Use of Machine Learned Mutual Information Between USDM and Correlated Drought Factors

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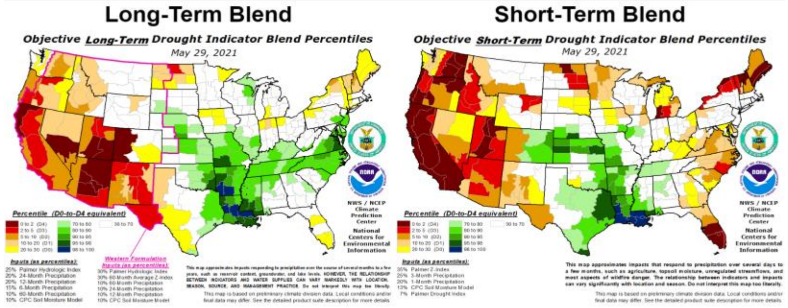
https://www.drought.gov/drought-research/quantifying-relative-importance-multiple-drought-indicators-us-drought-monitor

Soni Yatheendradas, David M. Mocko, Christa Peters-Lidard and Sujay Kumar, *Quantifying the Importance of Selected Drought Indicators for the United States Drought Monitor*, JHM.



The ***Short-Term Blend*** approximates drought-related impacts that respond to precipitation (and secondarily other factors) on time scales ranging from a few days to a few months, such as **wildfire danger, non-irrigated agriculture, topsoil moisture, range and pasture conditions, and unregulated streamflows.**

The ***Long-Term Blend*** approximates drought-related impacts that respond to precipitation on time scales ranging from several months to a few years, such as **reservoir stores, irrigated agriculture, groundwater levels, and well water depth.**

It should be noted that the relationship between indicators and impacts varies, sometimes markedly, with location and season. This is particularly true of water supplies, which are additionally dependent on the source (or sources) tapped, management practices, and legal mandates. Exercise caution when attempting to relate these maps to specific impact implications for a particular location and time of year. The blend-to-impact correlation is not always direct, and will vary spatially and temporally.

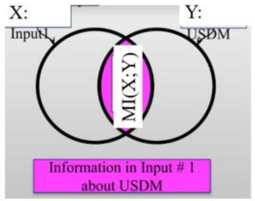
The following bullets describe the composition of these experimental blends:

- These products are generated using the Climate Prediction Center's real-time daily & weekly climate division data, and the National Climatic Data Center's monthly climate division data archive, back to 1932.
- The indices used in the blends and their weights are as follows:
  - ***SHORT-TERM:*** 35% Palmer Z-Index; 25% 3-Month Precipitation; 20% 1-Month Precipitation; 13% Climate Prediction Center Soil Moisture Model; and 7% Palmer (Modified) Drought Index.
  - ***LONG-TERM:*** 25% Palmer Hydrologic Drought Index; 20% 12-Month Precipitation; 20% 24-Month Precipitation; 15% 6-Month Precipitation; 10% 60-Month Precipitation; 10% Climate Prediction Center Soil Moisture Model.
- All parameters are first rendered as percentiles with respect to 1932-2000 data ... relative to the National Climatic Data Center's historic climate division data for the current month, except for the Z-Index which is rendered relative to all months on record (this introduces evaporative seasonality into the short-term blend).

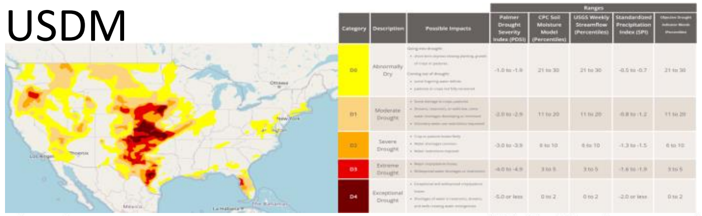
$$MI(X;Y) = H(X) - H(X|Y) = -\sum_n \sum_z P(x_n, y_z) \log(P(x_n)/P(x_n|y_z))$$

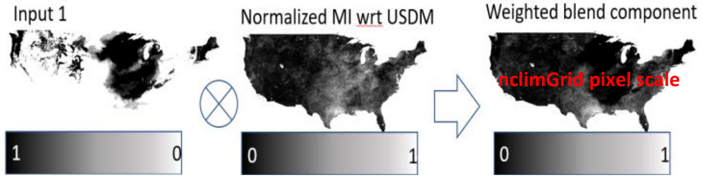
$$H(X) = -\sum_{n=1}^{N} P(x_n) \log P(x_n)$$

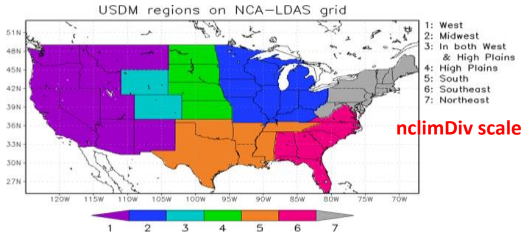
$$H(X|Y) = -\sum_n \sum_z P(x_n, y_z) \log P(x_n|y_z)$$

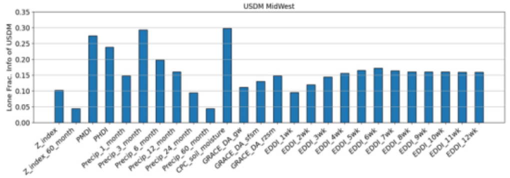


USDM









Through mutual information, ClimateEngine.org, and Google Cloud

- Mechanistic **understanding of what drives drought when, where (nclimGrid pixel scale; nclimDiv scale)**
- **MIDIs** (Multi Indicator Drought Indices) from, e.g., linear model out via remotely sensed, modeled, observed datasets
  - Forecasting (future)
  - Monitoring (present)
- **drought.gov indices to present when, where** (state, county, watershed pages: short term versus long term – local, **state, regional, and temporal scales matter**…)
- **Stakeholder engagement** and **index priority wrt "drought"** reflected to some extent implicitly via DM author localized priorities' use in MI/FI calculation