Improving Multi-Index Drought Monitoring Using Satellite Observations

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1. Drought Early Detection

Meteorological Drought: Deficit in precipitation

Agricultural Drought: Deficit in soil moisture

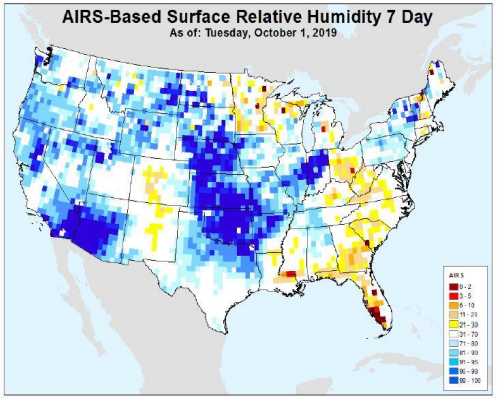
Hydrologic Drought: Deficit in runoff/groundwater storage

Drought Early Detection

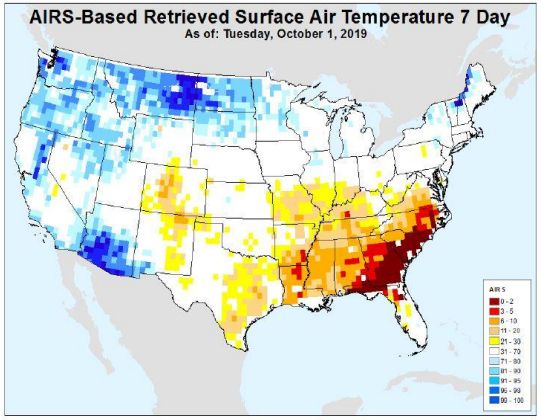
- Early drought detection is important in several sectors including water and agriculture:
  - Water managers – for water resource planning
  - Farmers – purchase less fertilizers and increase insurance coverage before growing season
- Precipitation is the most commonly used index for drought onset detection.
- Research shows near-surface air Relative Humidity, Temperature, and Vapor Pressure Deficit (VPD) from the NASA AIRS mission have the potential to detect drought earlier than precipitation

AIRS products for the USDM

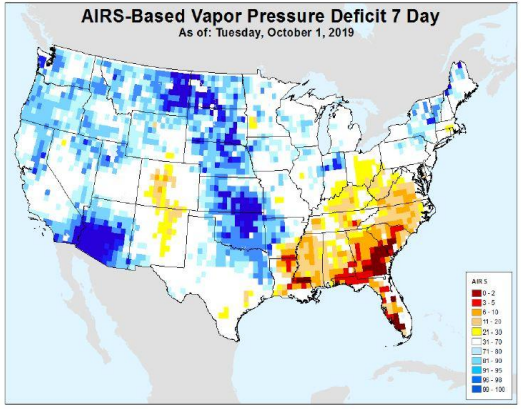
Relative Humidity

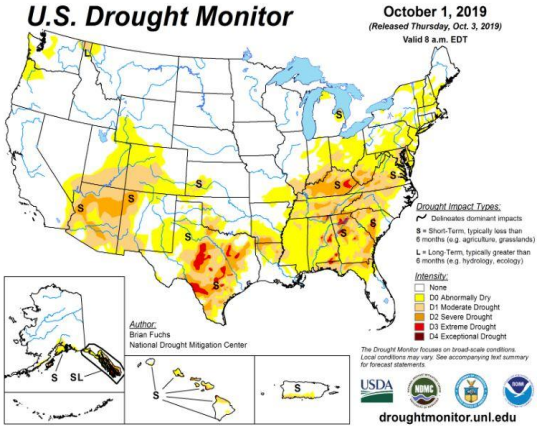


Temperature



Vapor Pressure Deficit





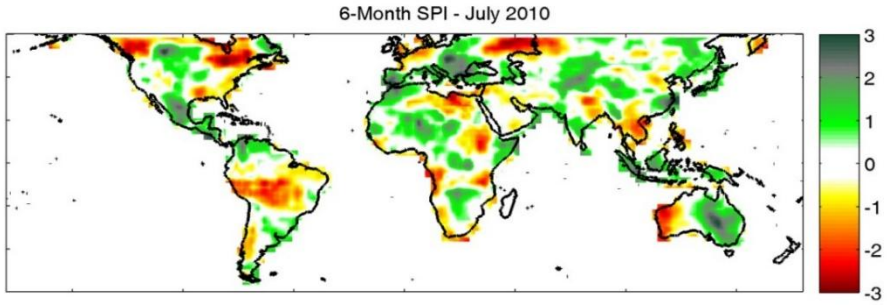
2. Multi-variable drought monitoring

Meteorological Drought: Deficit in precipitation

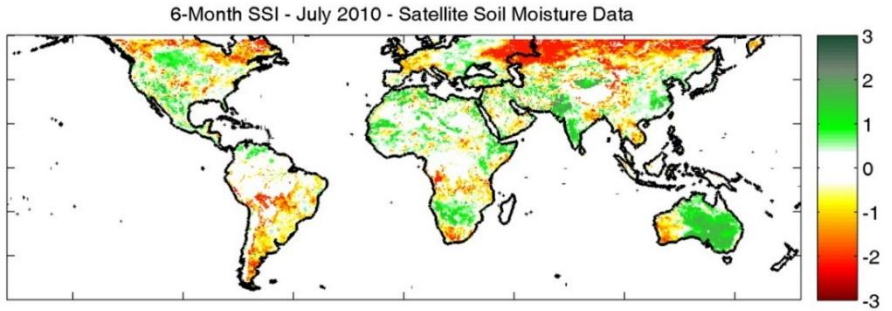
Agricultural Drought: Deficit in soil moisture

Hydrologic Drought : Deficit in runoff/groundwater storage

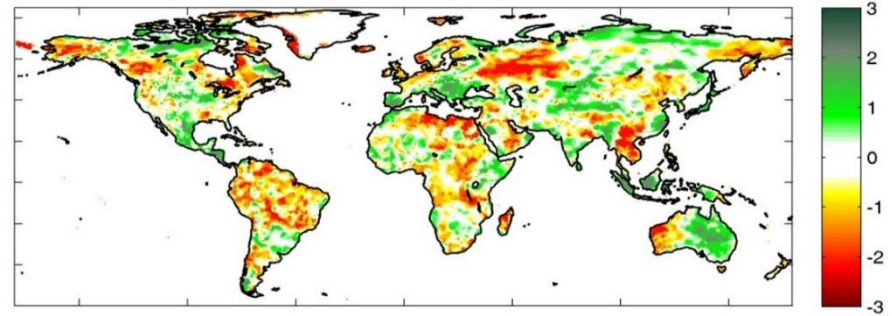
Droughts require multiple sources of input



Precipitation
July 2010



Soil Moisture
July 2010



Precipitation and Soil Moisture
(Bivariate distribution)
July 2010

Novel Drought Framework

Comprehensive assessments of droughts

One variable
Two variables

Can be applied to a range of hydrologic variables

Software available for public

Farahmand A., AghaKouchak A., 2015, A Generalized Framework for Deriving Nonparametric Standardized Drought Indicators, **Advances in Water Resources**, 76, 140-145, doi: 10.1016/j.advwatres.2014.11.012.

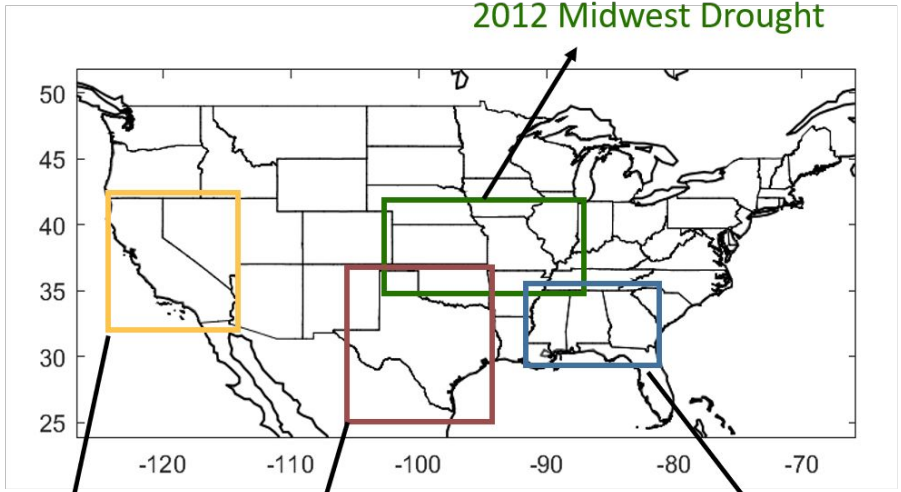
3. Drought Cascade in the hydrologic cycle

Meteorological Drought: Deficit in precipitation

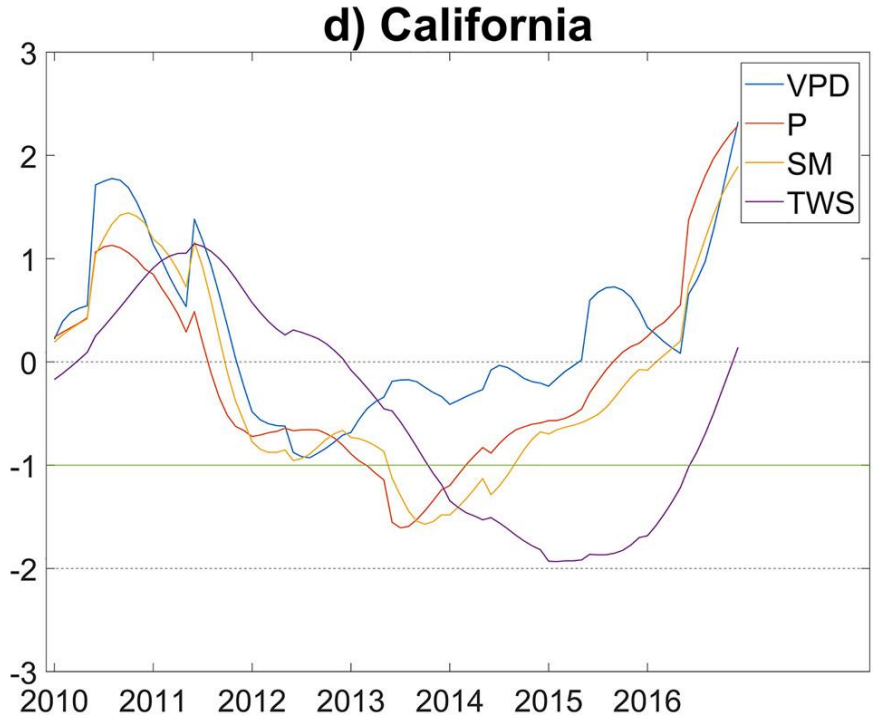
Agricultural Drought: Deficit in soil moisture

Hydrologic Drought : Deficit in runoff/groundwater storage

- Utilized satellite observations of vapor pressure deficit, precipitation, terrestrial water storage, and soil moisture to characterize cascade phenomena for four major US drought case studies



Farahmand A., Reager JT, Geophysical Research Letters, 2021, Drought Cascades in the Hydrologic Cycle: A Set of Case Studies from Remote Sensing, **Geophysical Research Letters**, 48(14), https://doi.org/10.1029/2021GL093482



- We find characteristic lag times in the propagation of drought onset, termination, and timing from precipitation to soil moisture and TWS

- It took 3 months for precipitation deficits at drought onset to propagate to soil moisture, and 8 months to propagate to TWS

Thanks!

Questions?

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