

general population with water and electricity shortages, and dependent on water being transported to them. During most of 2016, western Amazonia was dominated by drier conditions, and in the state of Acre rainfall was about 85% of the 1961–90 average annual rainfall of 1947.5 mm. The Rio Acre levels were 1.41 m on 4 August, the lowest level since 1970. The Rio Madeira, at Porto Velho, was just 2.98 m high on 5 August, its lowest level in 48 years; the level dropped even more—to 1.9 m at Porto Velho on 30 September, the lowest value in 2016. The Ucayali River in the Peruvian Amazon reached 85 m on 22 September, its lowest level in 23 years. This was due to below-average rainfall of about 400 mm month⁻¹ in western Amazonia during the first half of 2016.

Problems related to rainfall deficits and subsequent low water supplies were particularly intense in the central Andes, and this situation is considered the worst drought Bolivia has seen for 25 years (see Sidebar 7.2).

3) SOUTHERN SOUTH AMERICA—M. Bidegain, J. L. Stella, M. L. Bettoli, and J. Quintana

This region includes Argentina, Chile, and Uruguay.

(i) Temperature

Near or below-normal temperatures were observed over most of southern South America during 2016, with mean temperature anomalies between -0.5° and $+0.5^{\circ}\text{C}$ (see Fig. 7.13a). The 2016 mean temperature anomalies for Argentina and Uruguay were $+0.1^{\circ}\text{C}$ and -0.4°C , respectively. Argentina's 2016 mean temperature anomaly was its coolest since 2011, breaking the streak of four consecutive years (2012–15) with record or near-record high temperatures. Chile had the largest positive anomaly at $+0.7^{\circ}\text{C}$.

Summer (December–February) 2015/16 was warmer than normal across northern and central Argentina, Chile, and Uruguay, with temperature anomalies 0.5° – 1.0°C above average.

Mean temperatures for autumn (March–May) were 0.5° – 1.0°C below average in northern and central Argentina, central Chile, and Uruguay. Conversely, northwestern Patagonia experienced warmer-than-average anomalies of greater than $+1^{\circ}\text{C}$. For Argentina, its autumn mean temperature was the sixth lowest since national records began in 1961, with average maximum temperatures that were record low. Of note, the average mean temperature for April was much above average for northeastern Argentina ($+1^{\circ}\text{C}$), Uruguay ($+0.8^{\circ}\text{C}$), and northern Chile ($+0.7^{\circ}\text{C}$), while much-below-average anomalies

(-2.0°C) were observed across southern Argentina and Chile. Cooler-than-average conditions occurred across much of Argentina and Uruguay during May, with several locations setting new monthly low average maximum temperature records. Meanwhile, central Chile had above-average temperatures.

Winter (June–August) was characterized by cooler-than-average conditions across northeastern Argentina and Uruguay, with above-average conditions across central and southern Chile and western and southern Patagonia ($+1.3^{\circ}\text{C}$).

Below-average conditions continued during spring (September–November) for northeastern Argentina and northern Uruguay (-0.2°C to -0.5°C anomalies). Above-average temperatures returned to the region in December for the first time since February, particularly notable over central Chile, Argentina, and Uruguay.

(ii) Precipitation

The 2016 annual rainfall anomaly in Argentina and Uruguay was $+14.3\%$ and $+9\%$, respectively (see Fig. 7.13b). Although the annual rainfall was above average, drier-than-average conditions were observed across central and northeastern Argentina, northern Uruguay, and central Chile during the second half of the year, following the influence of the cold phase of ENSO.

Several events in April brought abundant rainfall to northeastern Argentina and Uruguay, with several stations setting new monthly precipitation records. In central Chile, Santiago had its wettest April since 1878, accumulating 109 mm, which is nearly seven times the monthly average. The extreme precipitation was associated with the strong El Niño that developed in 2015 and dissipated in May 2016, and impacted the Rio de la Plata basin with above-average rainfall during summer and fall.

During autumn, there were two zones with excess precipitation: central-western Argentina, where precipitation totals for April–May were the most significant for the year; and central-eastern Argentina and western Uruguay, with April rainfall totals contributing the largest portion of the annual precipitation total. The much-above-average precipitation during April resulted in devastating floods.

During spring, much of southern South America observed below-normal precipitation, with the exception of areas in northern Patagonia and central and northern Argentina which had above-average precipitation in October. Accumulated rainfall anomalies during October were as high as $+200$ mm in an extensive area that included central-western

and northeastern Argentina. Central Chile also had above-average precipitation, with anomalies as high as 235% of average in Curicó.

(iii) Notable events and impacts

A heat wave impacted a large area in central Argentina during 20–25 January, leading to a great demand for electricity that resulted in power outages. New high records for monthly mean minimum temperatures were set in northeastern and central-western Argentina [Resistencia (23.3°C), Formosa (24.3°C), Posadas (23.5°C), Oberá (22.0°C), Ceres (21.0°C), Rosario (20.7°C), Bernardo de Irigoyen (20.2°C), Laboulaye (19.2°C), and Malargüe (13.3°C)].

Extreme precipitation events in April over central-eastern Argentina and Uruguay resulted in new records for the number of rainy days (days with precipitation >0.1 mm) for the following locations: Concordia and Gualeguaychú (21 days), Buenos Aires (20 days), Monte Caseros (19 days), Sauce Viejo and Rosario (18 days), Ceres and Paraná (17 days). On 15 April, an intense tornado was observed across southwestern Uruguay, affecting the city of Dolores (Soriano Department). Five people were reported dead and more than 500 people were injured. Heavy rainfall in mid-April caused floods in southern Uruguay (departments of Rocha, Maldonado, Canelones, and San Jose), displacing nearly 4000 people and claiming three lives. A maximum daily rainfall total of 250 mm was reported in Nueva Palmira station (Colonia Department) on 15 April.

An extratropical depression affected the central-eastern region of Argentina and Uruguay during 12–14 September. Winds up to 110 km h⁻¹ caused severe damage, including toppled trees, power outages, and evacuations. Along the coastal area of Buenos Aires, the strong winds also caused serious problems to ship navigation, caused erosion, and damaged beaches; the city of Mar del Plata was the most affected.

Storms on 12 October affected a large extent of Argentina, including northern Patagonia, La Pampa province, southern Córdoba, and northwestern Buenos Aires. The intense rainfall, strong winds, and hail led to severe flash floods and power outages in several locations.

On 27 October, an extratropical cyclone impacted Uruguay's Atlantic coast, causing estimated losses of \$2 million U.S. dollars; it was the second extratropical cyclone to affect the area in fewer than 40 days.

During December the city of Mar del Plata (Buenos Aires province) recorded 14 days with maximum temperatures above 30°C, with three of those days reaching 35°C. This was the second highest number of

days in a single month with maximum temperatures above 30°C on record, behind December 2013. A large area in Argentina, including La Pampa province and southern and western Buenos Aires province, was affected by dry conditions, extreme high temperatures, and winds, which triggered severe bushfires, burning more than 500 000 hectares.

Santiago, Chile, recorded a new December maximum temperature on 14 December, when temperatures climbed to 37.3°C, surpassing the century-old record of 37.2°C set on 19 December 1915.

e. Africa

In 2016, most of Africa experienced above-average surface air temperatures (Fig. 7.16). Rainfall over the region 7.5°–15°N was above average whereas rainfall over most of equatorial Africa and the region south of the equator was below average (Fig. 7.17). Several extreme weather conditions were reported, including heat waves, droughts, and floods associated with convective storms in Morocco and Egypt and in several countries in West Africa. Unusually low temperatures (around -6°C) were also reported in Ethiopia.

The reference period for this annual climate assessment is 1981–2010. Both observed and reanalysis data-

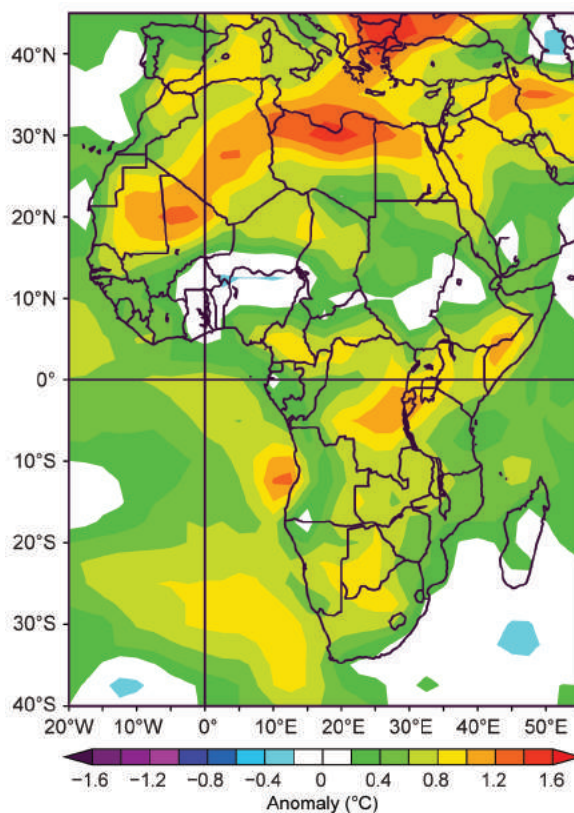


FIG. 7.16. Annual 2016 surface air temperature anomalies (°C; 1981–2010 base period) over Africa. (Source: NOAA/NCEP.)