

anomaly of +150.7 mm. Along the Valles, precipitation was close to normal except in Cochabamba where the annual anomaly was 167% of normal. At the Villa Montes station, an annual anomaly of 266.1 mm (134% of normal) was registered. In contrast, most of the Llanos Orientales region experienced negative precipitation anomalies. In Puerto Suárez the annual precipitation was 60% of normal.

2) TROPICAL SOUTH AMERICA EAST OF THE ANDES—J. A. Marengo, J. Ronchail, and L. M. Alves

In this section, unless otherwise noted, normals and anomalies are based upon a 1961–90 average.

(i) Temperature

According to data from the INPE and INMET in Brazil, across most of tropical South America, east of the Andes, the monthly mean temperatures were about 1°C warmer than average. In northern Paraguay and southern Bolivia seasonal temperature anomalies were as high as +3°C between August–October. Some extreme hot days were recorded during 2012. On 18 September, the maximum temperature soared to 34.1°C in São Paulo, Brazil, the highest during the last 57 years (the September mean maximum temperature is about 24°C). In contrast, on 25 September the situation changed and temperatures dropped as low as 0.7°C in southern Brazil, and snow was reported in some cities in this region. On 28–31 October, southeastern Brazil experienced high temperature records: 43°C in the city of Ribeirão Preto on 28 October and 42°C in São Paulo on 31 October. The mean maximum temperature for that region is between 19°C and 22°C. Brazil's most important record high temperature of 2012 occurred on 26 December in Rio de Janeiro, where temperatures reached 43.2°C, the highest temperature detected for any month since 1915.

From May to August, six cold surges affected southeastern South America, especially southern Amazonia and southern Brazil. In May, air temperatures dropped to 0°C in southern Brazil, and a cold air intrusion dropped temperatures to -4.3°C at Bom Jesus, in extreme southern Brazil on 7 June and -9.3°C on 8 June—Brazil's lowest temperature of 2012. On 8 June, the cold air reached western Amazonia where temperatures dropped to 12.7°C. This system also affected the southern Peruvian Andes, causing extreme cold weather events with some areas reporting below-freezing temperatures.

(ii) Precipitation

During 2012, rainfall was above average between January and April (50 mm–100 mm above the 1961–90 average) across the 5°S–15°S latitude bands in South America. Rainfall was well-above-normal in Bolivia, Paraguay, and southeastern Brazil between May and July (50 mm above normal). Wet conditions prevailed in Amazonia during austral spring and summer (300 mm above normal). Many rainfall records were broken during this period. In contrast, dry conditions prevailed in northeast Brazil, from January to May (100 mm below normal), due to an anomalously northward displacement of the ITCZ over the Atlantic and an unfavorable phase of the MJO for convective activity and precipitation, resulting in the worst drought in the region in over 30 years (Sidebar 7.2). After April, deficit expanded from northeast towards the west and north, compromising the northern tropical rainy season. From August to December, rainfall deficits were observed in most regions from southern Brazil to the northern tip of South America (Sidebar 7.2).

In January 2012, heavy rains produced landslides and floods in Minas Gerais, in southeastern Brazil, affecting 53 cities and killing 7 people, and in February the intense rains in Acre, western Amazonia, generated floods that affected 13 000 people. In Ecuador, heavy rains occurred in the provinces of Guayas and El Oro, and left nearly 20 000 people affected by floods. Floods and landslides in Bolivia left 13 people dead and almost 14 000 affected. Also in January, the Paraguayan government declared a state of food security emergency due to drought as 263 800 families suffered crop losses. On 8 January, 12 people died as consequence of intense rains in the central region of Rio de Janeiro, Brazil.

In March, floods in 18 of Colombia's 32 departments affected more than 66 000 people, and in July, floods affected the Putumayo region. Heavy rains, floods, and mudslides affected Paraguay's Chaco region in April. In the Sierra of Rio de Janeiro, intense rainfall affected the region of Teresopolis on 7 April, killing seven people. In October, floods and landslides occurred in Colombia, leaving 10 people dead and almost 200 families affected. In contrast, the La Niña phenomenon was blamed for the drought that affected parts of southern Brazil, which began in November 2011 and lasted through November 2012. Of note, on 17 September the city of São Paulo had its 62nd consecutive day without rainfall—its longest dry spell during the last 50 years. December was a dry month in most of central Brazil.

(iii) Notable events

Amazonia experienced one of the worst flooding episodes in recent history. Many cities and urban areas were under states of emergency as the Solimões River and the Rio Negro, the two main branches of the Amazon River, overflowed their banks. Intense rain across western and central Amazonia in December 2011, January and February 2012 (Fig. 7.15) led to early peak flows in various rivers in western Amazonia, and subsequently affected the levels of Rio Negro and the Solimões and Amazon Rivers, with floods in Iquitos and Manaus during the April–June season. The level of the Rio Negro at Manaus reached a new record of 29.97 m in May 2012, the highest since records began in 1903. The previous record, 29.77 m, was set in July 2009.

The main cause of the abundant rains and floods in western Amazonia were related to the La Niña event early in the year. A more coherent picture of the involved teleconnection patterns, from SST anomalies in both the tropical Pacific and the subtropical Atlantic oceans to regional rainfall anomalies in Amazonia, are discussed by Marengo et al. (2013, manuscript submitted to *J. Climate*) and Espinoza et al. (2013). The scatter diagram (Fig. 7.16) shows that record floods in Amazonia (1989, 1999, 2009, and 2012) occurred during La Niña events.

3) SOUTHERN SOUTH AMERICA—M. Bidegain, M. Skansi, O. Penalba, and J. Quintana

This section refers to southern South America as the regional name for the combined territory of Argentina, Chile, and Uruguay, and sometimes adjacent areas of far southeastern Brazil. To reduce potentially confusing characterizations, such as “northern southern South America”, the region is abbreviated SSA. In this section, unless otherwise noted, normals and anomalies are based upon a 1961–90 average.

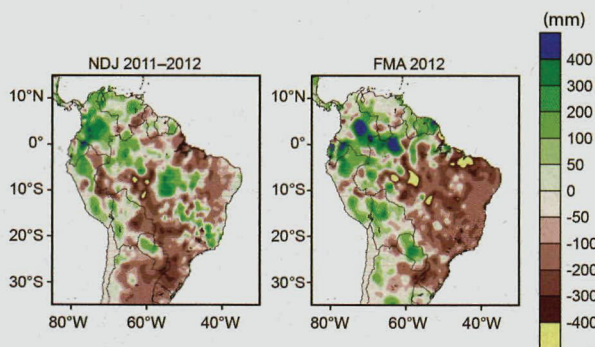


FIG. 7.15. Precipitation anomalies (mm) for Nov 2011–Jan 2012 (left), and Feb–Apr 2012 (right). (Source: NOAA/Climate Prediction Center.)

(i) Temperature

Above-normal temperatures were observed over most of northern SSA during 2012, with average anomalies between 1.0°C and 1.5°C. Argentina as a whole recorded its warmest year since 1961 with an estimated national mean temperature anomaly of +0.78°C. During the Southern Hemisphere fall (March–May), above-average mean temperatures were observed over a large part of Argentina, particularly over the northwestern region (+1.0° to +3.0°C).

The winter season (June–August) brought near-normal mean temperatures over the entire region, with isolated extreme events. In Uruguay, freezing weather events took place during 7–9 June, with many locations across northern Uruguay having the most significant intense cold event recorded during the winter period (e.g., -4.5°C in Salto). Also, during June, snowfall affected parts of Argentina. The city of Ushuaia, the southernmost city of the world, was affected by heavy and persistent snowfall during June, equaling the record 19 days of snowfall in June 1986 and 1995. Below-average temperatures were widespread across SSA during July 2012. According to Argentina’s Servicio Meteorológico Nacional, monthly mean temperature anomalies of 2°C–3°C below average were widespread across SSA, with minimum mean temperature anomalies ranging between -3°C and -5°C. These low temperatures, coupled with frost, hindered wheat planting in The Pampas. Cold conditions were also observed in central Chile. During the first weekend of July, nighttime temperatures dipped to -8°C, causing 16 deaths. During 7–11 July, a “frost

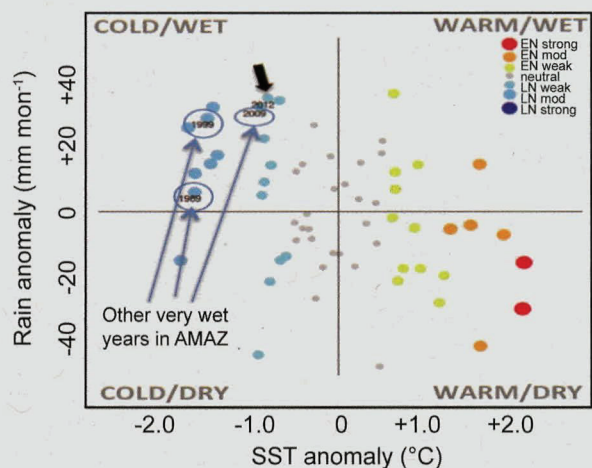


FIG. 7.16. Scatter diagram of SST anomalies in the Niño-3.4 region and rainfall anomalies in northwestern Amazonia during 1961–2012. The 2012 year is shown with a thick black arrow, and other years with extreme flood are also shown (Marengo et al. 2013, manuscript submitted to *J. Climate*).