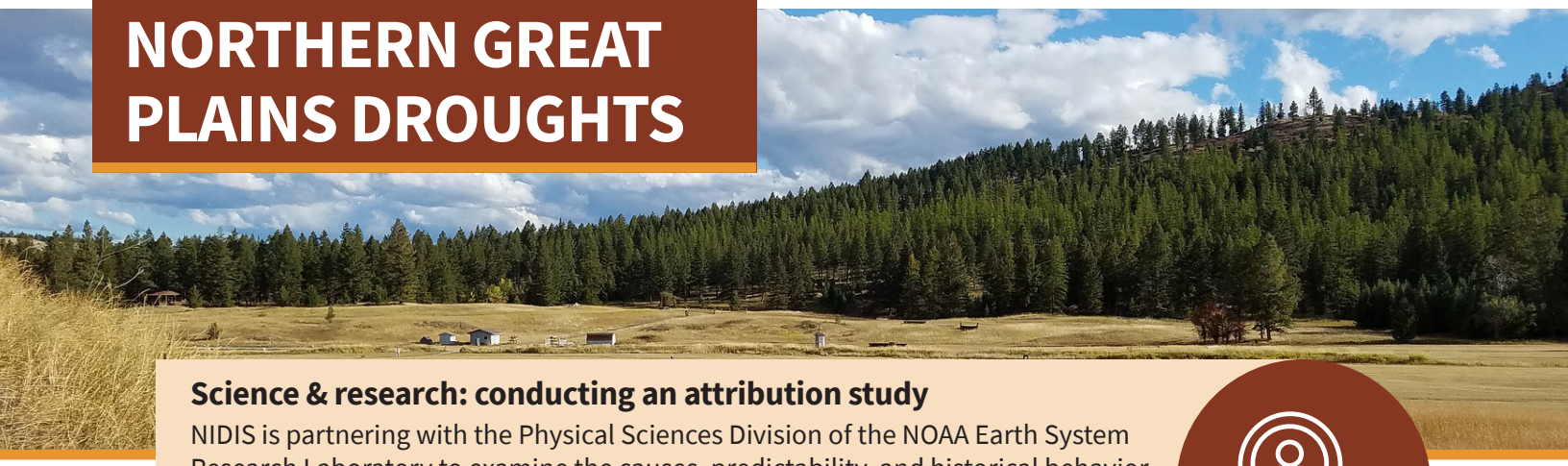
HISTORICAL CHARACTER OF U.S. NORTHERN GREAT PLAINS DROUGHTS

National Integrated Drought Information System
Drought.gov



Science & research: conducting an attribution study

NIDIS is partnering with the Physical Sciences Division of the NOAA Earth System Research Laboratory to examine the causes, predictability, and historical behavior of droughts over the Northern Plains. Drought behavior in the Northern Plains is understudied relative to other regions of the United States, and this research will help to lay a foundation for understanding drought predictability.

This study examines characteristics of past droughts over the U.S. Northern Great Plains region (shown in Fig. 1). There have been several instances of severe droughts over large areas of this region between 1916-2015 (Fig. 2). While a majority of those droughts lasted less than one year, prolonged drought periods do occur every few decades; e.g., the 1930s Dust Bowl, 1955-1960 and 1988-1990.

Drought over the Northern Plains is largely driven by short-term (months to seasons) and long-term (years to decades) tendencies in precipitation. The driest decade for the Northern Plains resulted in the Dust Bowl of the 1930s. However, even during the Dust Bowl, months of above-average precipitation were observed, which provided for short periods of temporary improvement during an otherwise protracted drought. By contrast, 2006-2015 was the wettest 10-year span over the Northern Plains since 1916, resulting in few droughts.

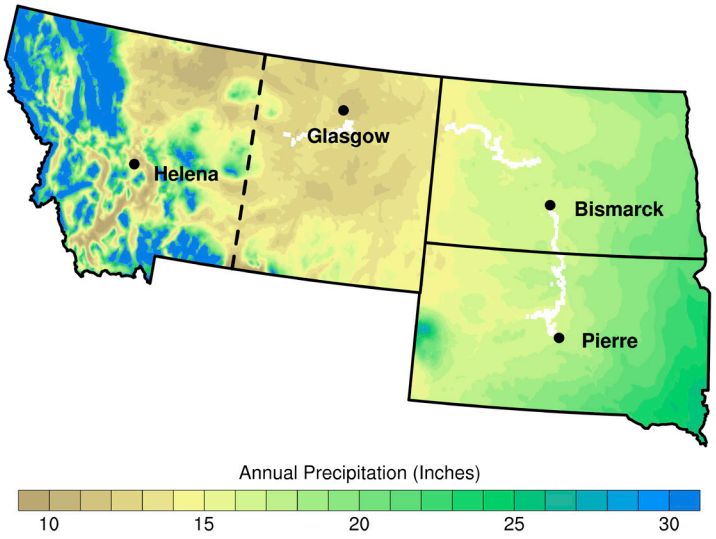


Fig. 1. Map of the U.S. Northern Great Plains region, which for this study comprises of North Dakota, South Dakota and Montana east of the 109˚W meridian (dashed line). Background shading shows annual average precipitation in inches.

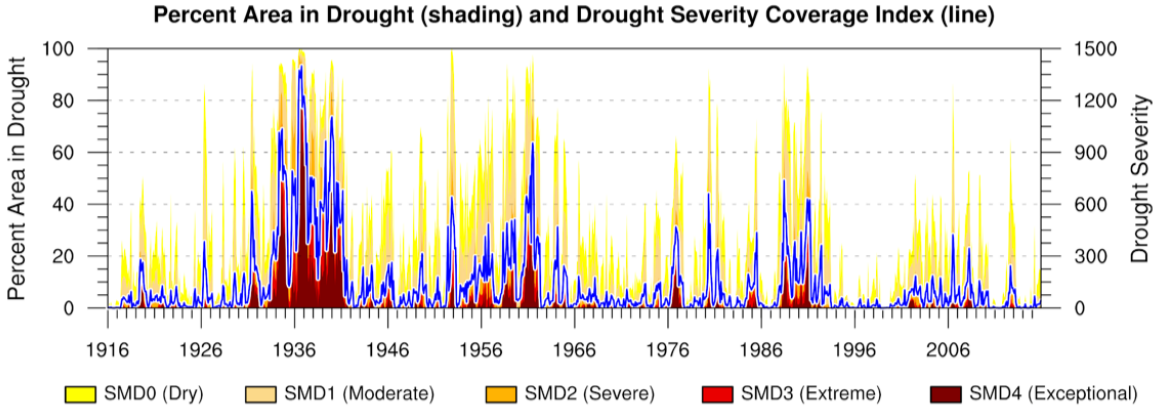


Fig. 2. Percent area affected by drought soil moisture categories (shading) between 1916-2015. Blue line shows the Drought Severity Coverage Index.

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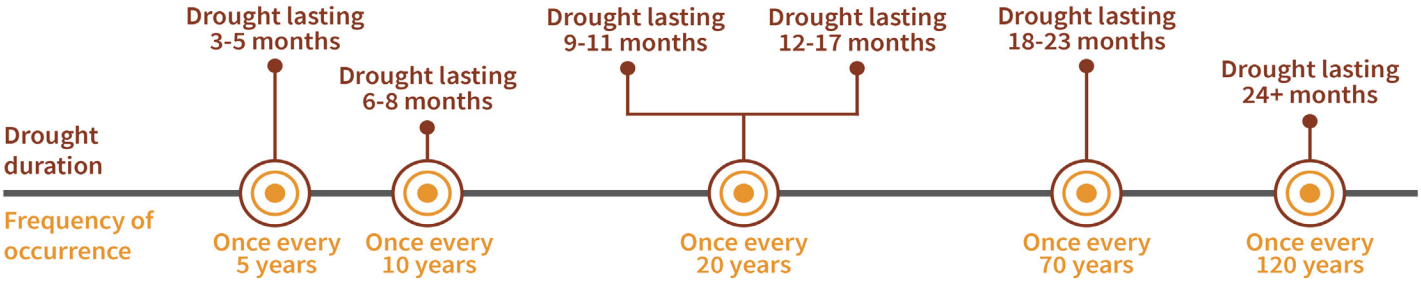


▲ **Fig. 3.** Estimates of the likelihood of consecutive months in drought.

Methods

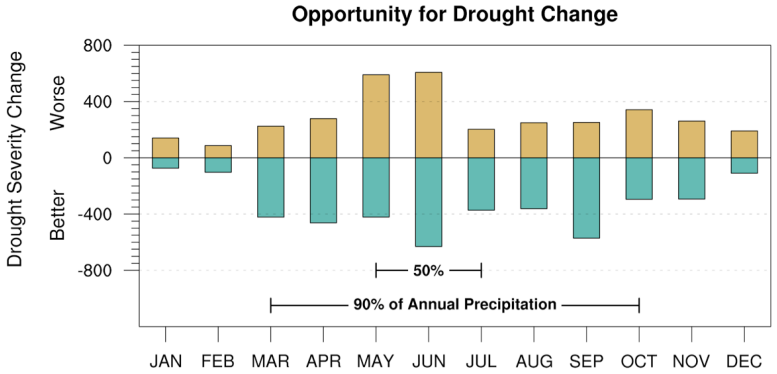
All analyses in this study are performed for the region containing North Dakota, South Dakota and Montana east of the 109˚W meridian (Fig. 1). Metrics analyzed include percent of area covered by five drought severity categories and the Drought Severity Coverage Index (DSCI). The drought classification follows the U.S. Drought Monitor (USDM) soil moisture percentiles, given the importance of agriculture over the Northern Plains. The DSCI is a weighted sum of the five USDM drought categories[1].

Time series of observed drought extent and severity (Fig. 2) and the range of month-to-month changes in the DSCI (Fig. 4) between 1916-2015 are estimated using 1-m soil moisture based on a land surface model driven by the observed meteorology[2]. Month-to-month changes in the DSCI are used to inform the rate at which drought can improve or worsen in different months of the year.

The likelihood of consecutive months with DSCI of greater than 150 are estimated based on 1-m soil moisture in 4000 years of climate model simulations (Fig. 3). A DSCI of 150 was chosen to reflect the intensity of notable droughts during 1916-2015 (Fig. 2). The simulations are based upon a coupled atmosphere-land model with prescribed boundary conditions[3]. The model effectively captures the seasonal cycle of precipitation, evapotranspiration, and temperature across the Northern Plains.

[1] http://droughtmonitor.unl.edu/AboutUSDM/DroughtClassification.aspx
[2] http://www.hydro.washington.edu/forecast/monitor/curr/conus.mexico/data.shtml
[3] https://www.esrl.noaa.gov/psd/repository/alias/facts

The likelihoods of how long droughts of given severity and coverage can last in the Northern Plains are estimated using climate model simulations, which indicate that short-duration droughts (months to seasons) occur more frequently than long-duration droughts (multi-year) (Fig. 3). Droughts lasting 3-5 months are fairly common, occurring once every 5 years. The recurrence interval of droughts that last between 9-11 months is about once every 20 years. Finally, droughts lasting two years or longer are quite rare, occurring once every 120 years.



▲ **Fig. 4.** Plausible changes in drought severity from one month to another.

The months of preferential drought change - both improvement and worsening - are related to the average seasonal variations in precipitation (Fig. 4). Noteworthy changes to drought conditions can occur between March and October, a period during which, on average, 90% of the annual precipitation falls. The largest changes in drought conditions can occur between May and July (when 50% of annual precipitation falls on average). During the spring and fall seasons, which register lower precipitation on average relative to May-July, marked drought improvements are still possible due to occasional seasonally-intense precipitation.

Have questions about the report? Please contact:

Andrew Hoell | Meteorologist
Physical Sciences Division, NOAA ESRL
andrew.hoell@noaa.gov

Imtiaz Rangwala | Research Scientist
Physical Sciences Division, NOAA ESRL
CIRES, University of Colorado-Boulder
imtiaz.rangwala@noaa.gov