

From Midwestern Regional Climate Center

Explanation of the weekly Palmer drought and crop moisture data products. (Written by the Climate Analysis Center, NOAA)

The Palmer Drought Severity Index (PDSI) and Crop Moisture Index (CMI) are indices of the relative dryness or wetness effecting water sensitive economies. The PDSI indicates the prolonged and abnormal moisture deficiency or excess. The CMI gives the short-term or current status of purely agricultural drought or moisture surplus and can change rapidly from week to week. Both indices indicate general conditions and not local variations caused by isolated rain. Calculation of the PDSI and CMI are made for 350 climatic divisions in the United States and Puerto Rico. Input to the calculations include the weekly precipitation total and average temperature, division constants (water capacity of the soil, etc.) and previous history of the indices.

The PDSI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. It can be used to help delineate disaster areas and indicate the availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and potential intensity of forest fires. The CMI can be used to measure the status of dryness or wetness affecting warm season crops and field activities.

The equation for the index was empirically derived from the monthly temperature and precipitation scenarios of 13 instances of extreme drought in western Kansas and central Iowa and by assigning an index value of -4 for these cases. Conversely, a +4 represents extremely wet conditions. From these values, 11 categories of wet and dry conditions are defined (Table 1). The index is a sum of the current moisture anomaly and a portion of the previous index to include the effect of the duration of the drought or wet spell. The moisture anomaly is the product of a climate weighting factor and the moisture departure. The weighting factor allows the index to have a reasonably comparable local significance in space and time. A value for a division in Florida would have the same local implication as a similar value in a more arid division in western Kansas. The moisture departure is the difference of water supply and demand. Supply is precipitation and stored soil moisture and demand is the potential evapotranspiration, the amount needed to recharge the soil, and runoff needed to keep the rivers, lakes, and reservoirs at a normal level.

The duration of the drought (or wet spell) is determined by calculating indices for different weather spells (incipient and established wet and dry spells). A week of normal or better rainfall is welcome in an area that has experienced a long drought but may be only a brief respite and not the end of the drought. Once a weather spell is established (by computing a 100% "probability" that an opposite weather spell has ended), the final value is assigned. In order for the program to have a real-time significance, a value is assigned based on a greater than 50% "probability" that the opposite weather spell has ended. This is not entirely satisfactory, but it does allow the index to have a value when there is a doubt as to whether it should be positive or negative. A "F" is placed after the PDSI when a weather spell is established and a "P" when a weather spell is not established.

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The CMI was developed from some of the moisture accounting procedures used in computing the PDSI. This index is the sum of the evapotranspiration anomaly (which is generally negative or slightly positive) and the moisture excess (either zero or positive). Both terms are a function of the previous week and a measure of the current week. The evapotranspiration anomaly is weighted to make it comparable in space and time. If the potential moisture demand exceeds available moisture supplies, the CMI is negative. However, if moisture meets or exceeds demand the index is positive. It is necessary to use two separate legends because the resulting effects are different when the moisture supply is improving than when it is deteriorating (Table 2). The stage of crop development and soil type should be considered when using this index. In irrigated regions, only departures from ordinary irrigation requirements are reflected.

A parameter obtained from the calculations is the monthly moisture anomaly (Z) index which is the product of the moisture departure of the most recent 4 weeks and a climate weighting factor. This index can be used as an indicator of forest fire ignition. The classes of dry and wet periods for the different index values are given in table 3.

Another parameter derived from the calculations is the additional precipitation in inches needed to bring the PDSI to near zero. This parameter is computed for all values of the current week's PDSI less than -.5 and left blank for all values greater than or equal to -.5. The precipitation values are the theoretical, additional amounts required to end the drought in each climatic division. In using this parameter to make projections, it must be realized that these values are instantaneous, valid only for the current week. To end the drought in a given climatic division for the oncoming period, the amount listed plus near-normal rainfall must occur.

The following is a listing of the parameters in the files and their meaning. Temperature and precipitation are data received from the field and the other parameter are results of the Palmer drought and crop moisture data calculations. The week number in the heading is the week of the growing season where week one is the week with the first Wednesday in March. The computations are reinited each year for week one using the output of the February Palmer data run. All initial data are replaced with the historical data received from the National Climatic Data Center in Asheville when available and the calculations rerun.

Columns of the Weekly Palmer Drought and Crop Moisture Data Files

- ST - State (states are grouped in each file by NWS region).
- CD - Climate division (CD) number in the state.
- TMP - Average weekly temperature (F) in the CD.
- PRCP - Total weekly precipitation (inches) in the CD.
- SOIL MOIST UPPR LAYR - Soil moisture in the upper layer at the end of the week (water capacity is one inch).
- SOIL MOIST LOWR LAYR - Soil moisture in the lower layer at the end of the week (water capacity in inches is a function of the average

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soil type in the CD).

- PCT FLD CPC END WEEK - The percent of field capacity of moisture in the soil at the end of the week. This value is the ratio of the soil moisture in the upper and lower layers to the available water capacity expressed in percent.
- POT EVAP - Potential evapotranspiration using Thornwaites method (based on temperature, solar declination angle, and division constants such as mean latitude).
- RUN OFF - Run off in inches at the end of the week.
- CROP MOIST INDEX - Crop moisture index (CMI). Values indicate dry or wet conditions in the short term.
- CHNG FROM PREV WEEK - The difference of the previous week's CMI from the current CMI (negative values indicate a drying of the soil).
- MONTH MOIST ANOML (Z) INDEX - The monthly moisture anomaly (Z) index.
- PRELIM FINAL PALMER DROUTH INDEX - Either a preliminary or a final Palmer Drought Severity Index (PDSI). Values indicate long term conditions.
- P - Preliminary. The listed PDSI could revert to a different value if the current weather trend (dry or wet) reverses to an opposite trend before it becomes established.
 - F - Final. A weather spell is established and the PDSI is final.
- PRCIP NEED TO END DROUTH - The additional precipitation in inches needed for the given week and CD to bring the PDSI up to a -.5 (the upper limit of a incipient drought). For any PDSI greater than or equal to -.5, this parameter is left blank.

TABLE 1

PDSI values for the 11 drought (or wet) categories.

4.0 and above	Extreme moist spell
3.0 to 3.99	Very moist spell
2.0 to 2.99	Unusual moist spell
1.0 to 1.99	Moist spell
.5 to .99	Incipient moist spell
.49 to -.49	Near normal
-.50 to -.99	Incipient drought
-1.0 to -1.99	Mild drought
-2.0 to -2.99	Moderate drought
-3.0 to -3.99	Severe drought

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-4.0 and below

Extreme drought

TABLE 2

CMI values when the index increased or did not change from the previous week.

3.0 and above	Excessively wet, some fields flooded
2.0 to 2.99	Too wet, some standing water
1.0 to 1.99	Prospects above normal, some fields too wet
0 to .99	Moisture adequate for present needs
0 to -.99	Prospects improved but rain still needed
1.0 to -1.99	Some improvement but still too dry
-2.0 to -2.99	Drought eased but still serious
-3.0 to -3.99	Drought continues, rain urgently needed
-4.0 and below	Not enough rain, still extremely dry

CMI values when the index decreased

3.0 and above	Some drying but still excessively wet
2.0 to 3.99	More dry weather needed, work delayed
1.0 to 1.99	Favorable, except still too wet in spots
0 to .99	Favorable for normal growth and fieldwork
0 to -.99	Topsoil moisture short, germination slow
-1.0 to -1.99	Abnormally dry, prospects deteriorating
-2.0 to -2.99	Too dry, yield prospects reduced
-3.0 to -3.99	Potential yields severely cut by drought
-4.0 and below	Extremely dry, most crops ruined

TABLE 3

Z index values for dry and wet periods

3.50 and above	Extreme wetness
2.50 to 3.49	Severe wetness
1.00 to 2.49	Mild to moderate wetness
-1.24 to .99	Near normal
-1.99 to -1.25	Mild to moderate drought
-2.74 to -2.00	Severe drought
-2.75 and below	extreme drought

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Last Modified: May 30, 1997

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