above-average precipitation totals for the year, causing flooding in many areas.

The January–March period was colder than average in all but eastern Bulgaria. January was generally warmer than average, but February saw significant cold in most areas, with temperatures in Serbia more than 3°C below average. Temperatures in March were also below average, but not significantly so. The greatest precipitation anomalies occurred in Bulgaria in all three months, which led to flooding there in February.

April saw the end of the anomalously cold weather, with above-average temperatures in all areas. May and June temperatures were above average in most areas, significantly warmer than normal in Croatia and Bosnia-Herzegovina, but below average for June in Bulgaria. Rainfall totals in April and June were close to average in most parts, but in Bulgaria significant May rainfall once again brought flooding.

Although July temperature anomalies in southeastern Europe were positive, they were lower than in most areas of Europe. Even so, temperatures along the Adriatic coast were significantly above normal. Temperatures in August were below average except in eastern Bulgaria, which experienced significant warmth. September was warmer than average. July, August, and September rainfall totals were far above average, with Bulgaria receiving more than twice the seasonal average, and large areas recording more than three times the average. In August, 500% above-normal monthly rainfall in Bulgaria produced flooding that continued into September and left more than 30 dead.

Excessive rains continued in the east into October, but November totals were close to average in all areas. October and November temperatures were below average in the south and east, but December saw the colder weather shifting to the west. Temperatures in the north were above average in October, but fell below average for the last two months of the year.

h. Oceania

1) Australia—A. B. Watkins[90]

Despite the notable absence of an active basin-wide El Niño event, 2005 was the hottest year on meteorological record for Australia.[2] Neutral to slightly warm conditions in the equatorial Indian and Pacific Oceans at the start of 2005 persisted until June, returning to near normal in the latter half of the year. Correspondingly, pressure over Australia was higher than normal during the first half of the year, and from normal to below normal during the remainder of 2005. The anomalously high pressure over the country during early 2005 greatly reduced rainfall over the interior and inhibited the northward penetration of frontal systems from the Southern Ocean. High pressure also contributed to a sporadic Australian monsoon, which failed to extend far inland, resulting in anomalously warm and dry conditions in the north.

(i) Temperature

Due in part to the inconsistent Australian monsoon, the tropical wet season (October 2004–April 2005) was relatively warm. Northern Australia experienced a +1.5°C maximum temperature (Tmax) anomaly (0.6°C above the previous wet season record). Additionally, April, ordinarily the start of the main winter cropping season, was climatologically one of the most remarkable months on record for Australia. Australia-wide, April mean Tmax was 3.11°C above normal (Fig. 6.36). Not only was this 0.7°C above the previous April record, but it was the largest anomaly recorded for any month since Australia-wide temperature records began in 1950, which is substantially higher than the previous record (+2.68°C) set in October 1988. Combined with record high minimum temperatures (Tmin), the April mean temperature anomaly of +2.58°C was 0.85°C above the previous April record set in 2002 and 0.26°C above the previous record for any month (June 1996). Notably, the April mean temperature was the highest on record over 66% of the continent, with 86% of the continent experiencing mean temperatures for the month in the highest 10% the of recorded totals.

June–December Tmax and Tmin remained above average across virtually the entire country (+0.75° and +0.94°C anomalies, respectively). When combined with the hot start to the year, temperatures for 2005 were exceptional. The Australia-wide Tmax anomaly for 2005 was +1.21°C, equal to the record set in 2002, while the Australia-wide Tmin anomaly

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[2] For Australia-wide, as well as large-scale regional averages, high-quality monthly temperature data is available from 1950, with high-quality annual temperature data starting 1910. For rainfall, high-quality area-averaged data commences in 1900. All records and percentile values are calculated with respect to these years. Anomalies are calculated with respect to the 1961 to 1990 average, in accordance with World Meteorological Organization guidelines (WMO Publication No. 100: www.wmo.ch/web/wcp/ccl/ GuideHome/html/wmo100.html).

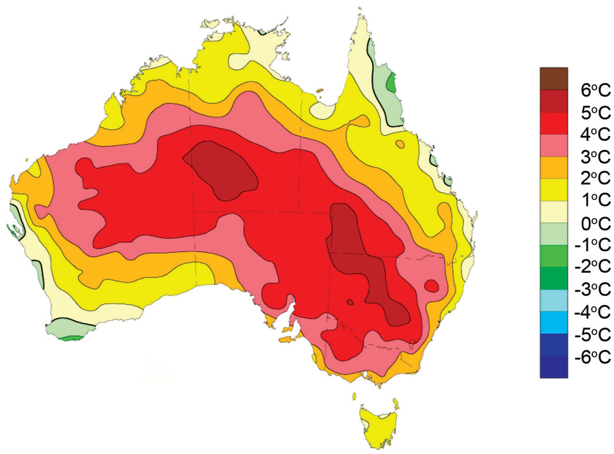

Fig. 6.36. Australian maximum April temperature (Tmax) anomalies (°C) for 2005 (1961–90 base).

of +0.91°C was the third warmest on record behind 1998 (+1.12°C).

Overall, the mean temperature anomaly for 2005 of +1.06°C was 0.23°C above the previous hottest year (1998). Consequently, Australia experienced its hottest mean temperature since annual mean records commenced in 1910. In total, 95% of the continent experienced above-average mean temperatures during 2005 (Fig. 6.37). With the absence of a decaying El Niño event, the record Australian heat of 2005 clearly highlights the impact of the long-term warming trend of the global and Australian climate upon the natural variability of year-to-year fluctuations.

(ii) Precipitation

High pressure over the continent and the weak Australian monsoon contributed to extremely dry conditions during the first five months of the year (Watkins 2005), with 44% of the country experiencing rainfall in the lowest 10% of recorded totals (decile 1). Australia-wide, April was the eighth driest April on record, with only 10.7 mm for the month (average of 31.1 mm). The Australia-wide average rainfall of 168 mm was the second lowest January–May total (after 1965) since Australia-wide monthly records began in 1900. While short-term dry spells are not unusual for Australia, it hindered the limited recovery from the devastating 2002/03 El Niño–related Australian drought (Coughlan et al. 2003), one of the worst droughts in Australia's recorded meteorological history (Nicholls 2004).

In a remarkable turnaround, 80% of the country experienced above-average rainfall between June and December, which corresponded to a change in ocean conditions in the equatorial Pacific. June–December precipitation over many previously drought-affected parts of New South Wales was in the top 10% (decile 10) of recorded totals. Australia-wide, 23% of the country experienced decile-10 precipitation between June and December, compared to only 0.6% for the January–May period.

Despite the average to above-average rainfall totals in the second half of the year, the extremely dry conditions during the first five months contributed to a generally below-average rainfall year for Australia (Fig. 6.37). The 2005 Australia-wide average rainfall of 407.2 mm was the 33rd driest such period since all-Australian records commenced in 1910, which is 65 mm below the 1961–90 mean of 472 mm. Overall, 63% of Australia experienced below-average rainfall during 2005.

(iii) Notable events

In January, Nyang Station, in the Gascoyne region of inland Western Australia, measured Australia's

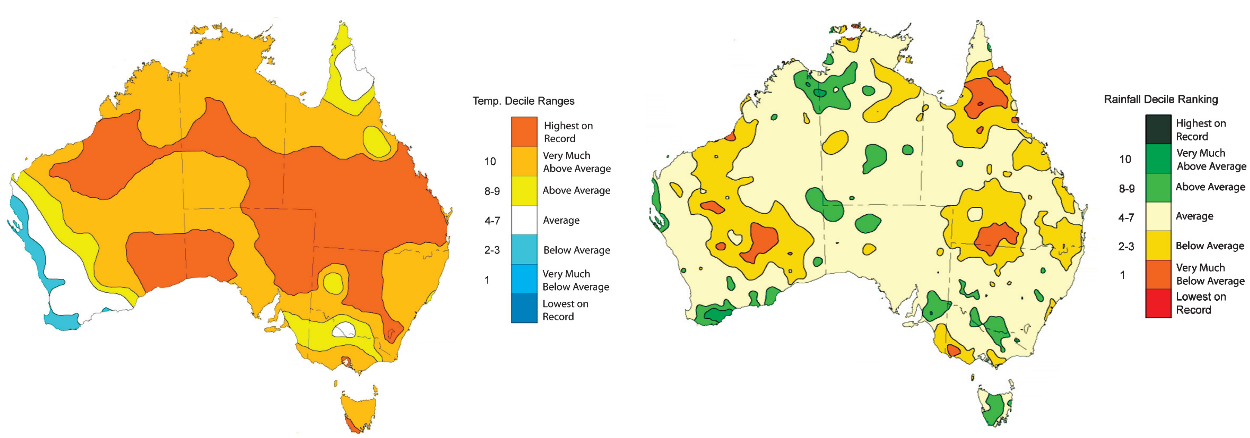

Fig. 6.37. Australian mean (left) temperature and (right) precipitation accumulation deciles for 2005 (relative to 1950–2005 for temperature and 1900–2005 for precipitation). [Source: Australian BOM]

hottest month on record, when its average maximum temperature of 44.8°C equaled the previous record, also set at Nyang, from February 1998.

An intense low pressure system developed over Eastern Bass Strait on 2 February, resulting in substantial rainfall and low temperatures for Victoria, southern New South Wales, South Australia, and Tasmania. The event made February 2005 Victoria's wettest February since 1973. Despite the 2-day event supplying 22% of Melbourne's annual mean rainfall (638.8 mm), the city's 2005 total precipitation of 589.8 mm was below average for the ninth year in succession.

Tropical Cyclone Ingrid, which occurred between 5 and 16 March (see section 4c), reached category 5 (Australian scale; information online at www.bom.gov.au/catalogue/warnings/WarningsInformation_TC_Ed.shtml) on at least two occasions, and is the only TC in Australia's recorded history to impact three different states or territories (Queensland, Northern Territory, Western Australia) as a severe tropical cyclone (category 3 or above).

Despite the generally mild winter, three major low-elevation snow events occurred during the season. These affected the Northern Tablelands of New South Wales and adjoining southern Queensland (22–23 June), the Monaro district of New South Wales (8–9 July), and southern Victoria and Tasmania (10 August). The August event brought snow to sea level in Victoria for the first time since 9 August 1951.

A notable heat wave affected large parts of central and eastern Australia during late December 2005 and early January 2006. The most abnormal conditions occurred in the period from 30 December 2005 to 1 January 2006, when northwesterly winds brought extreme heat to southeastern Australia. Arguably, the most exceptional record occurred at Montague Island (New South Wales), where a reading of 41.0°C broke its previous all-time record by 3.8°C. Sydney reached 44.2°C on 1 January 2006, second only to the 45.3°C reached there on 14 January 1939.

ii) New Zealand—M. J. Salinger[80]

New Zealand's climate of 2005 was influenced by more frequent anticyclonic activity in the Tasman Sea and to the east of the South Island, resulting in less wind, warmer temperatures, and generally decreased precipitation for much of New Zealand. However, more cyclonic activity was present in February, March, May, and December, and the northeast of the North Island experienced more frequent easterlies at times (Fig. 6.38). Notable climate features in various parts of the country included heat waves, low soil moisture, localized flooding, the Greymouth tornado, an unseasonable snowstorm, and damaging hailstorms.

(i) Temperature

The national average temperature in 2005 was 13.1°C, 0.5°C above the 1971–2000 normal. It was the fourth warmest year nationally since reliable records commenced in the 1860s. Only 1971, 1998, and 1999 have been warmer with temperatures of 13.2°, 13.3°, and 13.3°C, respectively. For New Zealand as a whole, there were seven warmer-than-normal months (February, March, May, July through September, and December), two cooler months (January and April), and three months with mean temperatures close to the climatological average (June, October, and November).

A combination of anticyclones and northeasterlies brought one of the warmest Februaries on record, with maximum temperatures of 30°C or more in many locations throughout New Zealand, and temperatures of 35°C or more in sheltered inland areas of the South Island during the first 10 days. The highest recorded extreme air temperature for the year was 38.7°C at Alexandra on 5 February (the highest temperature there for any month, in records back to 1929). Overall, February was the eighth warmest on record, with a mean temperature of 18.6°C (+1.3°C anomaly).

Halfway through the year, more frequent anticyclones over the North Island and northwesterlies over the South Island produced the sixth warmest winter (June–August) on record, even though June

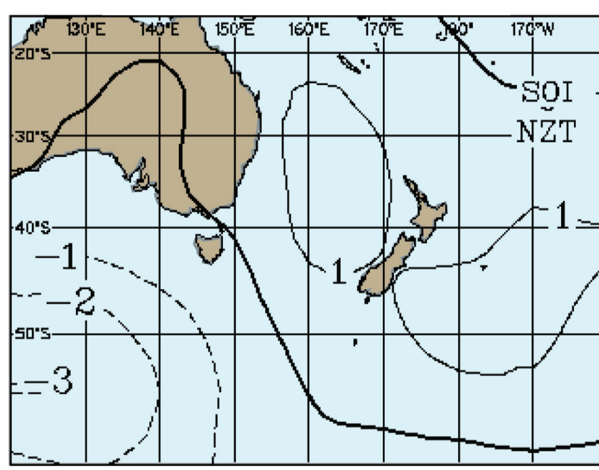

Fig. 6.38. 2005 mean sea level pressure anomaly map for the New Zealand region showing departures from average (hPa). Anticyclones were more frequent than normal east of the South Island and in the Tasman Sea.

was the coldest in a decade. With a mean temperature of 9.1°C (+1.2°C), July was the third warmest on record. Record high August maximum temperatures were recorded at Hanmer Forest (25.1°C on the 30th) and Amberley (25.4°C on the 31st). August's 9.8°C (+1.1°C) made it the fourth warmest on record. Mild conditions accompanied continued anticyclonic activity into spring (September–November). A changing atmospheric pattern to warm northerlies produced the third warmest December on record, with 17.5°C (+1.9°C).

Mean temperatures in 2005 were at least 0.3°C above average in most regions, and 0.5°–0.9°C above average in parts of Auckland, Coromandel, western Bay of Plenty, and western North Island from Wanganui to Wellington, as well as Wairarapa and much of the South Island. Temperatures were near average in coastal Wairarapa, along the Kaikoura Coast, and in coastal areas of south Canterbury. The warmest locales were Cape Reinga and Whangarei Airport, both with a mean temperature for the year of 16.1°C (0.2° and 0.5 °C above normal, respectively). Several locations observed record warmest annual average temperature in 2005.

(ii) Precipitation

New Zealand's climate for 2005 was marked by too little rain in some places, and too much in others. Annual rainfall during the year was less than 75% of normal over much of the South Island, and 75%–90% of normal in the north and west of the North Island (excluding Wanganui) and southern Wairarapa (Fig. 6.39). Clyde recorded the least annual precipitation at 348 mm (76% of normal). Near-record to record low precipitation was observed at numerous locations. Conversely, well-above-average precipitation (> 125%) fell in the western Bay of Plenty, Hawke's Bay, and the far southwest of the South Island. Precipitation was near normal elsewhere. The wettest location was Cropp River in Westland, with an annual total of 9290 mm.

Anticyclones in January commenced the trend of low rainfall and severe or significant soil moisture deficits in the northern half of the North Island and Canterbury; these conditions persisting into April. March was wetter in the North Island, but more anticyclones in April kept conditions dry. However, weather patterns changed abruptly in May, resulting in widespread flooding in the Bay of Plenty.

Frequent winter anticyclones over the North Island and northwesterlies over the South Island produced extremely dry conditions in the east of the South Island between June and September. Winter snowfall was much less frequent than normal. However, an early spring snow (19 September) down to sea level in Canterbury was unusual for the month.

Below-average spring rainfall resulted in significant soil moisture deficits developing much earlier than usual from Southland to Marlborough. Deficits spread to Nelson and the southwest of the North Island in November, and developed in Hawke's Bay, Auckland, and parts of Northland in December. However, southeasterlies in both October and November produced significant flooding in Gisborne.

(iii) Notable events

For the year, there were at least 26 heavy rainfall events, half of which produced floods. There were also 7 damaging hailstorms and 12 damaging tornadoes (or events attributed to tornadoes) in 2005. The Greymouth tornado of 10 March was particularly

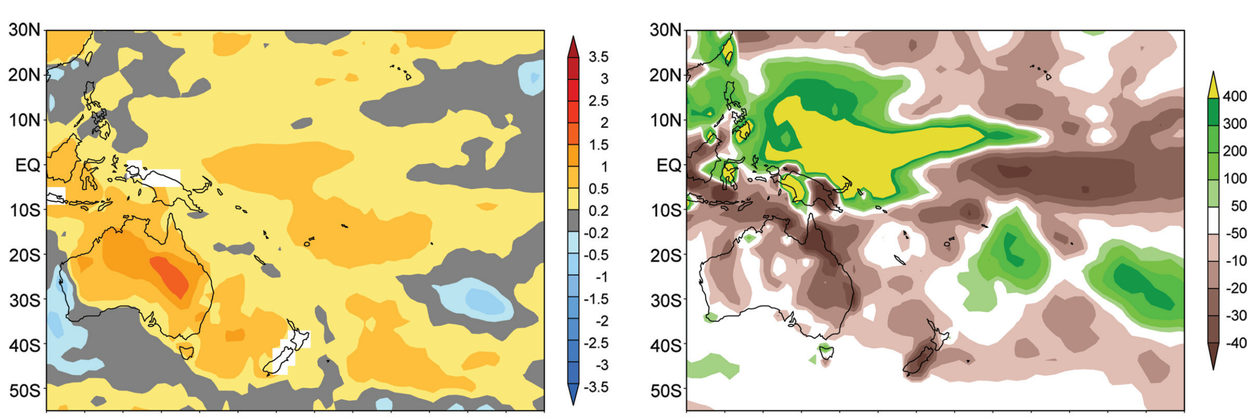

Fig. 6.39. South Pacific 2005 annual (left) temperature anomalies (°C; 1971–2000 base) and (right) precipitation anomalies (mm; 1979–2000 base) from CAMS–OPI.

destructive, leaving 30 people homeless and resulting in damage worth at least $10 million New Zealand dollars (NZD; $6.3 million USD). Wellington Airport was closed for many more hours than usual in 2005. There were 52 h with fog there, the highest for any year in 45 years of measurement.

The Bay of Plenty floods of 3–4 May and 17–18 May were most disastrous, with the earlier of the two causing widespread damage in parts of Tauranga, and the later being phenomenal, with unprecedented high rainfall for the district and a state of emergency declaration from Tauranga to Matata. Hundreds of people were evacuated. Homes were destroyed by mudslides and flooding, and rising waters threatened hundreds of others, especially in Matata.

The extremely high temperatures during the first 10 days of February are notable because there are very few instances prior to this event where temperatures anywhere in New Zealand have exceeded 38°C (100°F).

In Canterbury, the Christchurch airport, schools, and universities were closed due to an unusual early spring snow (19 September) in Canterbury. Snow depths of 5–10 cm were recorded in the region.

III) South Pacific Islands—M. J. Salinger[80] and S. M. Burgess[12]

A high frequency of surface equatorial westerlies occurred near the date line in February (the most since the last El Niño in 2002). Trade winds generally were near normal in strength at other times of the year. There was also some ENSO influence on the location of the SPCZ during the year. West of the date line, the SPCZ was further north than usual from January through August, and further south than usual from November through December. East of the date line, the SPCZ was very weak from March through August. It was further south than usual from October through December (see section 4d). Above-average equatorial SSTs occurred with the weakly negative El Niño; however, the region of positive SST anomalies drifted west as the El Niño faded. From August through December OLR anomalies showed enhanced convection over Papua New Guinea, and suppressed convection over Western and Eastern Kiribati, Tokelau, Tuvalu, and the North Cook Islands. For much of the year, mean sea level pressures were above average west of the date line, and below average in the east.

(i) Temperature

Overall, 2005 was warmer than normal (1971–2000 mean) across much of the region (Fig. 6.39). Above-average SSTs occurred throughout much of the tropical Southwest Pacific during 2005 (Fig. 6.40). Notably, SSTs were about +1.0°C above average around western Kiribati, and at least +0.5°C above average in many other island nations, especially those north of 20°S. New Caledonia, the Southern Cook Islands, the Austral Islands, and Pitcairn Island were surrounded by near-average SSTs. Southwest Pacific island surface air temperature anomalies for 2005 were consistent with the SST anomalies throughout the region. It was an extremely warm year in Tahiti-Faa'a, central French Polynesia, where the annual mean temperature was 27.0°C (+0.8°C above the 1971–2000 normal), and equal the highest since measurements commenced in 1957.

Locally, a heat wave occurred from 4 to 7 January in La Tontouta, New Caledonia, with maximum temperatures between 36° and 37°C. New Caledonia's mean temperatures were 1.3°C above normal for the month. In general, southern locations such as Vanuatu, Fiji, New Caledonia, and southern French Polynesia experienced a cooler-than-normal July and August. Tahiti-Faa'a recorded its hottest November and December maximum temperatures in 2005 (33.9° and 28.1°C, respectively).

(ii) Precipitation

Southwest Pacific 2005 OLR anomalies showed a region of enhanced convection over Papua New Guinea extending toward the Solomon Islands (Fig. 6.41). There was also an area of weakly enhanced convection over Niue and the Southern Cook Islands, as well as Pitcairn Island. Convection was suppressed in 2005 over western and eastern Kiribati, Tokelau,

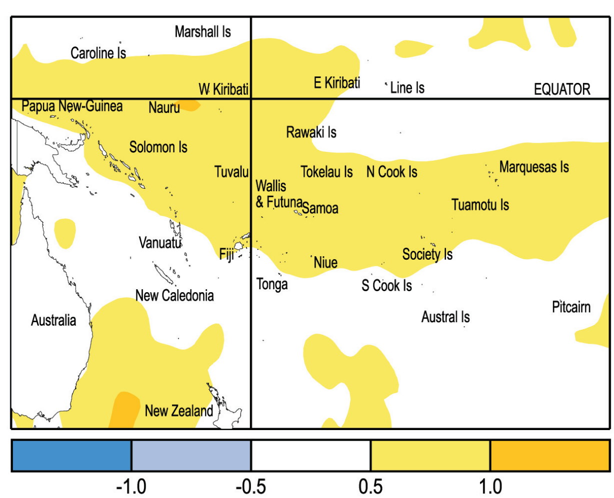

Fig. 6.40. South Pacific annual SST anomalies (relative to 1971–2000 mean; °C). Yellow or orange areas represent above-average temperatures.

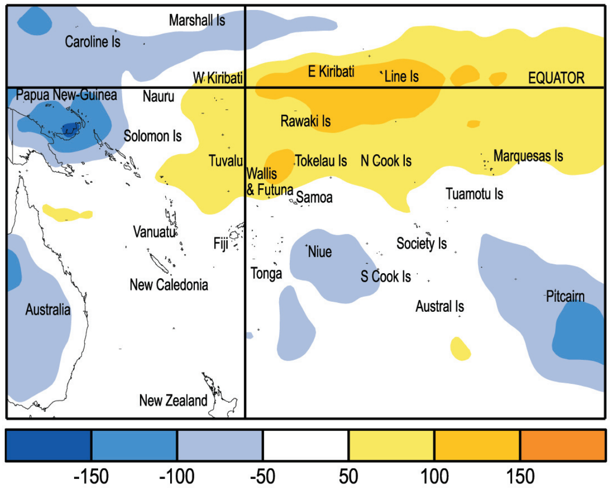

Fig. 6.41. Annual South Pacific outgoing longwave radiation anomalies (W m^{-2}). High radiation levels (yellow or orange) are typically associated with clearer skies and lower rainfall, while low values (blue) often indicate cloudy conditions and more rain for the region.

Tuvalu, Wallis and Futuna, the North Cook Islands, and the Marquesas Islands. The year's rainfall distribution shows similarities to the OLR pattern. However, for rainfall there were not many significant anomalies. Annual rainfall was at least 110% of normal in an area affecting a region extending from Niue to the north and east of Fiji, and also parts of Southern French Polynesia. In contrast, 2005 rainfall was less than 90% of the average throughout much of New Caledonia.

One location, Gambier, Rikitea, French Polynesia, recorded an extremely high 2005 precipitation anomaly of 127% of normal (2505 mm). Several locations received record monthly rainfall amounts: Vunisea, Fiji (786 mm, April), Viwa (205 mm, June), Monasavu (640 mm, June), Navua (587 mm, June), Nausori Airport (474 mm, September), Vatukoula (353 mm, November), and at Lupepau'u, Tonga (440 mm, June). On 4 March, Vunisea set a record for daily rainfall of 251 mm, and on 18 November, Vatukoula received a record 119 mm of precipitation. Record low monthly precipitation was also recorded at Udu Point, Fiji (84 mm), and Tuamotu, Takaroa, French Polynesia (25 mm), in March, Nadi Airport and Penang Mill, Fiji (1 and 7.8 mm, respectively), in May, and Bora Bora, French Polynesia (23 mm) in October.

Rainfall occurred almost every day from 6 to 20 April in Fiji's Western Division. Extensive flooding occurred in the Northern and Western Divisions over 16–20 April, closing almost 50 roads. There was one fatality. Vanuatu, Pekoa, recorded 950 mm for April, including 5 days exceeding 100 mm. Torrential rainfall occurred in Fiji's Central Division during the last week of September, leading to flooding in parts of Suva, Nausori, and Tailevu. A large number of villages were evacuated and there was one fatality. Nausori Airport recorded 187 mm of rain on the 28th.

(iii) Notable events

In February, a record four intense tropical cyclones (Meena, Nancy, Olaf, and Percy) impacted the South Pacific Islands (see section 4c). All four occurred east of the date line, with most being triggered during an active phase of the Madden–Julian oscillation. On the Saffir–Simpson scale, Meena and Nancy reached category 4 status, while Olaf and Percy were category 5 at their height.

The first of the cyclones, Meena, passed close to Rarotonga on 6 February, with wind gusts exceeding 115 km h^{-1}. Cyclone Nancy tracked through the Northern Cook Islands from 13 to 15 February with winds gusting to 163 km h^{-1} in Rarotonga and to 185 km h^{-1} elsewhere. In Aitutaki, trees were uprooted, roofs damaged, and low-lying areas flooded. Wind and storm surge caused widespread damage along the northern and eastern coasts of Rarotonga. On 16 February, Olaf's storm surge destroyed numerous coastal structures and high winds lifted many roofs in both Samoa and American Samoa. Rarotonga's west coast received substantial damage. Late in the month, Percy, with maximum sustained winds reaching 260 km h^{-1}, caused widespread damage and destruction on Pukapuka, Nassau, Swain, and Tokelau Islands. In Tokelau, Percy destroyed most of the island's agriculture and was reportedly the worst tropical cyclone in living memory. Fortunately, despite the intense nature of these four cyclones, and reconstruction estimates exceeding $25 million USD, there were no confirmed fatalities from these storms (two listed as missing at sea following Olaf).