

**FIG. 7.13. Precipitation anomalies (mm month<sup>-1</sup>; 1981–2010 base period) during Jan–Mar 2017. (Source: UCSB CHIRPS v2; processed by CIIFEN, 2018.)**

*(iii) Notable events and impacts*

During the first quarter of 2017, regional climate was highly influenced by sea surface temperature warming of the coastal El Niño (Sidebar 7.2). The sudden warming in the eastern equatorial Pacific was different from the typical development of El Niño events. Although its impacts in the Andean countries varied, the most significant effects of the intense and quick coastal El Niño were mainly associated with extreme precipitation events and subsequent flooding and landslides.

From January to April, rainfall exceeded normal conditions in a large part of the coastal region of Ecuador and most of Colombia, Suriname, and Venezuela. Heavy rain during February–April produced floods in Ecuador, which were responsible for more than two dozen fatalities and over 127 000 people affected in the provinces of Guayas and Manabi. Some locations set new precipitation records during March. In Mocoa, Colombia, extreme rainfall (130 mm in 3 hours) in late March fell in areas that were already saturated by heavy rain earlier in the month, causing flash floods and a landslide that killed more than 250 people and left over 300 people injured. During March–May, devastating floods affected the departments of Antioquia, Cundinamarca, and Choco in Colombia.

In Venezuela, above-normal precipitation fell during August–September, triggering the most devastat-

ing floods in more than a decade in the states of Bolívar and Delta Amacuro. The 5-day accumulated rainfall of 120 mm at the end of August caused flash floods and a landslide in Río Mercedes (State of Aragua), affecting hundreds of people and causing four fatalities.

**2) CENTRAL SOUTH AMERICA—J. A. Marengo, J. C. Espinoza, L. M. Alves, J. Ronchail, J. Báez, K. Takahashi, and W. Lavado-Casimiro**

The central South America region includes Brazil, Peru, Paraguay, and Bolivia.

*(i) Temperature*

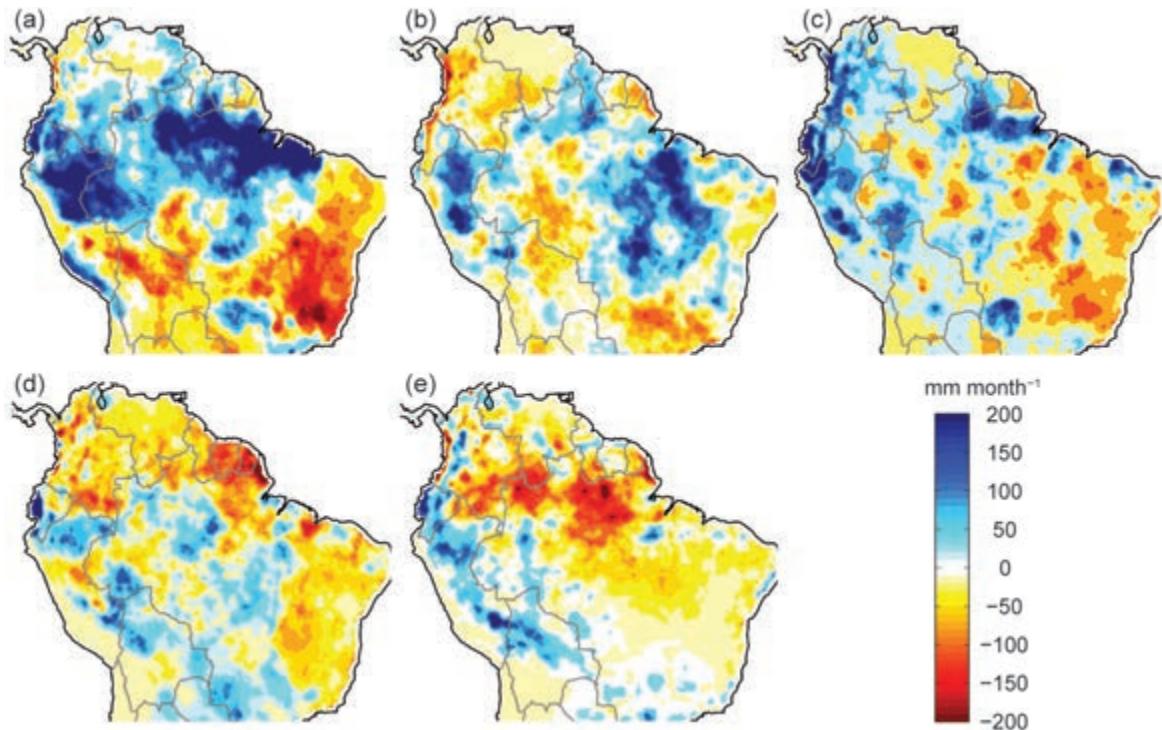
The first half of 2017 was characterized by extreme high temperatures (2°–3°C above normal) in Bolivia, Paraguay, northern Peru, and southern Brazil. Warmer-than-normal conditions continued to affect the region from June through September, with temperatures ranging from 1° to 3°C above normal over Bolivia, Paraguay, and northeastern Brazil. Near-normal temperatures were recorded across the region during October–December.

Several cold episodes occurred from April through July. The passage of a cold front on 20 June brought cold temperatures to the southern half of Brazil, with some regions recording minimum temperatures <0°C. São Joaquim and Bom Jesus (located in the state of Rio Grande do Sul; climatologies of 5.9°C and 8.0°C, respectively) reported minimum temperatures as low as –3°C and –2.6°C, respectively. A polar air intrusion during 17–19 July (see Notable events and impacts section) brought cooler-than-normal conditions to parts of southern and eastern Brazil and in western Amazonia, resulting in monthly minimum temperatures 1°–3°C below normal.

*(ii) Precipitation*

The first half of 2017 was characterized by below-normal precipitation in Bolivia and west-central and northeastern Brazil. Above-normal precipitation was observed in northwestern Amazonia, southern Brazil, and along the northern Peruvian coast during the second half of the year.

The dry conditions observed in 2016 in Bolivia and northeastern Brazil (Marengo et al. 2017) persisted through 2017. Most of central South America east of the Andes experienced below-normal rainfall (100–150 mm month<sup>-1</sup>; Fig. 7.14) from January through April, with only weak episodes of the South Atlantic convergence zone (SACZ)—a summertime circulation pattern associated with rainfall in the



**FIG. 7.14. Monthly rainfall anomalies (mm month<sup>-1</sup>; 1981–2010 base period) for Jan–May 2017. [Source: Climate Hazards group Infrared Precipitation with Stations (CHIRPS) dataset.]**

region. The extreme dry conditions were ideal for the development of wildfires. According to the Brazilian National Institute for Space Research, the total number of wildfires for the Amazon region in 2017 was 272 000, the highest number since records began in 1999, which burned over 986 000 hectares. In December, a SACZ episode caused heavy rainfall over southeastern Brazil, Paraguay, and Bolivia, resulting in high river levels for Amazonas-Solimões and Negro River basins. Floods affected the cities of Trinidad and Santa Cruz de la Sierra (Bolivia), as well as soybean crops and livestock in the lowlands of Bolivia.

*(iii) Notable events and impacts*

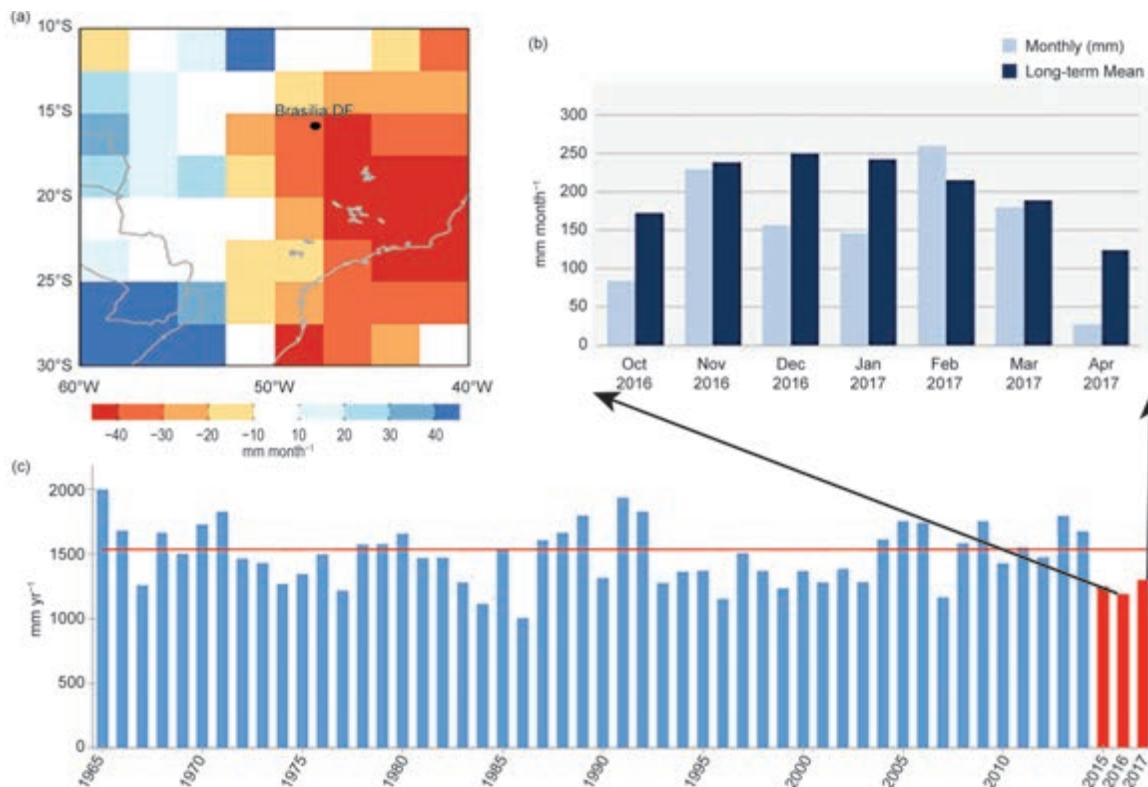
Heavy rains that fell in Peru during January–May (Fig. 7.14) were triggered by the coastal El Niño present in the eastern tropical Pacific Ocean (see Sidebar 7.2). Torrential rainfall triggered flash floods and landslides that affected over 625 000 people in the regions of Tumbes, Piura, Lambayeque, La Libertad, Ancash, Ica, and Arequipa and claimed nearly 100 lives. Losses include 242 bridges, 13 227 km of rural and main roads (1.5% of the national road system), 45 335 km of agricultural irrigation channels, and 60 400 ha of crops. In the suburbs of Lima, landslides (“huaycos”) destroyed houses, and the highway

between Lima and the Andean cities was inaccessible for several days.

The January 2017 precipitation total for the city of São Paulo was 453.8 mm, 179% of normal for the month, and its wettest January since 2011. The copious rain prompted flash floods in several locations across the city.

In the city of Maceio, located on the coast in the state of Alagoas in northeast Brazil, a state of emergency was declared due to torrential rains that produced landslides and flash flooding on 27 May, killing three people. By 29 May, over 8400 families were affected, and more than 16 500 people were left homeless. Total rainfall in May 2017 was 742.4 mm (more than twice the monthly normal of 344.7 mm), with 169.6 mm recorded on the 27th.

During the first two weeks of June, well-above-normal rainfall was observed in the eastern portion of the state of Santa Catarina (southern Brazil) due to the passage of a cold front. Torrential rains affected more than 28 800 people and, in some districts, a state of emergency was declared due to floods. The same cold front caused heavy rainfall and flash floods in Rio de Janeiro, and the total rainfall measured on 20 June was almost 247 mm (June climatology is 461.8 mm). This event affected public transportation in the city and flooded some neighborhoods.



**FIG. 7.15. (a) Rainfall anomalies in west-central Brazil during Jan–Apr 2017; the city of Brasilia is marked with a black dot; (b) Monthly rainfall (mm) in Brasilia from Oct 2016 to Apr 2017; 2017 monthly totals are depicted in light blue, while the 1981–2010 normals are in dark blue; (c) Time series of annual rainfall (mm) from 1965 to 2017; normal annual value is depicted with a red line. (Source: GPCP and INMET.)**

West-central Brazil, particularly Brasilia (Distrito Federal), has been affected by dry conditions since 2015. The drought conditions, which continued into 2017, were the worst in the last 57 years. In April 2017, Brasilia received only 20% of its normal April precipitation, which is 125 mm; in fact, during the peak of the rainy season (October 2016–April 2017), only February had above-normal monthly rainfall (Fig. 7.15). This prompted a state of emergency and mandatory water restrictions.

The most intense cold episode during austral winter 2017 occurred during 17–19 July. A polar air mass affected the Andes, bringing cooler-than-normal conditions to the western Amazonia regions of Brazil, Peru, and Bolivia. On 17 July, minimum temperatures as low as 10°C were recorded in the Bolivian Amazon and in Puerto Maldonado, Peru (July climatology of 18°C), while on 18 July the western Brazilian Amazon saw temperatures drop to 7.2°C in Campo Verde (located in the state of Mato Grosso; climatology of 21.2°C), 11.3°C in Epiteciolândia (located in the state of Acre; climatology of 19.0°C), and 11.1°C in Guajará-Mirim (located in the state of Rondonia; climatology of 20.0°C). In the city of São

Paulo, the maximum temperature was 8°C (climatology of 11.7°C) on 18 July, and one person died due to exposure to the cold temperatures. From mid-July to mid-August, a cold front in Peru produced temperatures as low as –20°C at 4000 meters above sea level (the record-coldest value is –25°C set on 6 July 1968 at Macusani station in Puno region), and snow fell in the Andes of Peru and Altiplano.

### 3) SOUTHERN SOUTH AMERICA—J. L. Stella and L. S. Aldeco

This region includes Argentina, Chile, and Uruguay.

#### (i) Temperature

Above-normal temperatures were observed across southern South America (SSA) during 2017, with annual mean temperatures 0.5°–1.5°C above normal. The national mean temperature anomaly for Argentina and Uruguay was +0.68°C and +1.0°C, respectively, placing 2017 as the warmest year on record since 1961 for both countries. The five warmest years on record for Argentina have all occurred since 2012 (Fig. 7.16). The mean temperature anomaly by decade since the 1960s (Fig. 7.17) shows an increase