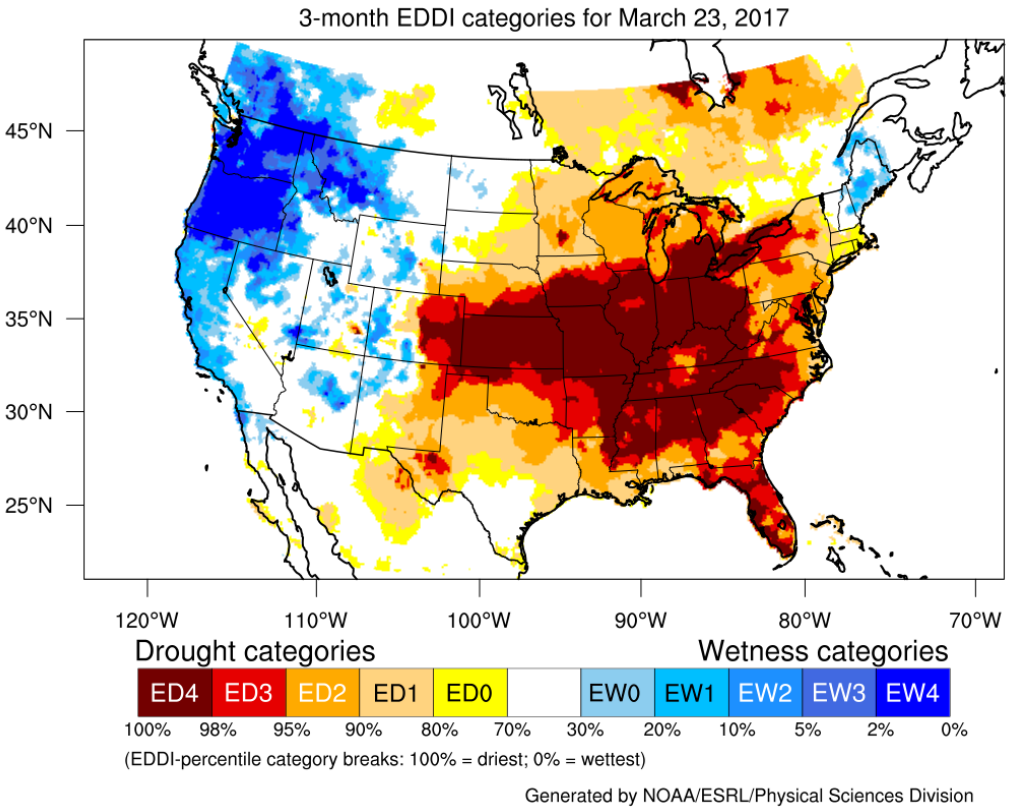
Drought Monitoring With The Evaporative Demand Drought Index



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Desert Research Institute

Tenth Biennial U.S. Drought Monitor Forum

April 3-5, 2017

K Bar S Lodge, Keystone, South Dakota

Desert Research Institute

Western Regional Climate Center
Providing climate services since 1986

CNAP
California-Nevada Climate Applications Program
A NOAA RISA team

NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Evaporative Demand Drought Index (EDDI) collaborators

NOAA, Boulder, CO

- Mike Hobbins
- Andrea Ray
- Heather Yocum
- Imtiaz Rangwala
- Candida Dewes
- Joe Barsugli

DRI

- Justin Huntington
- Charles Morton

Western Water Assessment

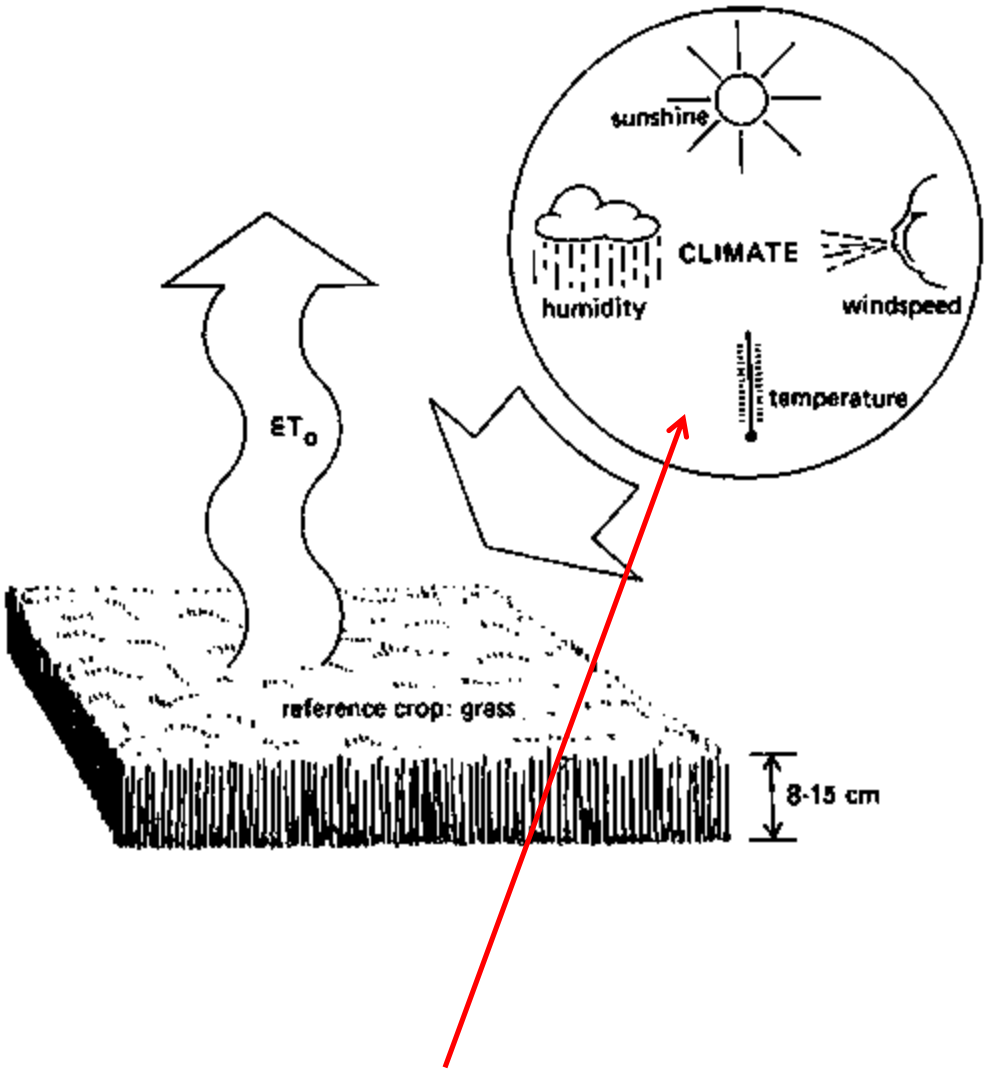
- Jeff Lukas

NIDIS

Evaporative Demand Background

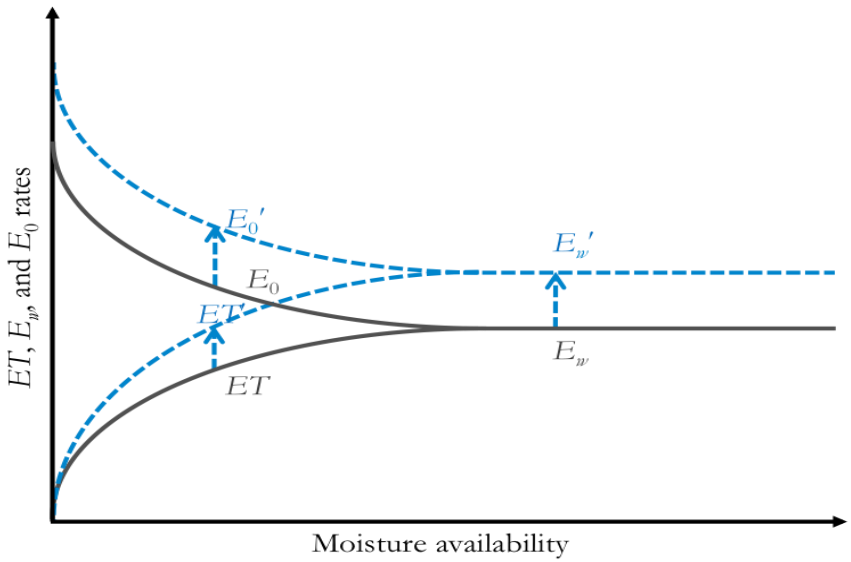
What is evaporative demand (E_0)?

- Evapotranspiration rate that could occur given an unlimited water supply
- Potential evapotranspiration
- Atmospheric demand
- **Reference evapotranspiration (ET_0)**
- Often estimated using temperature alone, but a physically based model should be used

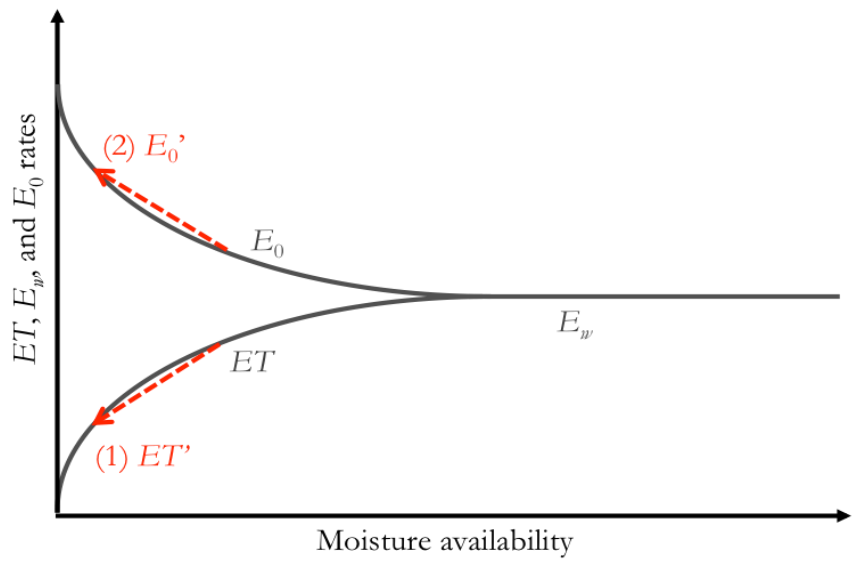


Physically-based E_0 contains valuable information related to drought dynamics

E_0 as a Drought Indicator



onset of drought: energy limited regions



extended drought: water limited regions

- Energy driven: actual evapotranspiration (ET) and E_0 vary in parallel
- Water limited: ET and E_0 vary in opposing directions (complementary relationship)
- In both situations, E_0 increases under drought conditions

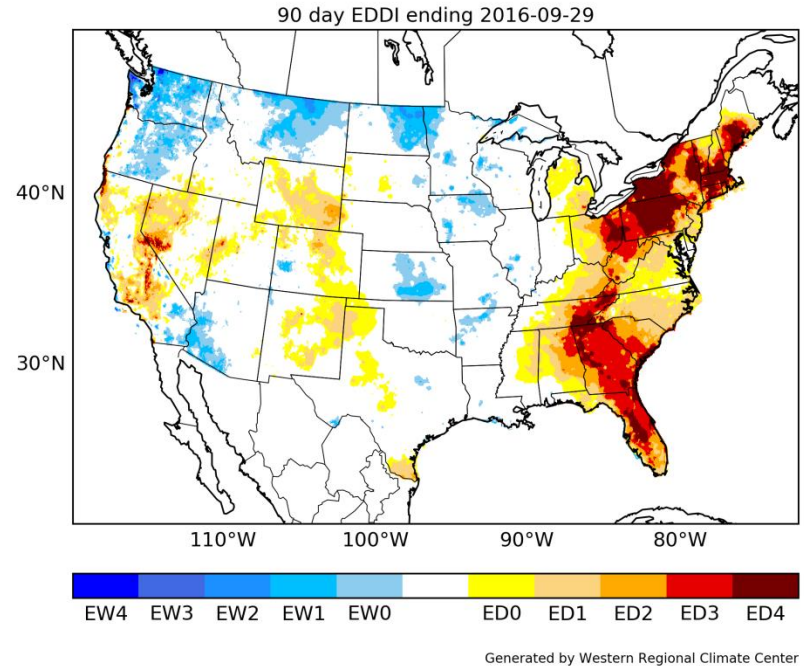
EDDI represents a standardized E_0 based on the climatology period

Figure credit: Mike Hobbins

Evaporative Demand Drought Index (EDDI)

EDDI data:

- Daily American Society for Civil Engineers Standardized Reference Evapotranspiration (ET_0)
- ET_0 computed from temperature, humidity, wind speed, and shortwave radiation



EDDI calculation procedure:

1. Accumulate ET_0 at desired time scale (2-weeks, 1-, 3-, 6-, 9-months, etc.)

2. Obtain daily ET_0 probability distributions (P(x)) using empirical plotting positions:

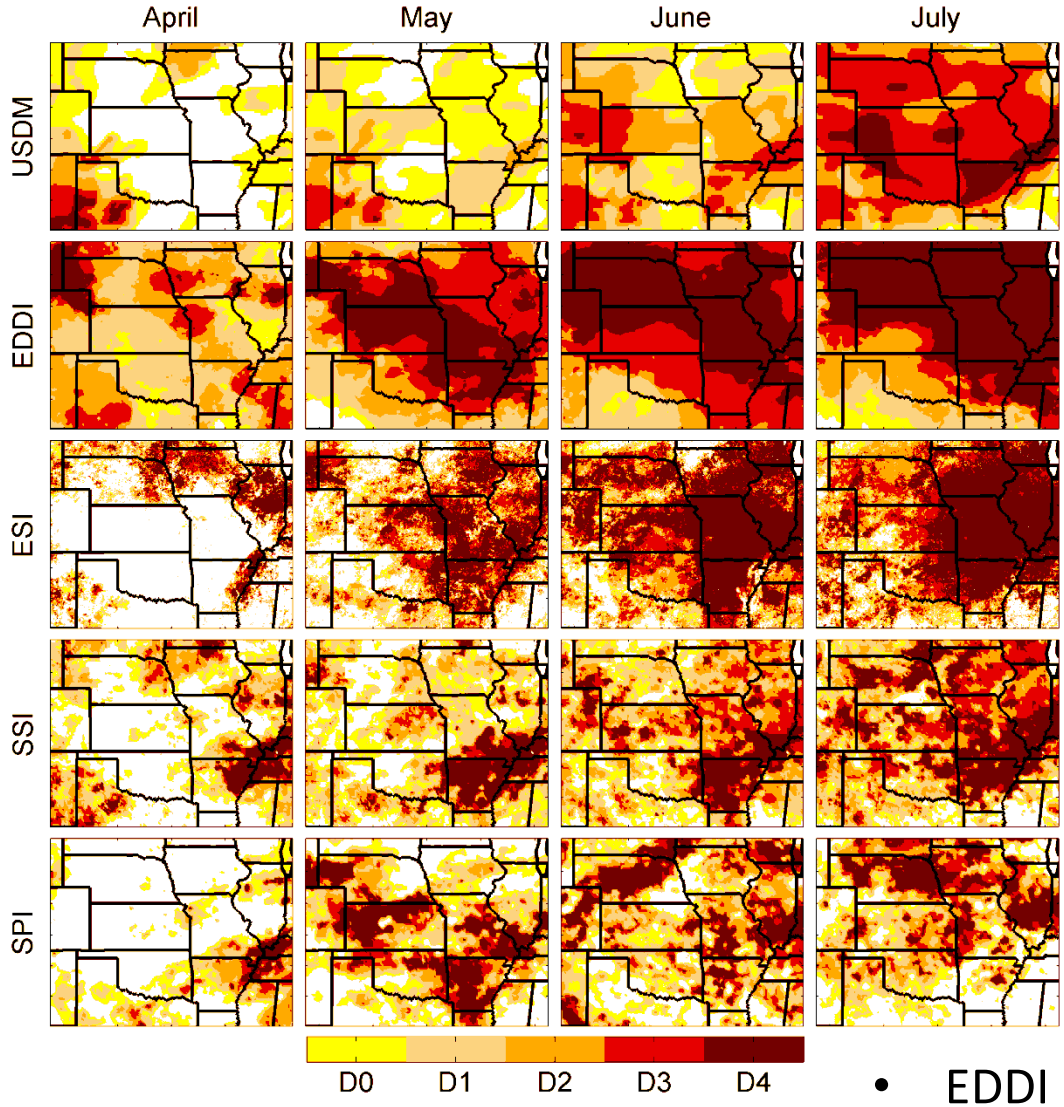
$$P(x_i) = \frac{i - 0.33}{n + 0.33}$$

i = historical position rank
n = number of observations

3. Standardize probabilities using the inverse normal approximation (Abramowitz and Stegun 1965), same as SPI (McKee et al. 1993).

Short Time Scale EDDI Applications: Flash Drought

2012 Central U.S. Drought



USDM from end of each month

1-month EDDI

1-month ESI (Evaporative Stress Index)

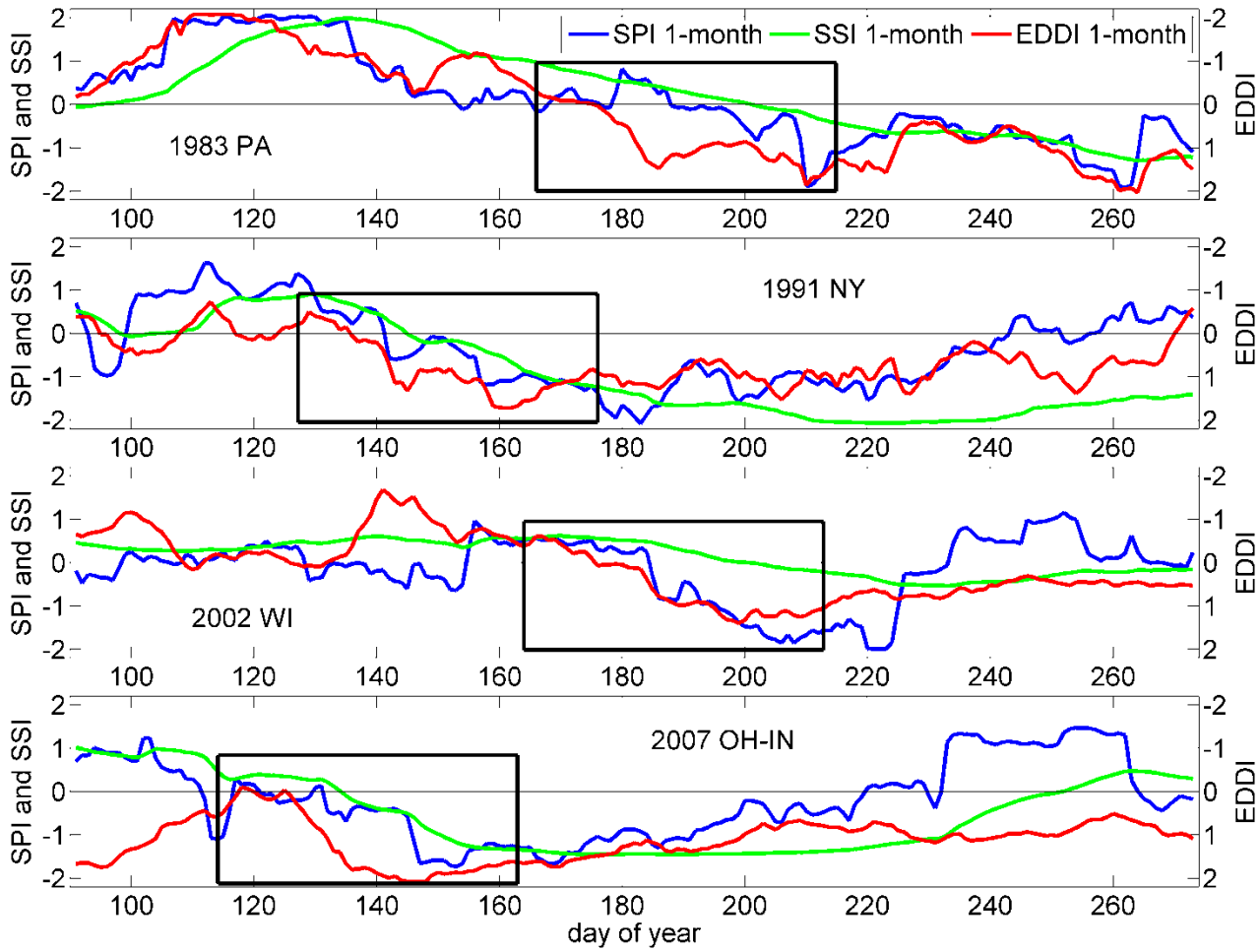
1-month SSI (Standardized Soil Moisture Index)

1-month SPI (Standardized Precipitation Index)

- EDDI provides early warning in April not found in other indicators

[Figure: McEvoy et al. 2016]

Short Time Scale EDDI Applications: Flash Drought



Pennsylvania, 1983

New York, 1991

Wisconsin, 2002

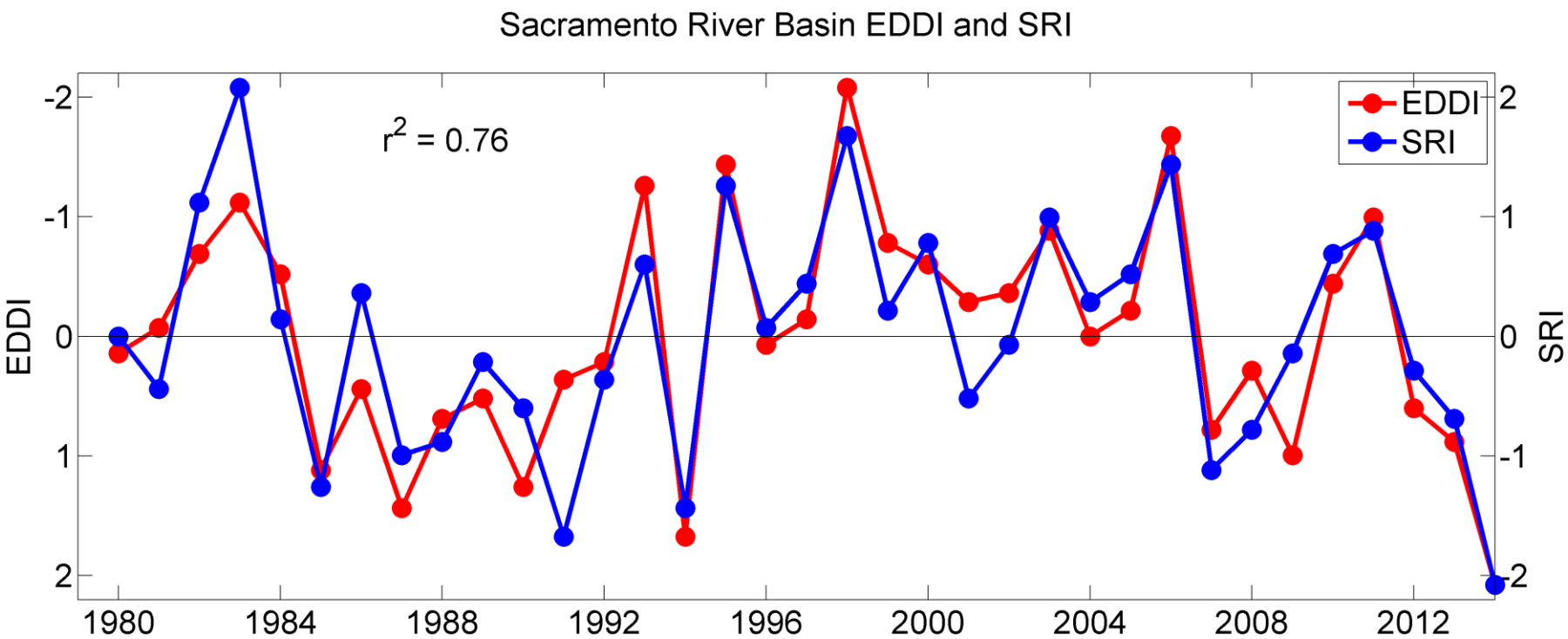
Ohio-Indiana border, 2007

- EDDI leads SPI and SSI about 2 weeks or more for the PA and OH-IN cases
- For the NY and WI cases, EDDI shows similar signal to SPI and leads SSI

[Figure: McEvoy et al. 2016]

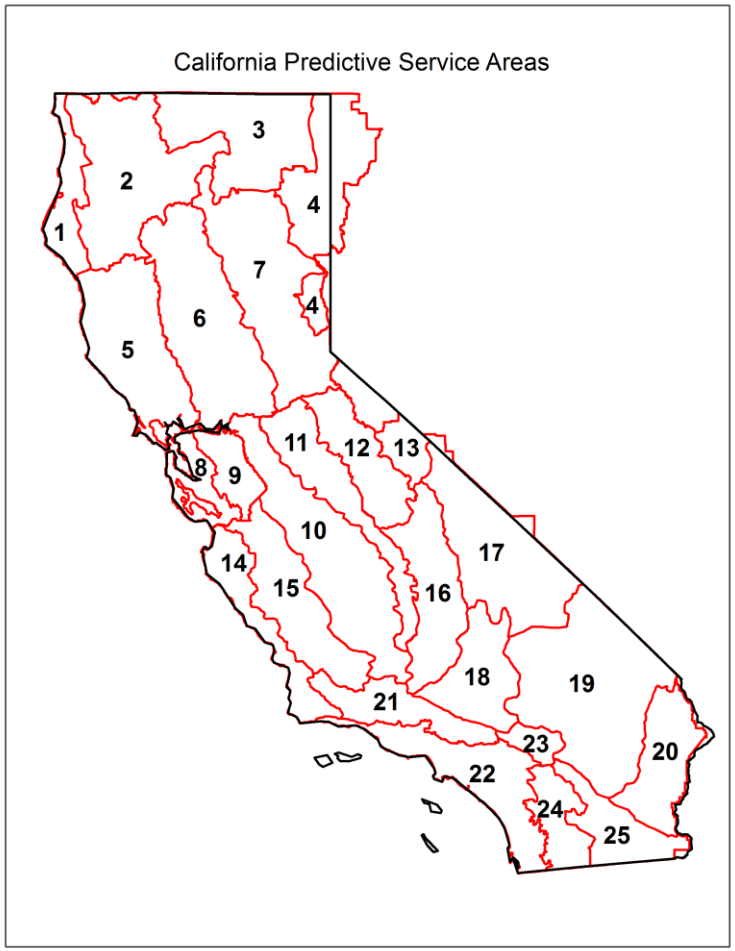
EDDI Extended Time Scale Applications: Hydrologic Drought

- Relationships between EDDI and streamflow
- 6 month EDDI ending in April (Nov-Apr) and 12-month Standardized Runoff Index (SRI) ending in September (Oct-Sep)
- Potential to improve late summer low flow streamflow predictions



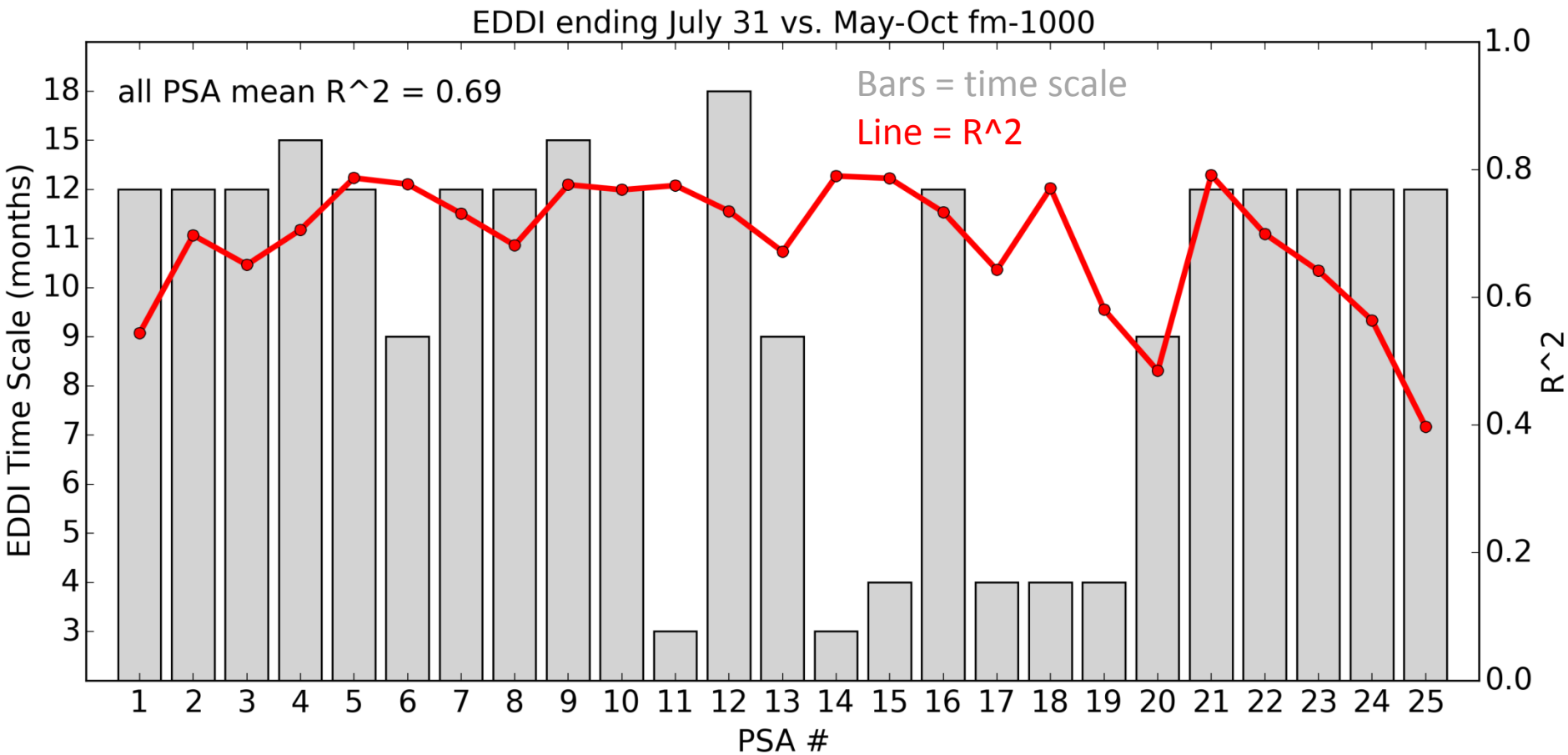
EDDI Applications: Wildfire

- Relationships between EDDI and fire danger indices
- NOAA funded Sectoral Applications Research Program grant: *Developing a wildfire component for the NIDIS CA Drought Early Warning System*
- 2-years, $295K



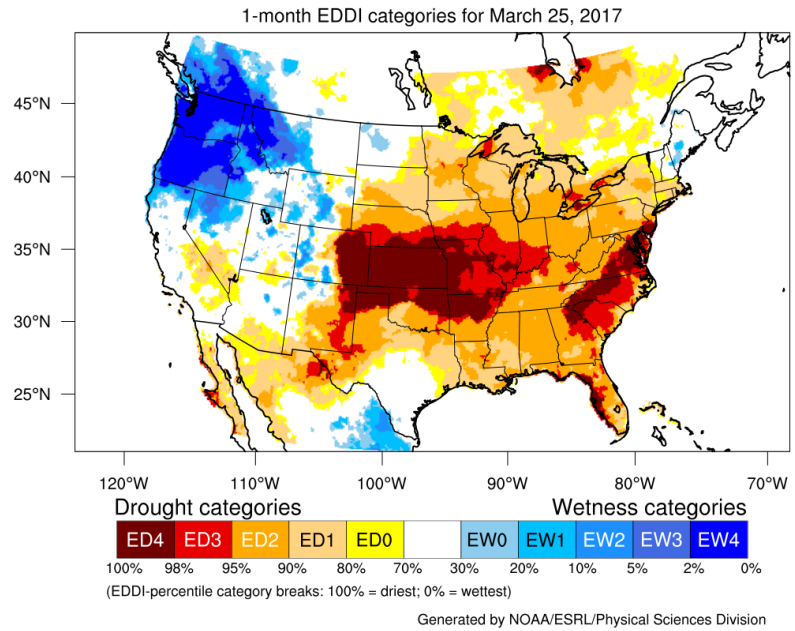
- How well do EDDI and other drought indices correlate to fire danger indices?
- What drought time scales are most appropriate for monitoring wildfire conditions?
- Can EDDI provide any early warning about developing wildfire conditions?
- Run analysis over each of the 25 CA Predictive Service Areas

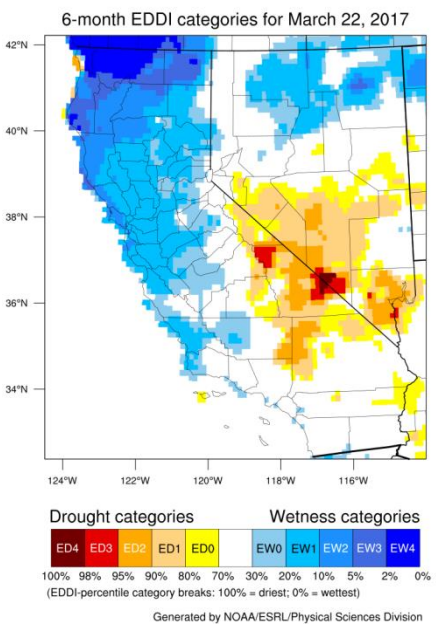
EDDI Applications: Wildfire

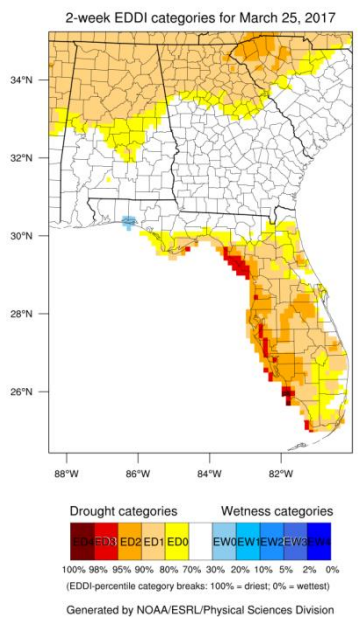


- EDDI correlated with 1000-hour fuel moisture (fm-1000) at each PSA, 1979-2015
- Optimized time scale to maximum correlation
- Lag-3 month correlations to seasonal fm-1000 are strong over most PSAs

Quasi-Operational EDDI Products







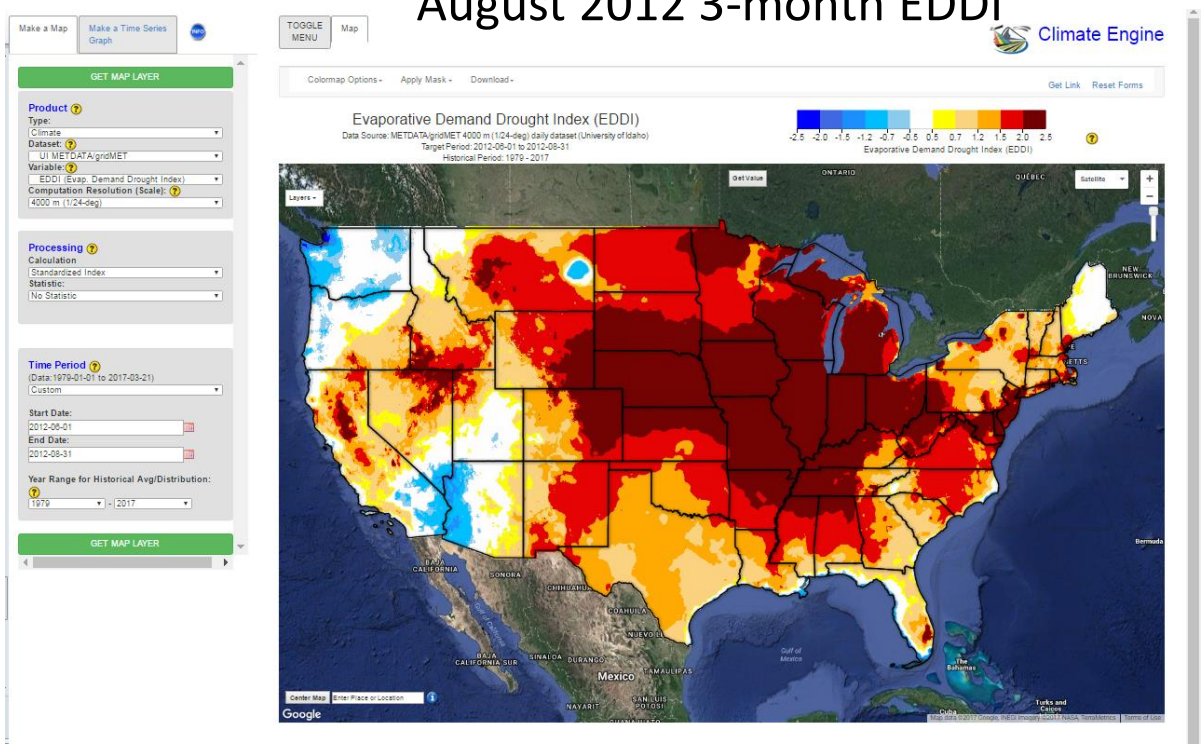
- NLDAS-2 12 km daily EDDI (1979-present)
- Produced by NOAA/ESRL/PSD
- CONUS and zoomed in DEWS regions
- Maps (.pngs) and ascii (text) grids (CONUS only) available
- Time scales: 1-12 weeks and 1-12 months
- EDDI converted to USDM percentiles

- FTP: ftp://ftp.cdc.noaa.gov/pub/Public/mhobbins/EDDI/

- Website (still in development): https://www.esrl.noaa.gov/psd/eddi/realtime_maps/

Experimental EDDI Products

August 2012 3-month EDDI



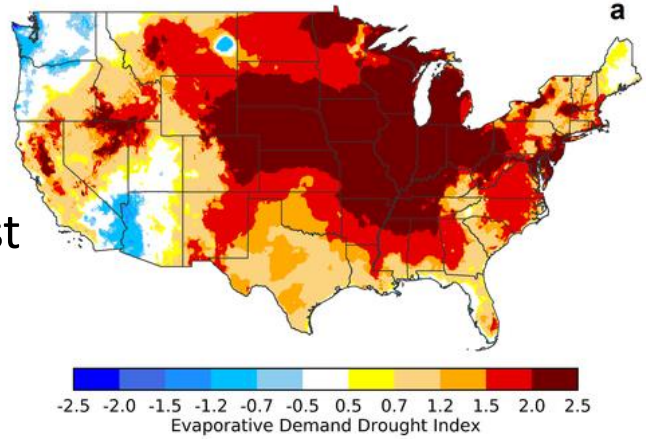
- U of I gridMET 4-km daily EDDI (1979-present)
- Produced by DRI
- Experimental data set
- Full map archive available
- Download as geotiff

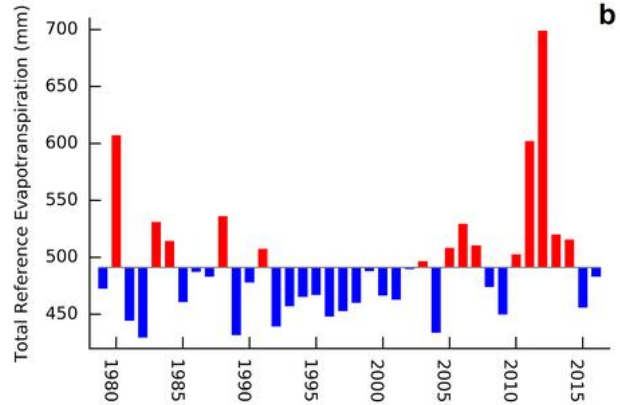
- http://climateengine.org/ (landing page)
- http://clim-engine.appspot.com/ (web application)

- **Climate Engine**: Google Earth Engine cloud computing and visualization of climate and remote sensing data

Climate Engine Example, 2012 Drought

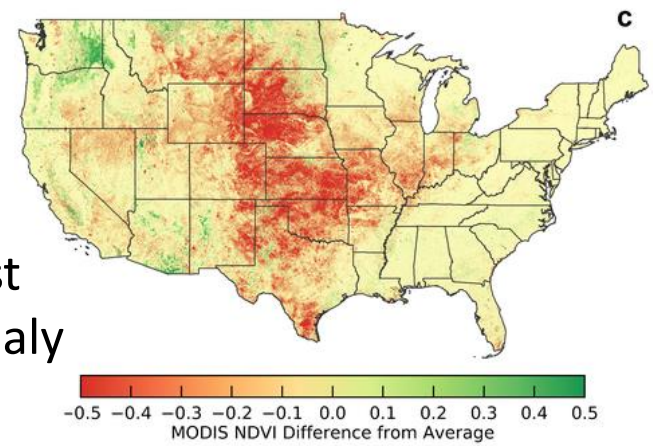
June-August EDDI

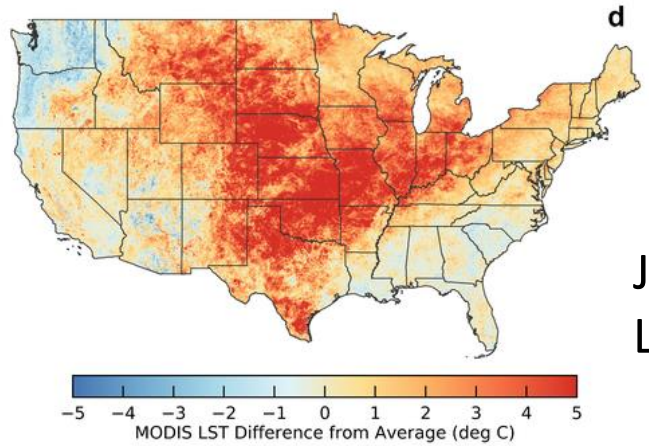




June-August total ET_0 over Missouri

June-August NDVI anomaly

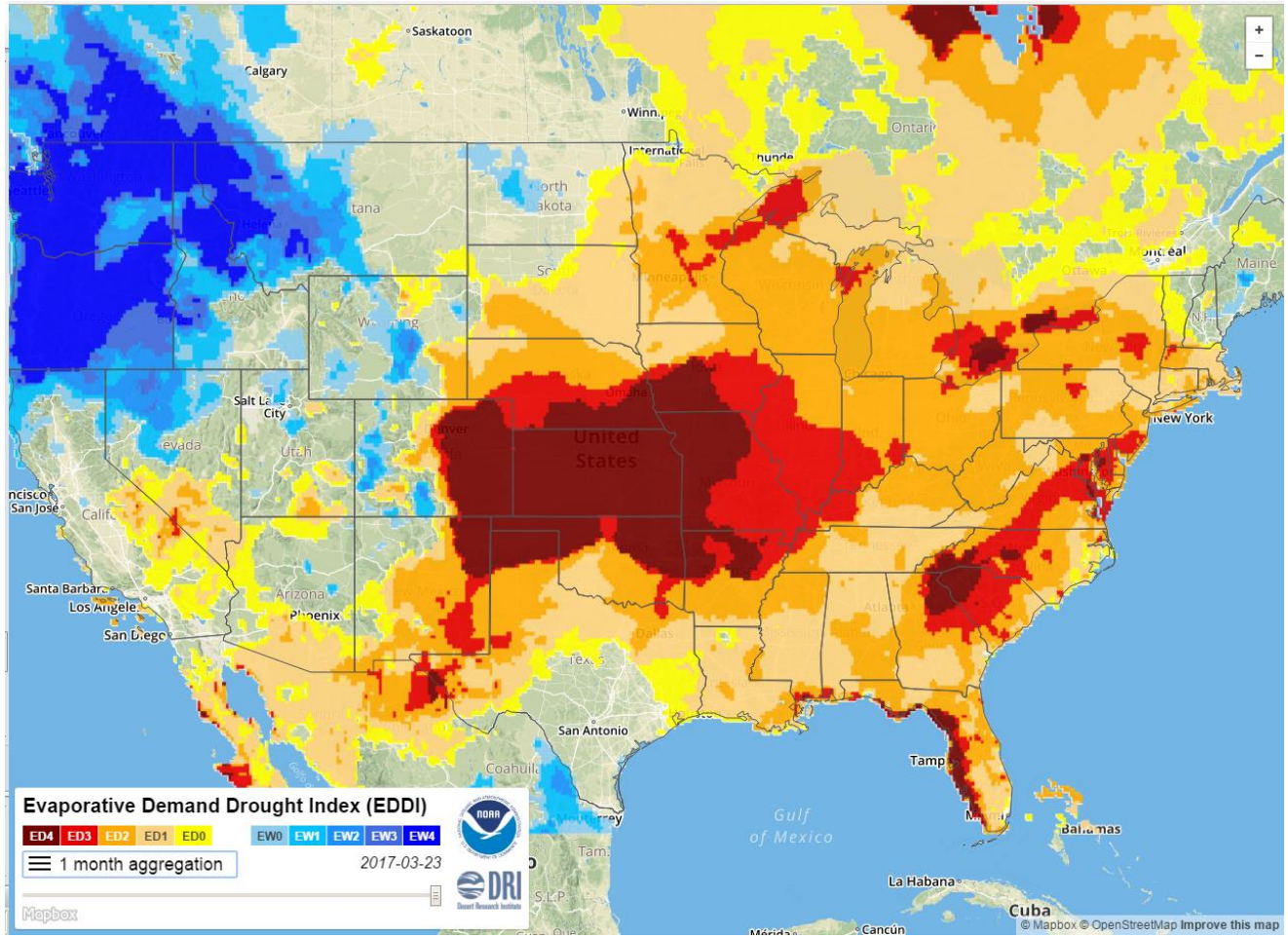




June-August LST anomaly

Huntington, J., Hegewisch, K., Daudert, B., Morton, C., Abatzoglou, J., McEvoy, D., and T., Erickson. Climate Engine: Cloud Computing of Climate and Remote Sensing Data for Enhanced Natural Resource Monitoring and Process Understanding. *Bulletin of the American Meteorological Society.* (in revision)

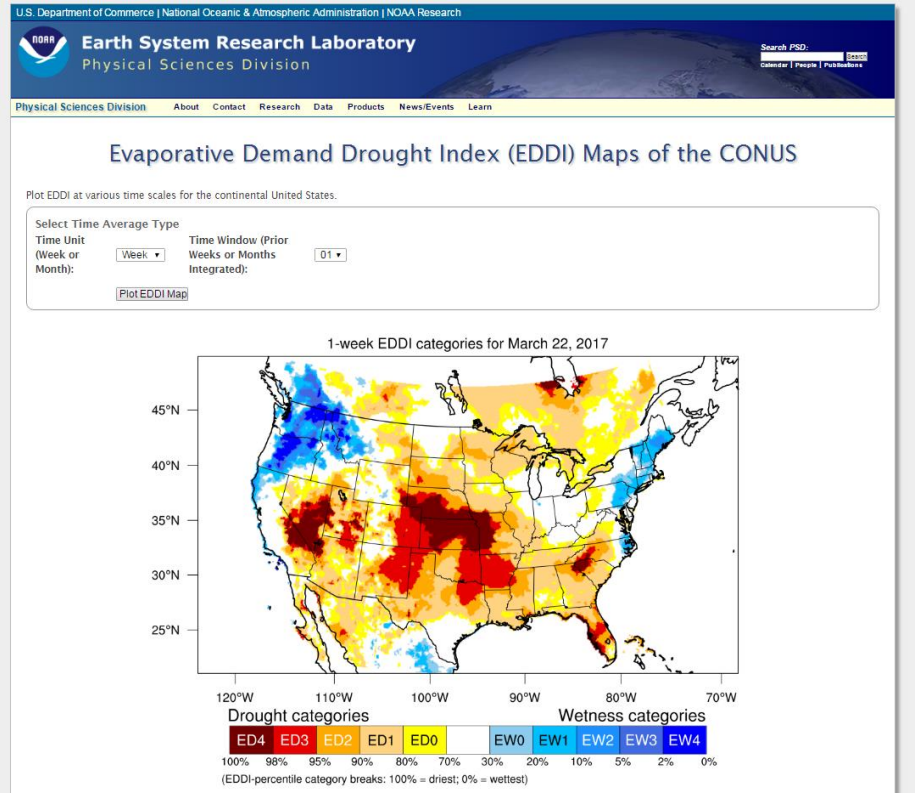
EDDI Products



- NLDAS-2 EDDI animation, produced by Charles Morton (DRI)
- Use the slider bar to animate archived EDDI images
- https://eddi-noaa.appspot.com/

Moving Forward – R2O

- *Operationalizing an Evaporative Demand Drought Index Service for Drought Monitoring and Early Warning*
- NOAA Research Transition Acceleration Program (RTAP)
- Transition NLDAS-2 EDDI as an operational product to be housed at the NOAA National Water Center by 2019
- Web page development
- New tools such as time series extractor
- Access to archived data



Screenshot of EDDI webpage in development

https://www.esrl.noaa.gov/psd/eddi/realtime_maps/

Lake Tahoe as seen from top of Incline Peak, NV. February, 2014

Thank you!

Questions?

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