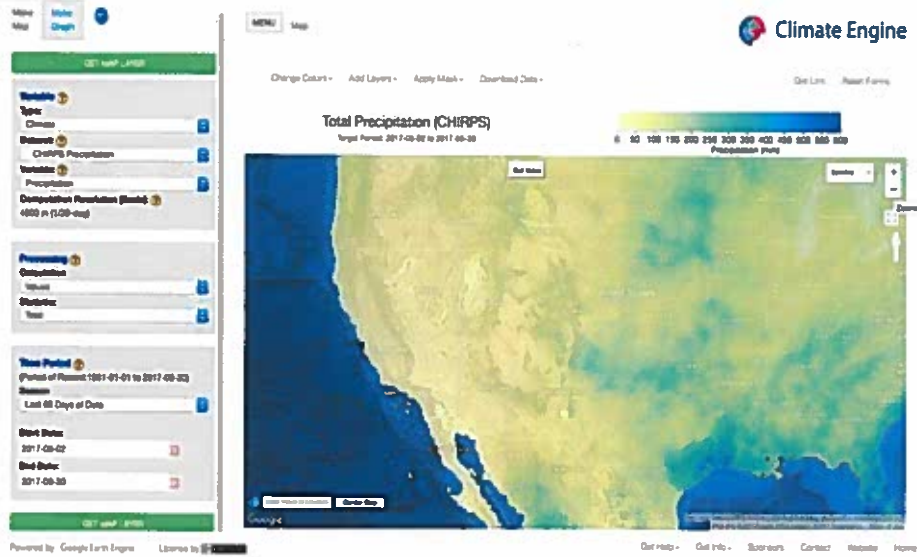
Step 2: Develop the DSET Webtool



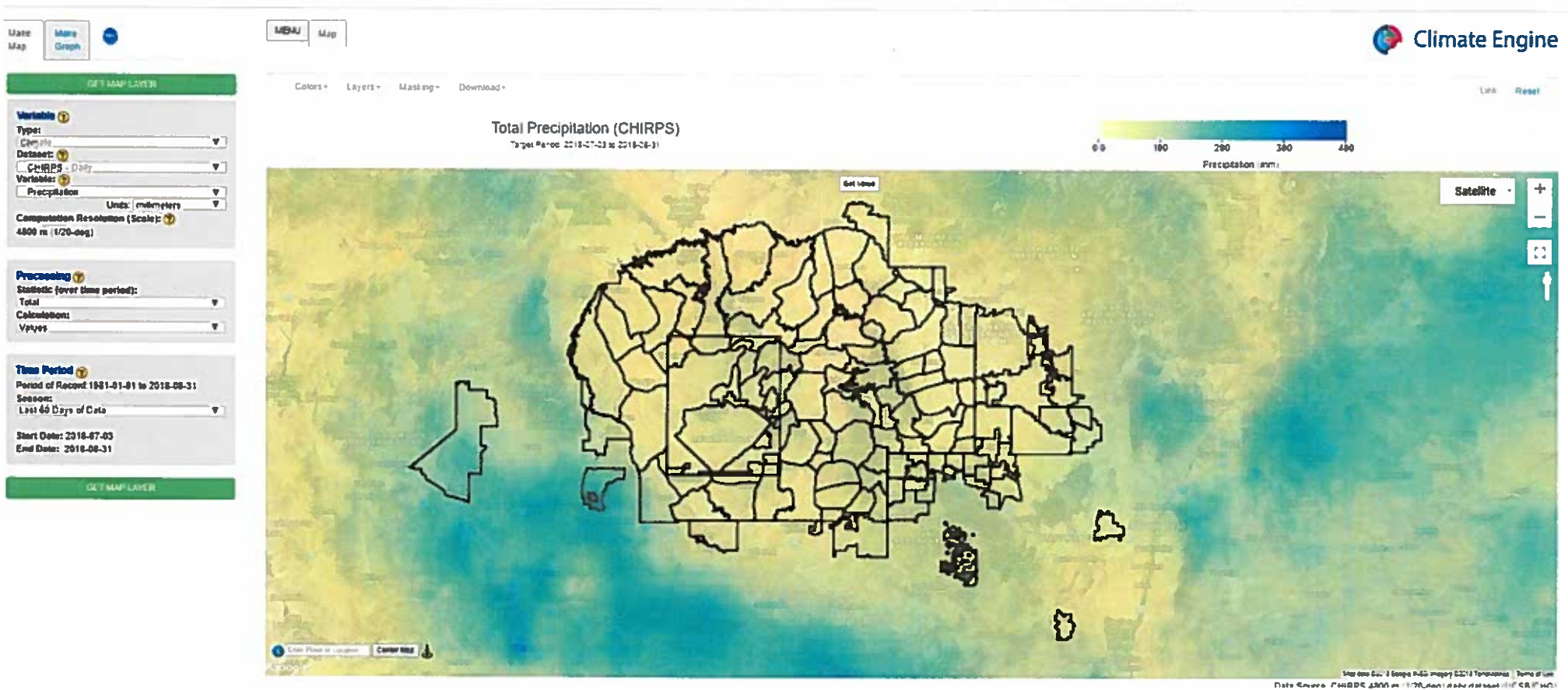
DEVELOP Pilot Project



DSET via Climate Engine



DSET via Google Earth Engine



Next Steps



- Continued comparisons of remotely sensed and in-situ precipitation data
- Create rain gauge point locations and ingest data into Climate Engine DSET
- Add TRMM and GPM data into Climate Engine DSET
- Conduct in-person tool training/feedback session with NNDWR
- Web development for beta DSET tool and revisions based on partner requests
- Integration of web tool outputs into drought status report



An aerial photograph of a desert landscape, likely the Navajo Nation, showing a winding river and rugged terrain. A semi-transparent white rectangular box is overlaid on the center of the image, containing text.

Thank You!

Questions?

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Amber McCullum: Amberjean.mccullum@nasa.gov