SHORTER CONTRIBUTIONS

AN OCCURRENCE OF LAND AND SEA-BREEZE FOG ON THE CENTRAL QUEENSLAND COAST

by H.E. Whittingham

Divisional Office, Brisbane

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1. INTRODUCTION

Fog in the day time along the central Queensland coast is a sufficiently rare phenomenon to warrant an analysis of the fog of Sunday 4 August, 1957. The A.B.C. evening news reported that thick fog swept in from the sea along part of the Queensland coastline in the afternoon, slowing car traffic and forcing a number of launches to anchor at sea. The Hervey Bay towns of Pialba and Urangan near Maryborough reported a heavy pea-soup fog all day. At Pialba motorists were using their headlights at midday. Many fishing parties left Urangan in the morning hoping the fog would lift; some returned with difficulty, others became fog bound. At Mackay fog blew in from the sea during the afternoon and motorists used their headlights well before dusk.

The morning newspaper next day reported that three airports had been closed and visibility over the Hervey Bay area had been reduced to 100 feet. The Mackay aerodrome was closed intermittently from about 4.40 p.m., and Bundaberg and Maryborough from about 7.30 p.m.

2. THEORY OF THE LAND AND SEA BREEZE FOG

Byers (1944) describes this type of fog in detail. An essential requirement is the transportation of warm moist air from the land out over the water, leading to the formation of advection fog which is carried back over the land by the sea breeze. As he points out, fluctuations in the wind direction of a diurnal nature are part of the mechanism. The warm air from the land is cooled as it passes over the cool surface afforded by the ocean. Light winds are required, otherwise stratus cloud will form under

the turbulence inversion instead of a dense surface fog over the sea. Byers states that the land and sea breeze fog is a frequent occurrence in summer along the eastern New England coast. Its formation comes with light westerly winds and widely spaced isobars. The westerly current is not only warm but also contains a high specific humidity and the cooling over the sea quickly produces condensation which, in the slight movement prevailing, must take place at the surface. Under this weak pressure gradient, afternoon sea breezes are likely and the fog is brought inland.

Table I is reproduced from Byers:-

Table I

Wind Force, Beaufort Scale	Number of cases	Mean values of air temperature minus water temperature °C
0	3	- 0.5
1	20	0.3
2	30	1.0
3	46	1.0
4	26	1.1
5	12	1.8
6	3	2.6
7	1	4.1

It is of interest to note that of 141 cases of fog occurrence over the sea no less than 102 were accompanied by wind force 2 to 4 (Beaufort), the mean value of the difference between air temperature and water temperature being only 1C (about 2F).

3. DETAILS OF THE FOG ON 4 AUGUST

Available evidence seems to indicate that the fog began as an early morning radiation type fog over the land. This is by far the commonest type of fog

experienced in Queensland. At 3 a.m. fog was forming at Rockhampton, Bundaberg and Mackay whilst at 6 a.m. visibilities were reported as follows:-

Mackay	440 yd
Gayndah	110 yd
Monto	1¼ mi
Maryborough	550 yd
Bundaberg	110 yd
Cape Capricorn	12 mi (fog in patches)

The 9 a.m. reports indicated fog at Bundaberg (visibility 110 yd), fog at Maryborough (visibility 110 yd), fog at St. Lawrence, fog patches at Bustard Heads and Rockhampton. On the noon chart shallow fog was reported from Pine Islet (visibility 2½ mi); it is important to note that this is the only hour at which Pine Islet's visibility was at all reduced, indicating that this was not an advection sea fog of the ordinary type. Mackay at noon recorded a visibility of 30 mi but also reported a fog bank over the sea. At 3 p.m. visibilities at the synoptic stations were unimpaired except that Double Island Point reported mist (visibility 12 mi) and Sandy Cape reported mist (visibility 1¼ mi). Maximum temperatures reached 81F at Rockhampton and Bowen, 80F at Bundaberg, 79F at Eagle Farm and from 70 to 75F at other coastal stations in the area. There was thus enough diurnal heating to induce the afternoon sea breeze under the quiet isobaric situation prevailing. By 6 p.m. Mackay was reporting past and present weather fog with visibility 220 yd, and at 9 p.m. fog but visibility 5 mi. Bundaberg at 9 p.m. reported fog at a distance, with visibility 12 mi. From the above data it becomes evident that the fog along the Queensland coast must have originated as a radiation fog, been carried out to sea by an off shore wind drift and then brought back again later by the sea breeze. Whilst at sea the fog was maintained and perhaps intensified by the land and sea-breeze fog mechanism. In Tables II and III are presented the relevant three hourly observations from Maryborough and Mackay respectively. Note the offshore winds at Mackay at 0600 and 0900 hours and the subsequent improvement in the visibility. On the coast near Maryborough (at Pialba and Urangan), as reported above, the fog remained almost the whole day.

TABLE II

Maryborough 4 August, 1957

Time	Temp	Dew Point	Wind	Weather	Visibility
0300	52	52	Calm	Fog	1100 yd
0600	53	53	Calm	Fog	550 yd
0900	58	58	Calm	Fog	1100 yd
1200	72	60	N 2 kt	-	12 mi
1500	80	40?	E 2 kt	-	12 mi
1800	68	59	N 2 kt	-	12 mi
2100	58	58	N 2 kt	Fog	550 yd

TABLE III

Mackay 4 August, 1957

Time	Temp	Dew Point	Wind	Weather	Visibility
0300	59	59	Calm	Haze	10 mi
0600	58	56	SW 4 kt	Fog	440 yd
0900	67	64	SW 3 kt	-	30 mi
1200	69	66	SE 6 kt	Fog bank over the sea	30 mi
1500	69	66	SE 6 kt	-	25 mi
1800	65	65	SE 6 kt	Fog	220 yd
2100	62	62	Calm	Fog	5 mi

4. THE SYNOPTIC SITUATION

At 3 a.m. on Saturday, 3/8/57, a weak anticyclone cell was located over Walgett, in New South Wales. By 3 p.m. on Saturday this cell had moved to a position at

23S, 154E where it became practically stationary. Gradient (3000 ft) winds at this hour were:

Townsville	210° 3 kt
Rockhampton	310° 8 kt
Brisbane	250° 8 kt

At 9 p.m., Saturday, Townsville's gradient wind was 50° 5 kt and it is significant that the fog was not reported north from Mackay (Bowen immediately to the northwards suffered no impairment to the visibility). However the 9 p.m. gradient winds at Rockhampton and Brisbane were respectively 320° 11 kt and 260° 9 kt (both offshore winds).

Gradient winds during Sunday were as follows (Table IV):

TABLE IV - (Gradient Winds, Sunday 4/8/57)

Hour	Townsville	Rockhampton	Brisbane
0300	80° 8 kt	no report	230° 5 kt
0900	90° 17 kt	110° 6 kt	220° 5 kt
1500	110° 7 kt	50° 1 kt	280° 2 kt
2100	80° 19 kt	120° 3 kt	330° 16 kt

It is important to note that the land and sea-breeze fog mechanism involves a positive temperature difference between the air from the land and the water surface. Normally an unassisted land-breeze, by its very nature, must be cooler than the water surface. Some gradient assistance is normally required, and in this instance appears to have been provided in the area affected.

It is interesting to note that the fog was not experienced at Brisbane. However, at Palm Beach, near the Queensland border, a dense fog was observed over the sea at 4 a.m., 4 August. By sunrise this fog had been driven well to seawards by the land breeze. The sun as it rose above the horizon assumed a shape reminiscent of the weather map symbol for large cumulus, indicating refraction due to a temperature inversion.

5. THE SEA WATER TEMPERATURE

No sea water temperatures are available from the fog affected areas, but a reading of 66F was obtained at Palm Beach on 3/8/57 at 6 p.m. This should be compared with the following temperatures (Table V) from island stations in the fog region:

TABLE V - Air Temperature/Dew Point at Island Stations 4/8/57

Station	1200 hr	1500 hr
Cape Moreton	65/56	70/56
Lady Elliott Is.	68/66	68/65
Pine Islet	71/68	71/68
Double Is. Point	72/62	73/63
Cape Capricorn	68/65	68/66
Sandy Cape	-	72/62

The table indicates that the temperature difference between air and water was of the correct order to maintain the fog over the sea during the daytime (compare Table 1).

6. CONCLUSIONS

The forecaster should beware of occasions where an early morning radiation fog is blown out to sea and persists during the heat of the day, particularly when the dew point depression at coastal stations remains small. If the sea water is cold enough the fog can be maintained by the land and sea-breeze fog mechanism and may be carried ashore by the sea-breeze during the afternoon.

REFERENCE

Byers H.R. 1944 General Meteorology p.509 et seq.