Chapter 1. Global agroclimatic patterns

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

1.1 Overview

Connections between variables

A statistical analysis of table A.1 (CWAIs by CropWatch MRU) illustrates the fact that climatic variables and their spatial variations are interconnected. Alongside the climatologically expected correlations such as RAIN-TEMP (more rainfall in tropical areas, r=0.425, N=65) and TEMP-RADPAR (temperature is higher in high sunshine areas), the current reporting period is also characterized by some associations that can be used to add some coherence to the patterns observed in figures 1.1 to 1.4. They include a weak but positive correlation between rainfall departure from average and temperatures departures; that is, excess rainfall is linked to above-average temperature (r=0.339), an observation that has been made repeatedly in the semi-arid tropics and which is consistent with climate change projections. Since we also have a correlation (albeit negative) between TEMP and TEMP anomaly (-0.680), the current period was characterized by major temperature departures in the temperate areas. The same observation was made based on the January-April 2016 data. Finally, with the CropWatch biomass production potential (BIOMSS) being based on rainfall and temperature, a clear association also exists between BIOMSS departures and the departures in RAIN and TEMP, with RAIN variability accounting for just under 90% of the BIOMSS variability, and even more so at low rainfall values. It is also stressed that the reference period for CWAIs is the recent fifteen years, while for BIOMSS it is five.

Figure 1.1. Global map of January-April 2017 rainfall anomaly (as indicated by the RAIN indicator) by MRU, departure from 15YA (percentage)

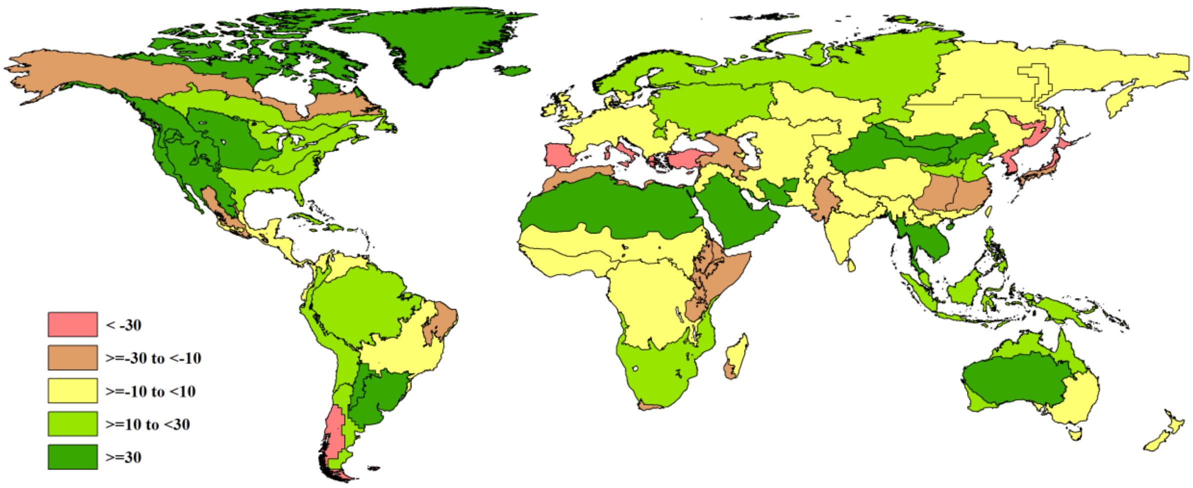
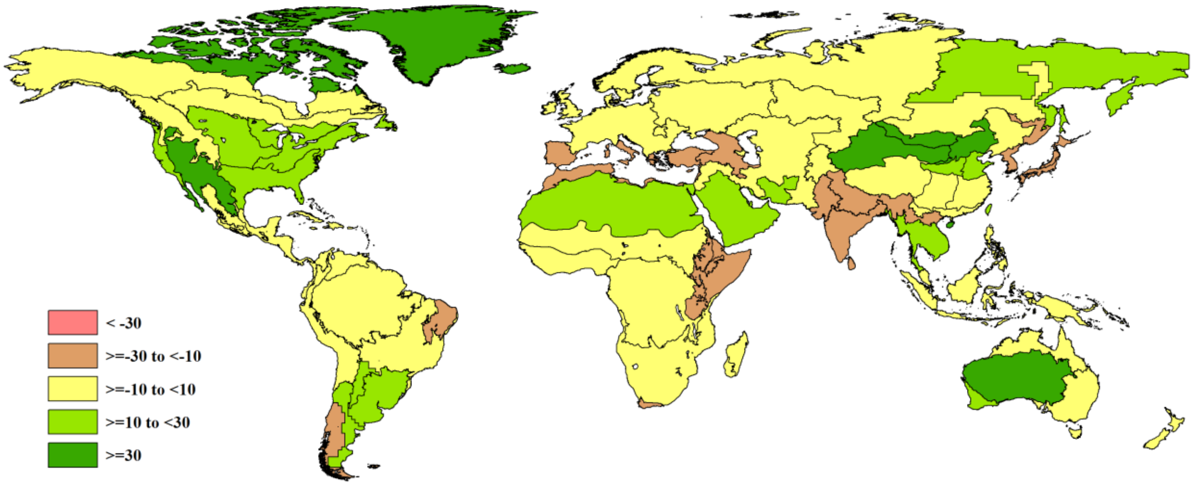


Figure 1.2. Global map of January-April 2017 biomass accumulation (BIOMSS) by MRU, departure from 5YA (percentage)



Rainfall and BIOMSS anomalies

Since rainfall and biomass are very directly connected, the BIOMSS anomalies are mentioned where appropriate in this section arranged according to rainfall anomalies. Figures 1.1 and 1.2 present the global maps showing the rainfall (1.1) and BIOMSS (1.2) anomalies over the reporting period.

Last year's May bulletin had identified some typical El Niño-related patterns, some of which persist into the current year and may be related to normal climate persistence (inertia) or to the possibility that 2017 may be another El Niño year (refer to section 5.4 on El Niño). Depending on prevailing climate conditions and the amounts of rainfall actually recorded, the anomalies do not always qualify as "drought" or "floods" as the impact on agriculture also varies as a function of the status of the local crop phenology. Typically, drought during the dormancy phase of winter crops is not immediately threatening crop production if adequate rainfall becomes available at the time when growth starts in spring. The "rainfall history" of the various MRUs also plays a part, of which two typical examples would be (i) abundant rainfall before the reporting period (which would have ensured that sufficient moisture had been stored in the soil before the dry spell) and (ii) even a minor deficit following another deficit period, which can result in disastrous conditions. Such situations are mentioned below.

Negative rainfall anomalies

The largest negative rainfall anomalies (RAIN shortage below -20%) all affect several MRUs and can be grouped into eight clusters. They are characterized by temperature values close to average in the range from -0.7°C (Horn of Africa, MRU-04 and the Caucasus, MRU-29) to +0.9°C (Brazilian Nordeste, MRU-22) or +1.0°C (Eastern Asia, MRU-43).

- *Eastern Asia.* In eastern Asia, where the largest MRU anomalies occurred, areas include the following: East Asia (MRU-43) with just 103 mm of rainfall, corresponding to a -43% deficit (BIOMSS: -18%), Southern Japan (MRU-46, 283 mm or -27%; BIOMSS, -11%), and the Lower Yangtze region in China (MRU-37) where the recorded amount (349 mm) is 21% below average (BIOMSS, -61%). These are winter crop areas where the situation needs close monitoring, which applies as well to summer crops planted now or to be planted, as they may suffer initial soil moisture stress.
- *Mediterranean basin.* The Mediterranean basin includes two MRUs. In the first, Mediterranean Europe and Turkey (MRU-59), 170 mm of rainfall were recorded (RAIN, -34%; BIOMSS: -26%); in the second, North Africa (MRU-07), rainfall was 20% below the average with just 126 mm

(BIOMSS, -17%). In particular the southern Mediterranean has recently experienced drought, as was reported in section 5.2 of the August 2016 bulletin.[1]. For the current season, the driest country in the area was Tunisia.

- *East Africa.* This area covers the Horn of Africa (MRU-04) where RAIN deficits amount to -30% (253 mm) and the East African highlands (MRU-02, 165 mm or -27%). BIOMSS departures are large as well (-22% and -18%, respectively). Some areas, especially pastoral lowlands, were affected by the 2016 El Niño drought and thus suffered a second deficit season at a time when the sequels of the previous drought had not been dispelled yet. The area receives detailed attention in the section on disasters (section 5.2).

The remaining areas are single MRUs, but they often border other deficit areas that may not be immediately apparent because of the large size of the MRUs:

- *Punjab to Gujarat* (MRU-48; RAIN, -19% or 43 mm; BIOMSS: -12%). Although rainfall appears to be "average" at the scale of the MRUs, BIOMSS, due to the shorter and more recent reference period of just five years, appears as below average area, which is probably closer to the actual situation than the situation described by rainfall alone. The MRU is bordered on the east by two large areas with a smaller rainfall deficit, namely the Southern Himalayas (MRU-44; RAIN, -6%) and Southern Asia, which includes all of India (MRU-45; RAIN, -9%), but where BIOMSS decreased more significantly (BIOMSS, -14% and -28% respectively).
- *Caucasus* (MRU-29), which recorded 200 mm (RAIN, -28%; BIOMSS, -14%).
- *Western Cape area in South Africa* (MRU-10), RAIN down 30% with just 78 mm and a BIOMSS drop of 22%.
- *Western Patagonia* (MRU-27, 84 mm of rainfall and 39% below average). This is a mostly pastoral area, and the water shortage has affected summer grazing areas where BIOMSS is down 18%.
- *Brazilian Nordeste* (MRU-22), with a large RAIN deficit (-30%) that nevertheless corresponds to 328 mm. No serious agricultural impact is reported even if BIOMSS fell 21% below average.

Positive rainfall anomalies

Even the largest rainfall excesses were mostly moderate: the 95% percentile corresponds to a +69% anomaly. The four areas listed below are those where the precipitation anomaly exceeds 30%, which is not very significant in low rainfall areas, as even a minor amount of rainfall can easily constitute a doubling. The largest positive departures occur in Asia.

- *Northern China, Mongolia and adjacent areas.* The largest positive departure (RAIN, +309%) occurred in MRU-47 (Southern Mongolia). The total rainfall amount, however, is 109 mm, so that the large excess corresponds to an average rainfall in the order of just 25 mm. The two other MRUs in this group are the two Chinese regions of Inner Mongolia (MRU-35; RAIN, +60%) and Gansu-Xinjiang (MRU-32; +78%). All recorded above average (but still freezing) temperatures (+2.1°C above average in Southern Mongolia). The biomass production potential, which will be brought about by stored soil moisture once low temperatures turn positive, varies between +48% to doubling (+209%) in southern Mongolia where water is normally the dominant limiting factor.
- *Southeast Asia to Australia.* A large region from mainland Southeast Asia (MRU-50; 228 mm and +49%) and Hainan (MRU-33; 206 mm or +52%) across maritime Southeast Asia (where excesses are moderate) to the Australian desert (MRU-63; +39% to reach 134 mm) experienced positive

[1] http://123.56.103.213/htm/en/files/eng16-3-6.pdf.

rainfall anomalies. Temperature was generally below average, while BIOMSS variations (all positive) vary from +18% (MRU-55) to +55% (MRU-33).

- *North America.* On this continent, the area with positive rainfall anomalies includes, from east to west, the Northern Great Plains (MRU-12; RAIN, +37%), British Columbia to Colorado (MRU-11, +38%), Southwest United States and North Mexican highlands (MRU-18, +71%), and the West Coast (MRU-16, +43%). BIOMSS increases amount to +20%, +8%, +32%, and +22%, respectively for these four MRUs, with relatively low values (compared with RAIN) as a result of lower than average temperature, especially in MRU-16.
- *South America.* This area includes MRU-25 (central-north Argentina, with 679 mm of rainfall or +44% over average) and MRU-26 (the Pampas, 768 mm and +34%). BIOMSS increases are more moderate and amount to 15% to 20%.

Temperature and sunshine anomalies

Figures 1.3 and 1.4 present the global maps showing temperature (1.3) and radiation (142) anomalies over the reporting period.

Figure 1.3. Global map of January-April 2017 temperature anomaly (as indicated by the TEMP indicator) by MRU, departure from 15YA (degrees Celsius)

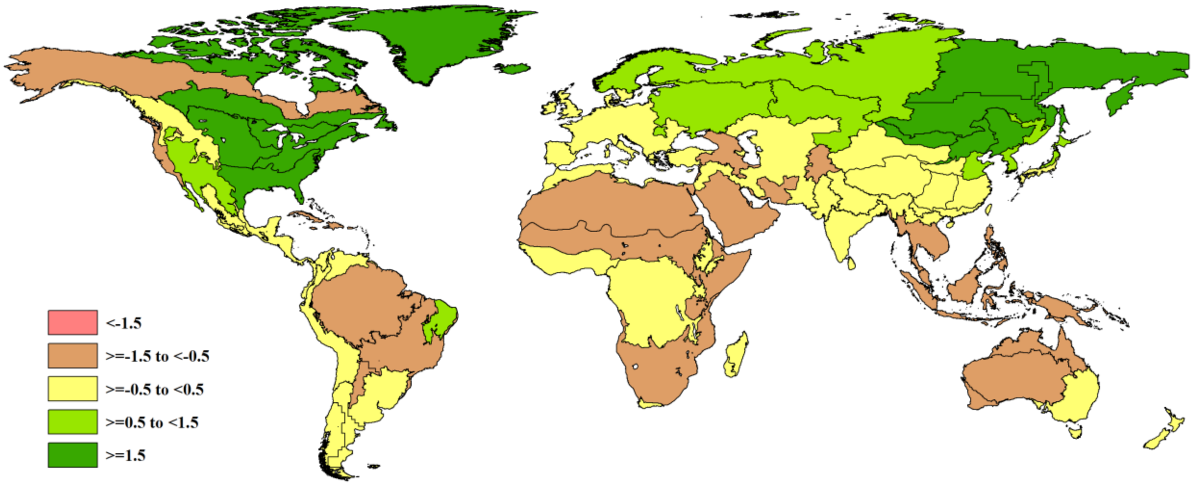
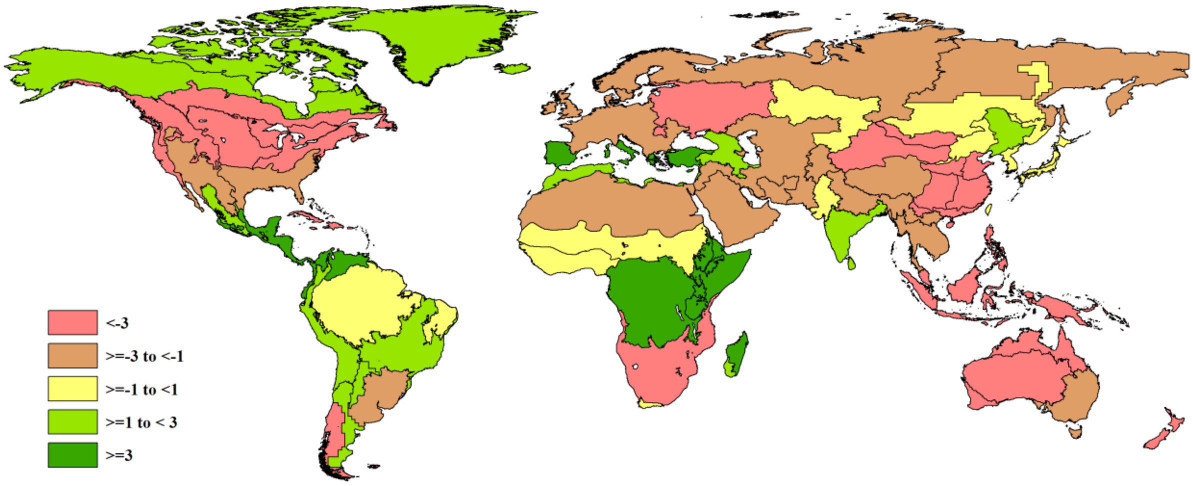


Figure 1.4. Global map of January-April 2017 PAR anomaly (as indicated by the RADPAR indicator) by MRU, departure from 15YA (percentage)



Few very large temperature anomalies occurred in important agricultural areas. The largest drop occurred in southern Africa (-1.2°C in MRU-09), which is now in its growing period of maize, the main crop in large parts of the area, in particular South Africa, Zimbabwe, and Zambia. The low temperature has contributed to a reduced crop water demand. The same mechanism may also have contributed to somewhat reduced water demand in the drought affected Horn of Africa (MRU-04) where, however, the temperature was just 0.7°C below average and RADAR increased (+4%). Southern Africa recorded a drop in sunshine (RADPAR, -3%).

Consistently higher than average TEMP was recorded in two areas starting on the eastern margins and extending land inwards of the Asian and North American continents. In America this was, paradoxically, accompanied by below average sunshine, sometimes markedly so, so that the temperature increase was brought about by cloudiness, which typically rises minimum temperature and reduces frost damage. This makes the qualitative assessment of crop condition difficult, as sunshine becomes the limiting factor once water requirements are covered. Values are TEMP, +1.7°C and RADPAR, -8% in the northern Great Plains (MRU-12), +2.2°C and -3% RADPAR in MRU-14, covering the area from the Cotton Belt to northeastern Mexico, and +2.3°C in the Corn Belt (MRU-13) where the lowest RADPAR was observed, reaching -9%. The MRUs adjacent to the ones mentioned also generally experienced warmer than average weather. In Asia, contrary to North America, high temperature was not correlated with any RADPAR pattern. Inner Mongolia (MRU-35) recorded a departure of 1.5°C with average RADPAR; in Northeast China (MRU-38), TEMP was up 1.9°C with +1% RADPAR; southern Mongolia (MRU-47) recorded +2.1°C in TEMP but a RADPAR drop (-4%), and, eventually, the largest absolute TEMP anomaly in eastern-central Asia (MRU-52; TEMP, +2.3°C) had close to average RADPAR (+1%).