Australian Government
Bureau of Meteorology

Special Climate Statement 69—an extended period of heavy rainfall and flooding in tropical Queensland

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1.0	15 February 2019	
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Cover image: Tegan Beveridge, Black Weir, Townsville, February 2019

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Executive summary

- An active monsoon trough and a slow-moving low pressure system over the northern tropics produced extremely heavy rainfall in tropical Queensland from late January 2019 into early February.
- In and around Townsville, the accumulated totals from consecutive days of heavy rainfall set many new records. The highest weekly accumulations were comparable in terms of geographic spread, duration, and intensity of rainfall to those of January 1998 and January 1953.
- In the seven days to 4 February 2019, the Bureau's site at Townsville Aero recorded 1052.8 mm, and 1259.8 mm in the ten days to 8 February. Prior to this event, the Townsville record for a 7-day period was 886.2 mm (January 1998) and for a 10-day period was 925.5 mm (January 1953).
- There were several sites in elevated areas including Paluma, Woolshed, and Upper Bluewater that reported 12-day accumulations of more than 2000 mm.
- In the Gulf Country and North West Queensland, record-breaking rainfall also occurred in previously drought affected regions, including at Julia Creek and Richmond.

Introduction

An unusual, extended period of heavy rainfall over large areas of tropical Queensland began in late January 2019 and continued into February.

The heavy rainfall was associated with an intense and very slow-moving monsoon low over northern Queensland that continued to affect Queensland until 9 February. While such slow-moving systems are relatively rare for this part of the country, there are a number in the historical record and they are all associated with extreme rainfall totals. The large size of monsoon lows means the areas they impact may be larger than tropical cyclones.

The rainfall from the 2019 event was exceptional. In and around Townsville, the accumulated totals from consecutive days of heavy rainfall were the city's highest on record since records began in 1888.[1] The highest weekly accumulations were comparable in terms of geographic spread of rainfall, duration, and intensity to those of January 1998 and January 1953. There were numerous sites in elevated areas that reported 12-day accumulations of more than 2000 mm, including at Paluma, Woolshed, and Upper Bluewater.

In the Gulf Country and North West Queensland, record-breaking rainfall also occurred in previously drought affected regions, including at Julia Creek and Richmond, resulting in major flooding across large areas. Several sites in northwest Queensland had 7-day rainfall accumulations of more than 600 mm, and large areas received more than four times their February average rainfall.

Historic return periods and probability of exceedance statistics

This Special Climate Statement provides estimates of annual exceedance probabilities based on historically recorded rainfall for the region. However, these historical estimates may not be an accurate guide to the actual probability of the recent heavy rainfall event, and are likely to underestimate the probability of such rainfall in the future. This is because the climate system is changing, and global warming increases the likelihood of heavy rainfall events in most locations. As noted in the joint Bureau of Meteorology/CSIRO State of the Climate 2018:

> "Although the range of natural variability in heavy rainfall is very large, there is evidence from observed weather station records that a higher proportion of total annual rainfall in recent decades has come from heavy rain days. As the climate warms, heavy rainfall is expected to become more intense, based on the physical relationship between temperature and the water-holding capacity of the atmosphere. For heavy rain days, total rainfall is expected to increase by around 7 per cent per degree of warming. For short duration, hourly, extreme rainfall events, observations in Australia generally show a larger than 7 per cent increase."

Work is currently under-way through the National Environmental Science Programme (NESP) Earth Systems and Climate Change Hub (ESCC) examining future projections of extreme heavy rainfall for Australia, which will result in improved estimates of future Intensity–Frequency–Duration (IFD) design rainfall curves.

[1] Since complete daily rainfall records are available for the Townsville Pilot Station (032047) site.

1. Evolution of the rainfall event

A pulse of the Madden–Julian Oscillation moved through the Australian region in the second half of January and invigorated a weak monsoon trough that previously lay north of the Australian continent. The monsoon trough intensified significantly in the ensuing days and moved south over Cape York Peninsula. A tropical low pressure centre embedded in the monsoon trough deepened and moved south, drawing the trough further south. The low became slow-moving over Queensland's northern interior by the end of January, with the monsoon trough also stalling, roughly at the latitude of Cardwell, remaining there for more than a week. The monsoon trough and its associated tropical low maintained a near-stationary position for an extended period as a result of the atmospheric flow over the Australian region. The broadscale winds surrounding and acting upon this weather feature acted in roughly equal measure from multiple directions, resulting in relatively little overall movement.

Maps of the daily mean sea level pressure (MSLP) analyses for 26 January to 9 February can be seen in Figure 4, showing the persistent monsoon trough extending across northern Australia and the embedded low pressure centre persisting over Queensland.

Maps of Queensland showing the daily rainfall totals for 26 January to 9 February can be seen in Figure 5.

Saturday 26 January – Wednesday 30 January

On 26 January, a monsoon trough stretched across the northern tropics, from tropical cyclone *Riley* off the Western Australia coast, across the Northern Territory and further east to a tropical low that was located over Cape York Peninsula. Over the next couple of days, as tropical cyclone *Riley* moved further away from the continent, the monsoon trough over Western Australia and the Northern Territory broke down. Over Queensland, the monsoon trough and embedded tropical low tracked slowly south over Cape York Peninsula between 26 and 30 January. The highest rainfall totals during this period were generally on the coastal strip between Innisfail and Cooktown (see Figure 1), but widespread totals of more than 100 mm were observed as far south as Mackay and over most of Cape York. Heavy rainfall began on 26 January in areas around Cairns and north to Cooktown, with daily totals of more than 100 mm at many locations in the Herbert and Lower Burdekin District. By 28 January, the focus of the rainfall shifted south to areas centred around Townsville, but still covered a long stretch of coast from Cairns to Mackay.

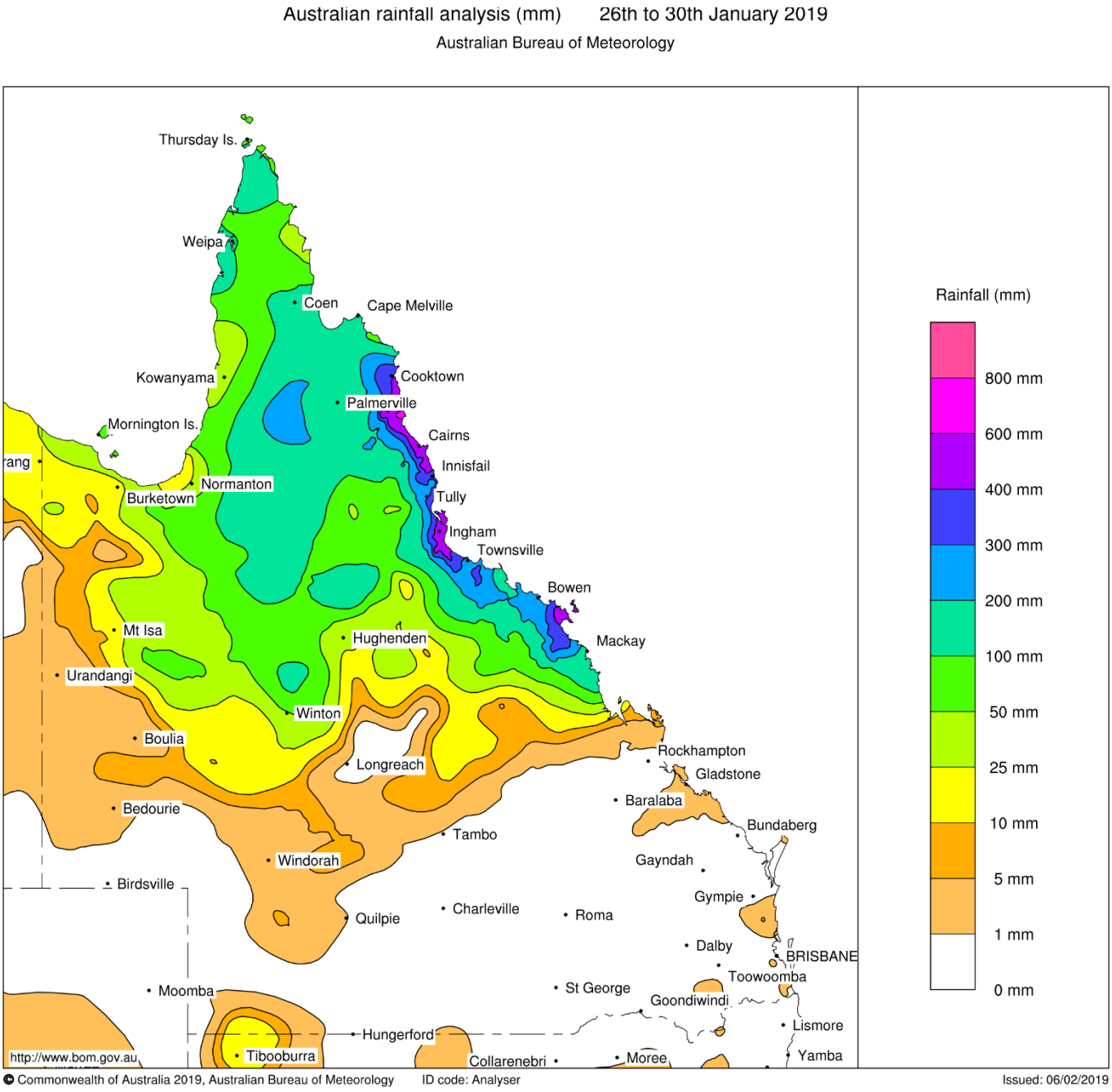

Figure 1: Map of Queensland showing rainfall totals from 26–30 January 2019.

Thursday 31 January – Monday 4 February

By 31 January, the monsoon trough extended from the Queensland east coast near Cardwell to the tropical low over the northern interior. The tropical low embedded in the monsoon trough acted as a focus for the humid monsoonal wind flow originating from the Coral Sea. The northwesterly monsoon winds converged with a moist southeasterly flow coming from the northern Tasman Sea. These interacted with the near-coastal topography of the Great Dividing Range, generating widespread, heavy rainfall over much of northern Queensland, heaviest about near-coastal parts near Townsville where the wind convergence was most pronounced.

Over the next few days, the northwesterly winds feeding into the monsoon trough strengthened, helping to deepen the low and maintain the strong onshore winds, generating very heavy rainfall along the length of the monsoon trough. The heaviest falls were along the coast near Townsville, but totals to 500 mm or more also fell in the vicinity of the tropical low pressure system.

During this period, extremely high rainfall totals accumulated over several days across the Herbert and Lower Burdekin District. Flooding occurred in the Burdekin, Ross, Bohle, Haughton, and Herbert rivers, along with Black River, and Bluewater Creek. Rivers in the Gulf Country were also rising, with the Flinders River at Walkers Bend in major flood early on the morning of 2 February.

With persistent, widespread daily rainfall of more than 100 mm over the region, the Ross River Dam spillway gates were fully opened on the evening of Sunday 3 February as its capacity reached more than 200%.[2]

During the afternoon of 4 February, the deep tropical low over Queensland's Gulf Country started moving slowly to the east, after several days of heavy rainfall in the North West district. The low was at its most intense on the 4th, and in the following days it gradually weakened. Maximum rainfall totals near the east coast were generally lower on 4 and 5 February than during previous days, leading to some reductions in river and water storage levels around Townsville. Large daily rainfall totals continued to be observed further inland, near the tropical low.

[2] See press release from Townsville City Council on 3 February 2019.

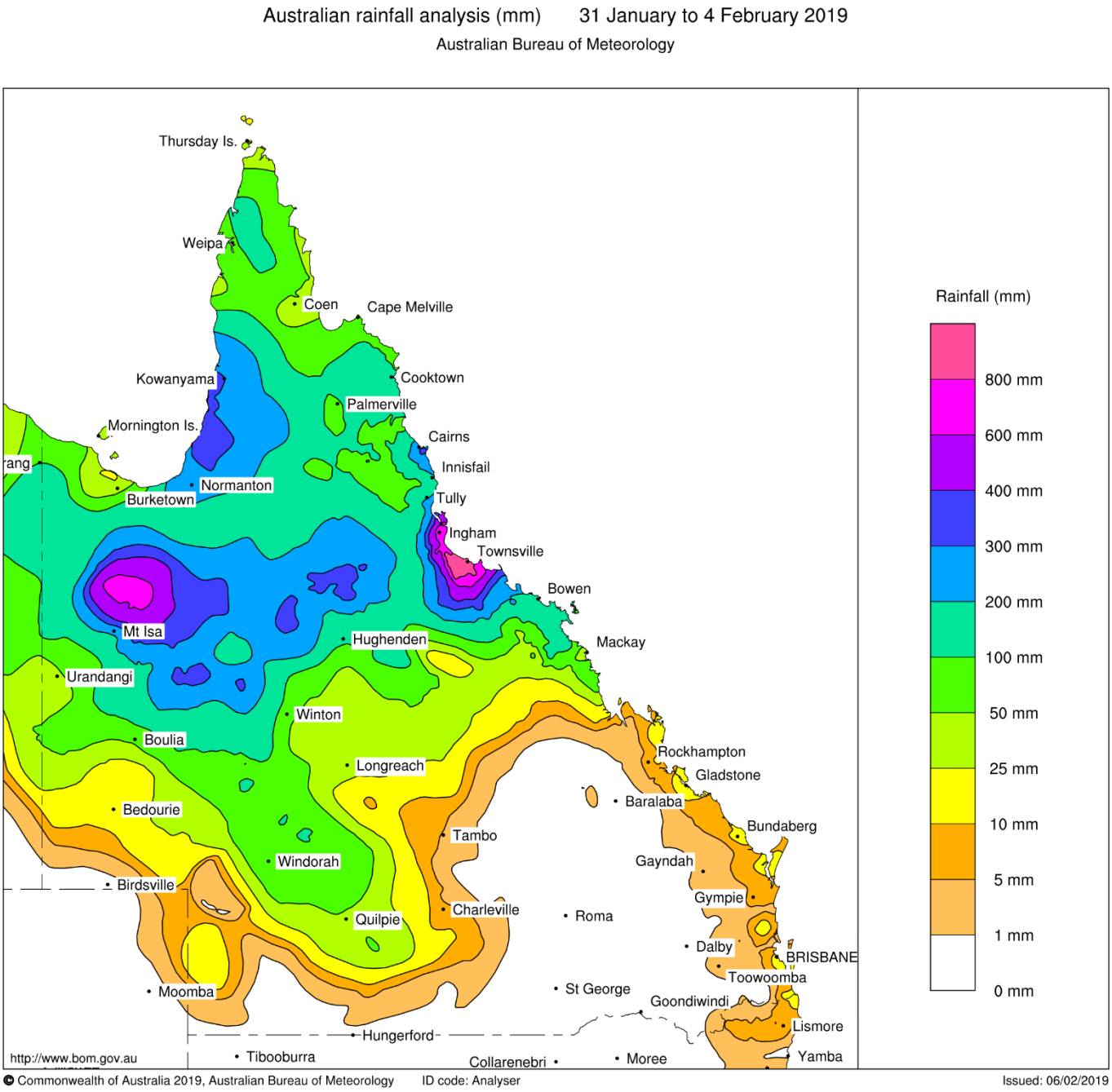

Figure 2: Map of Queensland showing rainfall totals from 31 January to 4 February 2019.

Tuesday 5 February onwards

The monsoon trough maintained a similar location to previous days, extending east to the coast near Cardwell. Embedded within the trough, the tropical low over the northern interior weakened further from 5 February and moved slowly east to the base of Cape York Peninsula by the 6th. The monsoonal winds remained relatively strong, although easing conditions were indicated by the presence of dry air in the mid-layers of the atmosphere on the 5th and 6th. Widespread daily rainfall totals in the order of 100 mm were observed around the Townsville region to 9am on the 6th, although peak falls were less than previous days, generally below 200 mm. Across the northern interior of Queensland, the highest daily rainfall totals were observed from Julia Creek to Richmond. To 9am on 7 February, rainfall totals along the coast, and over the interior near the tropical low, were generally less than 100 mm, apart from a small coastal area near Proserpine.

The following 24 hours saw an increase in rainfall along the coastal zone between Innisfail and Townsville. Falls of more than 100 mm to 9am on 8 February were recorded around the Townsville area. This coincided with the formation of a second tropical low that developed on the monsoon trough just offshore near Cardwell, before it moved slightly north later on the 7th.

The monsoon trough with two embedded lows continued to track slowly eastwards during the 8th, leading to reduced rainfall over the interior, however some coastal locations experienced moderate falls. By 9 February, the monsoon trough and embedded lows had moved off the Queensland coast and rainfall over northern Queensland eased significantly.

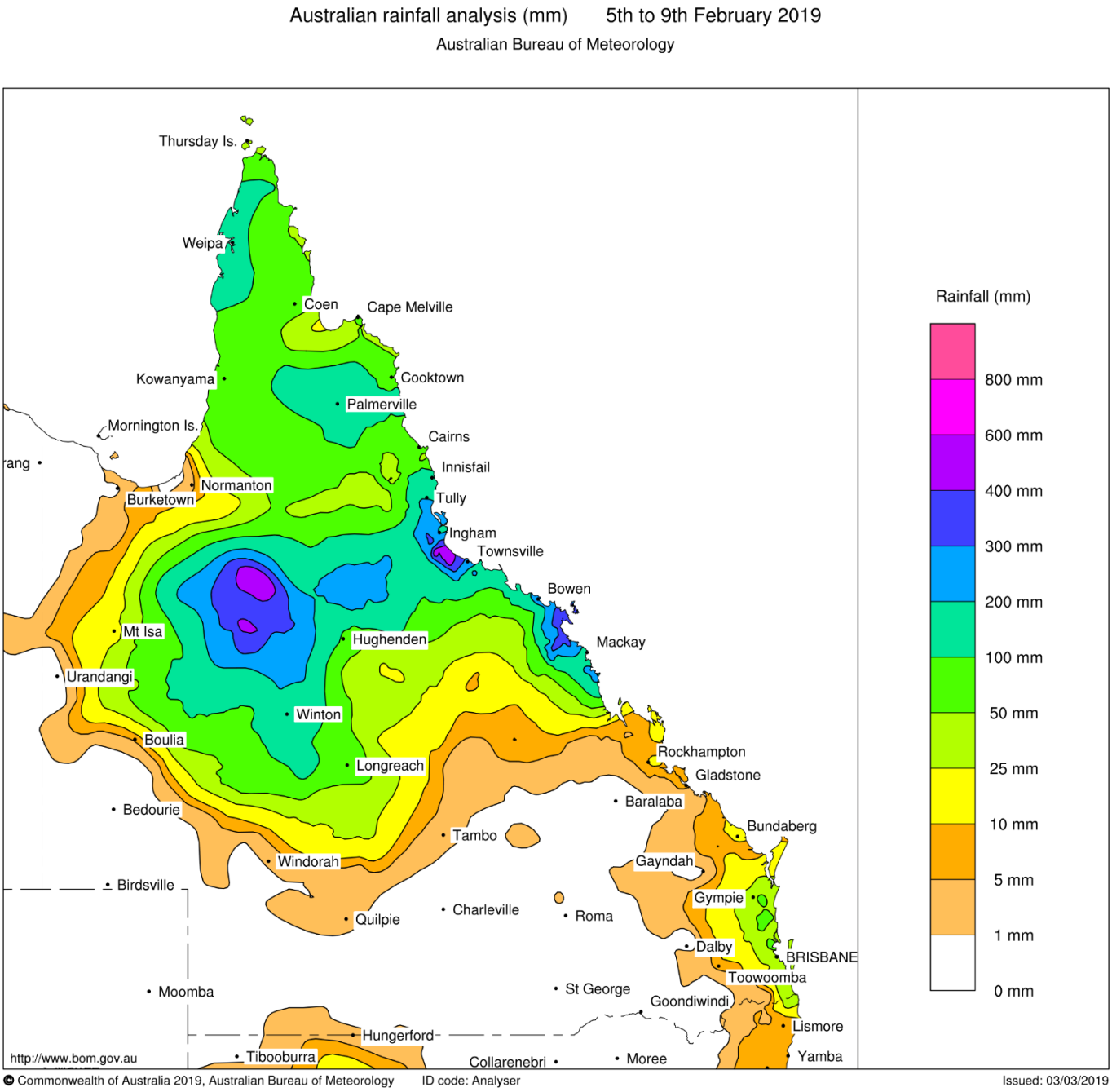

Figure 3: Map of Queensland showing rainfall totals from 5 to 9 February 2019.

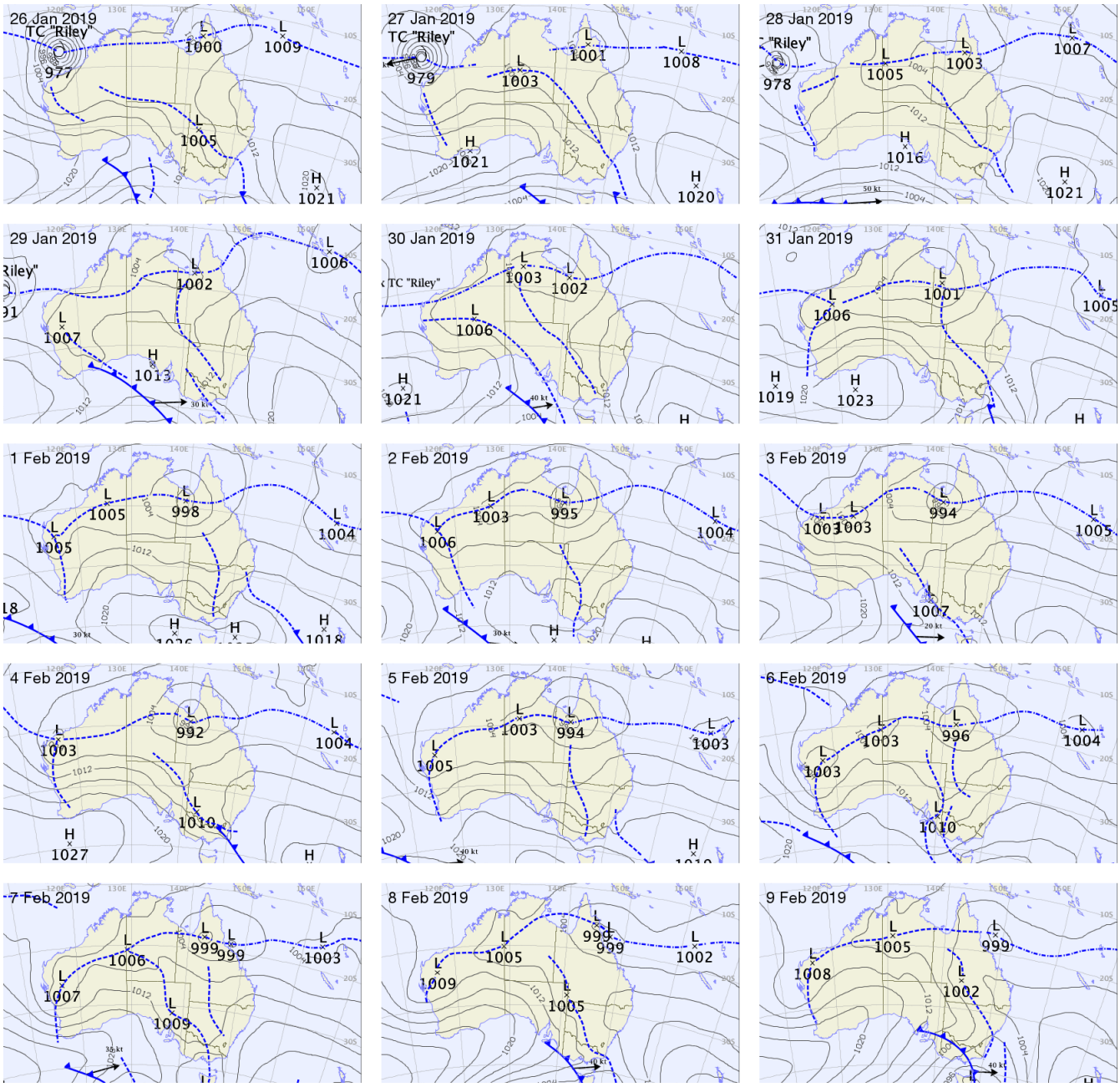

Figure 4: Mean sea level pressure (MSLP) analyses for 26 January to 9 February 2019.

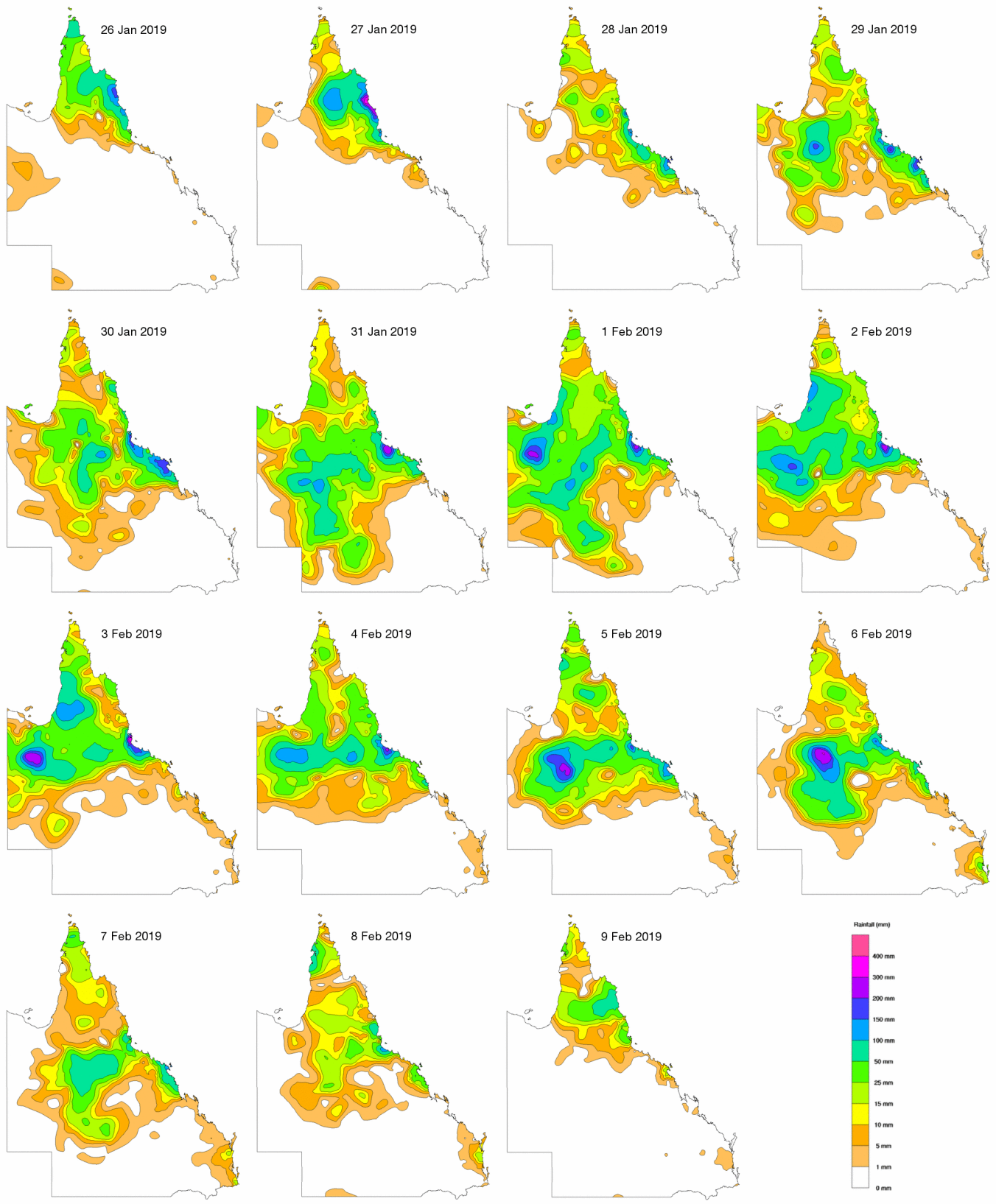

Figure 5: Maps of Queensland daily rainfall totals for 26 January to 9 February 2019.

2. Climate drivers

The role of natural climate drivers such as El Niño–Southern Oscillation (ENSO), the Indian Ocean Dipole (IOD), and Southern Annular Mode (SAM) in the event is likely to have been limited given that all were near neutral in early 2019.

Tropical Pacific Ocean sea surface temperatures reached El Niño levels during December 2018. However, atmospheric indicators such as cloud patterns, the Southern Oscillation Index (SOI), and trade winds did not show consistent or sustained signs of El Niño. Wetter than average conditions in eastern Australia are often associated with La Niña conditions in the equatorial Pacific Ocean, however ENSO was in a neutral phase in early 2019.

A positive IOD event was active from early September to December 2018, but had weakened and ended before this extended period of heavy rain. The IOD was neutral during this event.

The intra-seasonal tropical wave known as the Madden–Julian Oscillation (MJO)[3] was active across the Australian region during the second half of January. The favourable environmental conditions associated with this MJO contributed to the development and intensification of the monsoon trough and embedded tropical low, which became the focus for the heavy rainfall across northern Queensland from late January.

3. Extended period of rainfall around Townsville

Queensland's east coast is typically a very wet part of the country during the northern wet season. There are numerous instances in past years of 5-day rainfall totals of 1000 mm or above at various locations along the coast. The areas of major rainfall maxima are between about Cooktown and Ingham, and between Proserpine and Sarina on the central coast (see Figure 6). In these areas, the coast is well aligned to intercept the southeast winds and onshore flow.

Townsville is climatologically drier than locations further north. Rain shadows exist around Townsville to Bowen, where the coastal alignment is more parallel to the prevailing winds. For areas close to Townsville, the accumulated rainfall totals from consecutive days of heavy rainfall during January and February 2019 set many new records.

In the seven days to 4 February 2019, the Bureau's site at Townsville Aero recorded 1052.8 mm, and 1259.8 mm in the ten days to 8 February. Prior to this event, the Townsville record for a 7-day period was 886.2 mm (January 1998) and for a 10-day period was 925.5 mm (January 1953).[4] The multi-day rainfall totals at Townsville Aero exceeded site records for February at all durations from two to twelve days, with the accumulations for six or more days being records for any month.

Figure 7 shows cumulative daily rainfall totals at the Townsville Aero site since the start of 2019 compared to the site's 78 years of history. After a relatively dry start to the year, Townsville has already in 2019 recorded more than its average annual rainfall of 1128.0 mm (based on all years of data for the site from 1941–2018).

Only a few high daily rainfall records at long-term sites were exceeded during this event. However, the extended duration of heavy rainfall exceeded many multi-day rainfall records in and around Townsville, as well as in some western districts of Queensland. Figure 8 shows the storm envelope for periods from 1 minute to 7 days at the Townsville Aero site, showing the highest rainfall amount for each period, along with the Intensity–Frequency–Duration (IFD) design rainfall depths, showing the probability of those rainfall amounts occurring based on statistical analysis of historical rainfall.[5] At durations of between 4 and 24 hours, the peak rainfall rates were near

[3] Further information about the Madden–Julian Oscillation at http://www.bom.gov.au/climate/about/?bookmark=mjo

[4] The flood events of January 1953 and January 1998 are discussed in more detail later in this statement.

[5] Intensity–Frequency–Duration (IFD) design rainfall intensities (mm/h) or design rainfall depths (mm) corresponding to selected standard probabilities, based on the statistical analysis of historical rainfall. Further information about design rainfalls at http://www.bom.gov.au/water/designRainfalls/

or above the 20% annual exceedance probability (AEP) level.[6] This indicates that historically the site could expect to receive rainfall of that intensity—for durations of less than one day—once in every four-and-a-half or so years. At durations of four days or more, the storm envelope exceeds the 1% AEP level, indicating that these multi-day totals for more than four days are very rare. It was similar for other sites close to Townsville and also in northwest Queensland, with storm envelopes at many sites exceeding 1% AEP for durations of four or more days. Figure 9 shows that large areas extending from near Townsville on Queensland's tropical east coast to around Mount Isa in the northwest had their highest 7-day rainfall totals on record for February.

By early February, soils across much of tropical Queensland were close to saturated, with the rainfall quickly causing runoff into rivers and therefore increased flood levels. Figure 10 shows modelled root zone[7] soil moisture for 1–5 February 2019.[8] The top one metre of soils across large areas of tropical Queensland averaged more than 80% of their available water content over the first five days of February, including some areas approaching 100% of available water content in coastal locations between Cairns and Townsville.

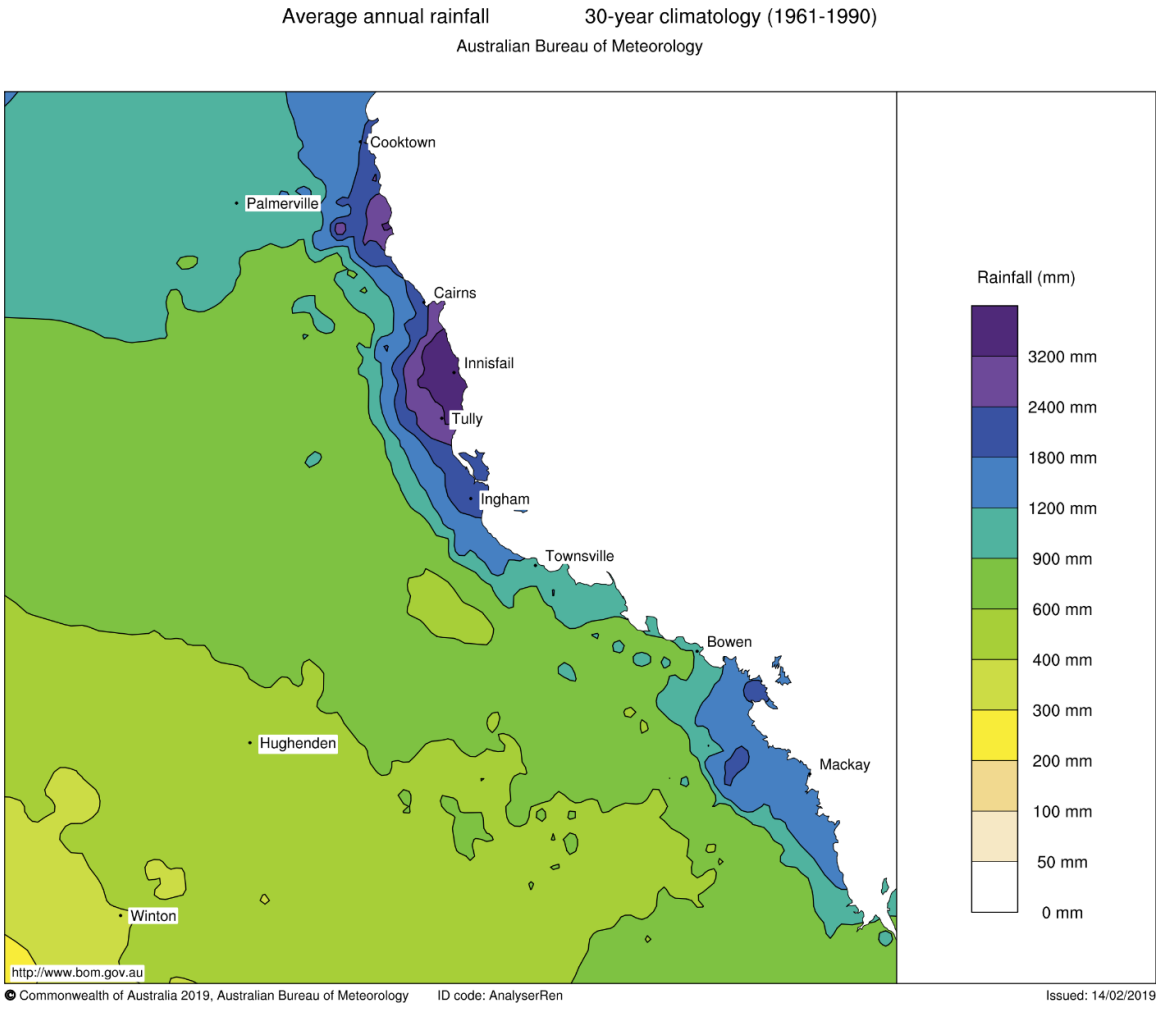

Figure 6: Map of the tropical Queensland coast showing average annual rainfall (based on a 30-year climatology from 1961-1990). Areas between Townsville and Bowen are climatologically drier than areas further north.

[6] The annual exceedance probability (AEP) is the likelihood of an event occurring or being exceeded within any given year, usually expressed as a percentage. A 1% probability of exceedance denotes a very rare event.

[7] Top one metre of the soil profile.

[8] Further information about the Bureau's modelled soil moisture is available at: http://www.bom.gov.au/water/landscape/

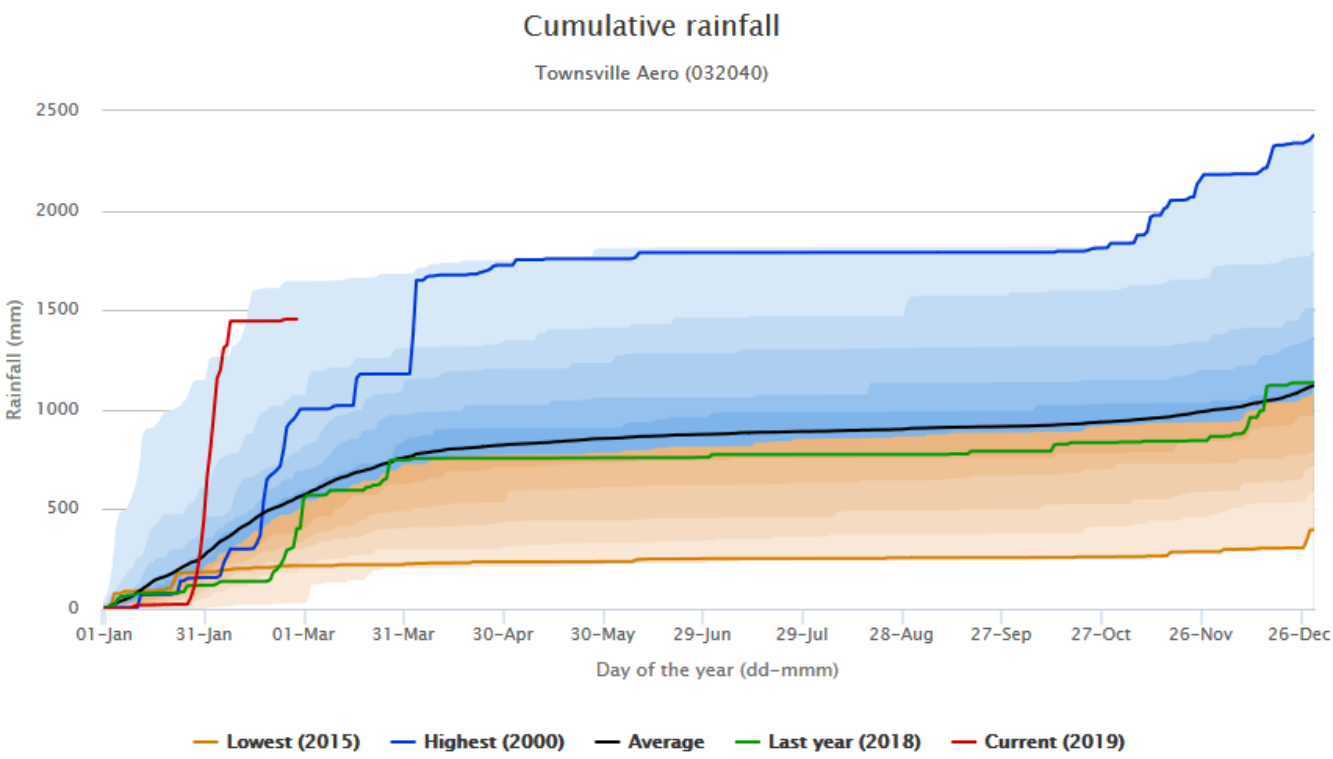

Figure 7: Graph of cumulative daily rainfall at the Townsville Aero site. The cumulative rainfall total for 1 January to 28 February 2019 is shown in red. By early February, it already exceeded the annual average at the site (black line). Shaded pale blue and orange background areas are rainfall deciles for that time of the year (based on all years of rainfall data for the site).

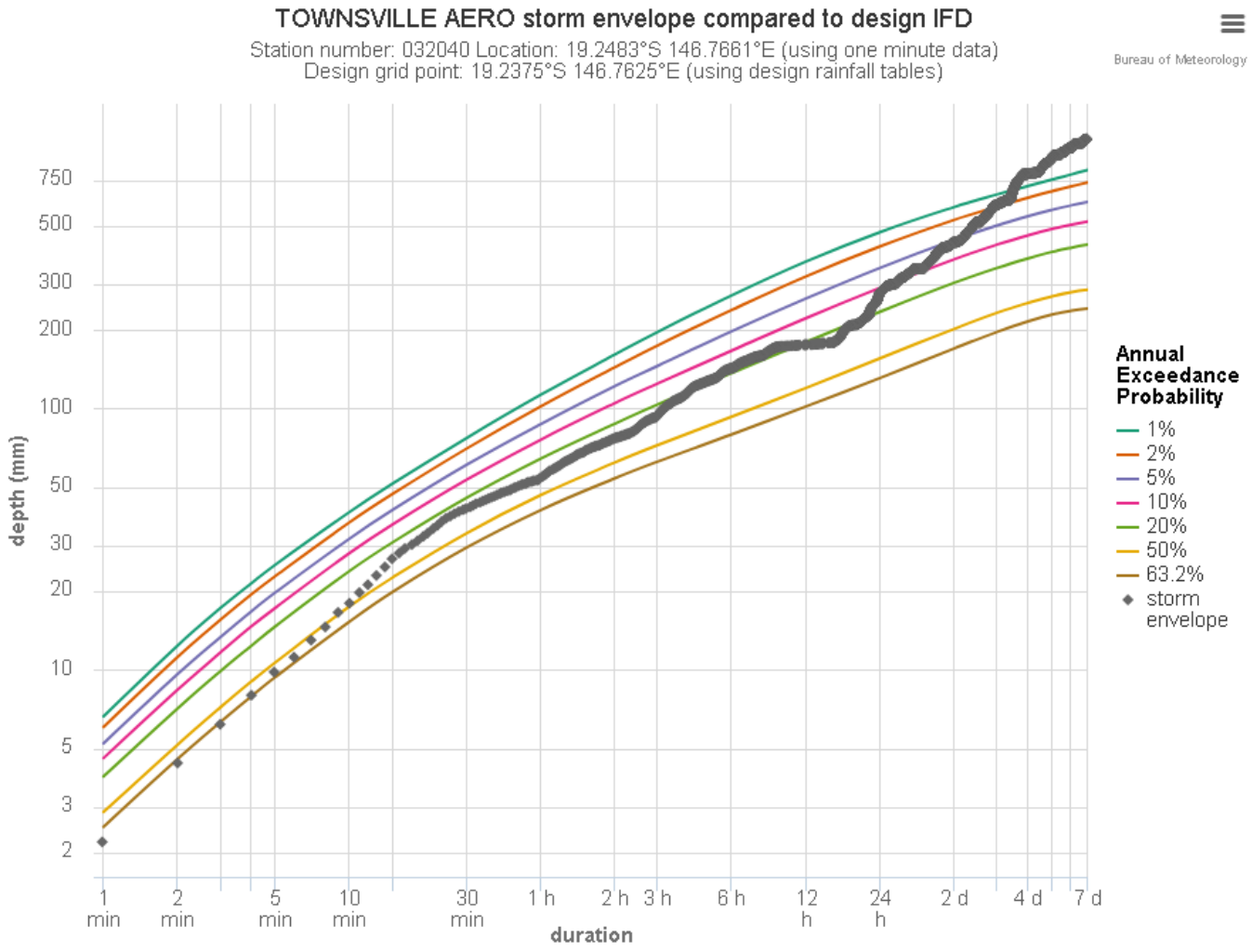

Figure 8: Highest rainfall intensities (storm envelope, grey diamonds) for periods from 1 minute to 7 days at the Townsville Aero site from 29 January to 4 February 2019, showing the greatest rainfall amount for each period; and IFD (intensity–frequency–duration) design rainfall depths, showing the probability of those rainfall amounts occurring based on a statistical analysis of the historical rainfall.

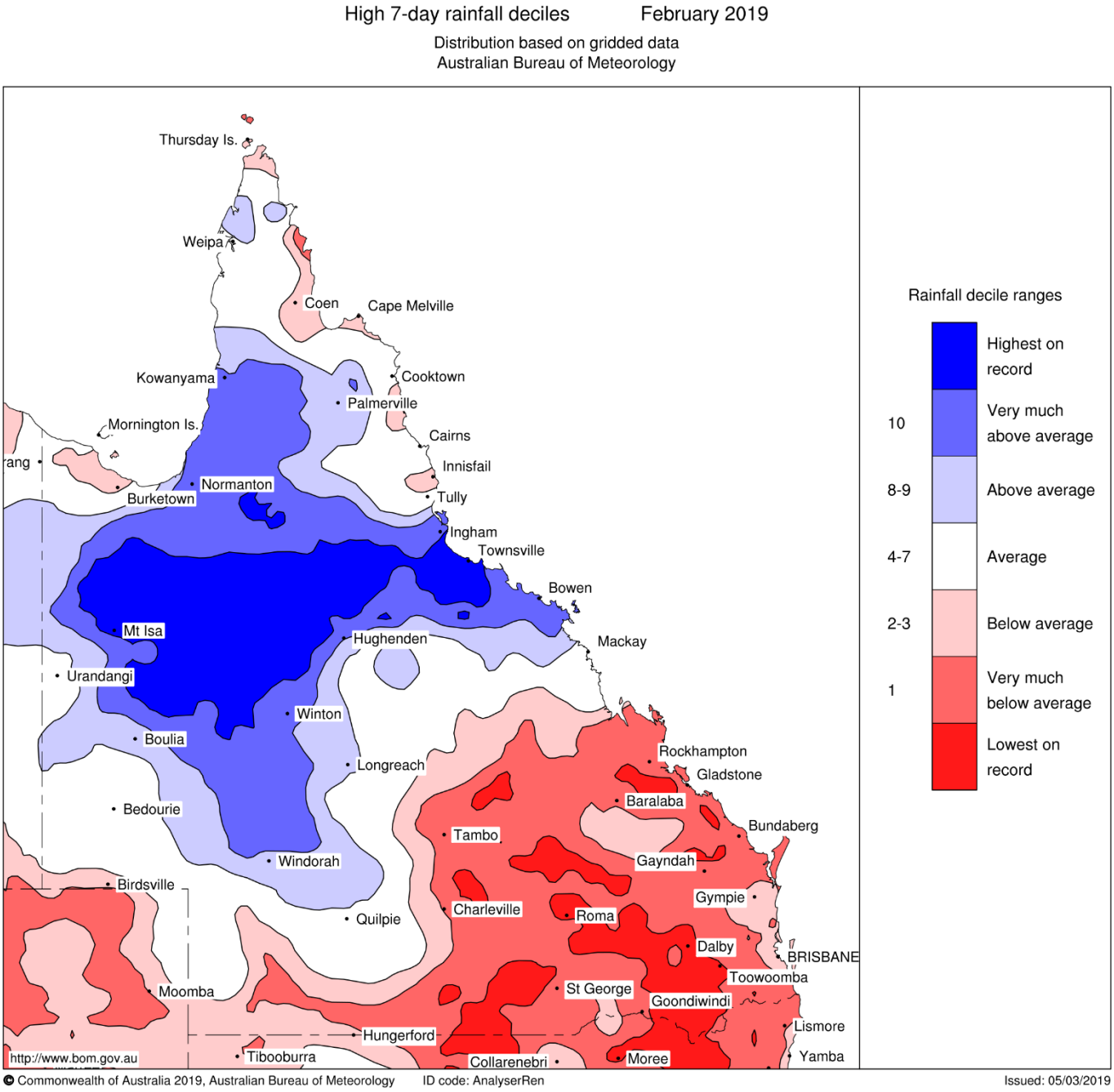

Figure 9: Map of Queensland showing the deciles for the highest 7-day rainfall totals during February 2019.

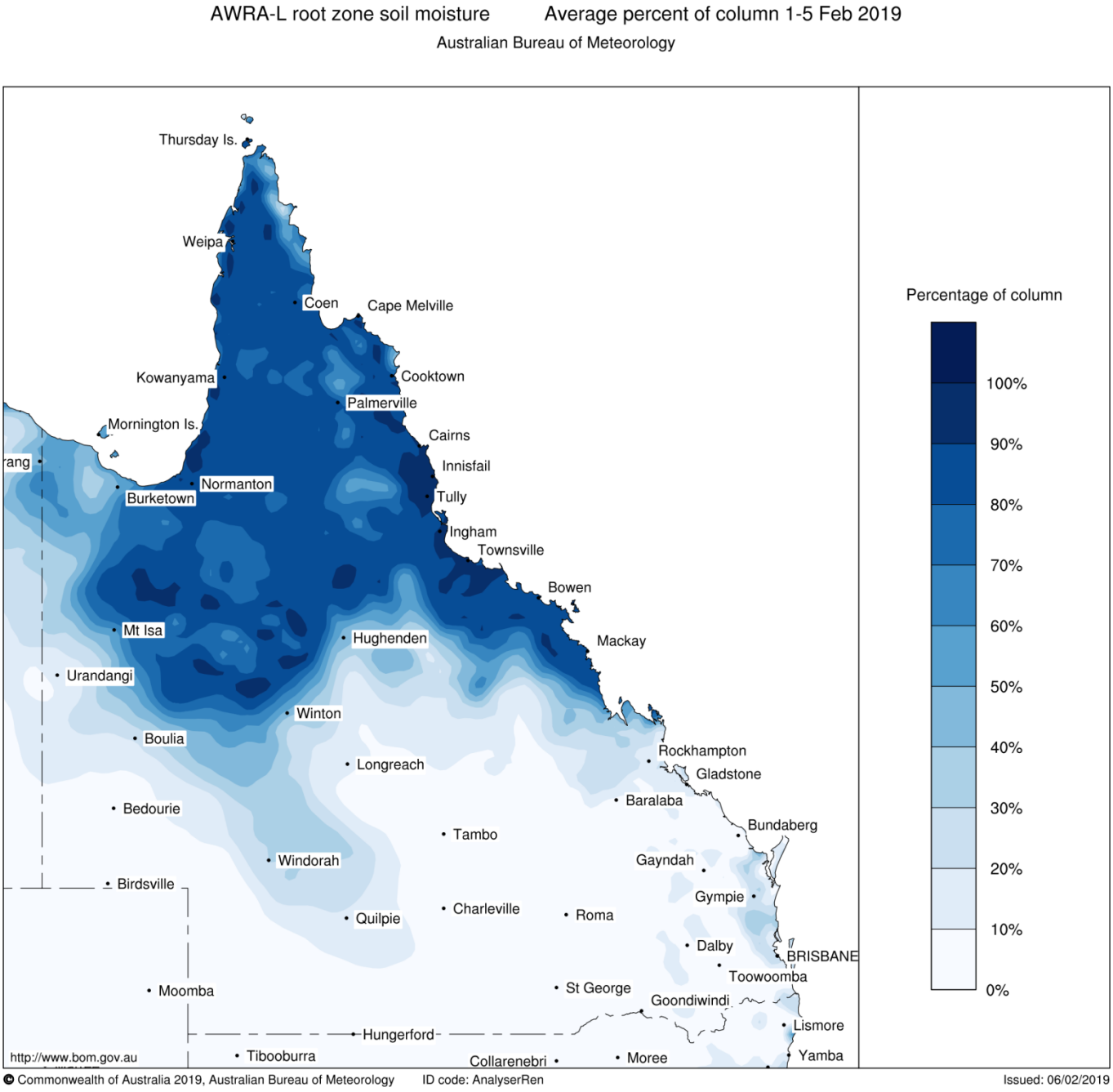

Figure 10: Australian Water Resources Assessment Landscape model (AWRA-L) 6.0 modelled root zone soil moisture average percentage of column for 1–5 February 2019.

4. Event rainfall totals

Figure 11 shows the rainfall totals for the event from 26 January to 9 February 2019. Large areas along the east coast from Cooktown to Mackay, and west of Townsville inland to near Mount Isa had more than 400 mm.

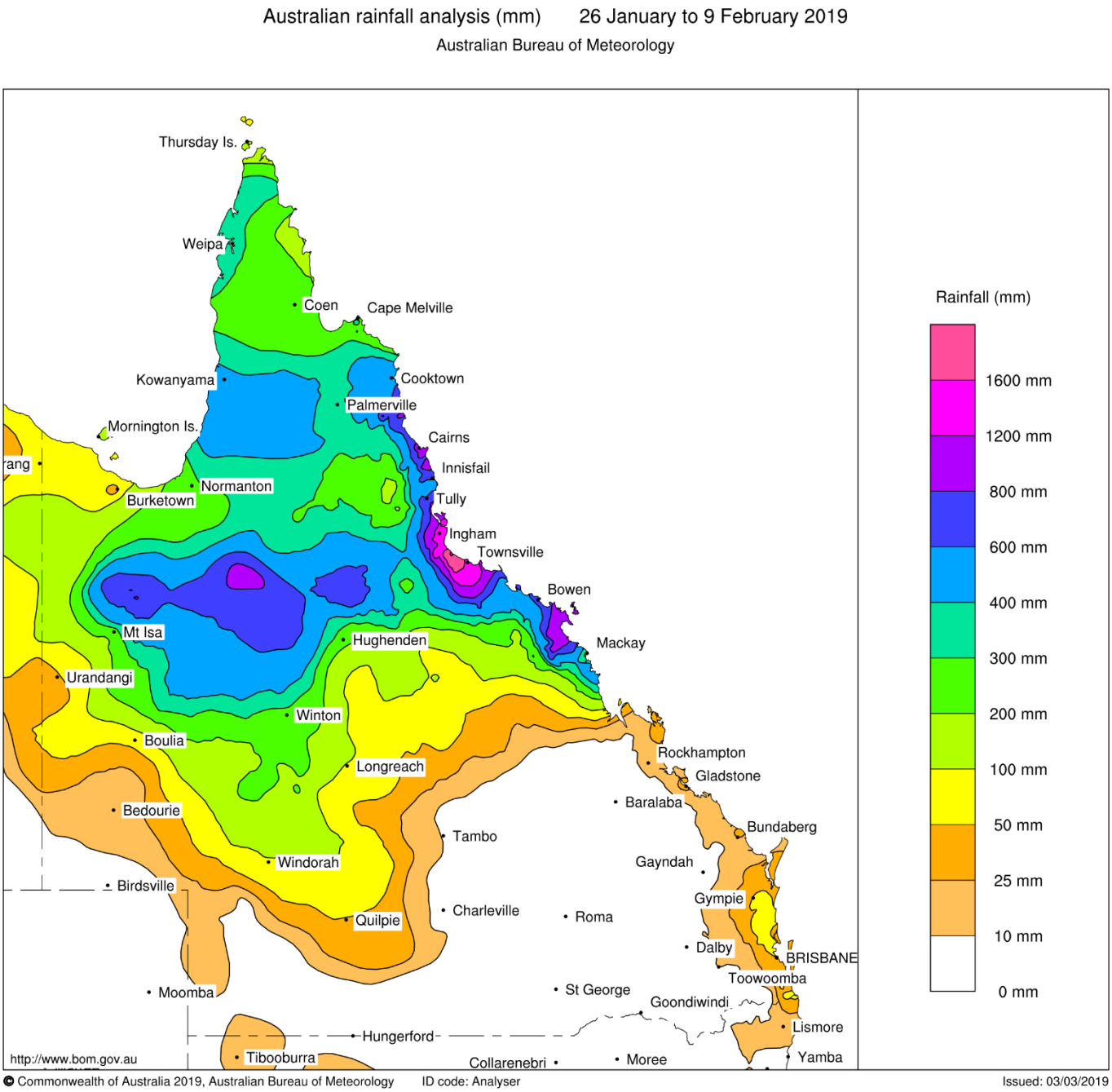

Figure 11: Map of rainfall totals for Queensland from 26 January to 9 February 2019.

Figure 12 shows the rainfall totals for the event from 26 January to 9 February 2019 in tropical coastal Queensland, which was the area that received the highest multi-day rainfall totals, including more than 2000 mm at some locations.

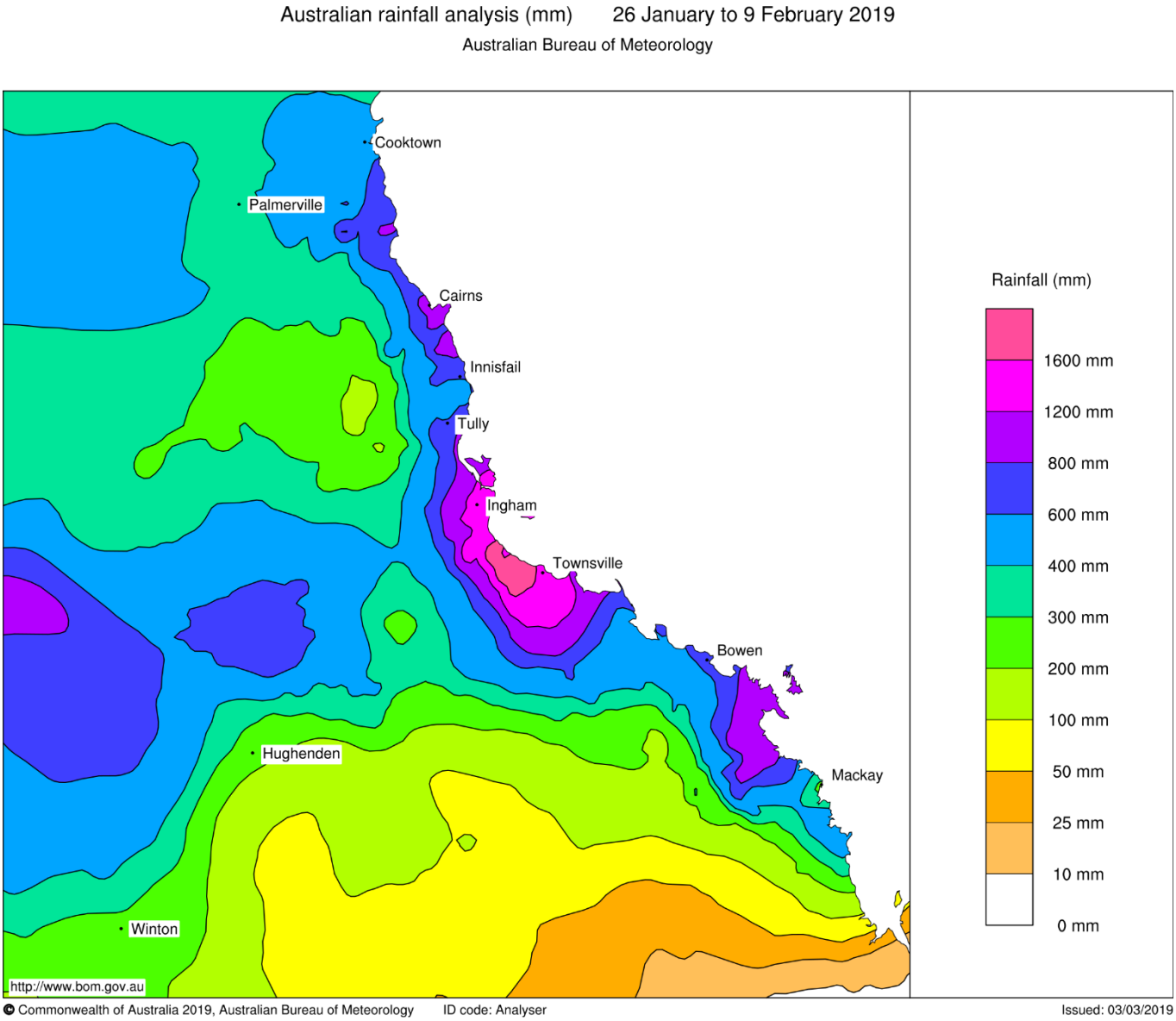

Figure 12: Map of rainfall totals for tropical coastal Queensland from 26 January to 9 February 2019.

Figure 13 shows the rainfall totals for 1–9 February 2019 as a percentage of the February mean rainfall (based on 1961–1990). Coastal areas close to Townsville and a large area north and east of Mount Isa had more than four times their February average rainfall during the first week of the month.

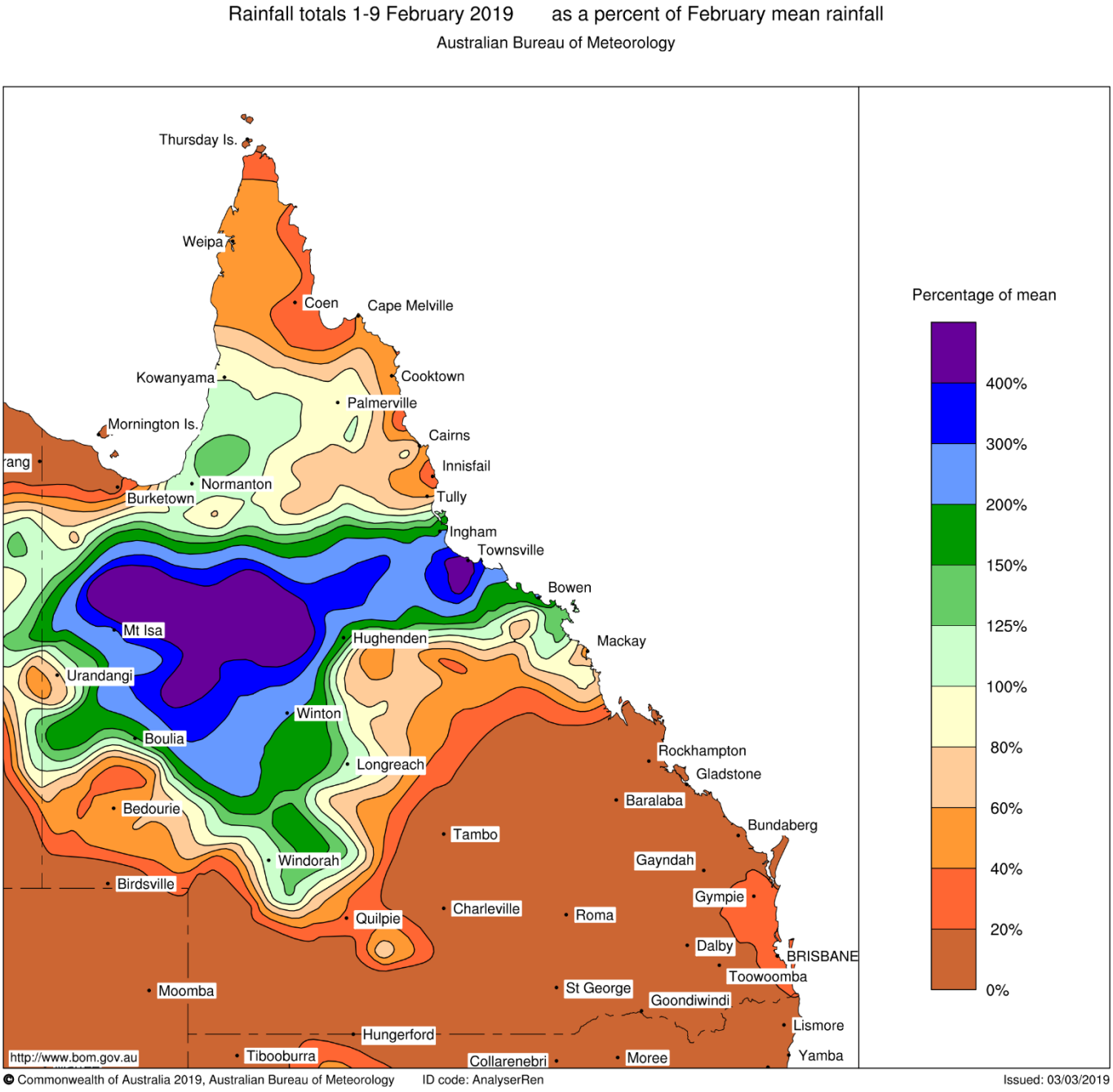

Figure 13: Rainfall totals for 1–9 February 2019 as a percentage of the February average rainfall (with respect to 1961–1990 averages).

Figure 14 shows the summer rainfall totals across Queensland from 1 December 2018 to 28 February 2019 as a percentage of the summer mean rainfall (with respect to 1961–1990 averages). Large areas of northern Queensland have had close to or above average rainfall for summer, with coastal areas around Townsville and isolated areas north and east of Mount Isa having had more than double their summer average. Southern areas of Queensland have had below average for the season.

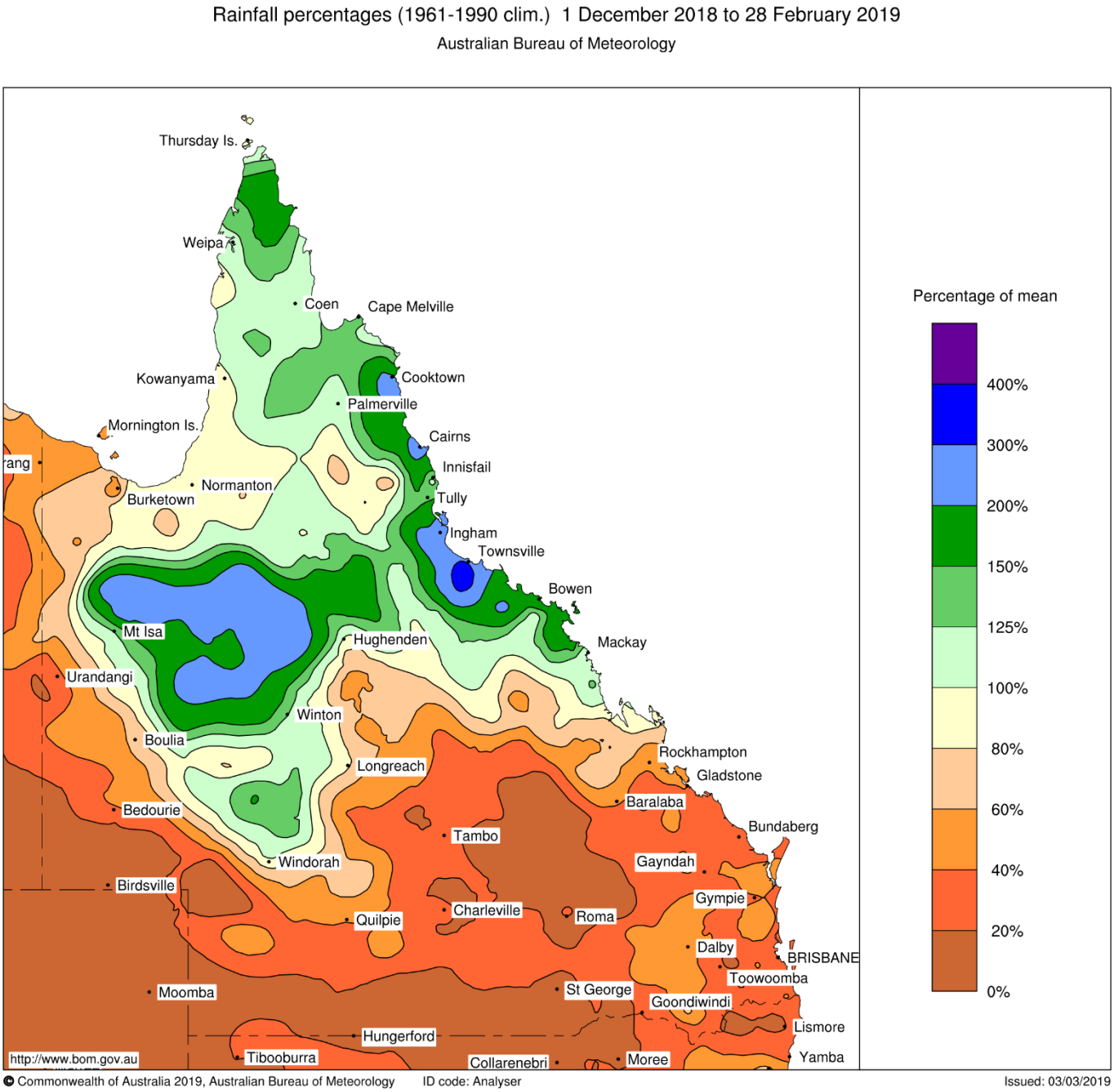

Figure 14: Rainfall totals from 1 December 2018 to 28 February 2019 as a percentage of the summer mean rainfall (with respect to 1961–1990 averages).

Highest multi-day totals—east coast catchments

The highest rainfall totals from the event known to the Bureau were recorded by rain gauges that are not part of the Bureau of Meteorology's standard rain gauge network. These rain gauges are part of a high density network of gauges generally concentrated in areas prone to flooding during major rainfall events. The gauges are operated by organisations other than the Bureau of Meteorology[9] or are sites within the Flood Forecasting Network.[10] The high density network typically uses different equipment from the Bureau's standard rain gauge network, so values between the networks are not always comparable. The highest 7-day rainfall totals for each network of rain gauges during this event are listed in Table 1 and Table 2, and the highest 10-day rainfall totals for each network during this event are listed in Table 3 and Table 4.

Table 1: Ten highest 7-day rainfall totals at sites in the Bureau's standard rain gauge network for the event to 9 February 2019.

Station number	Station name	7-day rainfall total (mm)	End date of highest 7-day total	Days of accumulation
33307	Woolshed	1669.2	2019-02-05	7
32064	Paluma Ivy Cottage	1445.0	2019-02-03	6
32195	Mount Stuart (Defence)	1196.2	2019-02-04	7
31141	Bellenden Ker Top Station	1183.0	2019-01-30	7
32050	Yabulu Qld Nickel	1131.0	2019-02-04	7
32101	Mutarnee Store	1105.0	2019-02-05	7
32098	Rollingstone	1099.0	2019-02-05	7
32117	Allingham Forrest Drive	1080.0	2019-02-07	7
32032	Macknade Sugar Mill	1058.8	2019-02-03	7
32023	Halifax Macrossan St	1057.0	2019-02-03	7

Table 2: Ten highest 7-day rainfall totals at sites operated by other organisations for the event to 9 February 2019.

Station number	Station name	7-day rainfall total (mm)	End date of highest 7-day total	Days of accumulation
532047	Upper Bluewater Alert	1852	2019-02-05	7
532049	Paluma Alert	1758	2019-02-05	7
532045	Upper Black River Alert	1645	2019-02-05	7
532042	Mt Margaret Alert	1471	2019-02-04	7
532091	Rollingstone Alert	1425	2019-02-05	7
533022	Woodlands Alert	1382	2019-02-04	7
532041	The Pinnacles Alert	1337	2019-02-04	7
532015	Bohle River TM	1311	2019-02-04	7
532044	Little Bohle River Alert	1306	2019-02-04	7
532089	Dalrymple Road Alert	1302	2019-02-04	7

[9] See list of organisations at: http://www.bom.gov.au/qld/flood/networks/owner_listing.shtml

[10] The data from this network don't undergo the same level of quality control as rainfall data from the Bureau of Meteorology's standard rain gauge network.

Table 3: Ten highest 10-day rainfall totals at sites in the Bureau's standard rain gauge network for the event to 9 February 2019.

Station number	Station name	10-day rainfall total (mm)	End date of highest 10-day total	Days of accumulation
32064	Paluma Ivy Cottage	2014.0	2019-02-07	8
33307	Woolshed	1962.6	2019-02-06	10
32098	Rollingstone	1469.0	2019-02-06	10
32101	Mutarnee Store	1443.0	2019-02-07	10
32050	Yabulu Qld Nickel	1379.5	2019-02-08	10
32117	Allingham Forrest Drive	1373.0	2019-02-06	9
32195	Mount Stuart (Defence)	1337.2	2019-02-06	10
32032	Macknade Sugar Mill	1312.6	2019-02-04	10
33284	Bloomsbury	1301.0	2019-02-06	10
32040	Townsville Aero	1259.8	2019-02-08	10

Table 4: Ten highest 10-day rainfall totals at sites operated by other organisations for the event to 9 February 2019.

Station number	Station name	10-day rainfall total (mm)	End date of highest 10-day total	Days of accumulation
532047	Upper Bluewater Alert	2223	2019-02-06	10
532049	Paluma Alert	2212	2019-02-05	10
532091	Rollingstone Alert	1899	2019-02-06	10
532045	Upper Black River Alert	1892	2019-02-06	10
532042	Mt Margaret Alert	1722	2019-02-06	10
533137	Sandy Plateau TM	1625	2019-02-06	10
532105	Saunders Ck Alert	1557	2019-02-08	10
532041	The Pinnacles Alert	1534	2019-02-06	10
533022	Woodlands Alert	1528	2019-02-06	10
532110	Stony Creek Alert	1505	2019-02-08	10

Highest multi-day totals—northwest catchments

In northwest Queensland, the peak rainfall totals were not as high as those along the east coast, but compared to average, a much larger area received extreme rainfall for the region. The highest 7-day rainfall totals for each network of rain gauges during this event in the Gulf Country and North West Queensland are listed in Tables 5 and 6, and the highest 10-day rainfall totals for each network in those northwestern districts are listed in Tables 7 and 8.

Table 5: Ten highest 7-day rainfall totals at northwest Queensland sites in the Bureau's standard rain gauge network for the event to 9 February 2019.

Station number	Station name	7-day rainfall total (mm)	End date of highest 7-day total	Days of accumulation
29131	Gereta Station	687.0	2019-02-04	7
29030	Lands End Station	637.0	2019-02-06	7
29092	Brinard Station	624.8	2019-02-06	7
29036	Millungera Station	589.0	2019-02-06	7
30082	Gregory Springs Station	580.2	2019-02-05	7
29181	Lake Julius AWS	573.8	2019-02-06	7
27061	Southwell Station	565.6	2019-02-07	7
29027	Kamilaroi Station	514.0	2019-02-06	7
29058	Julia Creek Airport	510.2	2019-02-06	7
29049	Werrina Station	509.0	2019-02-06	7

Table 6: Ten highest 7-day rainfall totals at northwest Queensland sites operated by other organisations for the event to 9 February 2019.

Station number	Station name	7-day rainfall total (mm)	End date of highest 7-day total	Days of accumulation
529041	Gilliat River TM	636	2019-02-06	7
529015	Dugald River TM	611	2019-02-06	7
529021	Miranda Creek TM	605	2019-02-05	7
530163	Hulberts Bridge TM	543	2019-02-05	7
529029	Glen Idol TM	531	2019-02-05	7
529022	Landsborough Hwy TM	521	2019-02-05	7
529018	Etta Plains TM	512	2019-02-06	7
529011	Cloncurry TM	495	2019-02-05	7
529014	Doughboy Ck TM	486	2019-02-06	7
529042	Punchbowl Rd TM	468	2019-02-06	7

Table 7: Ten highest 10-day rainfall totals at northwest Queensland sites in the Bureau's standard rain gauge network for the event to 9 February 2019.

Station number	Station name	10-day rainfall total (mm)	End date of highest 10-day total	Days of accumulation
29036	Millungera Station	782.0	2019-02-07	10
30082	Gregory Springs Station	739.0	2019-02-08	10
29131	Gereta Station	720.8	2019-02-06	9
29030	Lands End Station	690.0	2019-02-06	10
29092	Brinard Station	674.4	2019-02-07	10
30045	Richmond Post Office	646.0	2019-02-07	10
30161	Richmond Airport	610.0	2019-02-07	10
27061	Southwell Station	604.4	2019-02-07	10
30088	Werrington Station	589.0	2019-02-08	10
29181	Lake Julius AWS	586.0	2019-02-07	10

Table 8: Ten highest 10-day rainfall totals at northwest Queensland sites operated by other organisations for the event to 9 February 2019.

Station number	Station name	10-day rainfall total (mm)	End date of highest 10-day total	Days of accumulation
530163	Hulberts Bridge TM	674	2019-02-08	10
529041	Gilliat River TM	658	2019-02-06	10
529029	Glen Idol TM	655	2019-02-07	10
529015	Dugald River TM	627	2019-02-07	10
529021	Miranda Creek TM	619	2019-02-07	10
530009	Richmond TM	585	2019-02-07	10
529022	Landsborough Hwy TM	567	2019-02-07	10
529042	Punchbowl Rd TM	560	2019-02-07	10
529018	Etta Plains TM	546	2019-02-07	10
529011	Cloncurry TM	525	2019-02-07	10

5. Consecutive days of heavy rain

Many sites across tropical Queensland set records for high multi-day rainfall accumulations, including numerous sites that set records for any month. Table 14 and Table 15 list sites with 30 or more years of data that set new 7-day and 10-day accumulated rainfall records for any month, with their locations shown in Figure 15.

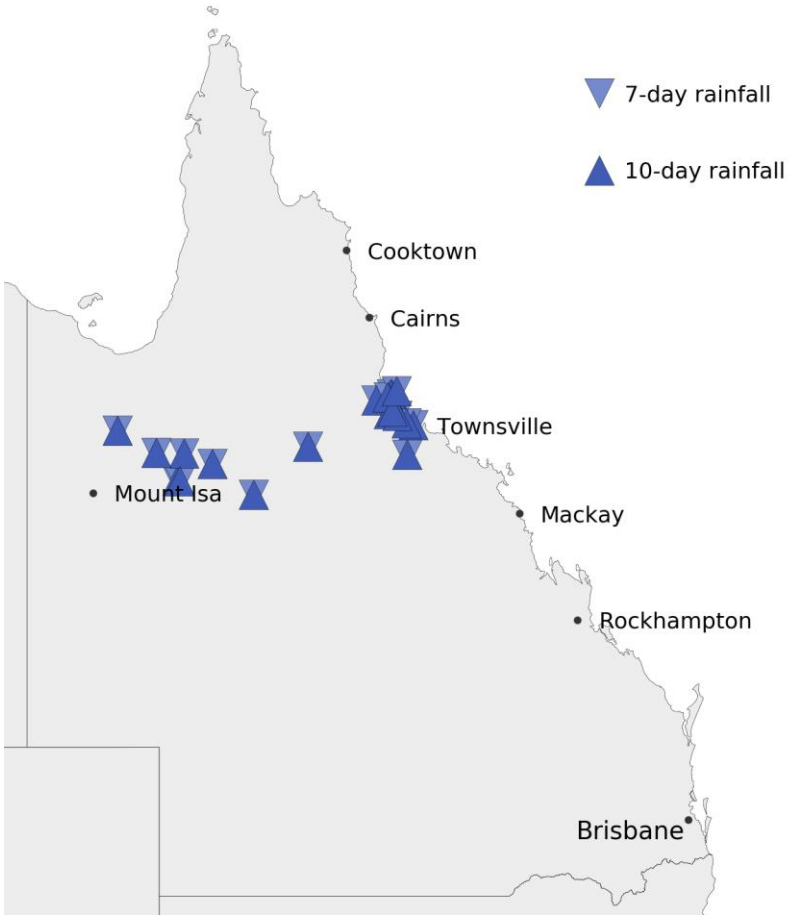

Figure 15: Map of Queensland showing sites with 30 or more years of data that set new records for 7-day and 10-day rainfall totals for any month.

Not only have the accumulated rainfall totals set new records, numerous sites across tropical Queensland set records for the duration of consecutive days of heavy rain. Table 16 lists sites with 30 or more years of data that set new duration records for long runs of consecutive days of 50 mm or more rainfall for any month, with their locations shown in Figure 16.

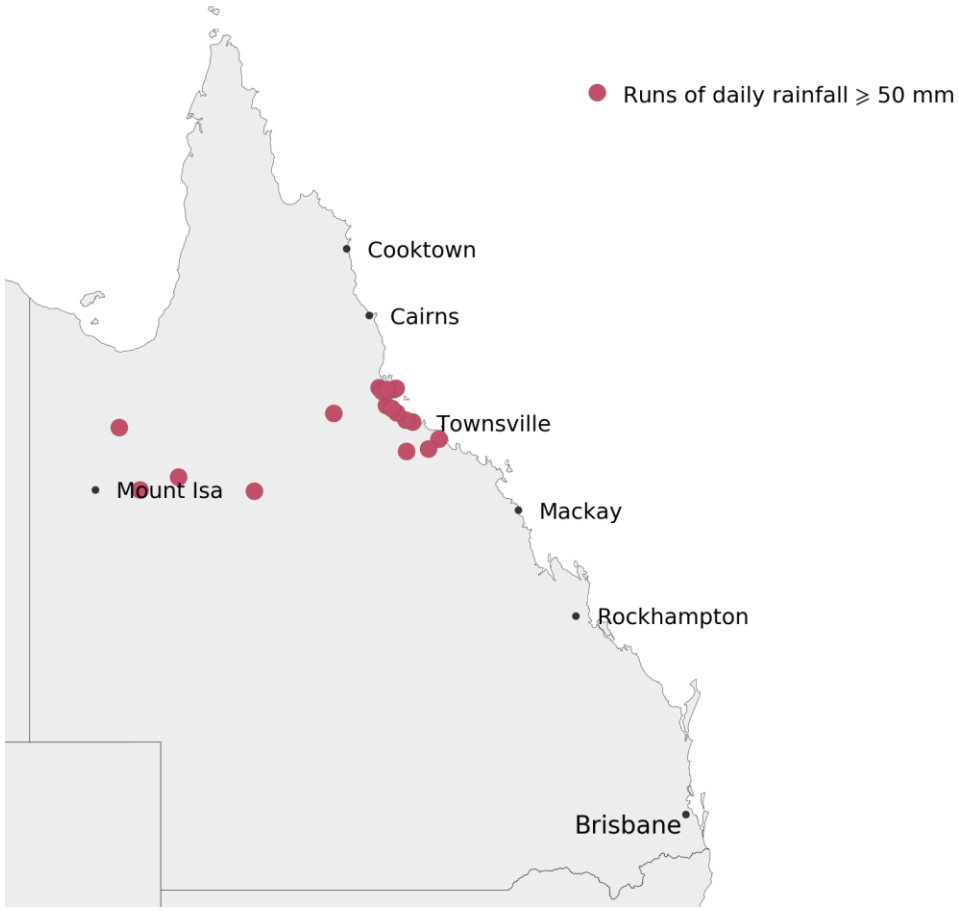

Figure 16: Map of Queensland showing sites with 30 or more years of data that have had their longest run of consecutive days with more than 50 mm of rainfall for any month.

6. Individual daily rainfall

While numerous sites had unprecedented multi-day accumulated rainfall totals during this event, some locations also had their highest daily rainfall totals for January or February, including a few in northwest Queensland that had their highest for any month. Figure 17 shows the location of sites with 30 or more years of data that exceeded their previous high daily rainfall record for January or February, with the sites listed in Table 12 and Table 13.

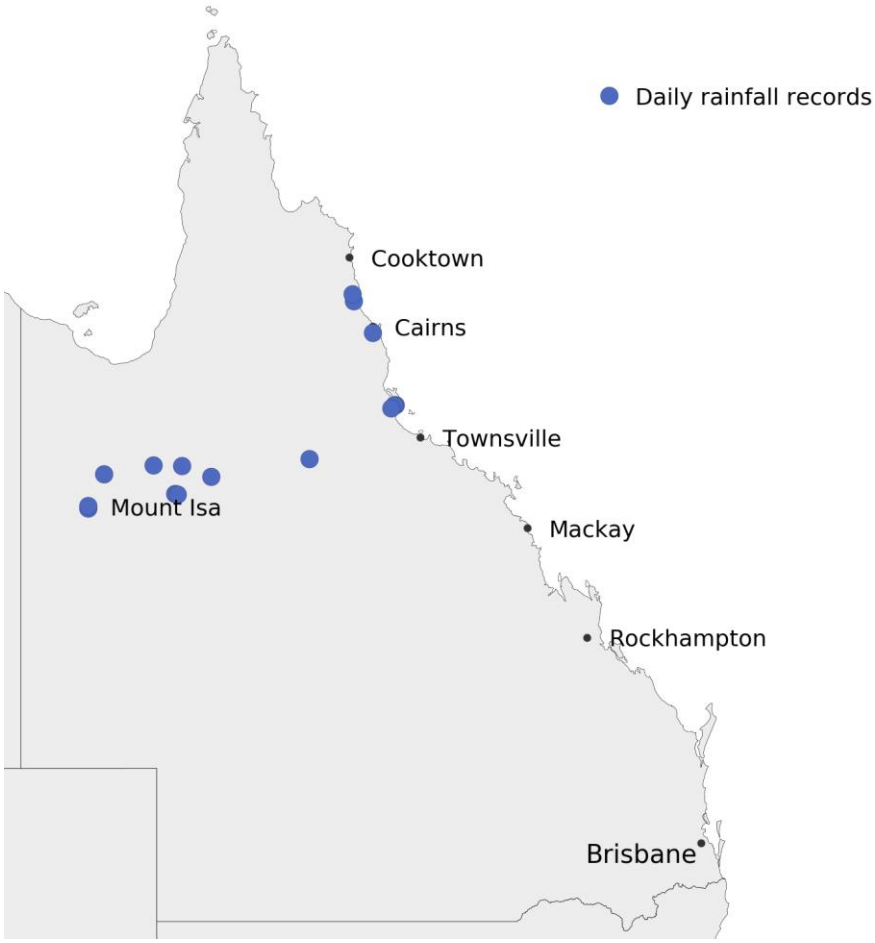

Figure 17: Map of Queensland showing sites with 30 or more years of data that had their highest daily rainfall totals for January or February during this event.

7. Other phenomena associated with this event

High precipitable water

The atmospheric moisture levels associated with this monsoon low were very much above average over large areas of tropical Queensland. Precipitable water provides an estimate of the amount of moisture in the atmosphere[11] and was close to highest on record for several days both near the coast and inland. At Mount Isa on both 1 and 2 February 2019, precipitable water was reported at more than 65 mm, the site's highest values on record for any month (based on comparable data since 1992). At Townsville, precipitable water stayed consistently in the top 10% of historical observations for summer (decile 10, based on available data from 1992–2018) from 27 January to 7 February 2019 (see daily differences from average for summer 2018–19 in Figure 18).

Precipitable water was similarly high off the east coast of Queensland at Willis Island, where reported values exceeded 70 mm several times in the first week of February (the site's February record is more than 71 mm in 1998). Further north, on Queensland's west coast at Weipa, precipitable water was also higher than average during the event, with reported values peaking at almost 67 mm on the night of 31 January.

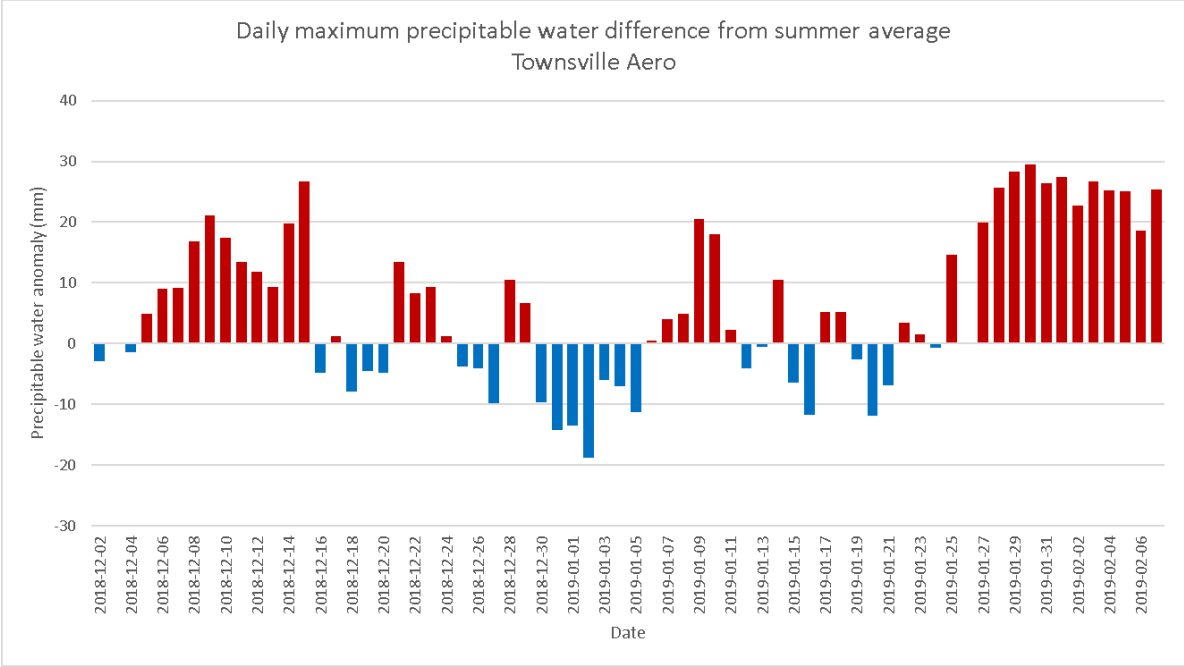

Figure 18: Daily maximum precipitable water differences from the summer average from 1 December 2018 to 7 February 2019 (based on available data from 1992–2018). Values were consistently high from 27 January.

[11] Precipitable water is the total water vapour contained in an atmospheric column of unit cross-section, expressed in terms of the depth of an equivalent mass of liquid water of the same cross-section. Further information available at http://www.bom.gov.au/climate/updates/articles/a024.shtml.

Cool temperatures

Maximum temperatures across much of tropical north Queensland were cooler than average during the first week of February. The mean maximum temperature for the first seven days of February was up to 12 °C below average southeast of Mount Isa and a larger area covering much of western Queensland was more than 6 °C cooler than average (see Figure 19).

Minimum temperatures were also cooler than average, though not as extreme. Mean minimum temperatures for the first week of February were up to 4 °C cooler than average across northwest Queensland.

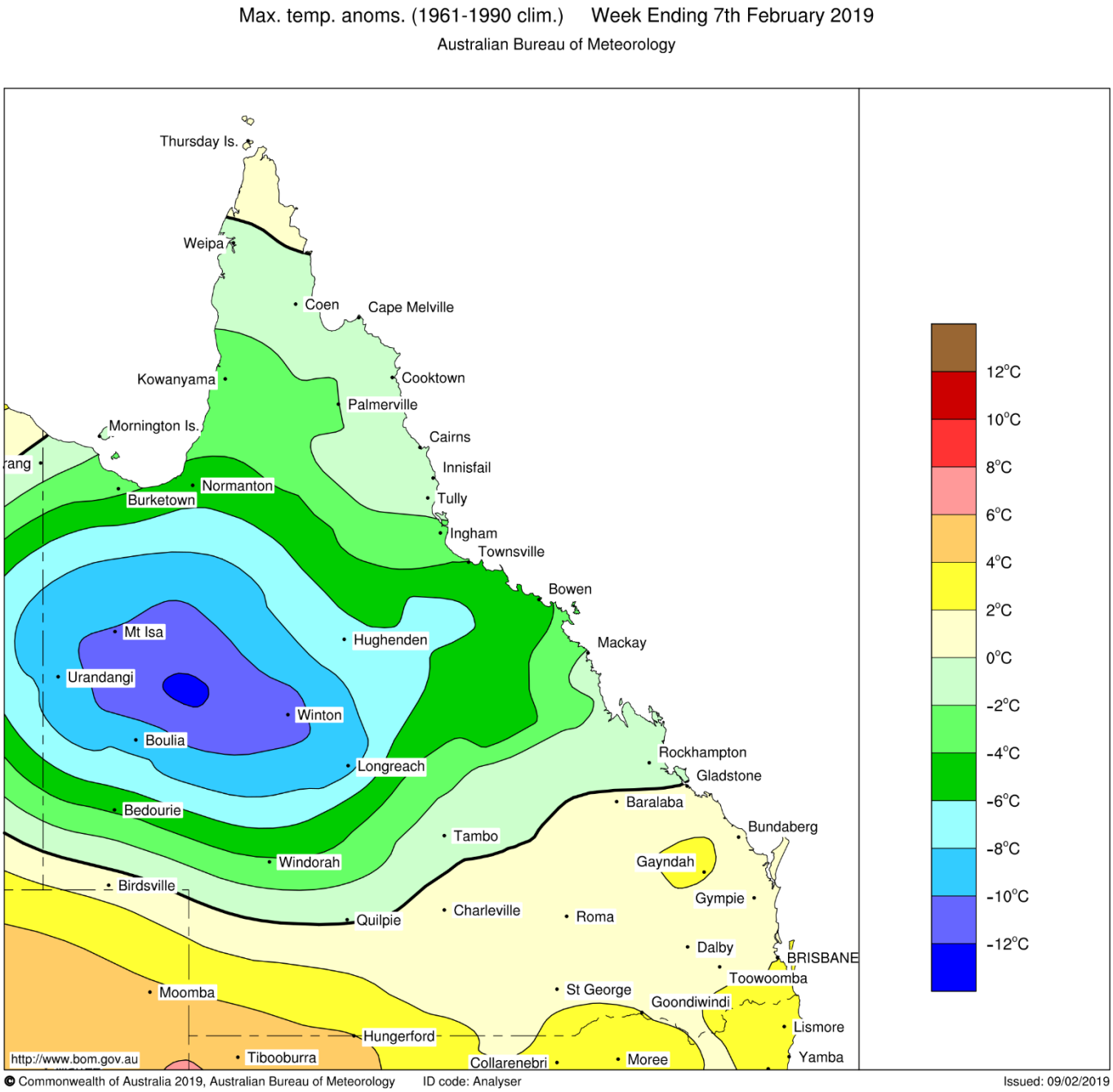

Figure 19: Mean maximum temperature anomalies for Queensland from 1–7 February 2019 compared to the February average (based on 1961–1990).

Strong winds

The monsoon low generated strong winds, with almost all sites across Queensland recording higher than average mean daily wind run[12] during the first week of February. At Townsville Aero, the mean daily wind run for 1–9 February 2019 was 578 km compared to the February daily average of 374 km (based on 22 years of comparable wind run data). At Mount Isa in northwest Queensland, the mean daily wind run for 1–9 February 2019 was 560 km compared to the February daily average of 297 km (based on 21 years of comparable wind run data).

Cooling of sea surface temperatures

Persistent long-lived cloud cover from 20 January 2019 significantly cooled the surface waters over the Great Barrier Reef and Gulf of Carpentaria. Over-turning of the water from the strong winds and river outflow are also possible causes for the cooler sea surface temperatures. Figure 20 shows the sea surface temperatures[13] around Queensland compared to average[14] from late January into early February, with the map for 9 February showing large areas of cooler than average waters surrounding most of the Queensland coast.

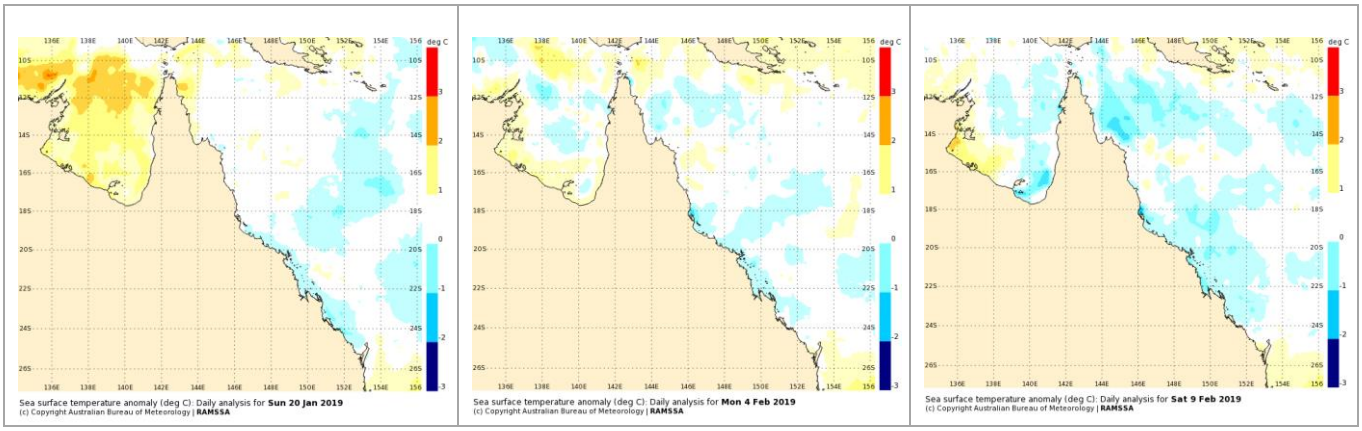

Figure 20: Maps of sea surface temperature[13] differences from average[14] for 20 January 2019 (left), 4 February 2019 (middle), and 9 February 2019 (right).

By 5 February, the salinity of surface waters off the coast of Townsville had reduced as a result of both the high rainfall totals and ocean discharge from nearby flooded rivers.[15]

Figure 21 is a satellite image from Himawari-8 on 11 February 2019 showing a large area of northwest Queensland covered by floodwaters, with plumes of run-off entering the Gulf of Carpentaria from the Flinders and Norman River basins as well as into coastal waters around Townsville from the Burdekin River.

[12] More information at: http://www.bom.gov.au/climate/cdo/about/definitionsother.shtml#meandailywindrun

[13] Regional Australian Multi-Sensor Sea-surface temperature Analysis (RAMSSA), developed at the Australian Bureau of Meteorology as part of the BLUElink Ocean Forecasting Australia project. http://www.bom.gov.au/jshess/docs/2011/beggs_hres.pdf

[14] Long-term average based on the Reynolds sea-surface temperature analysis for 1961–1990. https://www.nhc.noaa.gov/sst/

[15] Based on modelled data from both the Regional Ocean Modeling System (ROMS) and OceanMAPS (Ocean Modelling, Analysis, and Prediction System, version 2.0). More information at: http://www.bom.gov.au/climate/data-services/ocean-data.shtml#tabs=Forecasts-and-model-data

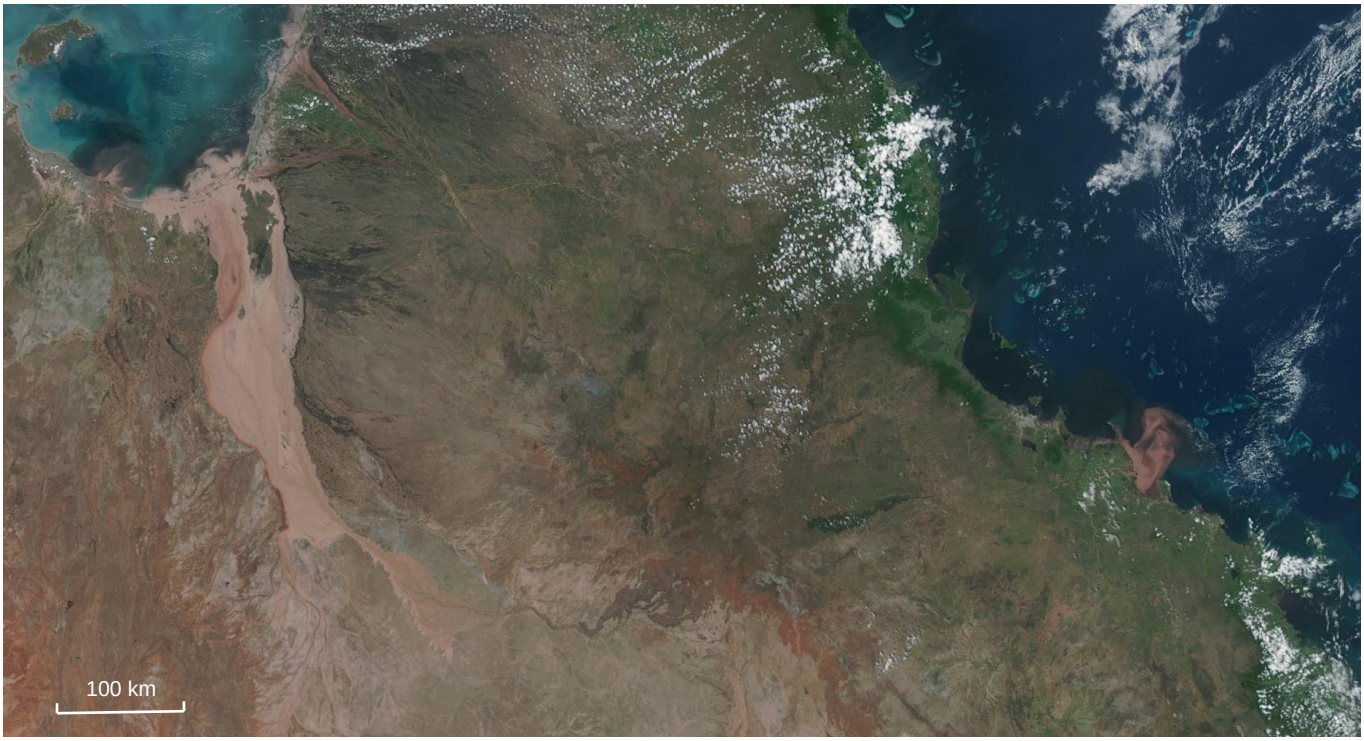

Figure 21: Real colour (RGB) satellite image of tropical Queensland from Himawari-8 on 11 February 2019. On Queensland's east coast south of Townsville, muddy floodwaters from the Burdekin River were draining into the ocean, forming a large red plume along the coast. In the Gulf Country, floodwaters covering an estimated 15,000 km^2 or more in the Flinders and Norman River basins north of Mount Isa drained into the Gulf of Carpentaria.

8. Previous notable heavy rain events around the north tropical to central coast

There have been a number of instances in the north tropical coast of Queensland where multi-day rainfall accumulations have exceeded 1000 mm.

Australian record for 7-day rainfall totals—Bellenden Ker (Top Station)

The Australian record for a 7-day rainfall accumulation is Bellenden Ker Top Station, with 3337 mm in the week ending 9 January 1979. This site also holds the Australian record for 10-day totals (3913 mm in the 10 days ending 12 January 1979). This included a 2-day total of 1947 mm to 9am on 5 January 1979. The persistence of tropical cyclone *Peter* over and near Cape York Peninsula early in the month brought heavy rains which resulted in major to moderate flooding in nearly all coastal streams from Tully to Cooktown. The major flood on the Barron River caused extensive agricultural, road and bridge damage around the Cairns area. These losses were exacerbated by extensive flooding of the Tully, Murray and Herbert rivers about the same time. *(source: http://www.bom.gov.au/qld/flood/fld_history/floodsum_1970.shtml)*

Australian record for 10-day rainfall totals at low elevations—South Johnstone

At low-elevation sites, South Johnstone Post Office holds the Australian record for the highest 10-day rainfall accumulation, with 2339 mm in the 10 days ending 15 January 1981. South Johnstone (Exp Station) reported 2414 mm in an 11-day period from 5 to 15 January 1981, with daily totals in excess of 120 mm on 10 of the 11 days (with 81 mm on the other day). A strong and near-stationary monsoon trough, along with a persistent east to northeast onshore flow resulted in exceptional rainfall totals in the area. Floods commenced in the Tully River and adjacent streams on the 7th, with this flooding extending to the Herbert River by the 11th. Whilst major flooding on these streams was confined to their lower reaches, the smaller nearby rivers like the Russell and Mulgrave caused severe local flooding. The heaviest rainfalls in this particular region were confined to the coastline. (*source: http://www.bom.gov.au/qld/flood/fld_history/floodsum_1980.shtml*)

Notable 4-day and 5-day rainfall totals—Paluma Ivy Cottage

At Paluma Ivy Cottage, in January 1972, 1863.8 mm fell in five days and 1749.0 mm in four days (including daily totals of 628.9 mm and 634.7 mm on 9–10 January). Tropical cyclone *Bronwyn* formed in the Gulf of Carpentaria and crossed the Queensland coast north of Weipa then moved southwards through the State. About half of Queensland received more than 50 mm of rain and Paluma had 1263.6 mm in 48 hours, with serious flooding occurring. Giru, south of Townsville, was isolated. About 0.9 m of water entered Ingham and the Burdekin River and flooded Ayr and Home Hill.

Notable 11-day to 14-day rainfall totals—Mount Charlton

A prolonged period of heavy rainfall was recorded near the Queensland coast between Townsville and Rockhampton in December 1990 to January 1991 as a result of ex-tropical cyclone *Joy*. The heaviest falls were recorded in the Mackay area, where Mount Charlton, west of Mackay, received 2257 mm over 11 days from 26 December 1990 to 5 January 1991 (100 mm or more fell on 10 of the 11 days, including eight consecutively). Over the fortnight from 25 December 1990 to 7 January 1991, 2384 mm was reported at Mount Charlton, 2271 mm at Sarina, and 2086 mm at Dalrymple Heights, including a daily total of 590 mm to 9am on 27 December. Mackay received 1824 mm, including a four-day total of 981 mm from 27–30 December 1990. Fortnightly totals exceeded 1000 mm over most of the coastal region between Bowen and St Lawrence.

9. Previous notable heavy rain events around Townsville

Comparisons with January 1998 and January 1953

There are two notable historical events that are analogous to the 26 January to 9 February 2019 event, in terms of multi-day rainfall totals and the geographic spread of rainfall. These two events cover the 7-day period 8–14 January 1998, and 7-day period 11–17 January 1953. In terms of area averaged rainfall, the events are ranked 2019, 1998, and then 1953 (see Table 9).

Table 9: Area-averaged daily rainfall totals for rainfall district 32 (North Coast Herbert) for the 1953, 1998, and 2019 flood events.

1953 event date	1953 rainfall totals (mm)	1998 event date	1998 rainfall totals (mm)	2019 event date	2019 event totals (mm)
1953-01-11	14.99	1998-01-08	41.20	2019-01-26	25.64
1953-01-12	34.12	1998-01-09	59.64	2019-01-27	50.27
1953-01-13	79.58	1998-01-10	154.56	2019-01-28	43.34
1953-01-14	65.76	1998-01-11	86.76	2019-01-29	45.32
1953-01-15	78.88	1998-01-12	21.04	2019-01-30	46.68
1953-01-16	54.71	1998-01-13	59.76	2019-01-31	61.21
1953-01-17	38.69	1998-01-14	35.53	2019-02-01	60.37
1953-01-18	46.65	1998-01-15	17.43	2019-02-02	56.55
1953-01-19	*18.51*	*1998-01-16*	*1.98*	2019-02-03	73.74
1953-01-20	*16.39*	*1998-01-17*	*29.44*	2019-02-04	62.11
1953-01-21	*6.55*	*1998-01-18*	*19.16*	2019-02-05	46.03
1953-01-22	*8.11*	*1998-01-19*	*12.58*	2019-02-06	60.42
1953-01-23	*11.17*	*1998-01-20*	*0.26*	2019-02-07	32.10
1953-01-24	*3.55*	*1998-01-21*	*0.09*	2019-02-08	38.85
1953-01-25	*19.54*	*1998-01-22*	*0.14*	2019-02-09	17.47
Event total (mm):	**497.20**		**539.57**		**720.10**

January 1998 (8–14 January)

Tropical cyclone *Sid* was named late on 26 December 1997, weakening to below tropical cyclone strength within 48 hours. Over the week and a half following *Sid* 's decay, the remnants meandered about the Top End of the Northern Territory and Gulf of Carpentaria without redeveloping into a cyclone. The low finally moved into Queensland in early January.

At 3pm on 9 January 1998, the low embedded on the trough was approximately 220 km west of Cairns with the location of the monsoon trough north of Cooktown. By 9pm, the monsoon trough was near Cairns and rapidly moved south to a band of strong winds between Cardwell and Bowen. By 3am 10 January 1998, the monsoon trough merged with this band of strong winds, and heavy rainfall began to develop just south of the monsoon trough, with the heaviest falls recorded just south of the area where the monsoon extended across the coast. Townsville Aero received 549 mm of rain in the 24-hour period to 9am on 10 January (the highest daily rainfall on record at this site), with another 245 mm falling during the next two days. Included in the first days' rainfall was a total of 120.6 mm in one hour and 205.2 mm in two hours.

The low remained very slow moving to the north of Townsville for 24 hours after 9am 10 January 1998. Daily rainfall totals of more than 300 mm were recorded in the Barron region, including Babinda (359 mm), Gordonvale (388 mm), and Mount Sophia (347 mm).

In Townsville, around 100 houses had substantial over-floor flooding with hundreds more sustaining property flooding. Numerous cars were damaged by flooding, and up to 50 per cent of the houses in Townsville lost power at some stage during the event. Damage to local Government infrastructure was high. On Magnetic Island just offshore from Townsville, a landslide caused major damage to a tourist complex. The small communities of Black River and Bluewater north of Townsville suffered extensive damage from flash-flooding. 48 houses were affected in this area with the majority rendered uninhabitable. Fourteen of these were destroyed with eight washed away. One hundred houses experienced over-floor flooding in the towns Halifax and Ingham north of Townsville. There was also extensive damage to the rural sector.[16]

Table 10: Daily rainfall totals (mm) at sites in rainfall district 32 (North Coast Herbert) from 8 to 14 January 1998. Taken from Queensland Flood Report http://www.bom.gov.au/qld/flood/fld_reports/nth_qld_jan1998.pdf.

Station name	08-Jan	09-Jan	10-Jan	11-Jan	12-Jan	13-Jan	14-Jan	Total
Abergowrie Br	33	84	233	23	0	36	32	**441**
Cardwell	68	82	147	44	6	79	57	**483**
Gairloch	30	122	311	34		53	53	**603**
Gleneagle	44		141	2				**241**
Halifax	39	80	260	6	32	21	30	**468**
Ingham	50	155	321	35		60	58	**679**
Innisfail	147	113	108		12	119	29	**528**
Lassie Ck Stn			52	264	20		16	**384**
Lucinda	32	61	244	→	12	21	31	**401**
Paluma	159	110	307	340	163	281	283	**1643**
Rangeview Ranch			110	507	239	149	37	**1117**
Townsville	12	2	46	549	82	163	30	**884**
Tully	120	171	284	10	2	118	43	**748**
Yabulu		2	66	341	69	146	27	**651**

[16] Source: http://www.bom.gov.au/qld/flood/fld_reports/nth_qld_jan1998.pdf

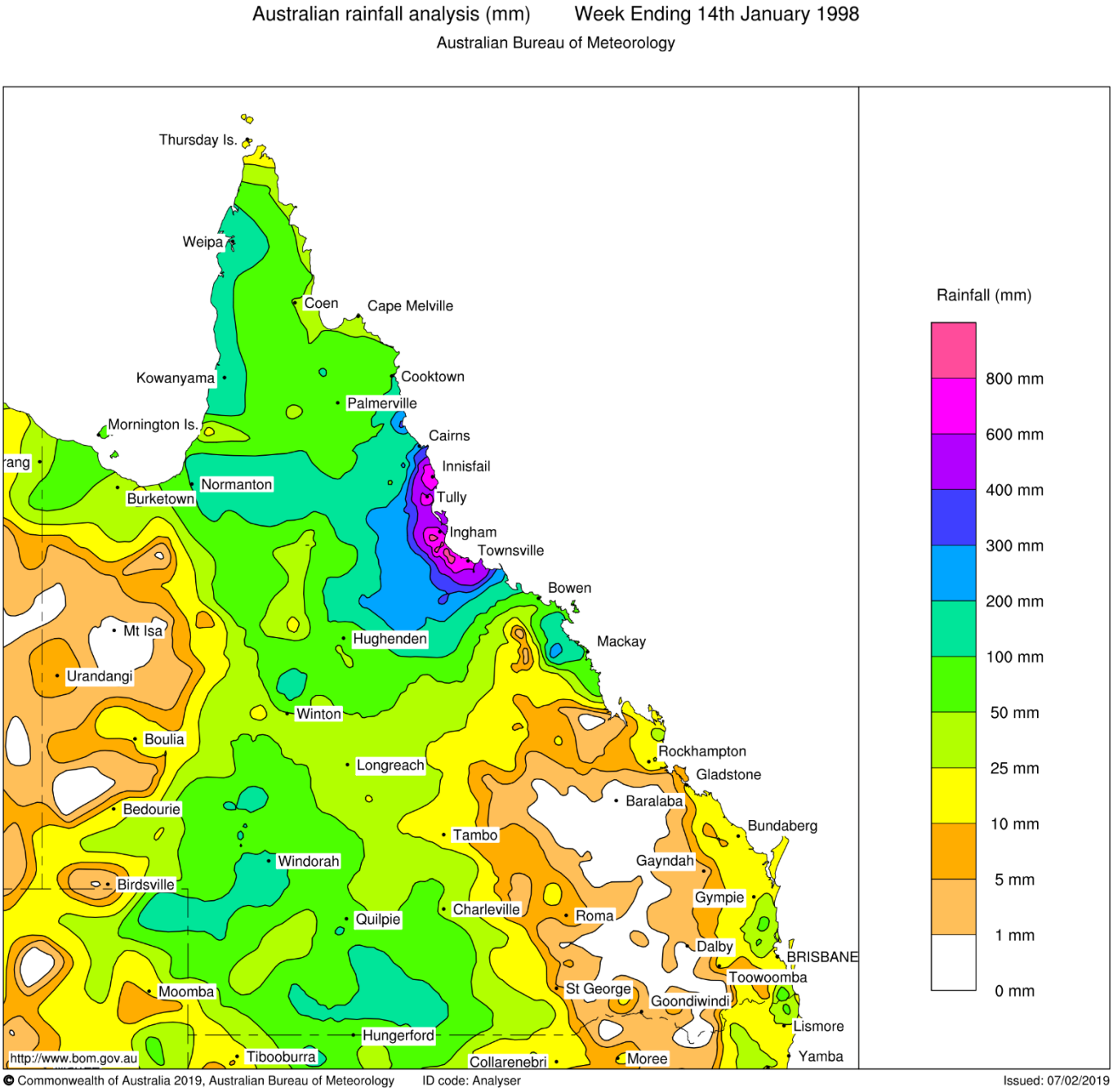

Figure 22: Map of Queensland showing total rainfalls for week from 8–14 January 1998.

January 1953 (11–17 January)

An unnamed tropical cyclone, referred to as AU195253_04U, developed in the Gulf of Carpentaria on 12 January 1953, and tracked southward over the following day, and crossed the Gulf coast northwest of Burketown on the morning of 13 January 1953. This event had a similar synoptic set up to this current January–February 2019 event, where a low pressure system over the northwest of Queensland was embedded on a surface trough that extended across the northern tropics.

A northeast to easterly onshore flow produced heavy falls along the north tropical coast, with 7-day accumulations of more than 600 mm between Innisfail and Ayr, and totals exceeding 800 mm in areas around Townsville, Ingham and Tully. Tully Sugar Mill recorded a daily rainfall total of 502.2 mm to 9am on 13 January 1953, and 1157.6 mm in the seven days (12–18 January); 980.2 mm in seven days (12–18 January) at Ingham Post Office; and 837.2 mm at Townsville Aero in the seven days (12–18 January), including 346.7 mm in the 24 hours to 9am on 16 January 1953.

Prolonged widespread flooding was experienced in all tropical divisions as a result of the heavy rainfall totals in the latter half of the month. Disruption to infrastructure and traffic dislocation was extensive both on the tropical coast and in the tropical interior. The northwest interior and Gulf streams reached high flood levels and sharp flooding occurred in tropical coastal streams on several occasions. The Inkerman railway bridge over the Burdekin River was submerged from the 17th to the 19th and from the 28th to the 31st, with the peak occurring on the 28th. Flood rains fell in January in all tropical divisions, the central and western interiors and on parts of the south coast.

Table 11: Daily rainfall totals (mm) at sites in rainfall district 32 (North Coast Herbert) from 11 to 18 January 1953.

Station number	Station name	Region	11-Jan	12-Jan	13-Jan	14-Jan	15-Jan	16-Jan	17-Jan	18-Jan	Total
32005	Cape Cleveland Lighthouse	Townsville	3.6	99.6	32.8	116.8	50.8	356.1	102.9	25.7	**788.3**
32040	Townsville Aero	Townsville	16.8	41.4	24.1	153.4	184.2	346.7	70.6	18.0	**855.2**
32041	Townsville Railway Stn	Townsville		55.9	14.5	149.9	180.3	361.7	64.8		**827.1**
32050	Yabulu QLD Nickel	Townsville	59.4	25.4	31.8	151.6	237.0	171.2	57.2	11.2	**744.8**
32028	Giru Post Office	Townsville	8.6	92.5	26.7	118.9	160.5	237.2	30.0	0.0	**674.4**
33074	Woodstock Post Office	Townsville	0.0	53.3	23.9	88.6	199.6	235.2	57.4	0.0	**658.0**
33151	Majors Creek	Townsville	0.0	76.2	64.8	143.8	298.5	449.6	49.5	5.6	**1088.0**
32004	Cardwell Marine Pde	Tully	14.2	44.5	294.9	84.3	120.9	32.3	53.3	115.3	**759.7**
32006	Carruchan	Tully	7.1	83.8	264.7	78.0	143.5	14.0	99.1	85.6	**775.8**
32009	Bingil Bay	Tully	13.5	140.5	179.6	33.0	46.2	56.4	52.8	221.7	**743.7**
32030	Lower Tully Post Office	Tully		137.2	470.4	88.4	78.7	102.6	0.0	218.4	**1095.7**
32042	Tully Sugar Mill	Tully	0.0	131.6	502.2	81.8	56.1	31.8	93.7	260.4	**1157.6**
32046	Bilyana Railway Station	Tully	0.0	207.0	388.6	92.2	110.2	30.0	144.8	135.9	**1108.7**
32001	Bambaroo	Tully	41.9	56.9	62.5	209.8	228.6	135.4	21.6	25.4	**782.1**
32002	Bemerside	Tully	0.0	147.3	210.1	149.4	127.8	362.2	161.5	0.0	**1158.3**
32012	Elphinstone Pocket	Tully	18.3	38.1	255.3	71.9	120.9	22.4	114.3	165.1	**806.3**
32023	Halifax Macrossan St	Tully	41.1	78.7	175.5	144.3	89.9	255.5	90.7	74.7	**950.4**
32024	Ingham Post Office	Ingham	0.0	115.8	181.4	241.0	165.1	186.7	90.2	missing	**980.2**
32029	Long Pocket	Ingham	17.5	53.3	190.5	85.3	129.5	21.3	140.5	149.9	**787.8**
32031	Lucinda Township	Ingham	37.8	87.1	190.0	77.0	119.9	141.5	79.5	65.5	**798.3**
32032	Macknade Sugar Mill	Ingham		129.5	188.0	142.2	110.5	219.7	134.1		**924.0**
32039	Stone River Prison Farm	Ingham	28.2	39.6	86.9	183.6	259.6	50.8	35.6	83.8	**768.1**
32043	Upper Stone Exelby	Ingham	25.4	47.8	86.9	117.6	260.6	31.8	57.7	59.2	**687.0**
32045	Victoria Sugar Mill	Ingham	30.0	68.3	169.4	161.0	99.8	213.1	67.6	120.9	**930.1**

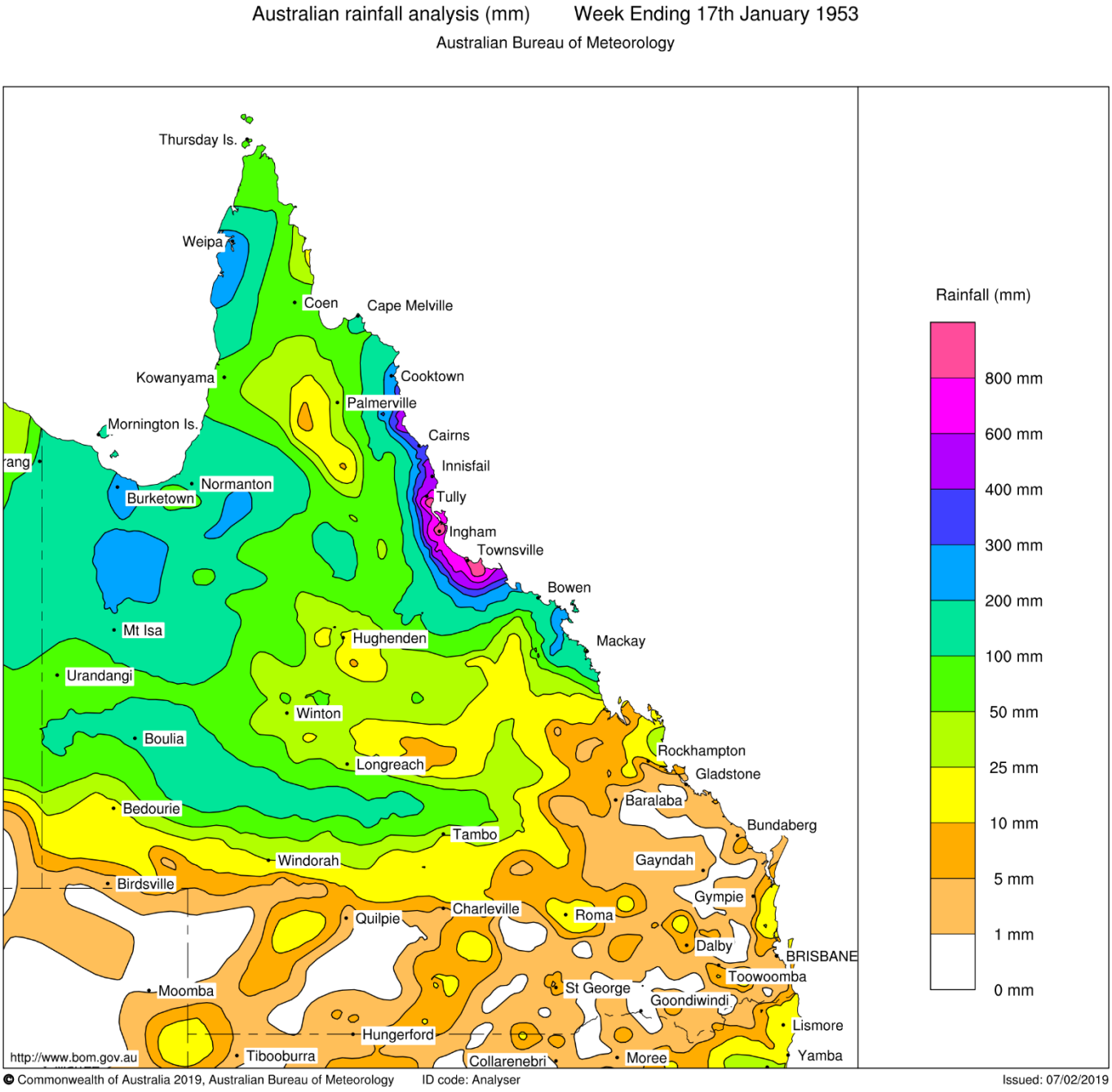

Figure 23: Map of Queensland showing total rainfalls for the week from 11–17 January 1953.

10. Was climate change a factor in this event?

It is salient to consider what, if any, role climate change plays in the occurrence of record-breaking high-impact weather. In Australia, it has been easier to determine the contribution of background warming to the severity and frequency of extreme heat events than it has been for extreme rainfall. This is largely because natural variability in extreme rainfall in Australia is inherently very large, making it more difficult to discern climate change influences. Nevertheless, it is expected that a warmer atmosphere and ocean will generally lead to an increased likelihood and severity of heavy rainfall events globally. For the Australian continent, there is evidence in recent decades that a higher proportion of total annual rainfall has come from heavy rainfall days.

A summary of the relationship between heavy rainfall and climate change can be found in State of the Climate 2018, http://www.bom.gov.au/state-of-the-climate/australias-changing-climate.shtml.

A more detailed and specific attribution of the local and global drivers that have contributed to this extreme rainfall will require complex scientific analysis. The Bureau employs its own, published methodology for undertaking such an assessment.

11. Tables of new records

Table 12: Locations with 30 or more years of data that set new high daily rainfall records for January.

Station number	Station name	New January record (mm)	Date of new record	Previous January record (mm)	Date of previous January record
31040	Meringa Sugar Exp Stn	494.0	2019-01-29	375.0	1998-01-09
31062	Whyanbeel Valley	471.6	2019-01-27	412.0	1969-01-28
31127	Daintree Village	405.0	2019-01-27	372.0	1979-01-02

Table 13: Locations with 30 or more years of data that set new high daily rainfall records for February. New records for any month are highlighted in bold.

Station number	Station name	New February record (mm)	Date of new record	Previous February record (mm)	Date of previous February record
29005	**Bunda Bunda**	**177.0**	**2019-02-06**	**168.7**	**1911-02-01**
29030	**Lands End Station**	**285.0**	**2019-02-04**	**155.2**	**2000-02-13**
29036	Millungera Station	161.5	2019-02-05	152.4	1964-02-06
29049	**Werrina Station**	**240.0**	**2019-02-05**	**144.0**	**1995-02-10**
29058 / 29025	**Julia Creek**	**233.0**	**2019-02-05**	**127.4**	**1994-02-01**
29092	Brinard Station	231.0	2019-02-05	120.4	1976-02-05
29127 / 29126 / 29128 / 29125	Mount Isa	123.2	2019-02-02	99.1	1930-02-02
29131	Gereta Station	232.5	2019-02-03	220.7	1936-02-20
30082	Gregory Springs Station	152.4	2019-02-04	138.8	2002-02-16
32023	Halifax Macrossan St	408.0	2019-02-03	390.4	1899-02-05
32032	Macknade Sugar Mill	400.0	2019-02-03	399.5	1927-02-11
32078	Ingham Composite	419.0	2019-02-03	369.0	1978-02-28

Table 14: Sites with 30 or more years of data that have set new 7-day rainfall records for any month.

Station number	Station name	Years of data	New 7-day record (mm)	End date of new 7-day record	Previous 7-day record (mm)	End date of previous record
29005	Bunda Bunda	121	452.4	2019-02-06	317.3	1954-02-06
29027	Kamilaroi Station	121	514.0	2019-02-06	444.6	2006-03-27
29030	Lands End Station	99	637.0	2019-02-06	398.2	1979-02-04
29036	Millungera Station	129	589.0	2019-02-06	457.0	2009-01-29
29049	Werrina Station	74	509.0	2019-02-06	304.4	2016-03-11
29092	Brinard Station	76	624.8	2019-02-06	428.0	2009-01-07
30045	Richmond Post Office	130	498.4	2019-02-07	367.4	1891-01-29
30082	Gregory Springs Station	92	580.2	2019-02-05	505.2	1981-01-21
32023	Halifax Macrossan St	121	1057.0	2019-02-03	1054.9	1972-01-11
32040	Townsville Aero	79	1052.8	2019-02-04	886.2	1998-01-14
32043	Upper Stone Exelby	80	736.0	2019-02-06	734.6	1998-01-15
32045	Victoria Sugar Mill	124	994.6	2019-02-05	946.4	2009-02-04
32050	Yabulu Qld Nickel	100	1131.0	2019-02-04	826.8	1998-01-14
32098	Rollingstone	47	1099.0	2019-02-05	965.2	2007-02-05
32101	Mutarnee Store	47	1105.0	2019-02-05	1050.8	1983-03-12
32141	Lucinda Point	36	669.2	2019-02-03	518.8	2018-12-16
33051	Mingela Post Office	120	778.3	2019-02-04	515.2	1972-01-12
33226	Lansdown CSIRO	52	972.0	2019-02-04	749.7	1972-01-12

Table 15: Sites with 30 or more years of data that have set new 10-day rainfall records for any month.

Station number	Station name	Years of data	New 10-day record (mm)	End date of new 10-day record	Previous 10-day record (mm)	End date of previous record
29005	Bunda Bunda	121	568.5	2019-02-07	382.3	1979-02-04
29027	Kamilaroi Station	121	523.0	2019-02-07	444.6	2006-03-24
29030	Lands End Station	99	690.0	2019-02-06	466.8	1979-02-05
29036	Millungera Station	129	782.0	2019-02-07	482.0	2009-01-30
29049	Werrina Station	74	556.0	2019-02-07	375.6	1974-01-23
29092	Brinard Station	76	674.4	2019-02-07	469.0	2009-01-07
30045	Richmond Post Office	130	646.0	2019-02-07	467.7	1891-01-30
30082	Gregory Springs Station	92	739.0	2019-02-08	606.9	1981-01-22
32023	Halifax Macrossan St	121	1232.0	2019-02-04	1127.5	1972-01-14
32032	Macknade Sugar Mill	129	1312.6	2019-02-04	1274.5	1981-01-17
32040	Townsville Aero	79	1259.8	2019-02-08	925.5	1953-01-19
32043	Upper Stone Exelby	80	904.4	2019-02-06	883.0	2009-02-08
32045	Victoria Sugar Mill	124	1245.6	2019-02-04	1103.2	1981-01-17
32050	Yabulu Qld Nickel	100	1379.5	2019-02-08	866.5	1947-02-11
32064	Paluma Ivy Cottage	50	2014.0	2019-02-07	2006.6	1972-01-13
32078	Ingham Composite	51	1202.4	2019-02-05	1188.1	2009-02-08
32098	Rollingstone	47	1469.0	2019-02-06	980.2	2007-02-08
32101	Mutarnee Store	47	1443.0	2019-02-07	1075.6	1983-03-14
32141	Lucinda Point	36	840.0	2019-02-05	542.0	2018-12-16
33051	Mingela Post Office	120	952.2	2019-02-06	579.0	1950-03-13
33226	Lansdown CSIRO	52	1212.0	2019-02-04	792.3	1972-01-13

Table 16: Sites with 30 or more years of data that set duration records for long runs of consecutive days of 50 mm or more rainfall for any month.

Station number	Station name	New record run (days)	Begin date of new record	End date of new record	Previous record (days)	Begin date of previous record	End date of previous record
29008	Cloncurry McIllwraith St	4	2019-02-02	2019-02-05	3	1946-02-13	1946-02-15
29027	Kamilaroi Station	4	2019-02-01	2019-02-04	3	1971-03-03	1971-03-05
29030	Lands End Station	4	2019-02-02	2019-02-05	3	1922-01-30	1922-02-01
30045	Richmond Post Office	4	2019-01-30	2019-02-02	3	1956-12-20	1956-12-22
30115	Lucky Springs Station	5	2019-02-01	2019-02-05	3	1972-01-09	1972-01-11
32001	Bambaroo	12	2019-01-27	2019-02-07	7	1998-01-08	1998-01-14
32031	Lucinda Township	9	2019-01-27	2019-02-04	8	1953-01-12	1953-01-19
32040	Townsville Aero	8	2019-01-28	2019-02-04	5	1968-02-11	1968-02-15
32050	Yabulu Qld Nickel	9	2019-01-29	2019-02-06	7	1968-02-10	1968-02-16
32091	Elphinstone Pocket No1	9	2019-01-27	2019-02-04	7	2009-01-29	2009-02-04
32098	Rollingstone	11	2019-01-27	2019-02-06	5	2012-03-16	2012-03-20
32101	Mutarnee Store	13	2019-01-27	2019-02-08	8	1998-01-08	1998-01-15
32141	Lucinda Point	9	2019-01-27	2019-02-04	3	1997-12-28	1997-12-30
32191	Hawkins Creek	12	2019-01-27	2019-02-07	8	2007-01-31	2007-02-07
32192	Cardwell Range	9	2019-01-27	2019-02-04	8	2007-01-30	2007-02-06
33002	Ayr DPI Research Station	5	2019-02-01	2019-02-05	4	2005-01-23	2005-01-26
33051	Mingela Post Office	10	2019-01-28	2019-02-06	3	1903-03-26	1903-03-28
33073	Woodhouse	6	2019-01-29	2019-02-03	5	1951-01-09	1951-01-13

References and further information

National gridded rainfall analyses are for the period since 1900.

This Statement in general covers information available as of 3 March 2019.

Links to further information

Intensity–Frequency–Duration design rainfall:

www.bom.gov.au/water/designRainfalls/ifd/index.shtml

Precipitable water:

www.bom.gov.au/climate/updates/articles/a024.shtml

Australia's changing climate:

State of the Climate 2018

Climate information:

www.bom.gov.au/climate

The Bureau of Meteorology's heatwave service for Australia:

www.bom.gov.au/australia/heatwave/

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Design Rainfall:

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Soil moisture:

Johnston, R.M., Barry, S.J., Bleys, E., Bui, E.N., Moran, C.J., Simon, D.A.P., Carlile, P., McKenzie, N.J., Henderson, B.L., Chapman, G., Imhoff, M., Maschmedt, D., Howe, D., Grose, C., Schoknecht, N., Powell, B. and Grundy, M., 2003. ASRIS: the database. Australian Journal of Soil Research, 41: 1021–1036.

Sea surface temperature:

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