Northern California and Southern California Operations

Drought Analysis Tools

Introduction

Increased emphasis has been placed on assessing drought in relation to prescribed burning in the US Forest Service. However, the management questions and critical thinking needed to fully assess drought conditions are applicable across all agencies in both wildfire and prescribed fire settings. The intent of this document is to support such critical thinking and aid land managers to not just address procedural check boxes, but to consider the impacts drought conditions will have on fire management actions and the overall fire environment.

The products and information included is not all-inclusive and other sources of drought related data exist. Most, if not all, of the references here can be found in other guides, link lists or training pages, though many lack context. This document is not intended to replace any existing product, analysis or forecast tool, and should be considered with other fire environment information (weather, fuel moisture, seasonality etc.) to generate the most complete understanding of the fire environment possible.

Drought occurs on various time scales and its impact on fuel flammability depend on the type of fuel involved. Most simply, drought is grouped into 2 categories and the first question one should ask is: What type (or types) of drought is influencing my fire environment?

- Flash drought or short-term drought represents a rapid onset or intensification of drought over a short time span (weeks or month). Multi-day heat wave events or unusually long periods of atmospheric warmth and dryness are flash drought triggers. Flash drought impacts include:
  - Rapid reductions in fine dead fuel moisture
  - Rapid reductions in live woody fuel moisture, increasing availability of these fuels.
  - Rapid curing of herbaceous and grass fuels.
  - Rapid changes in overall flammability of the fuel bed leading to changes in observed fire behavior over a short timeframe. Previously unavailable fuels suddenly consume readily.
- Long-term drought builds over several months to years, with increasing moisture stress and eventual mortality of vegetation. Impacts from long term drought may include:
  - Steadily increasing dead to live fuel ratio as vegetation succumbs to cumulative stress.
  - Decreases in moisture content of slow -changing fuels such as 10,000 hr. and larger dead and down material, thus increasing spotting potential and heat residence time.
  - Low to very low foliar moisture in conifer stands that otherwise appear green. Low foliar moisture contributes to more rapid transition to torching and crown fire activity, increasing mortality and spotting potential.
  - Areas and fuel types that are typically “green enough” to act as barriers to fire spread are likely to carry fire spread and may hold heat for extended periods (i.e., meadows and wetlands).
  - Vegetation flammability is more sensitive to flash droughts during ongoing long-term drought.

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Determining the type of drought affecting your fire environment will allow critical insights into expected fire behavior. Considering the following questions relating to how drought could impact fire management decisions:

- Will surface fuels hold heat longer than normal (i.e., mop-up & smoke effects)?
- Will surface fire transition into the canopy easier (i.e., fire effects & holding)?
- Are fuels more receptive to spotting than previously anticipated?
- Will mortality of overstory trees be higher than models predict due to increased heat residence time or cumulative drought stress?
- Is a re-sample of live fuels needed following a multi-day Heat Wave event (i.e., change in fuel flammability & control issues)?
- Could drought impact any other specific management objective of your operation?

Drought can be described many ways under varying sets of conditions. Specific questions regarding drought are often best handled combining several tools together with interpretation from fire environment experts and meteorologists so that nuances and caveats may be covered in-depth. All fire managers have the ability and are **strongly encouraged to communicate with** local GACC Predictive Services Units and National Weather Service forecasters.

- Predictive Services (including meteorologists) provides short-, medium- and long-term forecasts and outlooks relating specifically to fire weather and the fire environment. Products include daily 7-day outlooks for each GACC and monthly seasonal outlooks nationally and for each GACC.
- NWS offices provide short-term forecasts and weather information, including daily fire weather forecasts and spot weather forecasts. These short-term products can assist in predicting cessation or intensification of short-term drought conditions.

Many of the links and products described here are already available through the Climatology/Drought link lists on the GACC webpages:

Northern California Geographic Coordination Center:
https://gacc.nifc.gov/oncc/predictive/weather/index.htm

Southern California Geographic Area Coordination Center:
https://gacc.nifc.gov/oscc/predictive/weather/index.htm

Drought Analysis Tools

Drought Toolboxes, Dashboards and Guides

Many websites and resources consolidate multiple drought metrics and tools into a single interface, allowing the user to look at multiple inputs and combine information on short-term and long-term drought in one place. Some of the individual resources included later in this document are incorporated into these multi-variable resources.

Fire Behavior Field Reference Guide (FBFRG)

https://www.nwcg.gov/publications/pms437

The FBFRG is an online NWCG publication that consolidates information to assist in fire behavior analysis in the field and in sophisticated modeling programs used by LTANs and FBANs. The document addresses a wide array of fire environment topics, including drought. The following sections contain information and subsequent links related to drought:

- Weather > Fire Season Climatology > Drought Assessments: This section contains description of and link to many of the same resources included in this document.
- Weather > Fire Season Climatology > Regional Fire Seasonality: This section includes fire growth indicators frequently used in each region, some of which are drought metrics.
- Fuel Moisture References: Section contains moisture refences which are linked to and often controlled by drought. Includes soil moisture section, a direct drought impact.

National Integrated Drought Information System (Drought.gov)

https://www.drought.gov/

The Drought.gov website provides descriptions and links to numerous drought related products and web pages, including the current National Significant Wildland Fire Potential Outlooks. The current conditions page has nationwide maps of multiple drought indicators, including US Drought Monitor, Precipitation Conditions, EDDI, Palmer Drought Severity Index (PSDI), and more. This interface allows comparison of multiple tools that show both short-term and long-term drought conditions side by side. Most of the tools include tabs to show multiple time scales or change over time.

Climate Toolbox

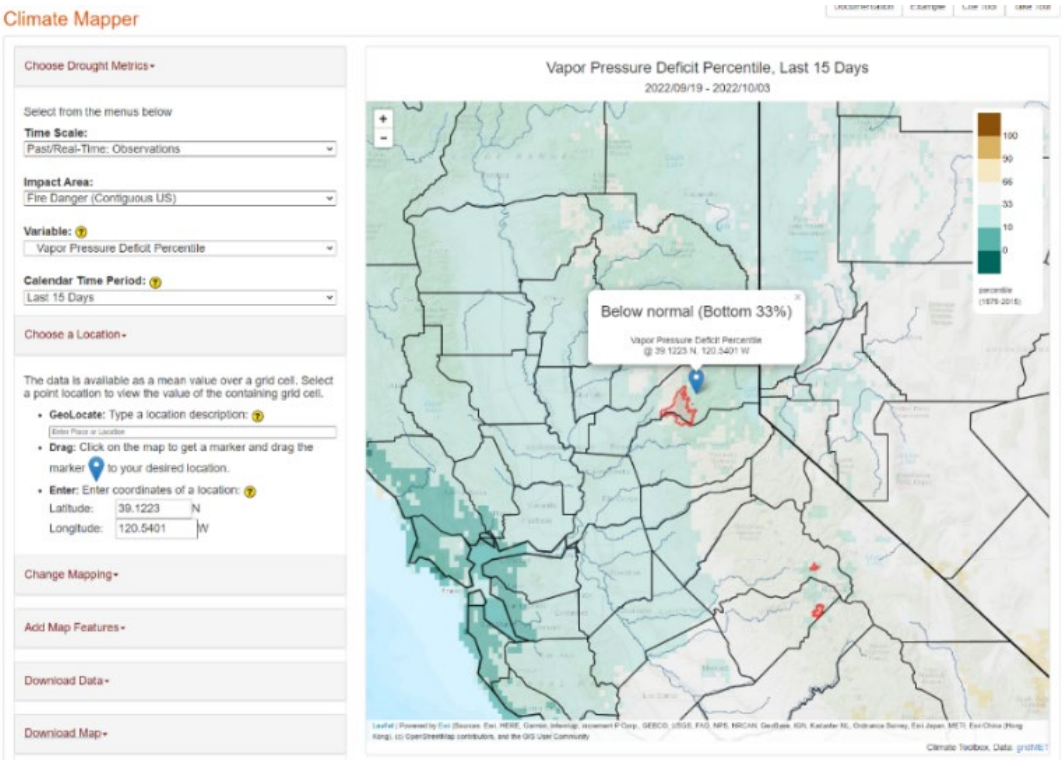
https://climatetoolbox.org/

The Climate toolbox is “A collection of web tools for visualizing past and projected climate and hydrology of the contiguous United States.” When visiting this website, there are multiple applications and tools available. Clicking on the Fire application brings one to a page hat displays multiple tools for analysis of fire and climate, both historic and predicated future. The Climate Mapper Tool is the visualization tool that incorporates many drought indices and metrics. The default tool loads with mean temperature on the map but working through the menus on the left allows the user to select an incredibly wide array of layers. Setting the impact area drop down to either Fire Danger or Drought is likely to be the most relevant, though useful information exists in other impact areas.

Using the location menu allows user to get the value for the currently displayed index or measure at a specific location. Clicking on the map also displays the value of the currently displayed variable. Additional options allow customizing of the base layer, location overlays as well as exporting and sharing map images.

Drought Analysis Tools

Example of map from the Climate Mapper Tool showing current vapor pressure deficit percentile over the last 15 days in the vicinity of the Mosquito Fire.



University of Arizona Drought View

https://droughtview.arizona.edu/

Visualization platform that includes greenness indicators such as NDVI from MODIS and VIRS as well as precipitation data and the US Drought Monitor layer.

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United States Drought Monitor

The U.S. Drought Monitor (USDM) is a product that updates weekly each Thursday that displays current drought conditions for the United States. This product is not a forecast but instead is a weekly assessment of drought conditions, based ecological and hydrologic conditions up to the Tuesday morning before the map comes out. Generally, this product is an illustration of long-term drought, though the national map does include indicators of short-term vs. long term drought.

The drought monitor page can be used to look at any specific state or region, and offers the ability to observe trends via the map archive and compare dates via the comparison slider.

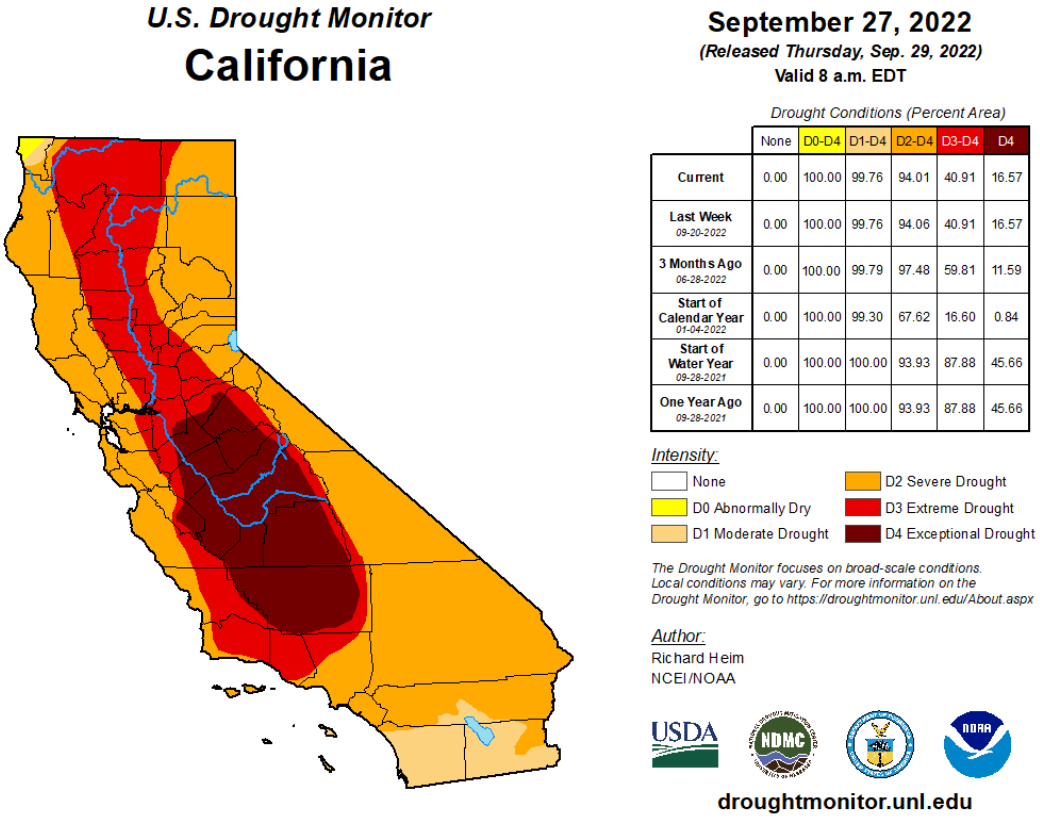
The drought monitor map for California can be found at the following link:

https://droughtmonitor.unl.edu/CurrentMap/StateDroughtMonitor.aspx?CA

The map at the above link is interactive and can be focused into a specific county. It also includes statistics about area in each category, impacted populations and is downloadable in multiple formats.

The continental U.S. map of the USDM can be accessed through multiple pathways, one of which is here: https://droughtmonitor.unl.edu/

Example USDM image for the state of California:



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Evaporative Demand Drought Index (EDDI)

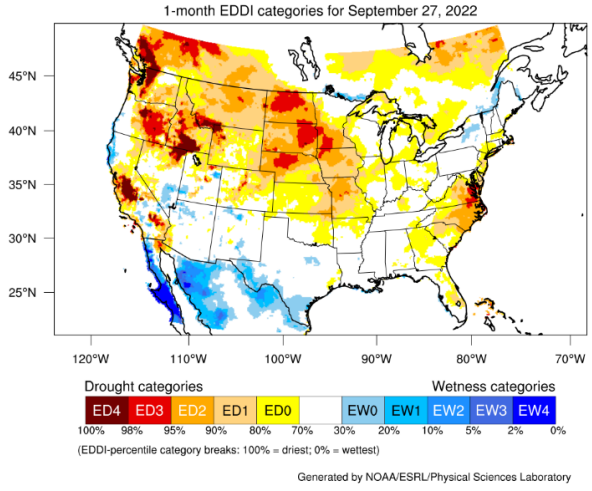
EDDI “eddy”” is a drought monitoring index that uses anomalies in temperature, solar radiation, wind speed and humidity to compare the current evaporative demand or “thirst” of the atmosphere to a normal value derived from pas past climatological data. The product can be scaled from short- to long-term, though is most often used as an indicator of short-term or flash drought conditions. A typical short-term analysis period for EDDI ranges from 2 weeks to 2 months. Such flash droughts have a strong correlation with rapid increases in overall vegetative flammability and overall fuel complex availability. Recent analysis has shown a strong correlation between fires receiving an IMT assignment and dry anomalies in EDDI at the 1-week, 2-week and 2-month time scale. This correlation indicates that EDDI is a reasonable predictor of rapid increases in vegetation flammability and potential for problematic fire behavior.

EDDI data is updated daily with a 5-day time lag. As with USDM, EDDI is not a forecast but is instead an analysis of near-current conditions based on observed weather conditions.

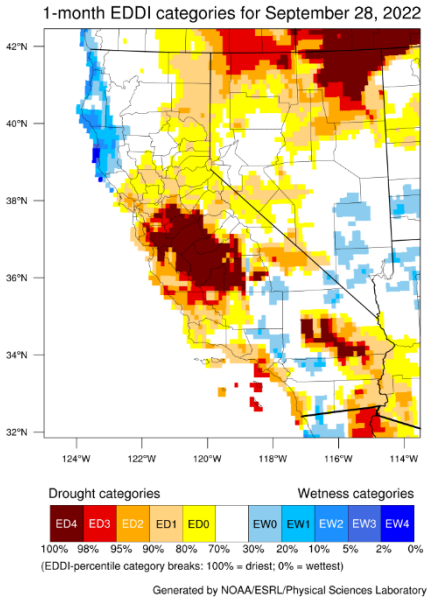
National EDDI products can be accessed at this link: https://psl.noaa.gov/eddi/ . The current conditions tab provides the most up to date information and includes the EDDI map, with cool colors indicating wetter than normal and warm colors indicating drier than normal. Below the EDDI map are maps indicating recent trends in EDDI in 1 week, 2 week and 1-month intervals. Set the drop down for period to month and set interval drop down to 1 or 2 for a typical short-term analysis. The EDDI Map Archive tab provides previous EDDI maps, allowing for a rapid way to observe trends visually.

California specific EDDI maps with county overlays are available here: https://downloads.psl.noaa.gov/pub/Public/mhobbins/EDDI/USFS_CA2/. The top of the page indicates the date of the most current maps in the folder. The naming convention begins with EDDI, followed by the number of the interval and then the length of interval, either weeks or months. For example, EDDI_01mn is a 1 month EDDI image and EDDI_05wk is an EDDI image for the previous 5 weeks starting with the date noted at the top of the page.

Example of EDDI across continental U.S:



Example of an EDDI map for California w/Counties.



Drought Analysis Tools

Precipitation Analysis

WRCC Precipitation Analysis

Though many factors can impact drought, precipitation amount and timing are significant. For the Western U.S., the Western Regional Climate Center (WRCC) produces products that display precipitation amount, departure from average and percent of average. These maps are available at multiple time scales, ranging from 1 week to 3 years. These products are available alongside numerous other climatological analysis products. The precipitation maps can be displayed for the entire wester area of the country or state by state. The California specific maps are found here: https://wrcc.dri.edu/anom/cal_anom.html . The precipitation maps are on green rows about halfway down the page; change to another state or region by using links at the top of the page.

California Snowpack

Snow accumulation and snow water equivalent contribute to drought initiation or drought cessation. California snowpack levels are measured periodically throughout the winter and spring months and can be viewed here: https://cdec.water.ca.gov/snowapp/sweq.action.

National Weather Service Precipitation Products

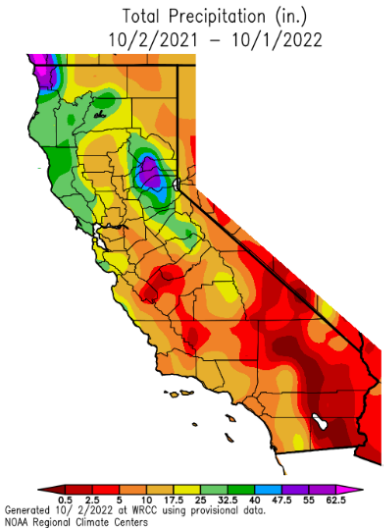
Additional precipitation analysis can be done using NWS products available nation-wide:

- Advanced Hydrologic Prediction Service's (AHPS) Quantitative Precipitation estimates (QPE) tool https://water.weather.gov/precip/index.php
- CPC NAMS precipitation monitor https://www.cpc.ncep.noaa.gov/products/Global_Monsoons/American_Monsoons/NAMS_precip_monitoring.shtml

Other Sources

The Climate Toolbox Climate Mapper Tool, Drought.gov current conditions, and the University of Arizona Drought View tools all contain precipitation analysis options, including recent precipitation, days since wetting rain, Standardized Precipitation Index (SPI), and precipitation percent of normal.

Example of total precipitation from WRCC



Example image of a QPE map from AHPS

Drought Analysis Tools

Soil Moisture

Soil moisture plays an integral part in determining drought impacts and vegetation flammability. There are several sources of information concerning soil moisture trends.

NASA SPoRT Land Information System (LIS)

https://weather.msfc.nasa.gov/sport/case_studies/lis_CONUS.html

The NASA SPoRT LIS generated graphics are a combination of ground based and satellite derived products that model soil moisture (various depths) and vegetation greenness. The LIS products are updated daily and provide trend changes over various time scales. The 0-10cm and 0-40cm percentile graphics are especially useful in determining soil moisture links to surface fuels such as the duff layer. Additional information on this soil moisture tool is included in the FBFRG: https://www.nwcg.gov/publications/pms437/fuel-moisture/nasa-sport-land-information-system.

NASA GRACE Groundwater and Soil Moisture Conditions from GRACE-FO Data

https://nasagrace.unl.edu

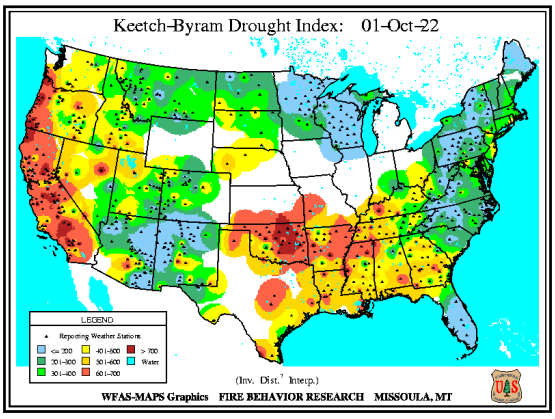
The NASA Grace graphics are generated using NASA satellites (past and present). Surface Soil Moisture and Root Zone Soil Moisture images reveal dryness or wetness levels using percentiles and are updated every week. Historical data goes back to early 2003.

Keetch-Byram Drought Index (KBDI)

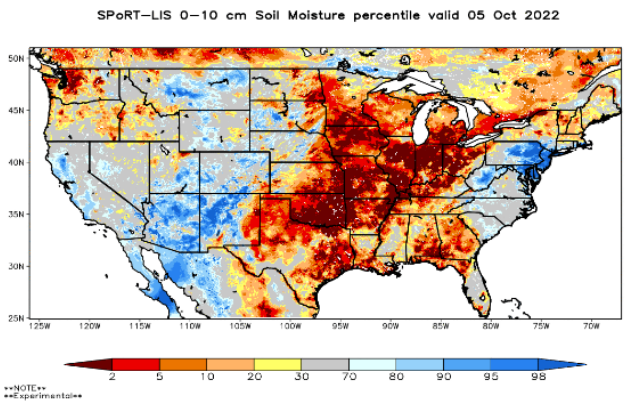
The KBDI is a relatively short-term drought index that estimates the amount of rain needed to return the soil to full saturation which would provide vegetation sufficient water for maximum foliar greenness/moisture content given the plants current growth stage.

KBDI is integrated into the National Fire Danger Rating system (NFDRS) and is a component of some of the subsequent NFDRS indices. *KBIS's utility as a stand-alone drought index and fire danger indicator is very region specific; consult with local experts in fuels, fire danger and fire environment before applying*. Individual RAWS KBDI values can be obtained from the Weather Information Management System (WIMS), a national map of KBDI is available here: http://www.wfas.net/index.php/keetch-byram-index-moisture--drought-49.

Example of a national KBDI map from WFAS.



Example of NASA SPoRT 0-10cm soil moisture percentile



Drought Analysis Tools

Drought Outlooks

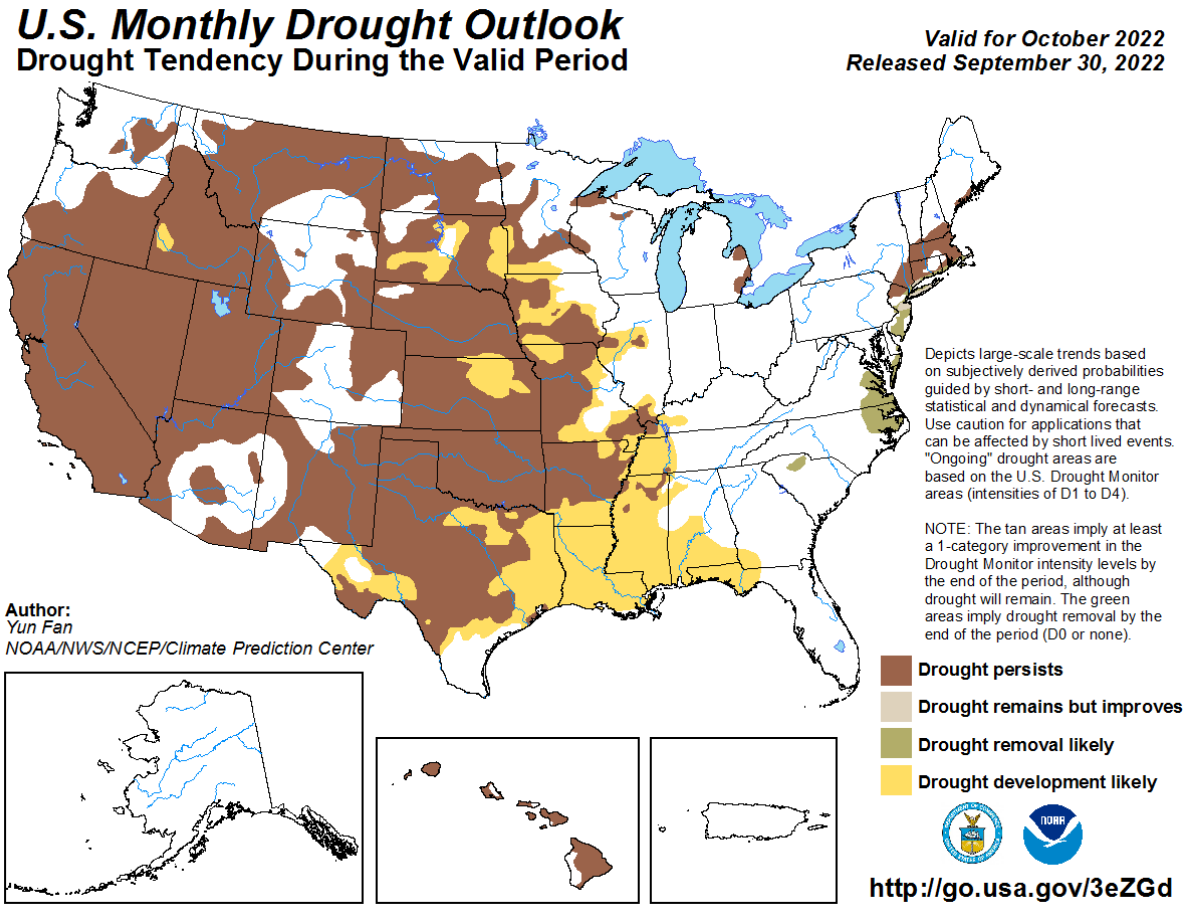
The National Weather Service's Climate Prediction Center (https://www.cpc.ncep.noaa.gov/index.php) generates a monthly and a seasonal drought outlook map. Unlike USDM and EDDI, these are forecast maps that predict the intensification, continuation, or cessation of drought conditions.

Each outlook has an accompanying discussion that includes region-specific information on the outlook and overall confidence in the predictions.

Monthly discussion: https://www.cpc.ncep.noaa.gov/products/expert_assessment/mdo_discussion.php

Seasonal discussion: https://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_discussion.php

Example of monthly drought outlook map:



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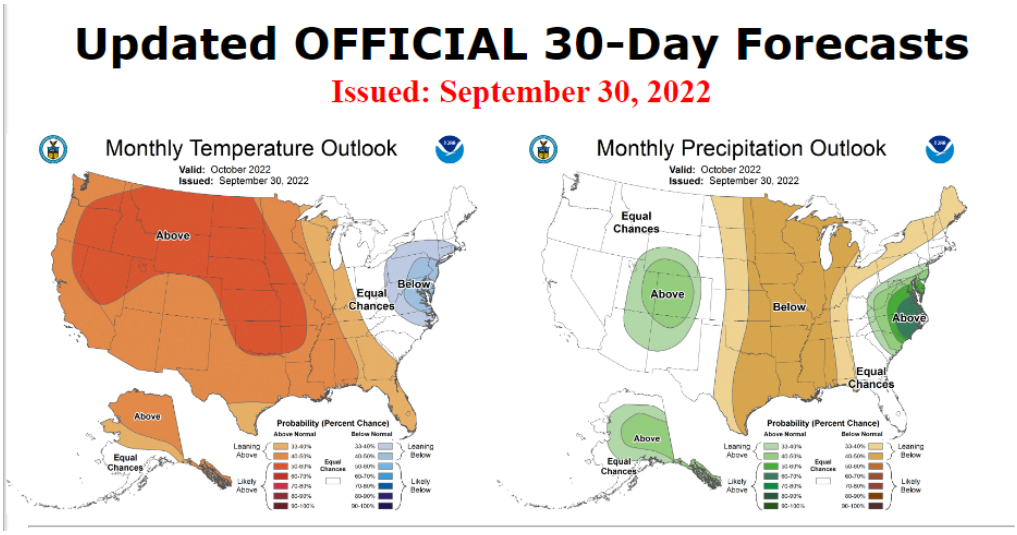
Seasonal outlooks

Similar to the drought specific outlooks, the CPC provides products that address temperature and precipitation predictions for the following timeframes:

- 6-10 Day (https://www.cpc.ncep.noaa.gov/products/predictions/610day/)
- 8-14 Day (https://www.cpc.ncep.noaa.gov/products/predictions/814day/)
- 3-4 Weeks (https://www.cpc.ncep.noaa.gov/products/predictions/WK34/)
- 1 Month (https://www.cpc.ncep.noaa.gov/products/predictions/long_range/lead14/)
- 3 Months (Seasonal) (https://www.cpc.ncep.noaa.gov/products/predictions/long_range/)

These outlooks provide information on the chances of temperature and precipitation being near, above, or below normal. These conditions may aid in suppressing or enhancing current drought conditions but should be considered as only a forecast. Limitations should be clearly understood and communicated before using in making fire management decisions.

Example of a CPC 1-month temperature and precipitation outlook:



Predictive Services Units also produce seasonal outlook products for each GACC. These outlooks are geared towards predicting large fire potential, and as such, incorporate information on a large suite of fire environment variables, including drought impacts to fuels and fuel availability. Many of the products included here are integrated into these outlooks.

Current North Ops Outlook Current South Ops Outlook Current National Outlook

Contact Information

The National interagency Mobilization Guide and the California Interagency Mobilization Guide both contain information on predictive services as well as contact information:

- National Mob. Guide: https://www.nifc.gov/nicc/logistics/reference-documents
- California Mob. Guide: https://gacc.nifc.gov/oncc/camobguide.php

Fire managers in California with specific drought or other predictive services related questions should contact the following:

- Northern California Geographic Coordination Center (North Ops): 530-226-2730
  - North Ops Fuels and Fire Danger - https://gacc.nifc.gov/oncc/fuelsFireDanger.php
  - North Ops Weather - https://gacc.nifc.gov/oncc/predictive/weather/index.htm
- Southern California Geographic Coordination Center (South Ops): 951-782-4852
  - South Ops Fuels and Fire Danger - https://gacc.nifc.gov/oscc/fuelsFireDanger.php
  - South Ops Weather - https://gacc.nifc.gov/oscc/predictive/weather/index.htm
- National Interagency Coordination Center (NICC)
  - NICC Fuels and Fire Danger, including any fire behavior advisories - https://www.nifc.gov/nicc/predictive-services/fuels-fire-danger
  - NICC Weather - https://www.nifc.gov/nicc/predictive-services/weather
  - NICC Outlooks - https://www.nifc.gov/nicc/predictive-services/outlooks

Additional weather and climate information can be gained from contacting appropriate local office of the National Weather Service (NWS). The following NWS offices serve portions of California, fire managers should contact the appropriate office for their area:

- Eureka - 707-442-2171
- Las Vegas - 702-263-9750
- Los Angeles/Oxnard - 805-988-6626
- Medford - 541-776-4332
- Monterey /SF Bay Area - 831-656-1717
- Phoenix - 602-275-7003
- Reno - 775-673-8105
- Sacramento - 916-979-3047
- San Diego - 858-675-8700 / 858-675-8705
- San Juaquin Valley / Hanford - 559-584-9505/ 559-584-9051

All images in this document were captured at the time of preparation and are examples only; they should not be used in fire business analysis or decision making. If you or your unit requires similar images, please acquire the latest version at the links provided within. If links are broken or do not point to the location indicated, please contact ONCC Predictive Services at 530-226-2730 or OSCC Predictive Services at 951-782-4852.