Chapter 1. Global agroclimatic patterns

Chapter 1 describes the CropWatch Agroclimatic Indicators (CWAIs) rainfall (RAIN), temperature (TEMP), and radiation (RADPAR), along with the agronomic indicator for potential biomass (BIOMSS) in sixty-five global Monitoring and Reporting Units (MRU). RAIN, TEMP, RADPAR and BIOMSS are compared to their average value for the same period over the last fifteen years (called the "average"). Indicator values for all MRUs are included in Annex A table A.1. For more information about the MRUs and indicators, please see Annex B and online CropWatch resources at **www.cropwatch.com.cn**.

1.1 Introduction to CropWatch agroclimatic indicators (CWAIs)

This bulletin describes environmental and crop conditions for the period from July 2020 to October 2020, JASO, referred to as "reporting period". In this chapter, we focus on 65 spatial "Mapping and Reporting Units" (MRU) which cover the globe, but CWAIs are averages of climatic variables over agricultural areas only inside each MRU. For instance, in the "Sahara to Afghan desert" MRU, only the Nile valley and other cropped areas are considered. MRUs are listed in Annex B and serve the purpose of identifying global climatic patterns. Refer to Annex A for definitions and to table A.1 for 2020 JASO numeric values of CWAIs by MRU. Although they are expressed in the same units as the corresponding climatological variables, CWAIs are spatial averages limited to agricultural land and weighted by the agricultural production potential inside each area.

We also stress that the reference period, referred to as "average" in this bulletin covers the 15-year period from 2005 to 2019. Although departures from the 2005-2019 are not anomalies (which, strictly, refer to a "normal period" of 30 years), we nevertheless use that terminology. The specific reason why CropWatch refers to the most recent 15 years is our focus on agriculture, as already mentioned in the previous paragraph. 15 years is deemed an acceptable compromise between climatological significance and agricultural significance: agriculture responds much faster to persistent climate variability than 30 years, which is a full generation. For "biological" (agronomic) indicators used in subsequent chapters we adopt an even shorter reference period of 5 years (i.e. 2015-2019) but the BIOMSS indicator is nevertheless compared against the longer 15YA (fifteen-year average). This makes provision for the fast response of markets to changes in supply but also to the fact that in spite of the long warming trend, some recent years (e.g. 2008 or 2010-13) were below the trend.

Correlations between variables (RAIN, TEMP, RADPAR, BIOMSS) at MRU scale derive directly from climatology. For instance, the positive correlation between rainfall and temperature results from high rainfall in equatorial, i.e. in warm areas.

Considering the size of the areas covered in this section, even small departures may have dramatic effects on vegetation and agriculture due to the within-zone spatial variability of weather. It is important to note that we have adopted a new calculation procedure of the biomass production potential in the August 2019 bulletin. The new approach includes sunshine (RADPAR), TEMP and RAIN. Readers are referred to the August 2019 bulletin for details.

1.2 Global overview

At the global scale, the series of record or close-to-record high temperatures continued throughout this monitoring period: July and August ranked as 2nd, September as 1st and October as the 4th warmest respective months in recent history, according to NOAA, which bases its analyses on a global data set spanning 141 years. For the months from January to October, this was the second warmest period on record. The temperature departure was +1.0°C above the 20th century average.

For most crops, warmer temperatures tend to shorten the growth period, especially the grain filling phase. This means that the crops mature earlier and that the plants have fewer days to absorb solar radiation for photosynthesis. This in turn causes a yield reduction. Extreme high temperature events can reduce pollination in maize or cause terminal heat stress in wheat and lead to crop failures. The critical air high temperature threshold for crop growth is 35ºC. The exact thresholds depend on water supply and relative humidity. The plant canopy is usually a few degrees cooler than the air, due to transpiration. Water stress causes closure of the stomata, reduces evaporative cooling and increases leaf temperature. Climate change not only increases the temperatures, it also causes more frequent droughts that tend to last longer. Plants cannot stay cool due to a lack of water for transpiration and suffer even more from high temperatures. Hence, warmer temperatures in combination with droughts, which are fueled by climate change as well, will greatly increase the likelihood of crop failures and agricultural production will become more volatile.

CropWatch calculates the temperatures over cropland only. Averaged over all cropland, temperatures were the same as the 15-year average (15YA) for this period ranging from July to October, 2020. Rain dropped to below average (-1%) and photosynthetically active radiation (RADPAR) by -2.0%. Due to a reduction in solar radiation and rainfall, the estimated biomass (BIOMSS) dropped to below average levels as well (-3%).

Overall, the prospects for crop production were quite favorable, mainly because no prolonged, large scale droughts were observed. In many regions, the crops benefitted from the above-average rainfall that had been recorded for the previous monitoring period. The stored soil moisture helped sustain crop growth, even when precipitation was below average. Below-average rainfall was recorded for Central and South America (-14%) and North America (-11%). Conditions were drier than usual in Europe as well (-6%). Above-average rainfall was recorded for Central Asia (+20%) and East Asia (+19%). The latter started this monitoring period under drought conditions, but a series of typhoons and tropical depression brought large amounts of rainfall to that region. Conditions turned back to normal in Oceania as well, where rainfall was 8% above average.

Above-average temperatures were recorded for Central and South America (+0.5ºC) and Europe (+0.4ºC). For Central and East Asia, a drop to below average temperatures was observed (-0.4ºC). On the other continents, temperatures fluctuated around the long-term mean.

A large drop in solar radiation was observed for East Asia (-10%), followed by Central Asia (-5%) and Oceania (-4%). The only positive deviation was observed for Central and South America (+1%).

Biomass dropped by 10% for East Asia. It also dropped in Central and South America (-4%), followed by North America (-3%) and Africa (-3%). Conditions in Africa stayed close to the mean for rainfall (-3%), temperatures (-0.2ºC) and solar radiation (-3%). Hence, conditions for Africa were close to normal.

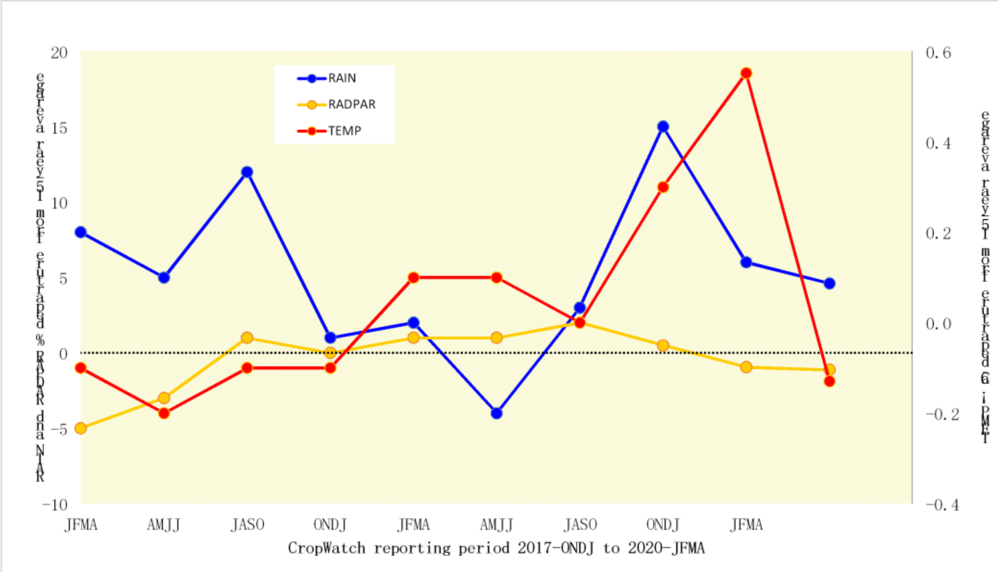

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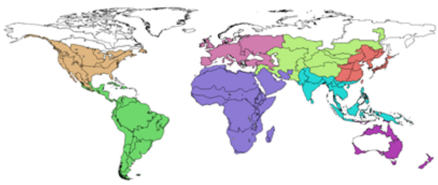
Figure 1.1 Global departure from recent 15 year average of theRAIN, TEMP and RADPAR indicators since 2017 ONDJ period (average of 65 MRUs, unweighted)

Table 1.1 Departures from the recent 15-year average of CropWatch agro-climatic indicators over regional MRU groups. Within each group, averages are weighted by the agricultural area of individual MRUs. "Others" include five non agricultural areas shown in white in the map. They are located mostly at high northern latitudes, and characterized by the largest positive TEMP departure. Some of them experienced unusually intense fires in their recent summer season.

	RAIN %	TEMP °C	RADPAR %	BIOMSS %
Africa	-3	-0.2	-2.6	-3.3
America S + C	-14	0.5	1.3	-4.1
America N	-11	-0.1	0.1	-3.5
Asia centre	20	-0.4	-4.7	0.9
Asia East	19	-0.4	-10.0	-10.2
Asia South	6	0.2	-1.6	-0.8
Europe	-6	0.4	-1.0	-1.2
Oceania	8	0.2	-4.2	-1.5
Others	-3	0.0	-0.3	-2.2
World	-1.0	0.0	-2.0	-3.0



1.3 Rainfall

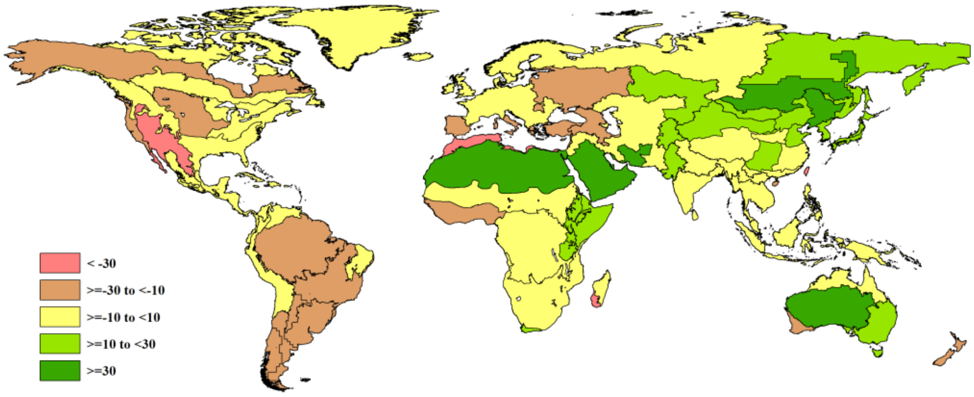


Figure 1.2 Global map of rainfall anomaly (as indicated by the RAIN indicator) by CropWatch Mapping and Reporting Unit: departure of July to October 2020 total from 2005-2019 average (15YA), in percent.

Rainfall was below average in most CropWatch Mapping and Reporting Units (MRU) of North America. The sharpest drop was observed for the Southwest of the United States and North Mexican Highlands (-36%), followed by the West Coast (-30%) and the Northern Great Plains (-17%). Moisture conditions were generally favorable in North America during the previous reporting period, except for the Western United States, where severe drought conditions had already been observed for the April to July period. Hence, the reduced rainfall had a limited negative impact on crop yields. The cotton belt to Mexican Nordeste received 5% more rainfall than the 15YA. The only other MRU with a positive departure in North America was Sub-boreal America. The Caribbean also received above-average rainfall (+7%), whereas all other MRUs in Central and South America experienced a rainfall deficit. The largest deficit was observed for the Pampas (-24%), followed by the Semi-arid Southern Cone (-19%), Amazon (-18%), Western Patagonia (-17%) and Central and Eastern Brazil (-16%). Hence, conditions in the Americas were generally drier than normal.

In Africa, where generally abundant rainfall had been observed for the last period, the conditions were more variable: The MRU from the Sahara to the Afghan desert received 46% more rainfall, yet the total was still low, at 33 mm. The Horn of Africa continued to receive above-average rainfall (+29%), as well as the Western Cape (+13%) and the East African Highlands (+10%). The wheat crops grown in these regions definitely benefitted from the above-average rainfall. Much drier-than-usual conditions were observed for Southwest Madagascar (-42%) and North Africa-Mediterranean (-36%) and the Gulf of Guinea (-22%).

Western Europe, which suffered from a rainfall deficit in the previous reporting period, received 10% more rainfall than usual. In all the other regions, Caucasus (-26%), Ukraine to Ural mountains (-11.5) and Mediterranean Europe and Turkey (-18%) a shortage of rainfall was observed.

In all of Central Asia, more rainfall than usual was recorded. The positive departures ranged between +59% in Eastern Central Asia and +8% for Qinghai-Tibet. This had a positive impact on cereal production in those MRUs.

Above-average rainfall was recorded for all MRUs in East Asia, except for Taiwan (China) (-60%). North-East China, which was hit by typhoons, had 46% higher rainfall, followed by Inner Mongolia (+24%) and Huanghuaihuai (+24%). The East Asia MRU received 25% more rainfall.

Conditions in South Asia were close to normal. Hainan received 25% less rainfall, whereas the largest positive departure was observed for the Punjab to Gujarat (+21%).

In Oceania, conditions were close to average, but mixed as well. Queensland to Victoria received more rainfall (+21%), whereas Nullarbor to Darling (-21%) and New Zealand (-18%) received less rainfall.

1.4 Temperatures

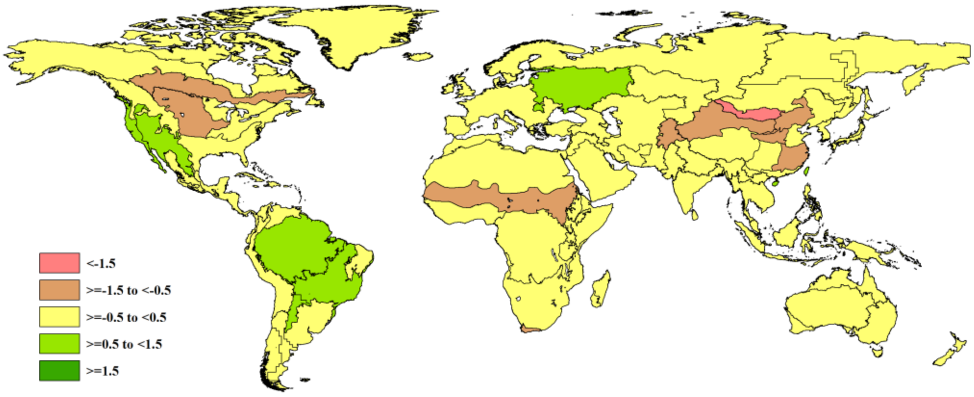


Figure 1.3 Global map of temperature anomaly (as indicated by the TEMP indicator) by CropWatch Mapping and Reporting Unit: departure of July to October 2020 average from 2005-2019 average (15YA), in °C

Temperatures were above average in the West Coast (+1.2ºC) and Southwest of the United States and North Mexican Highlands (+0.9ºC), the two MRUs which had experienced the largest drop in rainfall. Noteworthy are the slightly cooler conditions in the Northern Great Plains (-0.6ºC) and Corn Belt (-0.3ºC).

In South America, warmer conditions were measured for Central eastern Brazil (+0.9ºC), Amazon (+0.6ºC) and Central-north Argentina (+0.6ºC). Slightly above-average temperatures were recorded in the other MRUs of South America, except for Western Patagonia (-0.3ºC) and the Semi-Arid Southern Cone (-0.1ºC).

In Africa, cooler weather was recorded for the Western Cape (-0.6ºC) and the Sahel (-0.6ºC). The East African Highlands also experienced cooler temperatures than the 15YA: (-0.4ºC).

East Asia not only experienced more rainfall, but temperatures were cooler as well in return. The only exception is Taiwan (China), where the departure from the 15YA was +1.1ºC. In the MRUs of China, the largest negative departures were observed for the Loess region (-0.7ºC) and Inner Mongolia (-0.7ºC).

In Oceania, the departures ranged from +0.5ºC in New Zealand and Nullarbor to Darling to no departure for Queensland to Victoria.

1.5 RADPAR

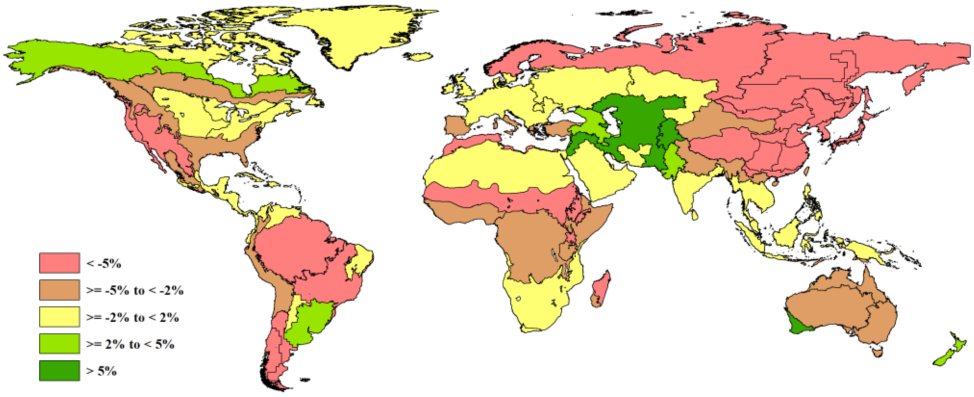


Figure 1.4 Global map of photosynthetically active radiation anomaly (as indicated by the RADPAR indicator) by CropWatch Mapping and Reporting Unit: departure of July to October 2020 total from 2005-2019 average (15YA), in percent.

In the Americas, the photosynthetically active solar radiation generally stayed close to the 15YA. In Africa, the East African highlands received 5.2% less solar radiation than usual, followed by Southern Africa (-3.6%) and Sahel (3.2%). In all the other MRUs of Africa, RADPAR departures were closer to zero. Similarly, RADPAR stayed close to average in Europe. However, sharp negative departures were observed for

Central and East Asia. The MRU Eastern Central Asia received 10.3% less solar radiation. However, the largest drop was observed for East Asia: In Southwest China, the departure was -18%. All important crop production regions of China also received less RADPAR: Lower Yangtze (-9.5%), Huanghuaihai (-5.1%), Loess region (-5.6%) and Northeast China (-8.6%). In South Asia, only Southern China (-6.5%) and Hainan (-5.4%) experienced a serious drop. A drop by -6.4% observed for Queensland to Victoria is noteworthy as well.

1.6 BIOMSS

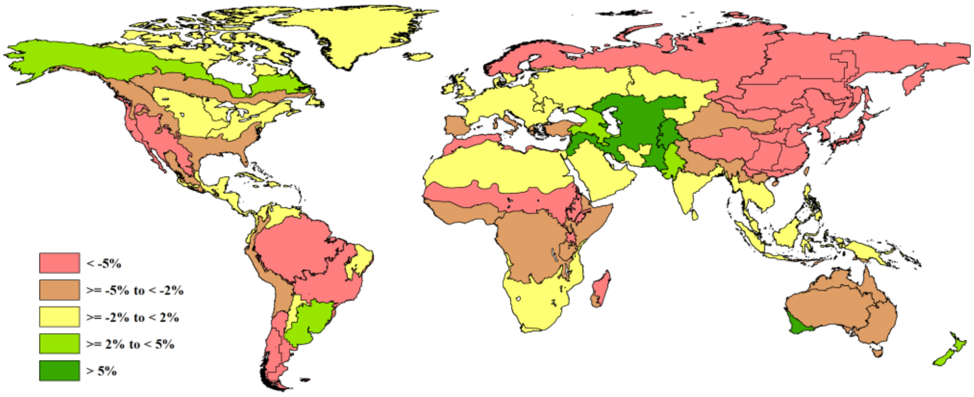


Figure 1.5 Global map of biomass accumulation (as indicated by the BIOMSS indicator) by CropWatch Mapping and Reporting Unit (MRU), departure from 15YA between between July to October 2020

In the Americas, large negative departures in biomass (BIOMSS) production estimates were calculated for SW U.S. and N. Mexican highlands (-14.8%) and the West Coast (-14.3%) because of the drought conditions. For Central eastern Brazil (-8.8%) and Amazon (-7.6%) rather large drops were estimated. Otherwise, the changes were relatively small.

In Africa, negative departures were estimated for the East African Highlands (-8%) and the Horn of Africa (-4.9%). For the other regions with significant crop production during this reporting period, the drops were relatively small.

In Europe, slight drops were estimated as well, with the exception of the Caucasus (+3.9%).

Larger changes were estimated for Central Asia: Eastern Central Asia had a drop by 11.7%, whereas the Pamir area had an increase by 8.9%.

In East Asia, the largest negative departures were calculated during this monitoring period: Southwest China (-17%) was followed by the MRU East Asia (-9.9%), Lower Yangtze (-9.6%), Loess region (-9.2%), North East China (-6.3%) and Huanghuaihuai (-6.1%).

For South Asia, the largest drop was estimated for Southern China (-5.0%). In the other MRUs, departures from the 15YA were minor.