

# National Academy of Sciences Future of Drought in the United States: United States Drought Monitor

Brian Fuchs

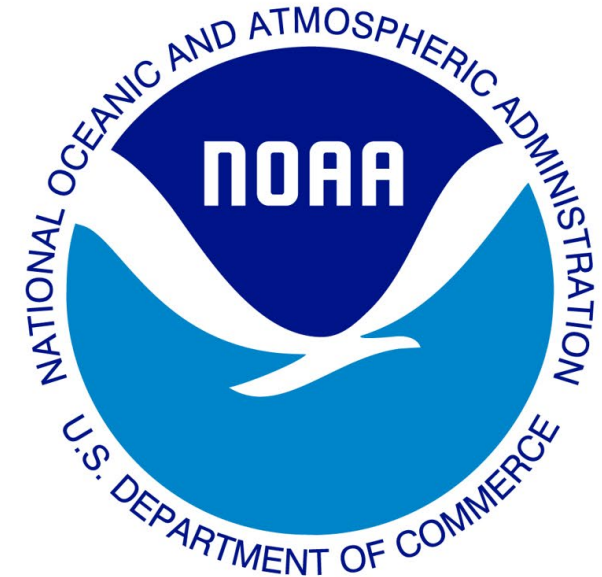


NATIONAL DROUGHT  
MITIGATION CENTER  
*UNIVERSITY OF NEBRASKA*

National Academy of Sciences  
Future of Drought in the United States

July 15, 2025

The map is a participatory process



Since the beginning in 1999, the partnering agencies  
collaborate on map standards & methodology



# How are the standards developed associated with the US Drought Monitor?

- USDM Forums (every other year since 2000)
- Monthly USDM Author Meetings
- USDM User and Stakeholder Surveys
- Open discussions on the USDM Listserver
- Direct communication and feedback from stakeholders and users to the Authors
- Discussions between the Authors and their respective leadership at the **NDMC, USDA, CPC**, and **NCEI** who oversee the entire USDM process



# U.S. Drought Monitor

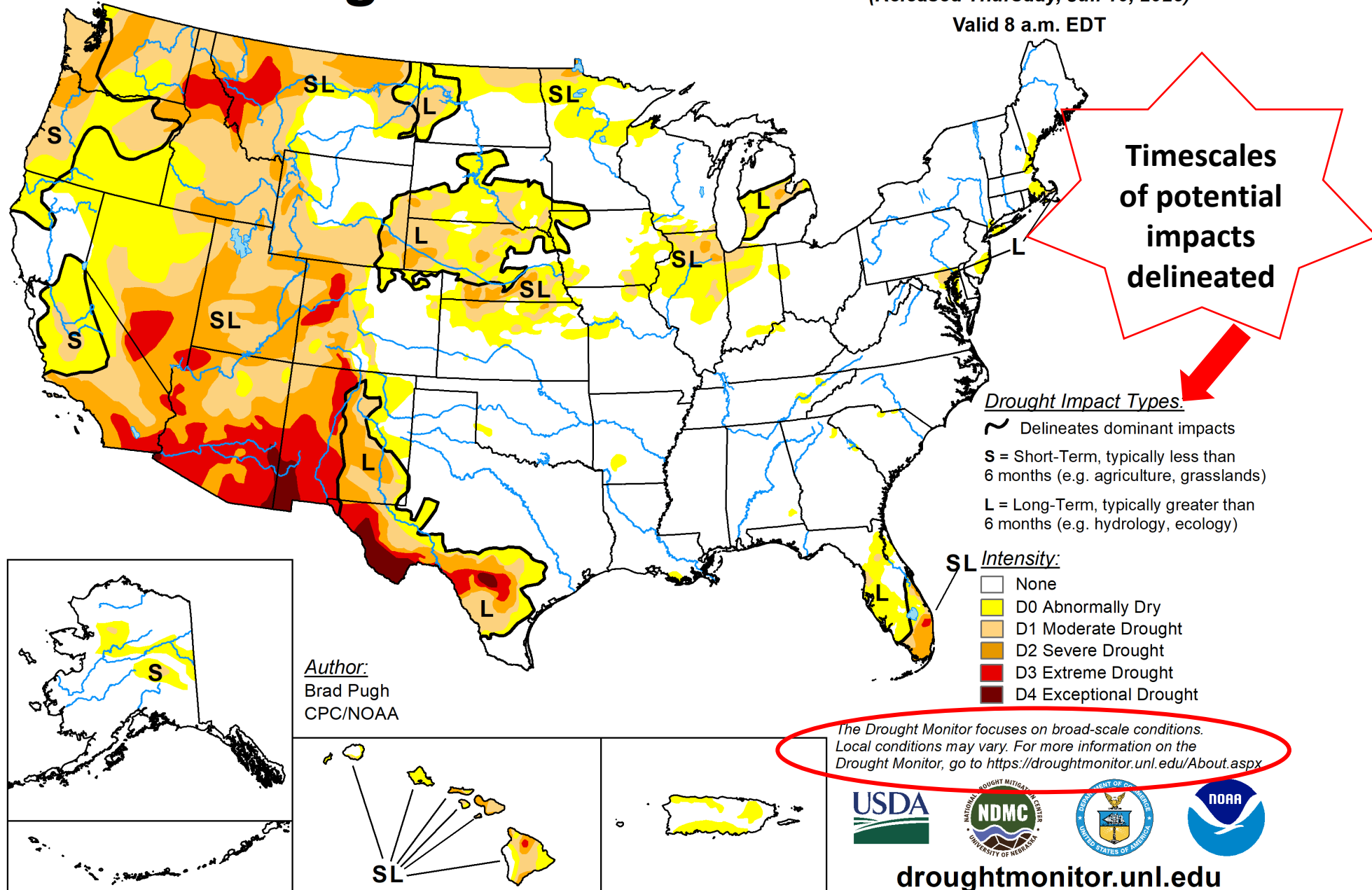
July 8, 2025

(Released Thursday, Jul. 10, 2025)

Valid 8 a.m. EDT

The USDM shows drought's

- Extent
- Intensity
- Relative duration



# Percentiles and the U.S. Drought Monitor

Every input can  
be put into  
percentiles to  
compare current  
data to historical  
records

## Advantages of percentiles:

- Can be applied to any parameter used in the drought analysis
- Can be applied to all indicators and indices regardless of length of data record
- Puts drought in historical perspective:

How many expected  
occurrences in a given  
period of time

|                         |                                                                                      |                                                      |
|-------------------------|--------------------------------------------------------------------------------------|------------------------------------------------------|
| D4: Exceptional Drought |   | ( <i>1<sup>st</sup>-2<sup>nd</sup></i> percentile)   |
| D3: Extreme Drought     |   | ( <i>3<sup>rd</sup>-5<sup>th</sup></i> percentile)   |
| D2: Severe Drought      |   | ( <i>6<sup>th</sup>-10<sup>th</sup></i> percentile)  |
| D1: Moderate Drought    |   | ( <i>11<sup>th</sup>-20<sup>th</sup></i> percentile) |
| D0: Abnormally Dry      |  | ( <i>21<sup>st</sup>-30<sup>th</sup></i> percentile) |

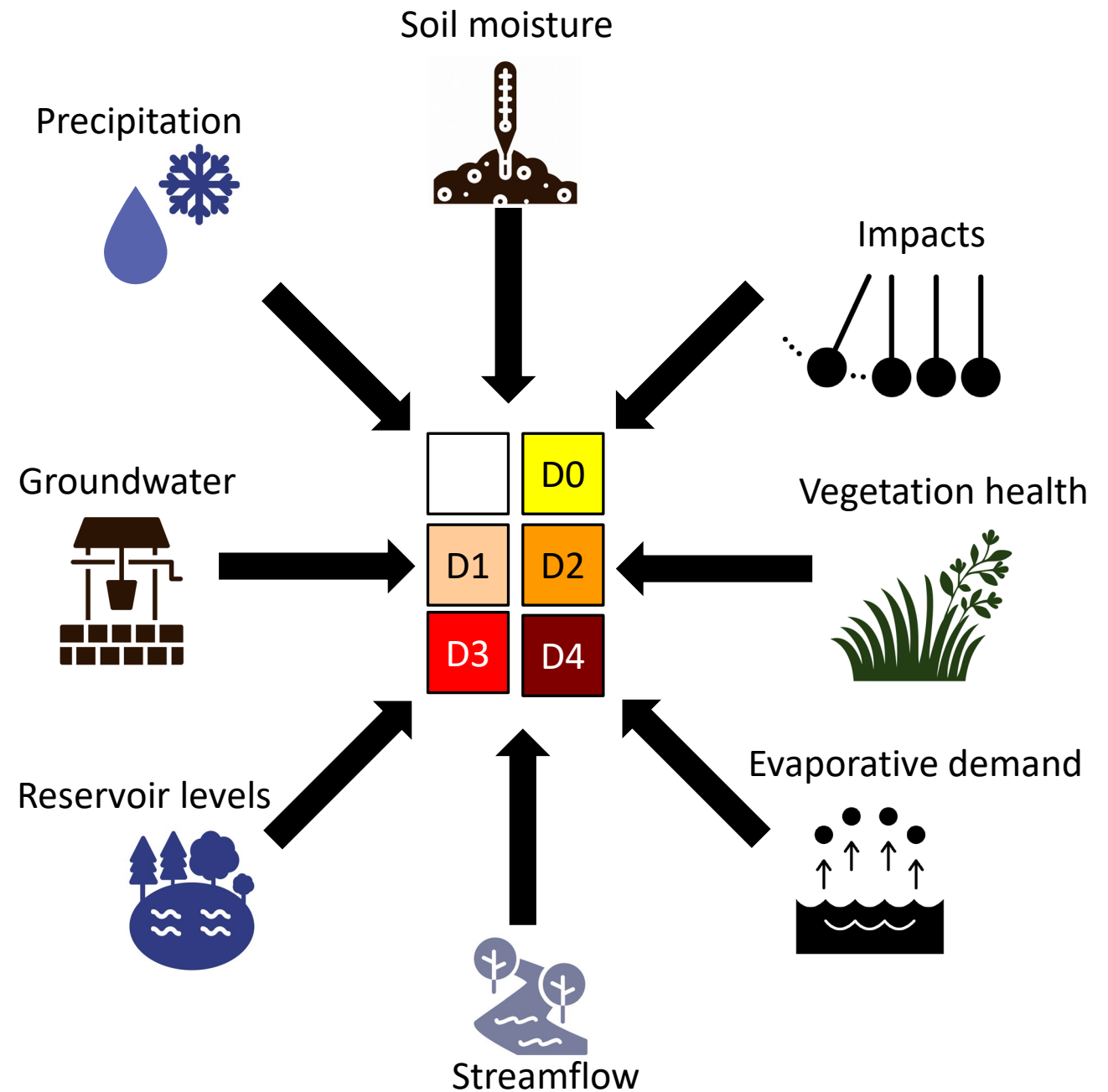
**Period of record is important !**



# Convergence of Evidence

Physical indicators at different points in the water cycle converge on a drought severity level.

- Type of drought  
Meteorological/flash/snow, agricultural, hydrological ecological drought
- Relative length/timescale  
Short- vs long-term
- Capturing the full water cycle



Drought Indices such as SPI/PDSI

12-month SPI through the end of September 2002

Soil Moisture: both modeled and measured

Streamflow, Reservoirs, and Wells

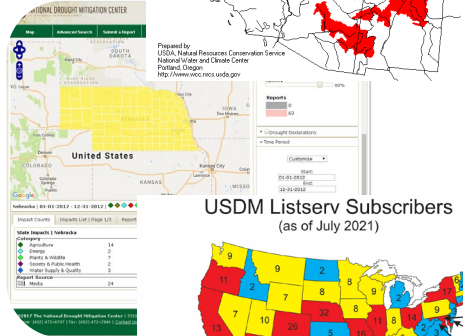
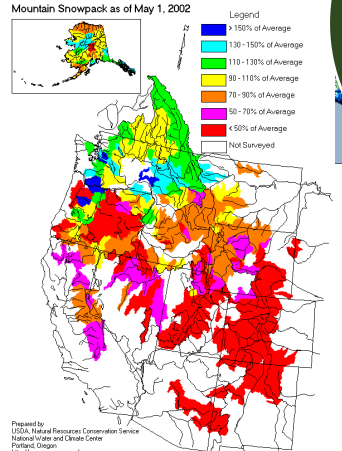
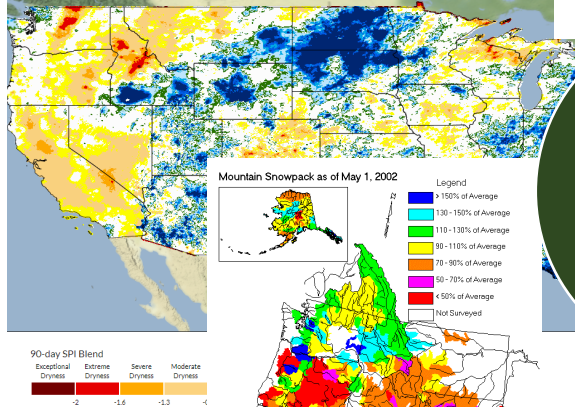
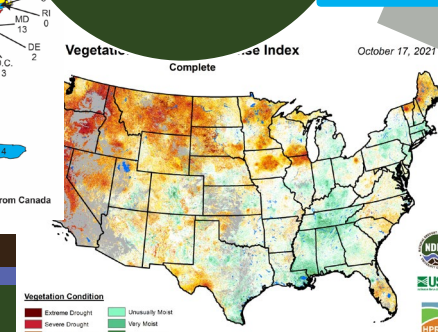
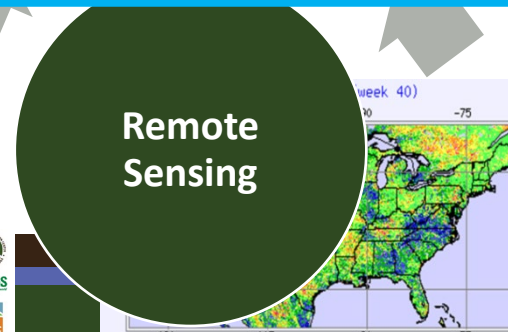
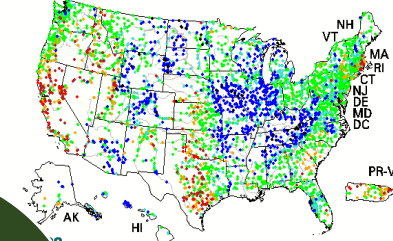
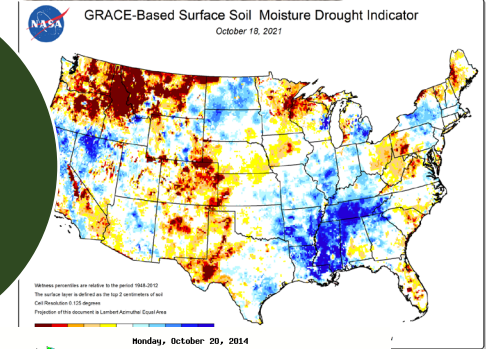
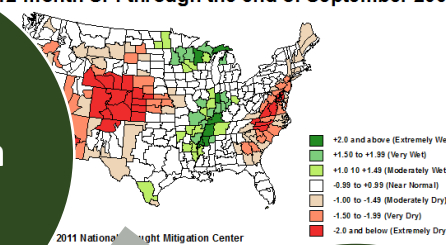
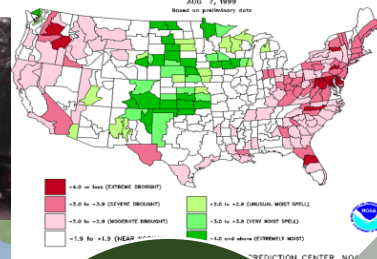
Remote Sensing

Precipitation and Snow

Expert Local Input and Impacts

Most of the information analyzed each week falls into one of these categories.

USDM Authors use dozens of pieces of data, all from official government sources, while creating the U.S. Drought Monitor map, but not all areas are represented equally by all pieces of data.

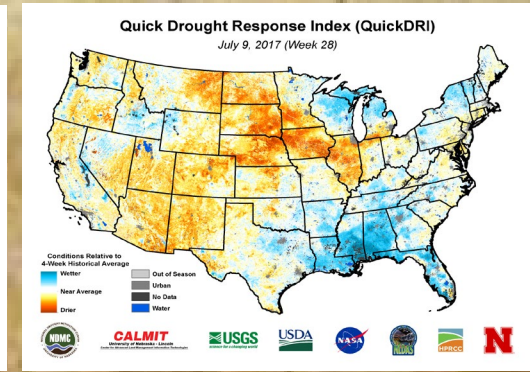
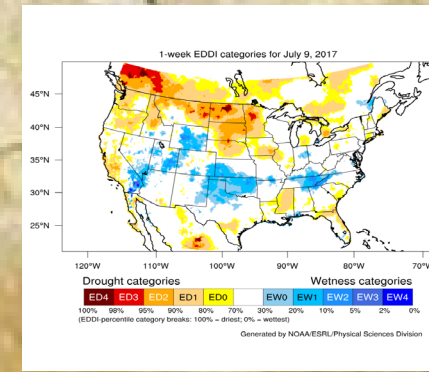
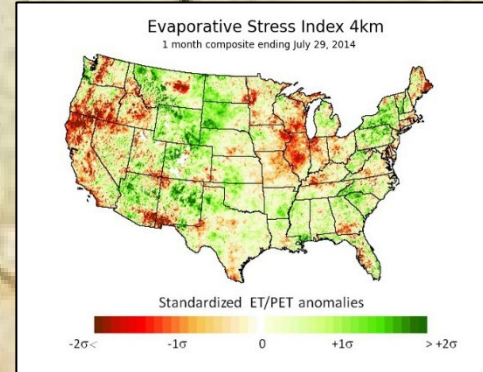
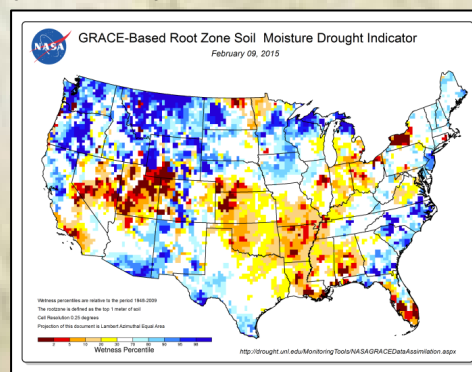
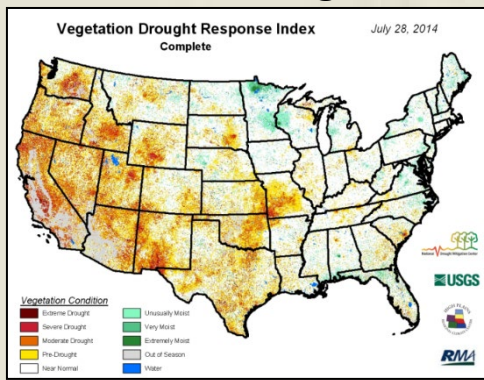
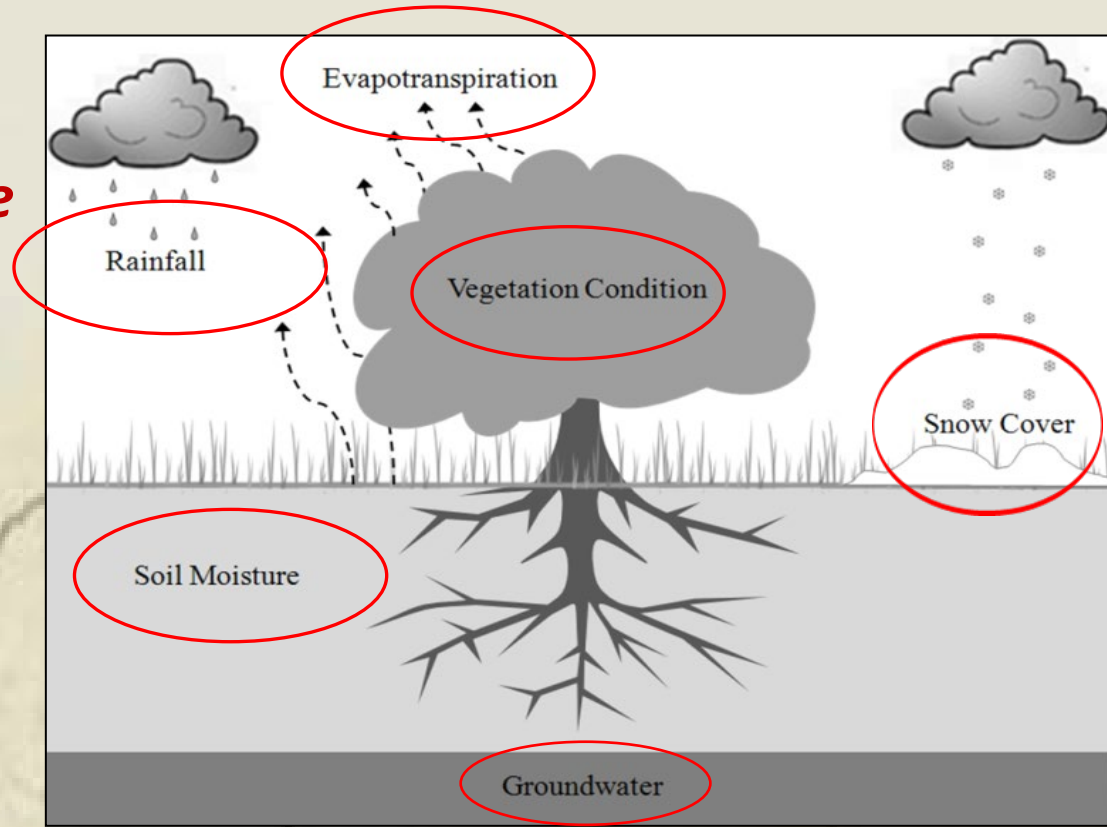


# Emerging Satellite-based Observations and Products

Over the past 10+ years, a number of satellite remote sensing-based tools and **products characterizing different parts of the hydrologic cycle that influence drought conditions** have allowed new composite drought indicators to be developed.

## Examples

- Evaporative Stress Index (ESI)
- Quick Drought Response Index (QuickDRI)
- Evaporative Demand Drought Index (EDDI)
- AIRS VPD, RH, and T products
- GRACE soil moisture and groundwater anomalies
- Vegetation Drought Response Index (VegDRI)
- Grass-Cast
- Forest Drought Index (ForDRI)



# The USDM Authors are “Data Consumers” in the USDM Process



# Review of Information Used to Produce the *United States Drought Monitor*

Submitted by the Office of the Chief Economist as Partial Execution of

## What are the data used for the USDM production?

### **Section 12512**

(IMPROVEMENTS TO THE UNITED STATES DROUGHT MONITOR)  
of The Agricultural Improvement Act of 2018

Public Law 115-334; 7 U.S. Code §5856



# What are the data used for the USDM production?



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# Other data incorporated since the 2020 report from USDA's Chief Meteorologist:

- **GRACE data**
  - Shallow Groundwater
  - Root Zone soil moisture
  - Surface soil moisture
- **AIRS data**
  - Surface RH
  - VPD
  - Surface Temperature
- **AHPS** derived products
  - KBDI, SPI, SPEI
- **CoCoRaHS** precipitation and impacts
- **PRISM** precipitation and SPI
- **USGS Well Data**



# Other data incorporated since the 2020 report from USDA's Chief Meteorologist:

- New NDMC ML based Composite Drought Indicators (CDI's)
  - Short-term
  - Medium-term
  - Long-term
  - Flash Drought
- West Wide Drought Tracker indices
  - SPI
  - SPEI
- Climate Engine
  - SPI
  - SPEI
- NASA Sport Soil moisture
- Crop-CASMA Soil moisture
- More Mesonet data provided by local experts
- And more.....



# How are new data introduced into the USDM weekly process?

- As shared in the 2020 document by USDA's Chief Meteorologist:

*There is no formal vetting process for introducing new data into the USDM* - All of the authors expressed an interest in having more data available to them, though several noted the time-consuming process required to test a new product, which would be a burdensome task given what is already required of them during their shift, as well as the underlying concern that data and products are not to their standards. In addition, several authors suggested that some products they would like to see are NOT available and they would like a process for engaging the product providers to share their input, rather than have providers supply them with information and expect the authors to use “as-is”. In fact, several authors noted they were not comfortable using some of the products as expected because they had not been properly vetted in a peer review process or were only local in nature.



# How are new data introduced into the USDM weekly process?

- As shared in the 2020 document by USDA's Chief Meteorologist:

## Data Requirements

From the onset, the authors underscored the importance of finding information that would allow them to follow the aforementioned methodology of using the USDM to describe place drought in historical perspective. The criteria for selecting datasets and products for this type of depiction are:

- A sufficient period of record to allow computation of percentile rankings, or similar method for determining how a value compares with the rest of the values in the period of record;
- A homogeneous historical record, with few missing data;
- Temporal resolution of at least one day;
- Timeliness of reporting;
- Data, observations, or indices are relevant to drought monitoring;
- Derived indices are based on peer-reviewed methodologies;
- Representativeness of the product regionally or nationally (not just locally); and
- GIS compatibility for any dataset provided to the authors.

An additional feature is the ease in access of the data, i.e. it is not only readily available but also in a format that allows for ingesting into the GIS systems with minimal effort (no single-station manual downloads, for example). Once these standards have been met, it is the authors themselves who determine which data and products offer additional information not already available in existing products.



# How is non-stationarity affecting the production and use of the USDM?

- The USDM Authors have discussed the topic regularly for 5+ years during monthly Author meetings
- The topic of non-stationarity was highlighted during a session at the USDM Forum in Boulder City, NV in 2023
- Authors will follow the lead of what the climate community determines, which there is no consensus at this time
- As “data consumers” much of this topic is left to data providers to determine in how various data are publicly provided and the methods they use to do so



# How is non-stationarity affecting the production and use of the USDM?

- There are various base periods and reference periods used in the data utilized in the USDM production.
- The USDM Authors do not dictate to data providers how to provide their data, at best we provide guidance when asked.
- To incorporate the idea of data non-stationarity in the USDM process, the Authors have utilized more remotely sensed, modeled, and gridded data that all have periods of record that are 30-40 years in duration (or less)



# How is non-stationarity affecting the production and use of the USDM?

- AIRS: 2002-present
- AHPS: 30 year normal and POR of 2005-present
- NLDAS: 1979-present
- EDDI: 1980-present
- QuickDRI: 2000-present
- VegDRI: 2009-present
- VHI: 1982-present
- WWDT: 1991-2020 base period
- ESI: 2000-present



# How is non-stationarity affecting the production and use of the USDM?

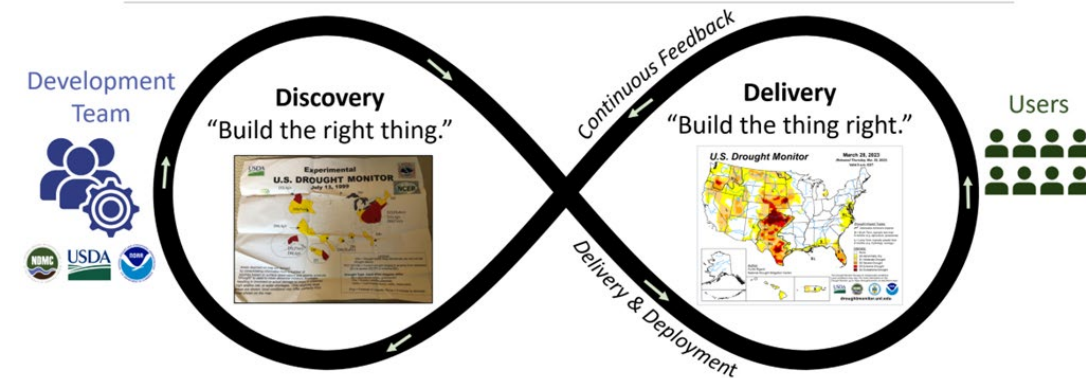
- **NDMC Composite Drought Indicators (CDI's)**
- Machine Learning correlations were used to determine the **optimal period of record** for each index aggregation length
  - 40 yr POR for  $\leq 3$  months
  - 50 yr POR for 4-6 months
  - 60 yr POR for  $> 6$  months
- The most recent **30 years are used for the reference mean**, rather than a static set of years
- The idea is to use more recent data to account for changing trends in the climate patterns and let the system determine the cell's mode (winter/summer) as the patterns change.
- By using the **most recent years for the reference mean**, we hope to capture the change from a cell being in exceptional drought to only moderate drought (or vice versa in wet situations) as the standard of "normal" changes.
- To further this endeavor, we are producing indices using shorter reference periods to test if accuracy increases with only a 10, 15, or 20 year mean.



# Final Thoughts and Recommendations

- Many of the recommendations outlined in the USDA Chief Meteorologist's 2020 report have been addressed since the report was released. Several more were highlighted that still need to be addressed from funding to author transition.
- The USDM is using and incorporating the state of the science into the weekly process of making the drought assessment.
- The USDM process can evolve and integrate new information and data now and into the future as it has done since developed in 1999.

## Continuous Development Process



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# Final Thoughts and Recommendations

- The Authors and USDM leadership teams at the NDMC, USDA, CPC, and NCEI have discussed many ideas as to how new data can be incorporated into the USDM process.
- The Authors are continually asked to provide guidance for new data products to incorporate into the USDM process.
- Data issues are discussed when brought to the attention of the Authors but sometimes they (the Authors) are sidestepped as groups push agendas to discredit the USDM process and products.



Thank You!  
Questions?



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