FREQUENCY DISTRIBUTIONS OF WEATHER PHENOMENA, PARTICULARLY PRECIPITATION TYPE, FROM DATA ASSOCIATED WITH SYNOPTIC ANALOGUES

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Frequency distributions of weather phenomena associated with synoptic analogues may be used to derive guidance for weather forecasting (Stern, 1980; Dahni et al, 1983). The purpose of the present paper is to illustrate the validity of this statement over a complete range of synoptic situations. This is achieved by displaying a table which presents the diurnal variation of the probability of occurrence of various weather states for analogues to each of Jasper and Stern's (1983) thirty eight synoptic types over southeastern Australia. The weather states referred to are those as defined by Stern et al (1984) and are applied here to Melbourne observations.

Table 1 presents the diurnal variation of the probability of occurrence of weather phenomena associated with analogues to each of the synoptic types (which are depicted in Fig 1). For each pattern, the analogues are those 0900 local time MSL pressure distributions more highly correlated with the pattern in question than any other. The table, which places particular emphasis on precipitation type, clearly demonstrates the substantial dependence of Melbourne's weather regime on the surface pressure pattern. To illustrate a few of the more interesting aspects, the following points are worth making :

synoptic types 2 and 3 both show an increase in convective precipitation in the afternoon, with a corresponding decrease in non-convective precipitation;

synoptic types 5 and 11 both show an increase in convective and non-convective precipitation late in the day;

synoptic type 14 shows a decrease in both forms of precipitation late in the day;

synoptic types 17, 29 and 33, patterns more likely to occur during the winter half of the year than in the summer, are associated with the highest probabilities of morning fog;

synoptic types 21 and 32, both possessing frontal characteristics, are the types most likely to be associated with dust.

REFERENCES

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Jasper, J.D. and Stern, H. 1983. Objective classification of synoptic pressure patterns over southeast Australia. Proc. II International Meeting on Statistical Climatology, Lisboa.

Stern, H. 1980. A system for automated forecasting guidance. Aust. Met. Mag., 28, 141-54.

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Table 1. The diurnal variation of the frequency (%) of occurrence of the weather states for thirty eight synoptic types (based on data 1960-1978 inclusive) looking at six aspects, namely :

(a) combining the two convective precipitation states 1 and 4;

(b) combining the three non-convective precipitation states 2,3 and 5;

(c) combining the cloudy and part-clouded states 8 and 9;

(d) taking the clear state 10 individually;

(e) for the fog state 6 presenting the frequency for all times combined;

(f) for the dust state 7 presenting the frequency for all times combined.

Three hours ended .... (local time)

Type	No.	(a) 00	(a) 03	(a) 06	(a) 09	(a) 12	(a) 15	(a) 18	(a) 21	(a) 24	(b) 00	(b) 03	(b) 06	(b) 09	(b) 12	(b) 15	(b) 18	(b) 21	(b) 24
1	734	11	5	6	8	10	18	21	16	13	7	6	6	7	7	5	8	11	11
2	609	26	22	26	29	33	36	29	22	21	16	16	17	17	8	6	5	7	7
3	535	20	13	16	20	29	53	47	30	20	15	16	20	18	13	9	8	8	9
4	490	5	2	3	3	3	5	4	4	3	4	3	3	3	3	3	5	4	5
5	490	4	3	2	4	3	7	12	12	10	3	6	4	4	5	8	13	16	15
6	473	3	1	2	3	2	5	8	6	7	3	3	5	5	4	6	7	8	9
7	313	4	1	1	2	2	6	7	8	9	2	4	5	5	4	5	6	8	9
8	272	9	6	7	7	8	6	3	3	3	9	6	9	8	4	2	3	1	4
9	286	2	5	3	3	5	5	5	2	1	4	5	8	8	5	7	7	8	9
10	218	27	22	21	23	21	17	13	9	9	23	19	21	16	7	6	5	6	6
11	187	3	3	4	5	3	10	20	22	20	5	5	9	14	13	15	19	20	17
12	143	16	13	13	15	10	5	6	8	8	13	13	15	9	3	2	3	1	6
13	152	11	13	14	15	22	30	36	21	16	13	20	26	20	17	15	17	16	19
14	143	31	31	34	50	44	36	33	38	34	30	31	29	27	20	13	13	8	10
15	135	5	2	1	1	1	4	7	5	4	1	2	2	2	2	4	4	4	7
16	129	0	0	2	0	1	2	2	2	2	2	2	2	4	2	2	2	3	2
17	132	3	5	3	4	5	6	5	2	0	6	2	2	2	1	1	4	3	7
18	122	9	9	11	8	14	20	20	27	17	15	15	22	24	21	16	15	14	13
19	120	8	12	17	19	9	7	7	6	4	17	11	18	20	7	4	3	4	7
20	121	12	10	2	8	7	11	14	10	10	21	21	30	27	17	17	17	15	14
21	107	8	5	6	11	12	20	19	13	11	15	20	28	27	20	21	22	18	15
22	80	3	3	3	4	3	0	0	1	0	3	3	5	1	0	1	1	1	1
23	94	19	20	18	13	13	3	4	2	4	6	5	12	11	1	2	2	1	6
24	76	5	3	0	4	1	0	3	3	3	4	5	9	11	4	3	5	3	1
25	73	7	10	12	7	5	3	1	0	3	5	7	11	15	4	3	4	1	3
26	77	14	14	12	12	6	34	32	36	10	17	22	29	26	29	22	27	22	27
27	66	2	2	2	6	3	2	0	0	0	3	3	8	3	5	3	5	6	5
28	67	15	7	6	7	6	9	25	16	18	15	16	18	12	15	13	18	13	12
29	53	2	0	0	2	0	0	0	0	0	2	4	4	2	2	0	0	0	2
30	55	4	0	2	4	4	2	4	2	2	15	7	4	7	7	5	4	5	5
31	63	11	16	16	14	13	17	30	29	30	40	35	46	43	38	40	29	33	29
32	57	7	11	14	14	14	19	26	18	12	16	12	21	32	32	28	23	18	28

../cont.

Table 1 (cont.)

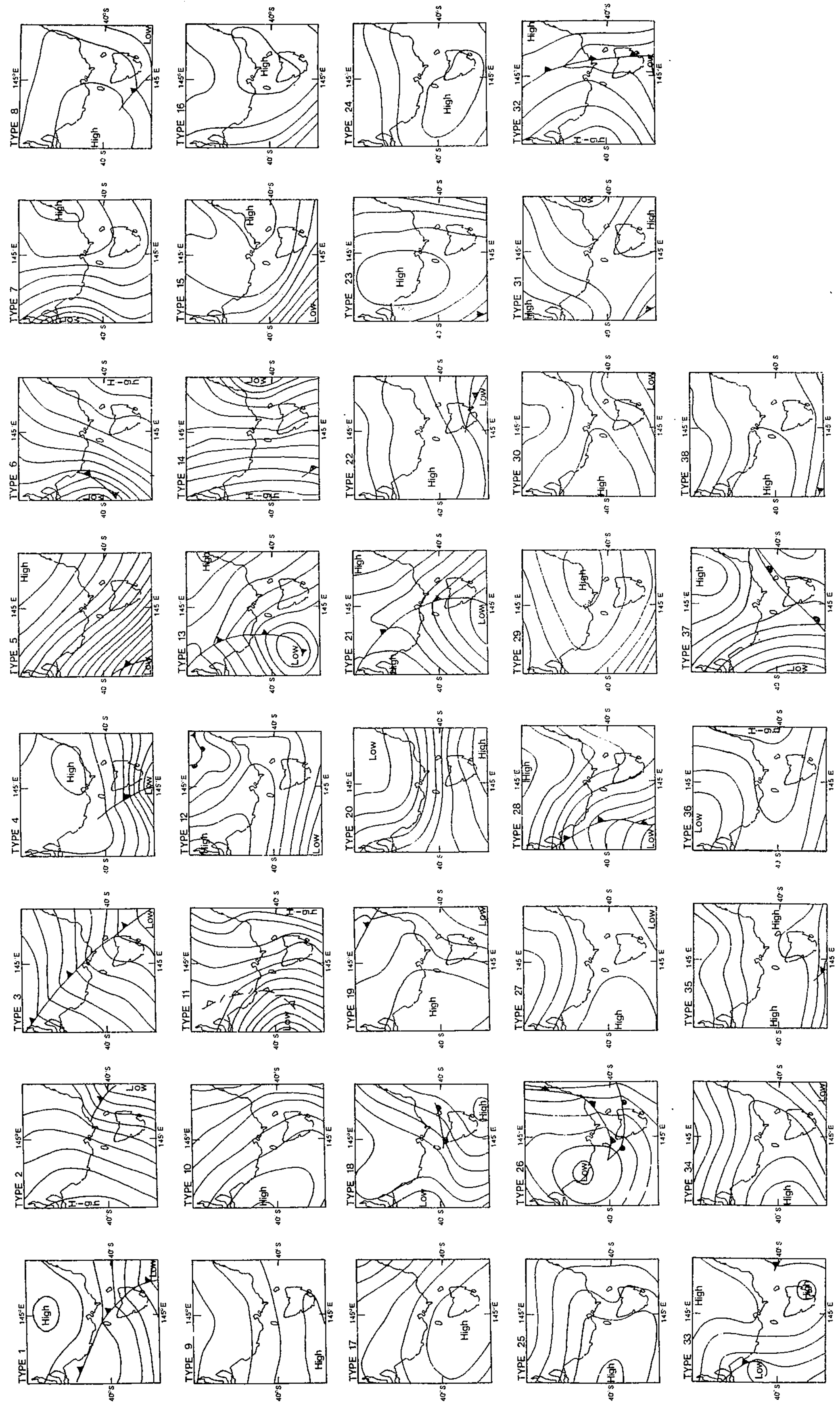
Three hours ended... (local time)

Type	No.	(a) 00	(a) 03	(a) 06	(a) 09	(a) 12	(a) 15	(a) 18	(a) 21	(a) 24	(b) 00	(b) 03	(b) 06	(b) 09	(b) 12	(b) 15	(b) 18	(b) 21	(b) 24
33	61	5	5	2	5	3	5	8	2	5	3	2	3	0	0	2	5	13	11
34	57	11	9	7	9	4	2	0	0	0	9	11	7	4	2	0	0	0	0
35	46	2	2	2	0	2	2	0	0	2	2	0	2	2	0	2	2	0	0
36	39	0	0	0	3	0	5	5	5	3	0	3	8	5	5	8	15	10	8
37	39	3	0	5	3	8	13	8	13	8	13	8	8	5	5	10	15	13	18
38	26	8	4	4	0	0	0	0	8	0	4	4	4	4	4	4	4	0	0

Three hours ended... (local time)

Type	(c) 00	(c) 03	(c) 06	(c) 09	(c) 12	(c) 15	(c) 18	(c) 21	(c) 24	(d) 00	(d) 03	(d) 06	(d) 09	(d) 12	(d) 15	(d) 18	(d) 21	(d) 24	(e) all	(f) all
1	41	43	47	55	66	62	52	46	40	38	44	38	28	17	13	18	26	35	1.2	0.0
2	37	42	40	40	47	40	42	48	45	19	20	15	11	9	18	24	22	23	1.6	0.0
3	40	43	41	44	52	34	30	36	39	24	27	22	16	6	3	14	25	31	0.7	0.1
4	40	42	45	53	56	48	47	44	42	48	47	43	35	36	44	43	46	45	3.2	0.0
5	34	37	48	56	61	61	51	44	44	57	54	42	34	30	23	24	27	30	1.6	0.1
6	23	23	30	35	39	46	40	34	29	65	63	50	47	51	43	44	49	50	5.7	0.0
7	29	31	33	42	51	57	55	42	36	57	55	50	40	41	32	32	39	42	5.5	0.0
8	43	57	63	66	60	49	45	55	49	37	28	15	13	26	43	49	39	40	3.4	0.0
9	36	31	34	40	36	34	31	26	21	52	49	39	35	46	50	52	58	61	8.3	0.0
10	39	44	41	44	56	56	46	46	45	9	11	11	11	13	22	36	38	38	2.9	0.0
11	30	35	44	49	52	52	43	36	37	59	53	42	32	31	22	17	21	26	0.9	0.3
12	51	52	52	59	61	50	38	50	50	17	19	17	13	24	43	52	38	34	2.2	0.0
13	44	39	40	52	51	45	28	37	34	32	26	19	13	9	9	18	26	31	0.2	0.1
14	29	29	32	20	30	38	40	40	43	9	8	3	2	6	13	15	13	12	0.5	0.0
15	24	25	23	33	41	48	44	36	33	60	60	53	50	52	43	44	49	53	7.3	0.2
16	34	37	43	43	19	26	20	19	22	58	50	36	37	72	68	72	67	61	9.3	0.0
17	39	30	33	31	42	49	30	25	20	41	46	38	32	30	37	55	55	54	17.4	0.0
18	31	28	30	39	38	38	43	30	30	44	41	30	26	25	25	21	26	38	3.0	0.1
19	59	66	56	52	64	47	43	44	49	14	9	7	7	19	43	48	45	38	1.0	0.0
20	44	42	42	36	55	51	42	40	37	18	19	15	15	15	18	24	31	34	6.2	0.1
21	36	38	38	38	49	38	35	40	40	40	37	23	20	18	20	23	28	33	0.7	0.8
22	49	51	53	60	37	34	31	26	35	44	34	27	21	56	64	67	66	59	6.0	0.0
23	41	43	39	40	50	52	41	47	33	21	18	11	11	21	40	51	41	41	12.5	0.0
24	57	66	64	64	53	43	34	34	32	32	22	16	14	38	51	57	58	57	4.5	0.0
25	70	59	63	64	64	47	40	48	40	16	22	10	10	22	48	55	48	53	2.3	0.0
26	36	31	47	49	55	38	26	27	27	32	31	12	10	10	6	14	13	31	1.2	0.0
27	44	58	52	53	44	33	36	30	41	50	33	32	30	41	58	56	62	52	4.5	0.0
28	42	51	40	57	61	64	27	33	37	27	22	31	19	18	13	28	36	31	1.7	0.3
29	32	40	34	28	28	34	38	26	23	45	32	34	32	53	57	53	58	58	19.3	0.2
30	55	67	73	65	53	44	44	47	58	25	20	13	16	35	49	49	45	33	3.0	0.0
31	32	40	24	35	48	30	33	27	25	16	8	10	3	2	13	8	8	13	2.1	0.0
32	44	47	47	35	39	35	33	49	42	32	25	12	14	12	18	18	16	18	1.4	1.0
33	30	30	31	39	48	56	57	46	41	39	31	31	25	28	36	25	28	26	19.5	0.0
34	58	51	54	54	53	44	42	26	30	19	30	28	33	39	54	58	74	70	1.6	0.0
35	63	59	59	48	43	28	30	26	26	26	28	26	33	43	61	63	65	63	8.9	0.0
36	51	36	44	38	38	36	33	36	41	49	59	49	49	54	51	46	49	46	1.4	0.0
37	23	38	37	56	62	59	56	44	36	36	26	28	15	23	18	21	31	36	11.1	0.0
38	46	62	65	77	50	50	35	27	31	42	31	23	12	42	42	62	65	54	3.8	0.0

Fig 1 (over-leaf) MSL pressure analyses (at 2 mb interval isobars) of the thirty eight synoptic types.



THE SPATIAL DISTRIBUTION OF RAINFALL IN THE HUNTER REGION

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The Hunter Region in eastern New South Wales is an area of intensive heavy industrial, power and mining development. Assessing the impact on the environment of these activities requires an extensive data base in many areas, including climatology. Knowledge of the spatial distribution of climatic parameters, such as rainfall, would assist greatly in the evaluation of the impacts of present and future developments in the Region.

This paper will analyse the spatial distribution of rainfall in the Hunter Region through the use of gamma distributions. The Region is defined by census districts, bounded by Merriwa on the west, Murrurundi, Gloucester and Great Lakes on the north, and Lake Macquarie on the south. Rainfall information from the region has been used on more extensive analysis over SE Australia (for example Sumner, 1983) or in plotting annual (Tweedie, 1963) or seasonal (Hutchinson and Bischof, 1983) averages, but a detailed evaluation of spatial patterns within the region has not been attempted.

The method of analysis chosen is gamma distributions, introduced by Thom (1958) as a frequency analysis:

$$f(X) = \frac{1}{\beta\gamma\Gamma(\gamma)} X^{\gamma-1} e^{X/\beta}; \quad \beta>0, \ \gamma>0 \qquad (1)$$

where X is precipitation, γ is the shape parameter of the distribution, β is the slope parameter and $\Gamma(\gamma)$ is the gamma function of γ.

γ and β can be determined in two ways, of which the Maximum Likelihood Estimate of occurrence is the harder:

$$A = \ln\bar{X} - \frac{1}{N} \Sigma \ln X \qquad (2)$$

$$\hat{\gamma} = \frac{1 + \sqrt{1+4/3A}}{4A} \qquad (3)$$

$$\hat{\beta} = \bar{X}/\hat{\gamma} \qquad (4)$$

where N is the number of occurrences in the data set.

If $\gamma \geq 10$, a simpler method is through the use of means and standard deviations (s) (Thom, 1958; Garcia and Aleman, 1981):

$$\gamma = \frac{\bar{X}^2}{s^2} \qquad (5)$$