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NOTES ON THE MACKAY STORM OF FEBRUARY, 1958

by A.T. Brunt

Abstract: During the night of 17th February, 1958, rainfall to the west and northwest of Mackay broke Australian records and reached world class. Falls of 21 inches in 5 hours and 23 inches in 6 hours were supported by others of near equal intensity. Depths approached those of maximum thunderstorm rainfall for short durations and were approximately equal to the thunderstorm model over a 12 hour period.

1. SYNOPTIC SITUATION

A rain depression which formed in the Gulf of Carpentaria on 12th February moved southeast into the Coral Sea on 15th giving evidence of its efficiency by 24 hour rainfalls of 9.14 inches at Townsville and 7.58 inches at Cape Cleveland. During 16th and 17th it moved slowly southeastward, with spheric activity reported in its centre, approximately 80 miles off the Queensland Coast. A deep circulation, at least to 300 mbs was apparent. At this stage a band of heavy rain (15 inches in 24 hours) was reported to the south of the centre mainly along longitude 149°E, i.e. through the Whitsunday group of islands and the coastal fringe near Mackay.

Evidence of a wave in the easterlies (or the rotary movement of a spiral band) was provided by a wind change from southeast to east both at Mackay and Pine Islet before midday, 17th. It was possible to track the westward movement of this wave into the Clarke Range 40 miles west of Mackay by isochrones of heaviest rainfall. A band of torrential rainfall moved westward during the afternoon and night of 17th February giving a number of stations 20 inches in 12 hours and some 20 inches in 6 hours. By 6 a.m., 18th, the heaviest rains had ceased.

Pressure gradients were not strong, reaching a maximum during the time of heaviest rain due to an intensification of a ridge along the Queensland coastline.

The strongest surface winds were 25 knots at Pine Islet, 20 knots at Mackay and 19 knots at Bowen (anemograph).

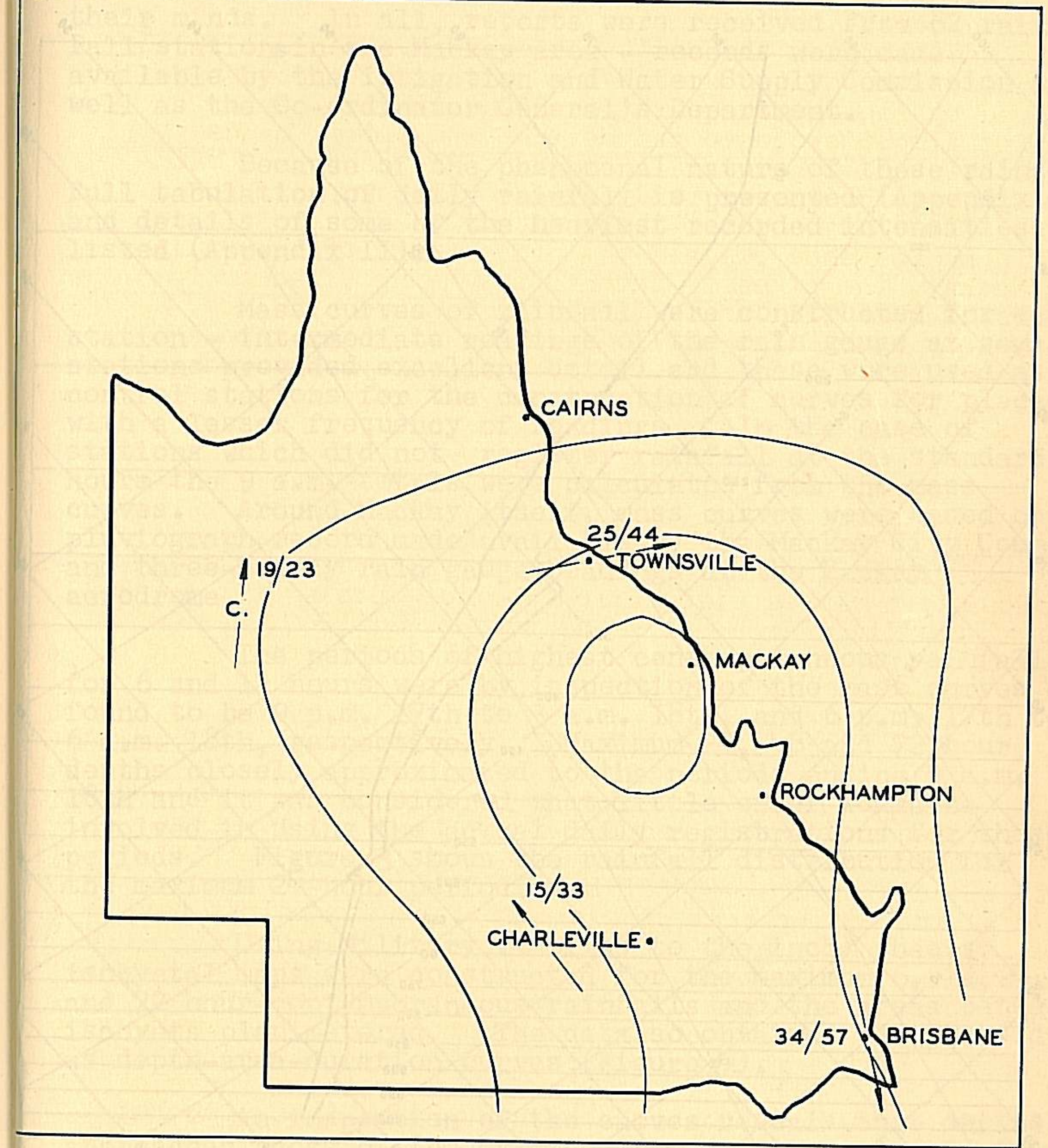
The most southern position of the rain depression appeared to be about latitude 20°S at 9 p.m., 17th, whence it turned northeastward during 18th, to circle Willis Island and approach the coast during 19th. A lull in the rainfall as the centre was moving away from the coast was followed by renewed intensity on 20th with the centre reaching almost cyclonic proportions and spiral bands being observed by Townsville radar. The centre of rainfall activity had moved to Ayr, where the depression crossed the coast about 6 p.m., 20th. Rainfall in this area in no instance reached the proportions of the falls near Mackay, the highest intensities being 5 inches in 2 hours at Home Hill and 8 inches in 6 hours at Clare. Twenty-four hour falls of 13.34 inches at Ravenswood and 12.85 inches at Balfe's Creek indicated the continued vigour of the depression which moved eastward over the Coral Sea on 21st and 22nd.

From 16th to 18th, 30,000 ft and 40,000 ft winds indicated a sharp trough through the whole of eastern Australia. The trough showed slight westward movement over Queensland and during the time of heaviest rainfall near Mackay a closed circulation could be drawn just southwest of the flood area, at least to the 30,000 ft level (Figure 1) and possibly to 40,000 ft. Isotherms showed that a warm-cored mechanism was involved.

2. MOISTURE CHARGE

Lapse rates as indicated by Townsville raobs of 18th were wet adiabatic and cloud developed to at least 250 mbs (Figure 2). The dew point lapse approximated quite closely to the wet adiabat (1,000 mb dew point 24.5°C or 76°F) indicating that observed surface dew points gave a reasonable picture of the vertical distribution of moisture in this instance. Sustained dew points for the 24 hour period of heaviest rain were 75°F at Mackay and 76°F at Pine Islet, reaching a maximum of 80°F for short periods. With a maximum possible sustained dew point of 79° (Walpole, 1951) it does appear that a slight increase of rainfall would be feasible with storm maximisation but the possibility of the cooling effect of heavy rain resulting in unrepresentative dew points should not be overlooked.

FIG. 1 30,000 FT. STREAMLINES 1600Z 17-2-58



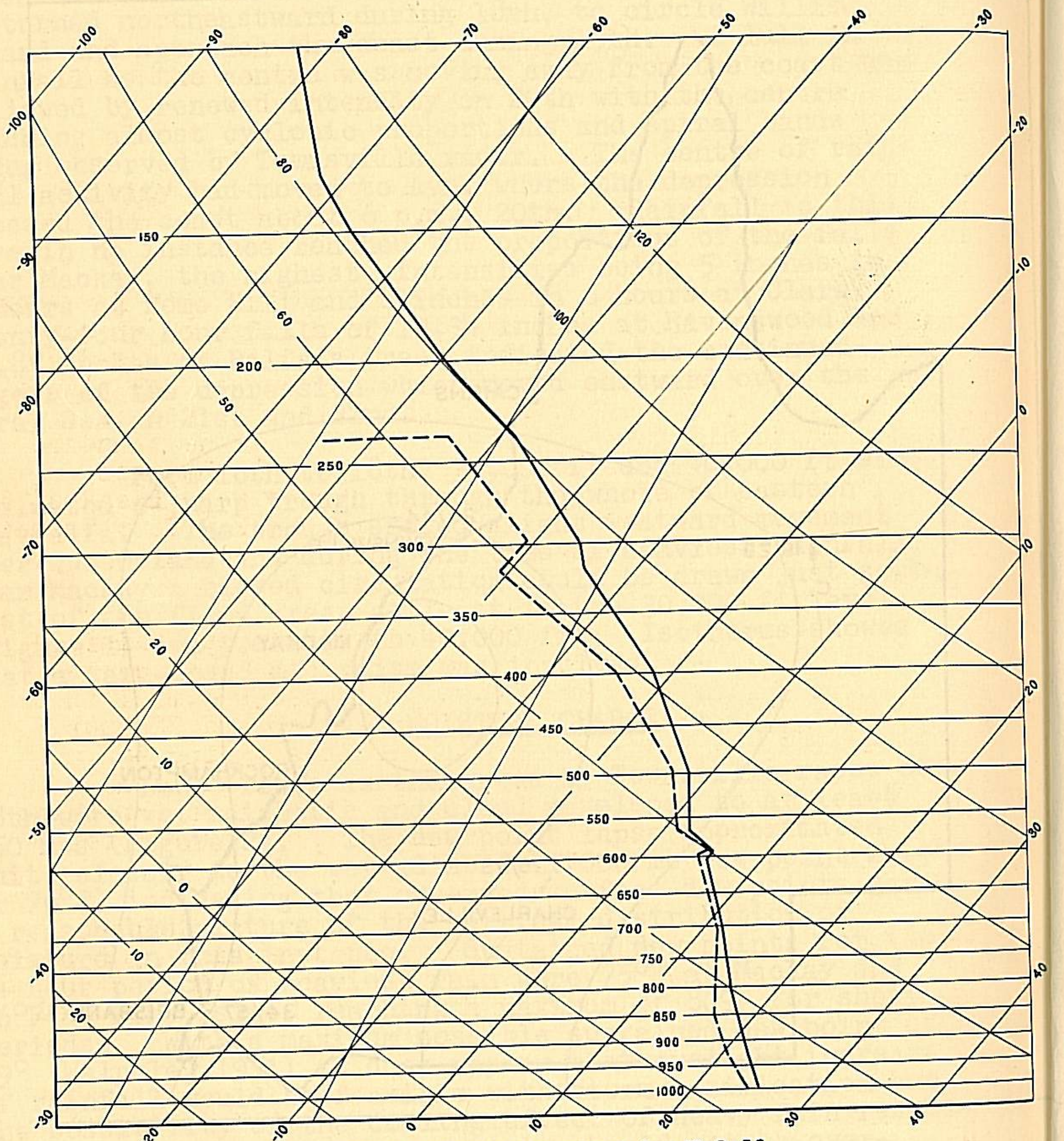


FIG. 2. TOWNSVILLE RAOBS. 9A.M. 18-2-58

3. RAINFALL

Daily rainfalls and details of rainfall intensity were obtained by circularising rainfall observers soon after the storm while details were still fresh in their minds. In all, reports were received from 62 rainfall stationsin the Mackay area - records were made available by the Irrigation and Water Supply Commission as well as the Co-ordinator General's Department.

Because of the phenomenal nature of these rains a full tabulation of daily rainfall is presented (Appendix I) and details of some of the heaviest recorded intensities listed (Appendix II).

Mass curves of rainfall were constructed for each station - intermediate readings of the rain gauge at some stations provided excellent detail and these were used as control stations for the construction of curves for places with a lesser frequency of readings. In the case of stations which did not register rainfall at the standard hours the 9 a.m. totals were calculated from the mass curves. Around Mackay itself, mass curves were based on a pluviograph record made available by the Mackay City Council and three-hourly rain gauge readings at the Mackay aerodrome.

The periods of highest contemporaneous rainfall for 6 and 12 hours were by inspection of the mass curves found to be 9 p.m. 17th to 3 a.m. 18th, and 6 p.m. 17th to 6 a.m. 18th, respectively. Maximum 24, 48 and 72 hour depths closely approximated to the periods ending 9 a.m. 18th and it was considered that little error would be involved in using the actual daily registrations for these periods. Figure 3 shows the rainfall distribution for the maximum 24 hour period.

Using Military (4 miles to the inch) sheets, isohyetal maps were constructed for the maximum 6, 12, 24, 48 and 72 hour contemporaneous rainfalls and the areas between isohyets planimetered. The data so obtained was plotted as depth-area-duration curves (Figure 4).

An inspection of the curves reveals that depths approached those of the maximum thunderstorm rainfall for the 6 hour period and were approximately equal to the model for the 12 hour period based on a thunderstorm of surface dew point $80^{o}F$ (Table 1).

Table 1

Comparison of 12 hour Storm Rainfall with
Maximum Thunderstorm Rainfall

Area	Feb., 1958, storm (inches)	Maximum thunderstorm rainfall inches (80° surface dew point)
500 sq. miles	21.7	21.9
200 sq. miles	24.5	25.1

Twenty-four hour depths were considerably greater than the equivalent maximum rainfall based on the thunderstorm model.

During the night of 17th February 10 stations recorded at least 20 inches in 12 hours and 4 stations reported falls of 20 inches in 6 hours, the highest being 21.20 inches in 5 hours at Elaroo. Some conscientious observers emptied their gauges twice during the night only to be amazed that they were again overflowing in the morning. Others gave up the task of trying to measure rainfall of such intensity.

It would appear that if rainfall in extreme storms on the Queensland Coast is to be registered accurately the use of tropical rain gauges should be more widespread, as the standard gauge is inadequate under such circumstances.

4. TOPOGRAPHIC INFLUENCE

The heaviest rainfall occurred in the wave in the easterlies mostly over the hilly country between Bloomsbury in the north and the Connors Range in the south. The storm was limited on the western side by the 2-4000 ft Clarke Range with rapid decreases of rainfall on the lee side, but little detail on the highest parts of the range was available.

The valleys of the Pioneer River and Cattle Creek form almost a straight line westward from Mackay to the range. With easterly winds, marked orographic convergence in this valley must have been partly responsible for the 24 hour fall of 34.58 inches at Finch Hatton. Three stations within 10 miles provided an excellent cross-section

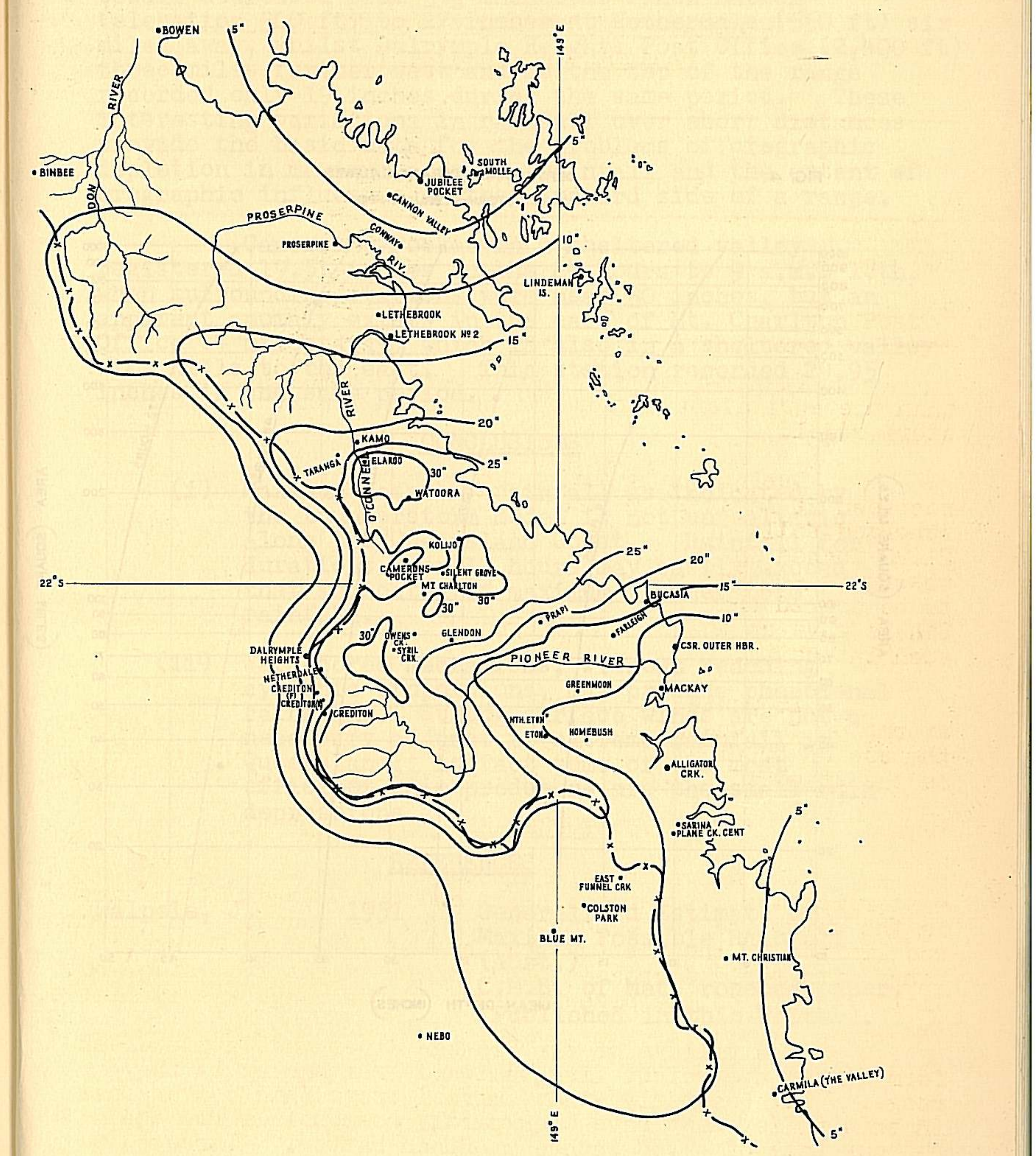
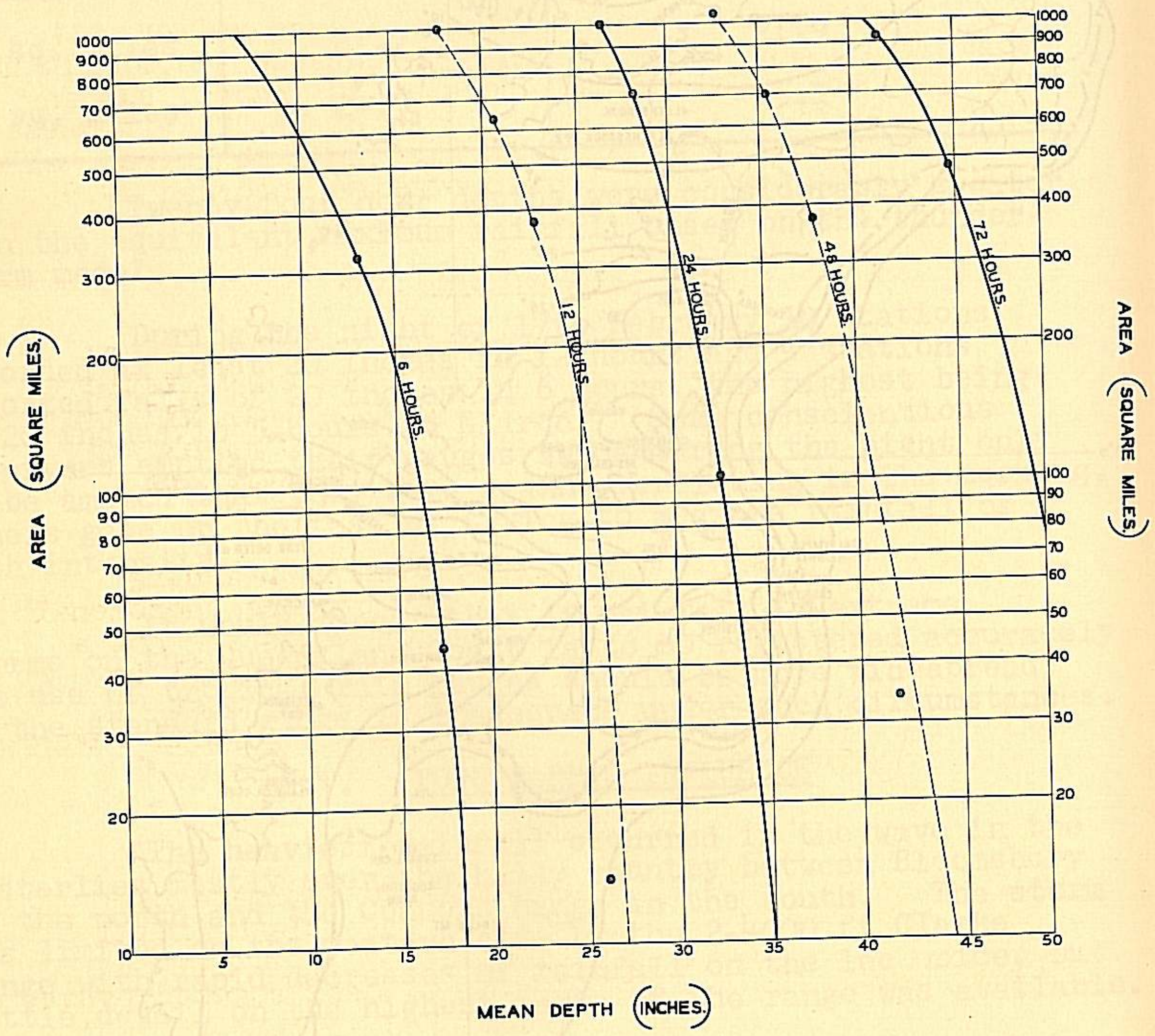


FIG. 3. ISOHYETS FOR 24 HRS. ENDING 9A.M. 18TH FEB. 1958.

FIG. 4.

DEPTH-AREA-DURATION CURVES.
MCKAY STORM-FEBRUARY 1958.



of rainfall at the head of the valley. Twenty-four hour totals decreased from 34½ inches at Finch Hatton (elevation 300 ft) to 27 inches at Netherdale (550 ft) six miles away, whilst Dalrymple Heights Post Office (2,400 ft) three miles further west and at the top of the range recorded only 19 inches during the same period. These interesting variations in rainfall over short distances provide the basic data for the problems of orographic depletion in maximum possible rainfall and the extent of orographic influences on the windward side of a range.

Cameron's Pocket in a sheltered valley registered 19.51 inches in the 24 hours to 9 a.m., 18th, when surrounding stations were near 30 inches, but an apparent anomaly exists in the case of Mt. Charlton Post Office (4 miles away) which is also in a sheltered valley with hills to the east. This station recorded 29.95 inches in the same period.

5. CONCLUSIONS

(i) Maximum possible rainfall as indicated by the thunderstorm model is not unrealistic along the Queensland Coast. Rainfall for durations over 12 hours may easily exceed that indicated by maximum thunderstorm rainfall.

(ii) Warm-cored mechanisms, without reaching cyclonic proportions, may produce phenomenal rainfall. Strong surface winds are not a necessary adjunct to extreme rainfall in Queensland; in fact some of the most efficient rain producers are the small rain depressions.

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Appendix I

Daily Rainfall (in inches)

February 1958

+ = Gauge overflowed.
X = Gauge read at times other than 9 a.m. and totals estimated from mass curves.

Station	15th	16th	17th	18th	19th
Alligator Creek	2.04	12.71	10.56	7.06	1.85
Binbee	2.45		2.20	8.35	0.02
Blue Mountain	0.94	1.74	4.65	10.48	3.32
Bloomsbury	1.14		5.39	18.10	0.98
Bowen	2.10	3.50	0.13	6.25	0.12
Bucasia	0.87	10.37	18.55	15.12	1.88
Calen	1.23	10.52	6.92	27.84	1.44
Cameron's Pocket	2.37	6.00	5.23	19.51	2.21
Cannon Valley	1.70	5.30	1.00	4.01	2.92
Carmila	1.05	2.92	4.48	5.10	1.80
Colston Park	1.10	1.95	4.71	11.10	3.20
Conway	2.91	5.49	2.97	5.54	1.00
Crediton	1.72	4.56	4.19	25.60	2.47
Crediton (Ross)	1.85	4.85	4.10	24.37	2.49
Crediton (Freigard)	1.21	3.67	3.21	21.80	2.30
Dalrymple Heights	1.54	4.94	3.69	18.78	2.33
East Funnel Creek	1.35	3.50	9.37	13.45	2.02
Elaroo	1.00	6.00	2.65	30.00+	1.45

Station	15th	16th	17th	18th	19th
Eton	1.35		11.20	10.50	3.93
Farleigh Mill	1.14	7.26	15.97	12.26	4.26
Finch Hatton	0.88		10.06	34.58	4.96
Gargett	1.09		14.50	22.70	4.38
Glendow	1.26	7.30	7.49	15.75+	2.87
Greenmount	2.03	6.40	12.30	11.11	2.95
Homebush X	-	4.00	10.20	7.30	3.20
Jubilee Pocket	-	5.22	5.15	4.30	0.81
Kamo	-	-	-	20.00	-
Kelsey Creek	1.08	3.98	0.96	7.43	2.74
Kolijo X	1.50	10.40	9.10	26.20	3.20
Lethebrook	1.20	4.65	1.60	13.05	1.06
Lethebrook (No. 2)	1.39	5.50	2.30	13.50	2.75
Lindeman Island	0.68	5.23	15.30	14.40	3.70
Mackay Aerodrome	1.06	6.35	15.20	9.20	3.84
Mackay Sugar Experiment Station	1.08	7.42	16.05	9.84	3.97
Mackay Outer Harbour	0.70	5.85	17.10	6.77	3.67
Mackay City Council (Water Tower)	1.05	6.52	15.51	9.33	2.45
Mackay Hinton St.	0.90	6.80	16.80	9.20	4.80
Marian Mill	1.70	6.80	9.72	12.07	2.52
Mirani	1.75	6.15	8.78	14.20	2.94

Appendix I (Contd.)

Station	15th	16th	17th	18th	19th
Mt. Charlton	1.02	7.96	14.72	29.95	2.70
Mt. Christian X	2.60	2.60	6.00	6.50	3.80
Mt. Jukes	1.65	9.24	10.00+	26.40+	3.00
Mt. Pelion	-	0.85	1.40	34.10	2.60
Nebo	0.53	0.60	2.05	9.56	2.55
Netherdale	1.41	4.55	2.36	21.38+	2.18
	(Observer estimated 6 inches lost)				
North Eton	-	-	8.48	9.88	-
Owens Creek X	2.00	7.00	8.50	28.50	4.00
Parapi X	2.60	6.95	7.50	15.75	5.20
Plane Creek Mill	1.30	4.01	9.30	9.25	3.40
Pleystow Mill	1.59	8.52	14.81	12.31	4.39
Proserpine	1.75	4.07	0.84	6.14	1.43
Sarina	1.26	3.60	10.41	9.11	3.11
Silent Grove	1.67	7.83	8.45	29.37	2.97
South Molle	1.92	4.39	7.97	2.64	1.30
Sybil Creek	1.38	5.68	5.72	29.14	4.15
Te Kowai	1.32	8.53	18.03	11.23	3.55
Taranga				20.00	(19" from 5pm to 5am)
Walkerston	1.57		23.49	12.02	2.99
Wagoora	All gauges overflowed, over 2'6" of rain night of 17th.				

Appendix II

Details of Heaviest Rainfalls from Intermediate Readings of Rain Gauges

Station: ELAROO

Date	Time	Rainfall (inches)	Highest Reported Intensities
17/2/58	9 am to 4 pm	1.80	
	4 pm to 5 pm	2.00	
	5 pm to 10 pm	21.20	21.20 ins in 5 hrs
	10 pm to 7 am 18th	6.00+	

Observer's Comments - Too worried by floodwaters after 10 p.m. to pay attention to rain gauge; water 2 ft 6 ins deep running down road in front of house. Next door neighbour recorded 36 inches of rain in a 44 gallon drum - most of which fell in the period 4 p.m. to midnight. Thunderstorm during heaviest rain.

Station: MT PELION

Date	Time	Rainfall (inches)	Highest Reported Intensities
17/2/58	9 am to 10.30 pm	3.80	
	10.30 pm to 1 am 18th	11.50	11.50 ins in 2½ hrs
18/2/58	1 am to 4.30 am	11.70	23.20 ins in 6 hrs
	4.30 am to 9 am	7.10	
		34.10	

Observer's Comments - All other gauges in the Mt. Pelion area overflowed at 30 inches during the night of 17th.

Station: MT. CHARLTON

Date	Time	Rainfall (inches)	Highest Reported Intensities
17/2/58	9 am to 6 pm	3.50	
	6 pm to 9.45 pm	7.20	
	9.45 pm to 1.10 am 18th	8.54	8.54 ins in 3 hrs 25 mins
18/2/58	1.10 am to 4.20 am	7.45	15.99 ins in 6 hrs 35 mins
	4.20 am to 9 am	3.26	23.19 ins in 10 hrs 20 mins
		29.95	

Observer's Comments - Gauge emptied three times during the night to stop overflow. Creeks 6 ft higher than in memory of oldest resident.

Station: MT. JUKES

Date	Time	Rainfall (inches)	Highest Reported Intensities
17/2/58	9 pm to 4 am 18th	20.00+	At least 20 ins in 7 hrs.

Observer's Comments - Gauge emptied twice but still overflowed during the night.

Station: SYBIL CREEK

Date	Time	Rainfall (inches)	Highest Reported Intensities
17/2/58	8 am to 2.50 pm	3.78	
	2.50 pm to 4.30 pm	3.39	
	4.30 pm to 5.30 pm	2.13	
	5.30 pm to 8.45 pm	3.30	
	8.45 pm to 9.45 pm	2.62	2.62 ins in 1 hr
	9.45 pm to 1 am 18th	6.55	6.55 ins in 3 hrs 15 mins
18/2/58	1 am to 4.30 am	5.77	12.32 ins in 6 hrs 45 mins
	4.30 am to 8 am	1.60	20.37 ins in 12 hrs
		29.14	

Station: CALEN

Date	Time	Rainfall (Inches)	Highest Reported Intensities
17/2/58	9 am to 6 pm	1.65	
	6 pm to 10 pm	4.80	
	10 pm to 1 am 18th	7.07	
18/2/58	1 am to 4.45 am	9.35	9.35 ins in 3 hrs 45 mins
	4.45 am to 8 am	3.15	16.42 ins in 6 hrs 45 mins
	8 am to 9 am	1.82	21.22 ins in 10 hrs 45 mins
		27.84	24.37 ins in 14 hrs.

Observer's Comments - All other gauges in Calen area overflowed.

Station: OWENS CREEK

Date	Time	Rainfall (inches)	Highest Reported Intensities
17/2/58	6 am to 3.45 pm	5.53	
	3.45 pm to 5.45 pm	2.25	
	5.45 pm to 8.45 pm	3.52	
	8.45 pm to 11.45 pm	6.25	6.25 ins in 3 hrs
	11.45 pm to 6.45 am 18th	11.25	11.25 ins in 7 hrs
18/2/58	6.45 am to 3 pm	4.78	17.50 ins in 10 hrs
			21.02 ins in 13 hrs

DISCUSSION

Mr. Brunt said that due to a great deal of doubt about the path of the 1893 cyclone, charts were reconstructed in full, showing that the rainfall was mainly the result of a marked trough and not the cyclone centre itself. Topographic influences were quite marked.

Maximization was based mainly on moisture increases - transposition was not considered feasible and doubt was cast on the methods of maximization for wind. The results obtained are presented on pages 221, 222 and 225.

The Mackay storm is remarkable because of the fact that it exceeded some of the maximum depths observed in the United States. A warm-cored rain depression was associated with many falls of 20 inches in 12 hours and a few of 20 inches in 6 hours. Such rainfall equalled that indicated by the thunderstorm model of 80°F surface dew point for a 12 hour period and greatly exceeded it for longer durations. Topographic effects were variable - in one case orographic depletion was indicated, in others hill features received remarkable rainfall.

Mr. Ashton suggested that micro-studies should be carried out involving effective storms on small areas of catchment, and also a study made concerning repetition of storms over short periods. This storm repetition appears to occur more frequently than would be expected by chance, and obviously the effect of a storm over a saturated catchment is much greater than if the catchment were dry.

Mr. Gibbs queried the validity of the envelopment curve as used by Mr. Brunt for the thunderstorm and the cyclone maximization and in the subsequent discussion it was agreed that the broken or "seagull" type curve might be justified.

MAXIMUM POSSIBLE RAINFALL OVER AUSTRALIA

Generalised Estimate of Maximum Possible Rainfall in Australia over areas of 10, 200 and 500 square miles for periods of 1, 3, 6, 12 and 24 hours.

by J. Walpole

(Submitted for Publication 1951)

Abstract: The maximum dew points possible in the Australian region have been found from an examination of past records of the Australian Meteorological Service. Using methods developed by the Hydrometeorological Section of the United States Weather Bureau, the assumption is made that for the small areas and durations considered, the maximum possible rainfall intensity results from a thunderstorm in an air mass with the maximum possible surface dew point.

Duration - area - depth data for thunderstorms in the United States of America are transposed to the Australian region with appropriate modifications to give generalised estimates of the maximum possible rainfall that can occur anywhere in Australia over areas varying from 10 to 500 sq miles and times ranging from 1 to 24 hours.

1. STATEMENT OF THE PROBLEM

It is the aim of this paper to give generalised estimates of the maximum possible rainfall that can occur anywhere in Australia over areas varying from 10 to 500 sq miles for times ranging from 1 to 24 hours. The estimates will be generalised in that no attempt will be made to allow for detailed topographic influences, such as slope and orientation, although the general effects of elevation will be taken into account.

The results for the Australian continent will be presented in the form of a series of isohyetal maps, while the results for Tasmania will be presented in the form of a table.