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2.a.1 Monitoring global drought using the self-calibrating Palmer Drought Severity Index

Index - J. Barichivich, T. J. Osborn, I. Harris, G. van der Schrier and P. D. Jones

Hydrological drought results from a period of abnormally low precipitation, sometimes exacerbated by a concurrent increase in evapotranspiration (ET). Its occurrence can be apparent in reduced river discharge, soil moisture, and/or groundwater storage, depending on season and duration of the event. Here, a simple estimate of drought called the self-calibrating Palmer Drought Severity Index (scPDSI; Wells et al. 2004; van der Schrier et al. 2013) is presented, using global precipitation and Penman-Monteith Potential ET from an early update of the CRU TS 4.05 dataset (Harris et al. 2020). Moisture categories are calibrated over the complete 1901–2020 period to ensure that "extreme" droughts and pluvials (wet periods) relate to events that do not occur more frequently than in approximately 2% of the months. This calibration affects direct comparison with other hydrological cycle variables in Plate X that use a different baseline period.

The sharp increase in global drought area (based on different severities of the scPDSI) that began in mid-2019 (Barichivich et al., 2020) continued in 2020 and reached a historical peak in October 2020, with a small decrease afterwards (Fig. Y). Around 6.8% of the global land area experienced extreme drought conditions in October, marking the third historical peak since 1950 after earlier peaks in October 1984 (7.7%) and October 1983 (7.3%). The extent of severe plus extreme drought conditions peaked at 15% of the global land area in October and November, matching the largest historical peaks of this drought severity in September 1983. Moderate or worse drought conditions peaked in August at 27.8% of the global land

area, marking the fifth historical peak after June 1987 (29.6%) and the largest peak since August 2002 (29%).

Extensive severe-to-extreme drought conditions during 2020 affected most of the Southern Hemisphere, southern and central Europe, the Middle East and Southeast Asia (Plate X). Compared to 2019 (Barichivich et al., 2020), drought severity worsened to extreme in central South America (Fig. Z). Worsening drought during the austral summer contributed to ravaging fires across the Chaco floodplains and Pantanal wetland in northern Argentina, Paraguay and southern Brazil (Rodríguez, 2020). The decadal drought in north-central Chile (Garreaud et al., 2017; Alvarez-Garreton et al., 2021) continued through its 11th year in 2020, with extreme conditions in the central and most populated region of the country (Plate X). In North America, the east-west moisture contrast observed across the US since 2017 also persisted during 2020 (Plate X). Extensive wetter conditions extended over the whole eastern half of the country and moderate but protracted drought prevailed in the west. Under these persistent drought conditions, California saw another extreme season of wildfires (Goss et al., 2020), which might repeat in 2021 as La Niña conditions continue.

Previous drought conditions in southern Africa eased slightly, but worsened in northern Mozambique (Fig. Z). South Africa declared a state of disaster as many parts of the country persisted under extreme drought since 2018. Wetter conditions from 2019 in most of Central and East Africa persisted in 2020 (Plate X), though moisture anomalies in these regions are uncertain because of sparse coverage of station data. Previous drought conditions also eased in Australia (Fig. Z) but most of the country persisted under drought during 2020 (Plate X).

In Southeast Asia, extreme drought because of a weak Monsoon affected Malaysia, Myanmar, Thailand, Cambodia, Vietnam and particularly Laos (Plate X), resulting in record low levels of the Mekong River. Extreme drought affected a vast region of northeastern Siberia. Dry conditions through the Sakha Republic, Russia, were associated with anomalously extensive wildfires that burned around 6 million hectares. The entire mid-latitude belt from Mongolia in central Asia to western Europe and the Mediterranean saw moderate to extreme drought severity during 2020 (Plate X). Extreme drought in Europe was once again exacerbated by increasingly recurrent spring and summer heatwaves combined with below-average spring precipitation and antecedent soil moisture deficit. In the midst of two heatwaves, France experienced the driest July in the last 60 years. As in 2019, the most intense drought on the annual average persisted across northern Germany and Poland, where a strong soil moisture deficit has developed since 2018 (Fig. Z). Contrasting wet conditions occurred across northern Europe from the British Isles to Fennoscandia and the Ural Mountains.

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Figures

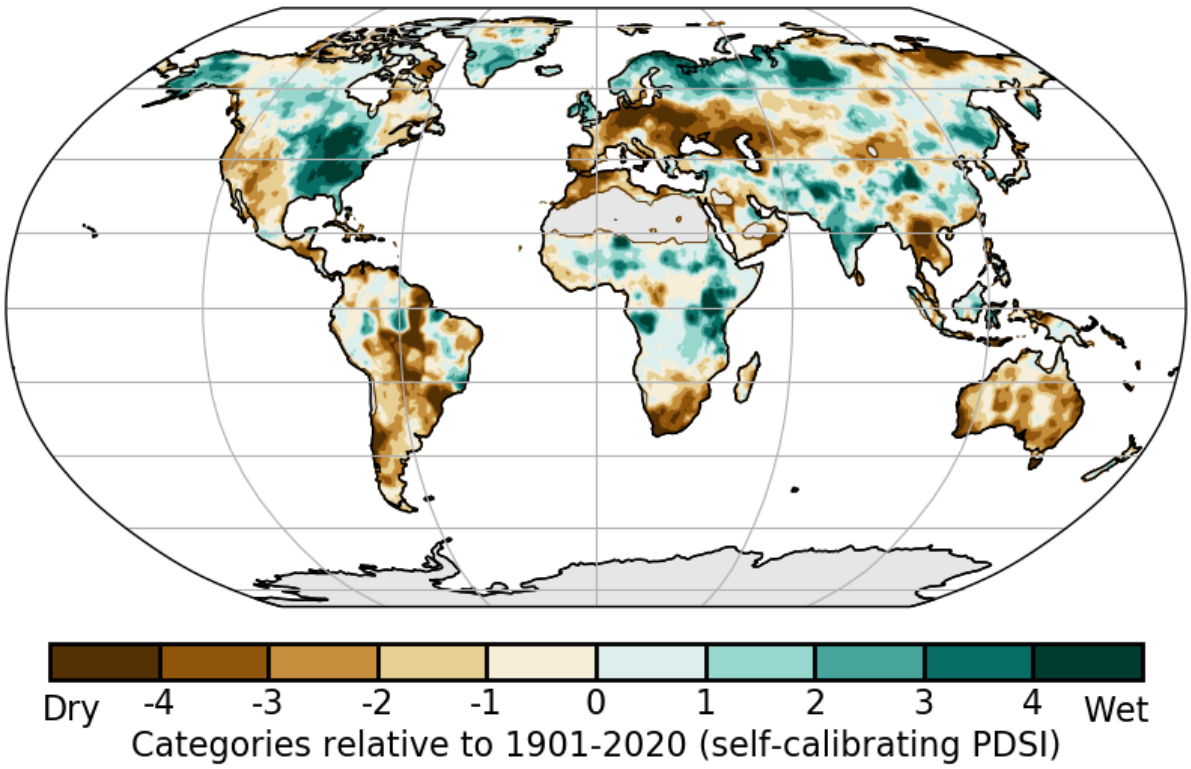

PLATE X. Mean scPDSI for 2020. Droughts are indicated by negative values (brown), wet episodes by positive values (green). No calculation is made where a drought index is meaningless (grey areas: ice sheets or deserts with approximately zero mean precipitation).

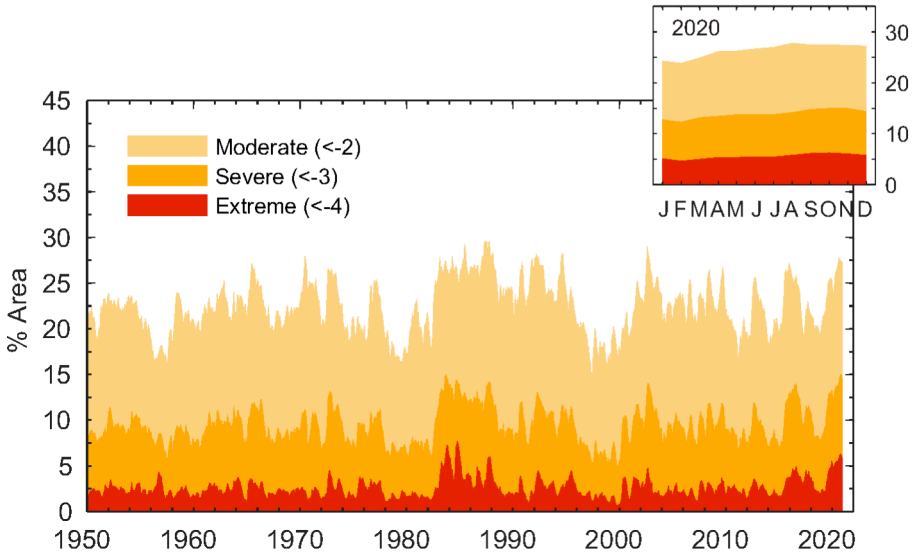

FIG. Y. Percentage of global land area (excluding ice sheets and deserts) with scPDSI indicating moderate (<–2), severe (<–3) and extreme (<–4) drought for each month of 1950–2020. Inset: each month of 2019.

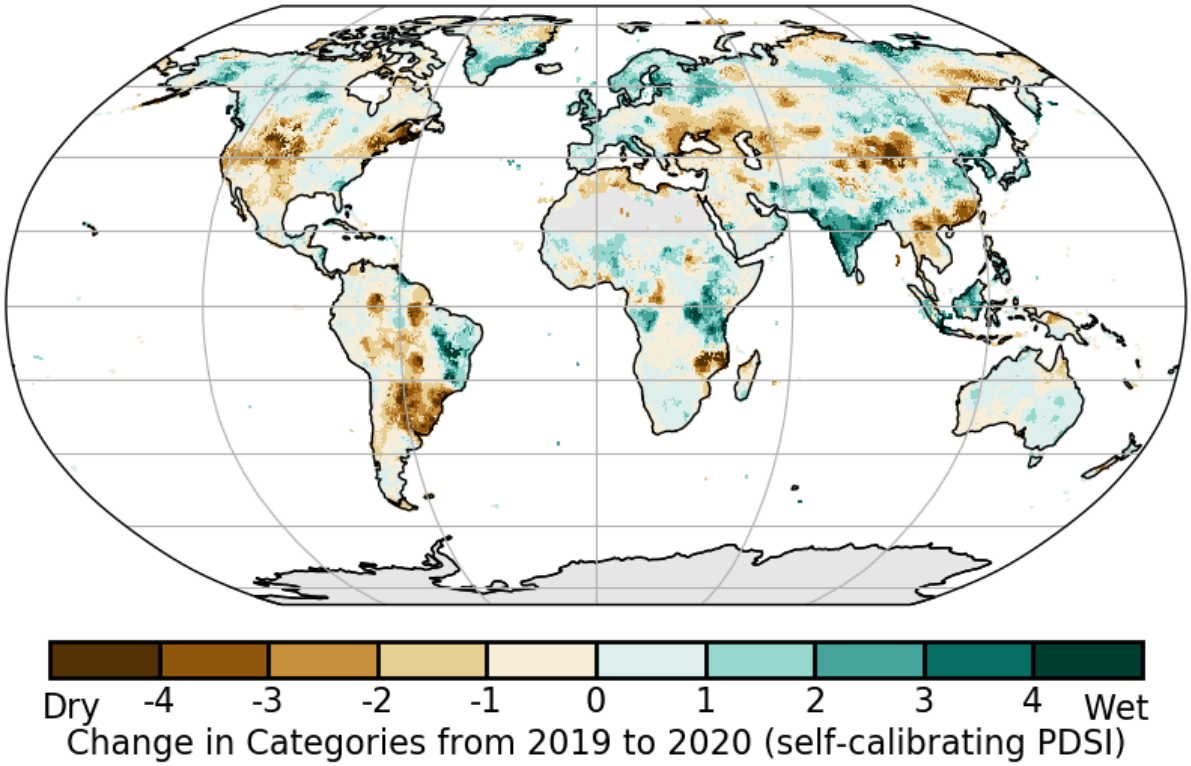

FIG. Z. Change in drought from 2019 to 2020 (mean scPDSI for 2020 minus mean scPDSI for 2019). Increases in drought severity are indicated by negative values (brown), decreases by positive values (green). No calculation is made where a drought index is meaningless (grey areas: ice sheets or deserts with approximately zero mean precipitation).

Datasets used and their URLs

https://crudata.uea.ac.uk/cru/data/drought/

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Summary bullet points

- The sharp increase in global drought area (based on different severities of the scPDSI) that began in mid-2019 continued in 2020 and reached nearly historical peaks in October 2020, with a small decrease afterwards.

Supplementary Information