Droughts

Outline

- Definitions of different types of droughts
- Drought indicators
- Droughts and heat waves
- Drought monitoring and outlook

What is Drought?

- Drought: A period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance (AMS Glossary).
- Different types of droughts:
  - Meteorological drought happens when dry weather patterns dominate an area, which depends on the degree of dryness and the duration of the dry period.
  - Agricultural drought happens when crops become affected. The variable susceptibility of crops during different development stages often needs to be considered.
  - Hydrological drought occurs when low water supply becomes evident, especially in streams, reservoirs, and groundwater levels, usually lag the occurrence of meteorological and agricultural droughts.
  - Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather related shortfall in water supply

https://www.ncdc.noaa.gov/monitoring-references/dyk/drought-definition

Drought Indicators

- Many different indices have been developed to measure drought
  - Simple indices can be defined based on the percentile of precipitation and number of days with no precipitation
  - Specific indices have been created to assess drought, such as the Palmer Drought Index (PDI) and Standardized Precipitation Index (SPI)
  - Some indices are used for water supply forecasting
  - Some indices reflect impacts on agriculture, such as the Vegetation Health Index (VHI), Vegetation Drought Response Index (VegDRI) and water availability

https://www.ncdc.noaa.gov/monitoring-references/dyk/drought-indicators

Palmer Drought Severity Index

- Palmer Drought Severity Index (PDSI) (AMS Glossary and https://climatedataguide.ucar.edu/):
  - PDSI uses temperature and precipitation to estimate relative dryness.
  - The calculation takes into account precipitation, potential and actual evapotranspiration, infiltration of water into a given soil zone, and runoff.

- Key Strengths
  - Effective in determining long-term drought, especially over low and middle latitudes
  - PDSI takes into account the basic effect of global warming through potential evapotranspiration
  - Takes precedent conditions into account
- Key limitations
  - Not as comparable across regions as the SPI
  - Lacks multi-timescale features of indices like the SPI, making it difficult to correlate with specific water resources like runoff, snowpack, reservoir storage, etc.
  - Does not account for snow or ice

(from https://climatedataguide.ucar.edu/climate-data/palmer-drought-severity-index-pdsi)

Standardized Precipitation Index

- Standardized Precipitation Index (SPI) - a widely used index for meteorological drought.
  - SPI quantifies precipitation deficit at a given location for multiple timescales.
  - Standardized precipitation is the difference of precipitation from the mean for a specified time divided by the standard deviation, where the mean and standard deviation are determined from the climatological record. The fact that precipitation is not normally distributed is overcome by applying a transformation (i.e., gamma function) to the distribution.
  - Drought events are indicated when the SPI is continuously negative and reaches a value of -1. The drought event is considered to be ongoing until SPI becomes positive. (Different researchers may use different thresholds)

AMS Glossary: https://glossary.ametsoc.org/wiki/Standard_precipitation_index

Standardized Precipitation Index (cont'd)

- Key Strengths
  - allows comparison across regions with different climates.
  - uses precipitation only and is easier to compute than PDSI.
- Key Limitations
  - SPI measure water supply only and does not account for evapotranspiration, which limits its ability to capture the effect of climate change on moisture demand and availability
  - Sensitive to the quantity and reliability of the data used to fit the distribution; 30-50 years recommended
  - Does not consider the intensity of precipitation and its potential impacts on runoff, streamflow, and water availability

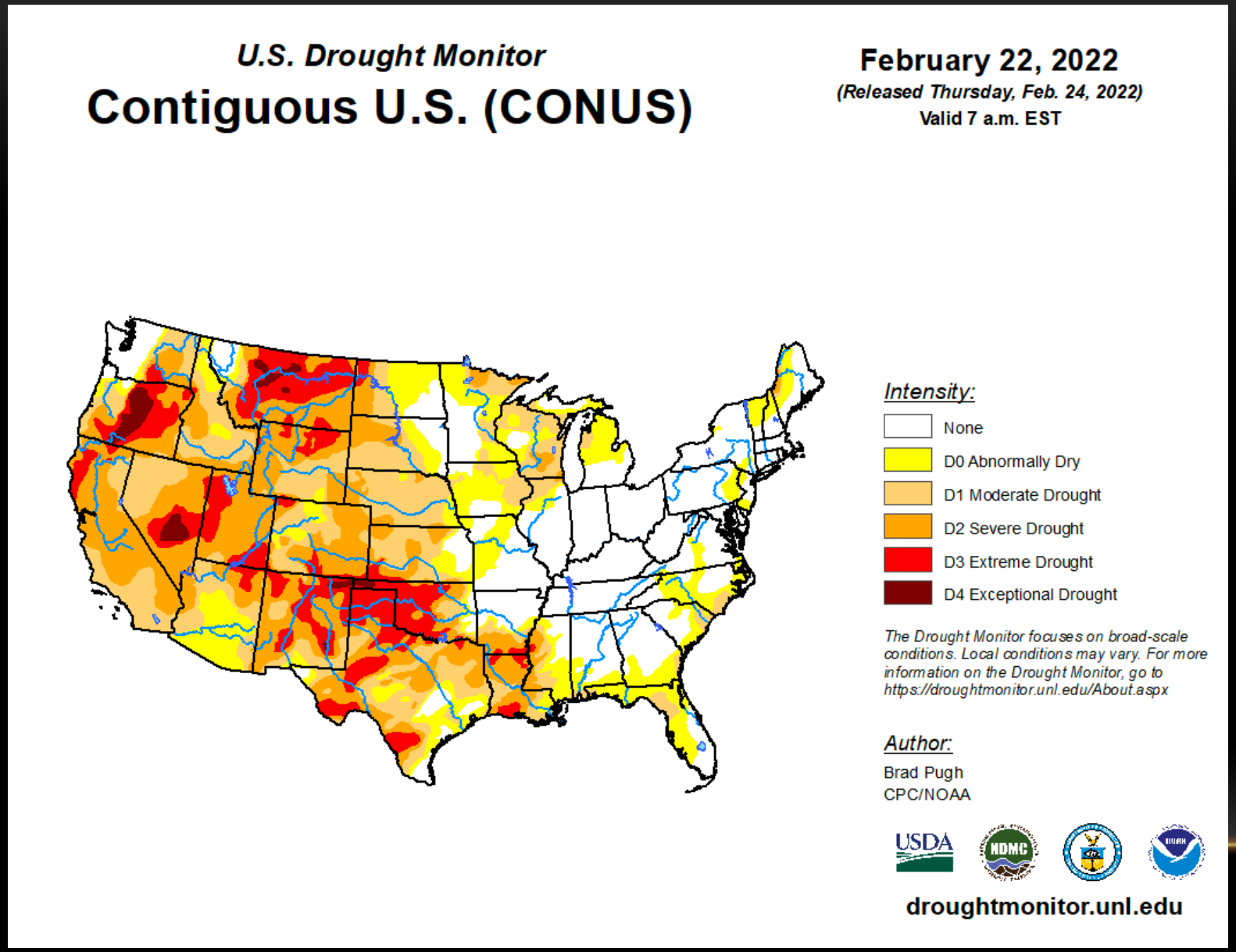
Heat Wave, Drought and Blocking

Heat wave →
Large thickness →
Upper-level anticyclone (blocking)→
subsidence and increased insolation
associated with clear skies →
temperature increase

Droughts →
Reduced soil moisture →
Reduced surface evaporative cooling →
higher surface temperature →
build up of the upper-level anticyclone →
Steer storms northward and subsidence →
reduced frontal precipitation

- The strong connection between drought and excessive heat reflects in part the central role of anticyclones in the development of midlatitude droughts.
- Climate feedback is often involved, such as cloud-radiation feedback and soil moisture feedback

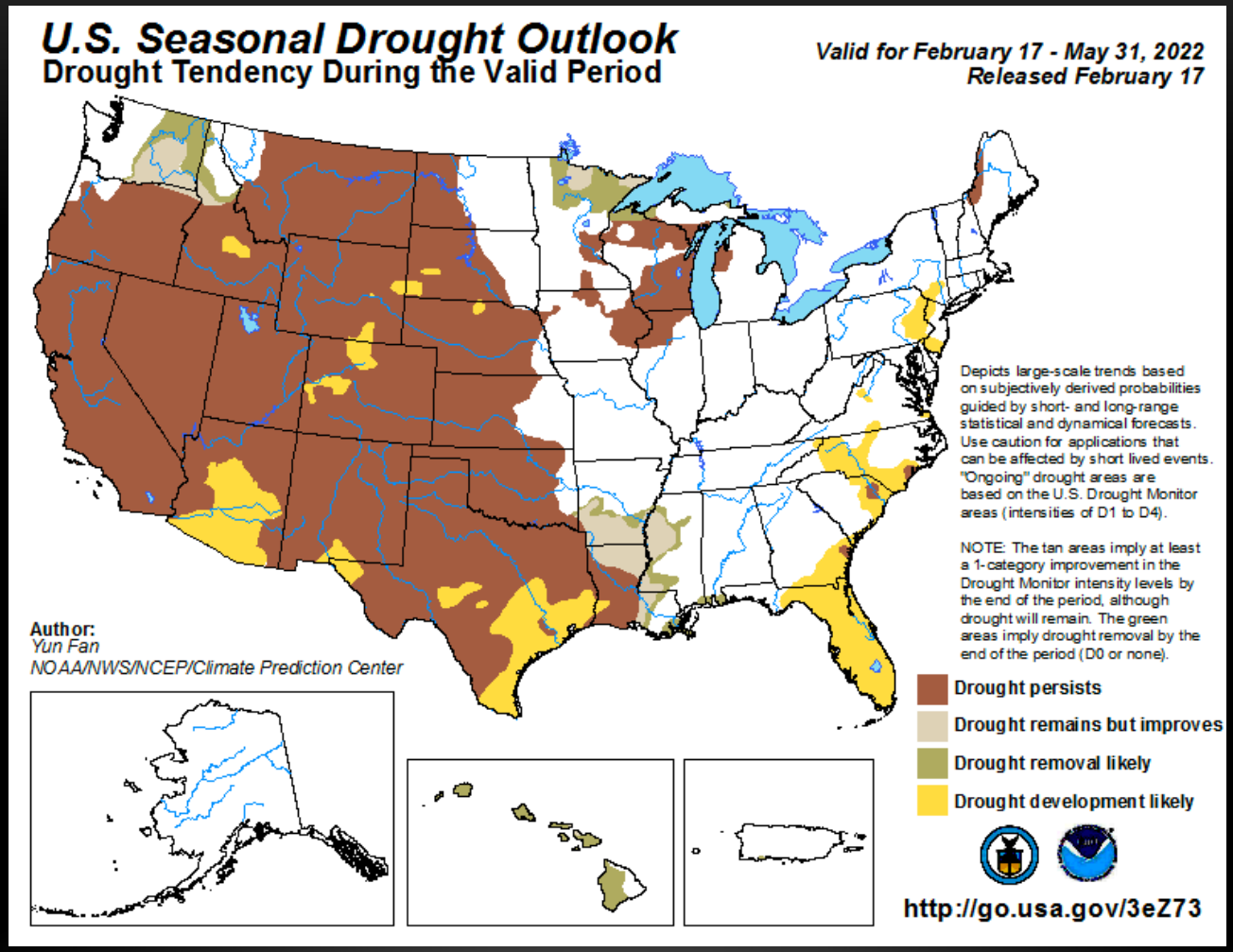
See Schubert et al. 2014



The **U.S. Drought Monitor (USDM)** is a weekly product updated every Thursday. It provides a general summary of current drought conditions (location and intensity). Multiple drought indicators, including various indices, outlooks, field reports, and news accounts are reviewed and synthesized.

https://www.drought.gov/current-conditions

Operational Drought Outlook: Seasonal Outlook



http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdohomeweb.png

CPC issues outlooks on the first and third Thursday of each month: predicted trends for areas experiencing drought depicted

References

- Schubert, S. D., Wang, H., Koster, R. D., Suarez, M. J., & Groisman, P. Y. (2014). Northern Eurasian Heat Waves and Droughts, *Journal of Climate*, *27*(9), 3169-3207.
- Palmer, W. C. 1965. Meteorological Drought Research Paper 45. U.S. Weather Bureau, Washington, D.C.
- NOAA CPC: http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdohomeweb.png