ISSN: 0128-7680
Pertanika J. Sci. & Technol. **8(1)**: 73 - 83 (2000)

Monthly and Annual Rainfall Variability in Peninsular Malaysia

Alejandro Livio Camerlengo and Nhakhorn Somchit
Faculty of Applied Sciences and Technology
Universiti Putra Malaysia Terengganu
Mengabang Telipot
21030 Kuala Terengganu
e-mail: alex@uct.edu.my

Received 7 December 1998

ABSTRAK

Kajian ini meneliti semula variasi taburan hujan di Semenanjung Malaysia. Satu kajian awal telah dijalankan 40 tahun yang lalu. Memandangkan: (1) kehadiran lebih banyak stesen kaji cuaca kini, (2) kesan pemanasan bumi 'global warming' keatas taburan hujan. Kami berpendapat kajian baru mengenai variasi taburan hujan adalah sesuai dan bertepatan. Jadi ini merupakan objektif utama kajian yang dijalankan. Keputusan yang diperolehi menunjukkan bahawa nilai yang tinggi bagi variasi taburan hujan tidak (jarang) berlaku apabila jumlah hujan paling rendah.

ABSTRACT

This paper re-addresses the study of the rainfall variability in Peninsular Malaysia. An earlier investigation has been conducted forty years ago. Due to the fact that: (1) a larger and more sophisticated number of meteorological stations is nowadays in place, and (2) the effect that global warming has on precipitation, we feel that a new study of rainfall variability is both timely and pertinent. This is, therefore, the aim of this particular study. Our results show that larger variability does not (always) occur whenever lowest rainfall is recorded.

Keywords: North-east monsoon, South-west monsoon, inter-monsoon season, Peninsular Malaysia, precipitation

INTRODUCTION

The aim of this study is to gain some understanding about the monthly rainfall variability in Peninsular Malaysia. In this regard, to the authors' knowledge, only a single previous attempt has been made (back in the late fifties). In that particular study, all analysed stations did not have the same number of years of data. As a consequence of this, the resulting rainfall variability is highly distorted due to the fact that it is affected by distinct meteorological events (for example, different El Niños or La Niñas events).

Our approach is fundamentally different from the one mentioned above, as we have chosen a considerable larger number of stations than in that particular study (Dale 1959). Furthermore, all our stations were selected in order to have the same period of time: fifteen years (from 1982 to 1996). Therefore, all stations are affected by similar meteorological events (e.g. the 1991-93 El Niño event and the 1988 La Niña event).

We strongly believe that our approach gives a far better and a more accurate resolution of the rainfall variability than previously attained. In particular, a considerable departure from earlier results is obtained.

DATA

Precipitation data of 94 stations were obtained from the "Monthly Summary of Meteorological Observations" published by the Malaysian Meteorological Service (1982-96). The location as well as the name of each station is shown in *Fig. 1* and Table 1, respectively.

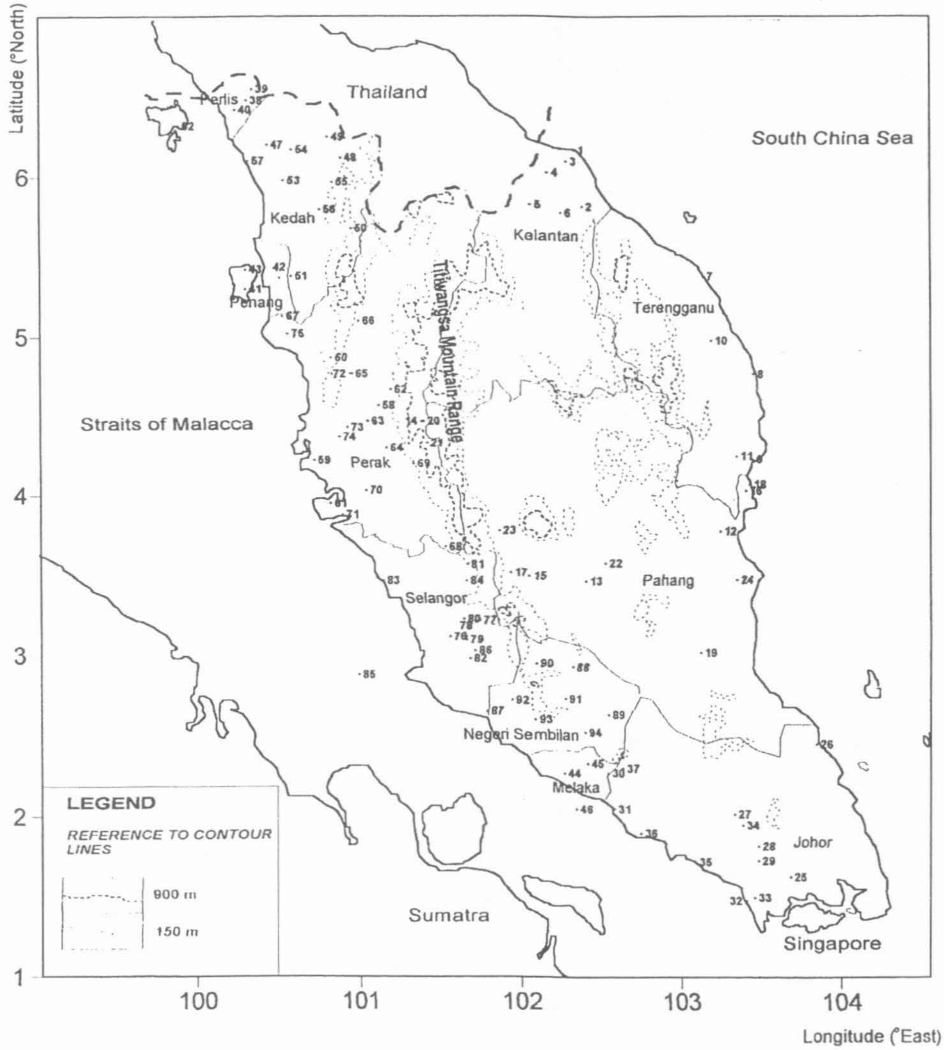

Fig 1. Location of the stations analysed in this investigation

TABLE 1
Names of stations used in the investigation

No	Station	Latitude (°N)	Longitude (°E)	Elevation (m)
1	Kota Baharu	6° 17'	102° 17'	5
2	Mardi Jeram Pasu	5° 49'	102° 20'	31
3	Pusat Pertanian Lundang	6° 06'	102° 14'	6
4	Pusat Pertanian Pasir Mas	6° 18'	102° 07'	9
5	Pusat Penternakan Haiwan Tanah Merah	5° 50'	102° 02'	0
6	Pejabat Haiwan Jajahan Machang	5° 47'	102° 12'	31
7	Kuala Terengganu	5° 23'	103° 06'	5
8	Dungun	4° 46'	103° 25'	3
9	Kemaman	4° 14'	103° 25'	3
10	Mardi Jerangau	4° 59'	103° 09'	15
11	Mardi Kemaman	4° 15'	103° 19'	50
12	Kuantan	3° 47'	103° 13'	15
13	Temerloh	3° 28'	102° 23'	39
14	Cameron Hinghland	4° 28'	101° 22'	1545
15	FELDA Kampong Sterik	3° 30'	102° 02'	70
16	FELDA Padang Piol	4° 18'	103° 23'	0
17	Bentong	3° 31'	105° 55'	97
18	MARDI Sungai Baging	4° 04'	103° 25'	4
19	MARDI Bukit Riden	3° 01'	103° 06'	26
20	Mardi Cameron Hinghland	4° 28'	101° 23'	1449
21	NEB Jor	4° 20'	101° 24'	607
22	Pusat Pengeluaran Tanaman	3° 35'	102° 30'	31
	Kampung Awan			159
23	Pusat Pertanian Gali, Raub	3° 47'	101° 51'	
24	Pekan	3° 29'	103° 02'	4
25	Johor Baharu	1° 39'	103° 40'	38
26	Mering	2° 27'	103° 50'	44
27	Kluang	2° 01'	103° 20'	88
28	Camara Research Layang-layang	1° 52'	103° 28'	31
29	Kota Tinggi	1° 44'	103° 28'	31
30	Tangkak	2° 16'	102° 32'	31
31	Muar	2° 03'	102° 34'	6
32	Pontian	1° 28'	103° 23'	5
33	MARDI Alor Bukit, Pontian	1° 30'	103° 27'	3
34	MARDI Kluang	1° 11'	103° 22'	107
35	Pusat Pertanian Parit Botak	1° 43'	103° 04'	2
36	Pusat Pertanian Sungai Sudah	1° 54'	104° 44'	2
37	Segi Estet	2° 18'	102° 37'	77
38	Cuping	6° 30'	100° 16'	22
39	Felda Cuping A	6° 33'	100° 18'	53
40	Kangar	6° 25'	100° 12'	3
41	Penang International Airport	5° 18'	100° 16'	2
42	Hospital Bukit Mertajam	5° 22'	100° 29'	14
43	Pusat Kesihatan Bukit Bendera	5° 25'	100° 16'	732
44	Malacca	2° 16'	102° 15'	9
45	Chemara Research Serkam, Jasin	2° 20'	102° 24'	27
46	Rumah Api Pulau Undan	2° 03'	102° 20'	53
47	Alor Setar Airport	6° 12'	100° 24'	4

Table 1 cont'd

No	Station	Latitude (°N)	Longitude (°E)	Elevation (m)
48	DID Muda	6° 07'	100° 51'	110
49	DID Pedu	6° 15'	100° 46'	59
50	Baling	5° 41'	100° 55'	52
51	Kulim	5° 23'	100° 33'	32
52	Pulau Langkawi	6° 20'	99° 51'	4
53	Sugai Petani	5° 59'	100° 30'	8
54	Mardi Gajah Mati	6° 10'	100° 33'	15
55	Pusat Pertanian Batu Seketol	5° 58'	100° 48'	71
56	Pusat Pertanian Charuk Padang	5° 48'	100° 43'	31
57	Pusat Pertanian Teluk Chengai	6° 06'	100° 17'	1
58	Ipoh	4° 34'	101° 06'	40
59	Setiawan	4° 13'	100° 42'	7
60	Bukit Maxwell (Larut)	4° 52'	100° 48'	1037
61	FELDA Terolak	3° 57'	100° 48'	0
62	Ulu Kinta	4° 40'	101° 10'	70
63	Batu Gajah	4° 28'	101° 02'	34
64	Kampar	4° 18'	101° 09'	38
65	Kuala Kangsar	4° 46'	100° 56'	39
66	Lenggong	5° 12'	100° 58'	101
67	Parit Buntar	5° 08'	100° 30'	3
68	Tanjung Malim	3° 41'	101° 31'	43
69	Tapah	4° 12'	101° 19'	35
70	Teluk Intan	4° 02'	101° 01'	3
71	Mardi Hilir Perak	3° 53'	100° 52}	9
72	Mardi Kuala Kangsar	4° 46'	100° 55'	66
73	Mardi Parit	4° 26'	100° 54'	5
74	Pusat Pertanian Titi Gantong	4° 22'	100° 51'	0
75	JKR Bagan Serai	5° 01'	100° 32'	3
76	Kuala Lumpur	3° 07'	101° 33'	17
77	Universiti Malaya	3° 13'	101° 44'	104
78	Kolej Tunku Abdul Rahman	3° 07'	101° 39'	0
79	Petaling Jaya	3° 06'	101° 39'	46
80	FRI Kepong	3° 14'	101° 38'	97
81	Hospital Kuala Kubu Baru	3° 34'	101° 39	61
82	MARDI Serdang	2° 59'	101° 40	38
83	Mardi Tanjung Karang	3° 28'	101° 01'	3
84	Pusat Pertanian Batang Kali	3° 28'	101° 39'	46
85	Rumah Api One Fathom Bank	2° 53'	100° 59'	21
86	Universiti Putra Malaysia Serdang	3° 02'	101° 42'	40
87	Cemara Research Tanah Merah	3° 39'	101° 47'	5
88	FELDA Pasoh 2	2° 56'	102° 18'	0
89	Haiwan Jelai, Gemas	2° 38'	102° 32'	46
90	Jelebu	2° 57'	102° 04'	137
91	Kuala Pilah	2° 44'	102° 15'	107
92	Seremban	2° 43'	101° 56'	64
93	Pusat Pertanian Cembong	2° 36'	102° 04'	61
94	Pusat Pertanian Gemencheh	2° 31'	102° 23'	70

The coefficient of variability is defined as:

$$C.\ V. = (SD_i/R_i)\ 100,$$

where SD represents the monthly standard deviation; R, the monthly rainfall average and; the subindex i (ranging from 1 to 12), the particular month of the year. For the sake of comparison with previous results we have chosen to use the same coefficient of variability.

RESULTS AND DISCUSSION

A principal maximum rainfall variability is recorded in the northwestern sector of the peninsula both in January (*Fig. 2*) and in February (not shown), while a secondary maximum is observed in the southern part of Terengganu. The former maximum may be attributed to the relative dryness observed in that part of the country during both months. The secondary maximum observed in the east coast during February may also be attributable to the same effect (Camerlengo *et al.*, 1996). On the other hand, the larger variability observed in the southern part of Terengganu during January may solely be attributed to the variations of the annual retreat of the leading edge of the North-east (NE) monsoon (Camerlengo and Somchit, 1998).

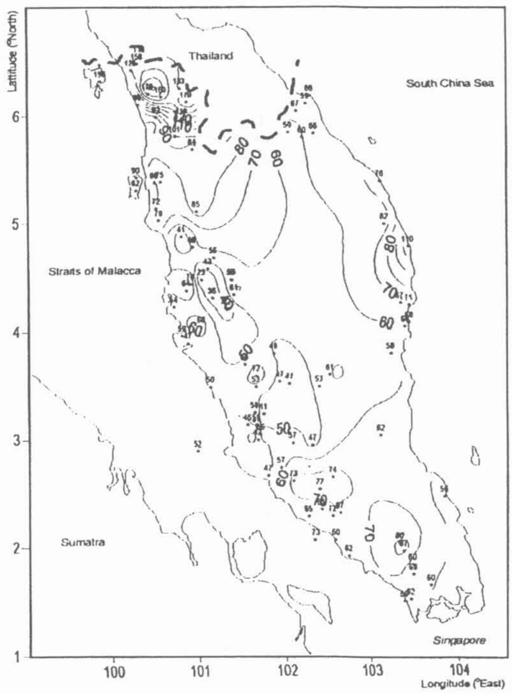

Fig 2. January coefficient of variability of precipitation (in %)

Maximum variability, of a slightly lesser magnitude than the one observed in Terengganu, is observed in the third southern part of the peninsula. This may also be attributed to the variations of the yearly retreat of the NE monsoon.

Minimum variability is recorded at the windward side of the Titiwangsa mountain range in January. However, a larger variation is recorded in this same area during the following month. This is found in spite of the fact that the February monthly rainfall is larger compared to the January one. It contradicts previous results in the sense that the largest variability is observed whenever lesser rainfall is recorded at Peninsular Malaysia' s west coast (Dale, 1959).

Larger variability is recorded in the eastern half of the peninsula as opposed to the western half during March (*Fig. 3*). In particular, maximum variability is observed in the state of Kelantan. On the other hand, minimum variability is recorded at the windward side of the Titiwangsa mountain range where maximum rainfall is observed in this particular month.

Similar pattern of rainfall variability as in March (larger at the eastern half and lesser at the western half) is observed in April (not shown). However, values of rainfall variability observed in this latter month are considerably lesser than in the former month.

The rainfall pattern at the western half is slightly larger in May compared with the previous month (*Fig. 4*). There is also a considerable increase of precipitation at the eastern half (Camerlengo and Somchit 1998). May represents

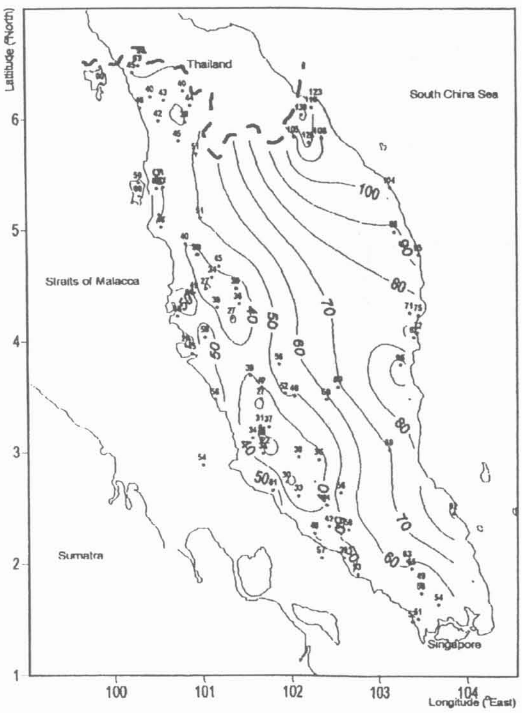

Fig 3. Idem as Fig 2, but for March

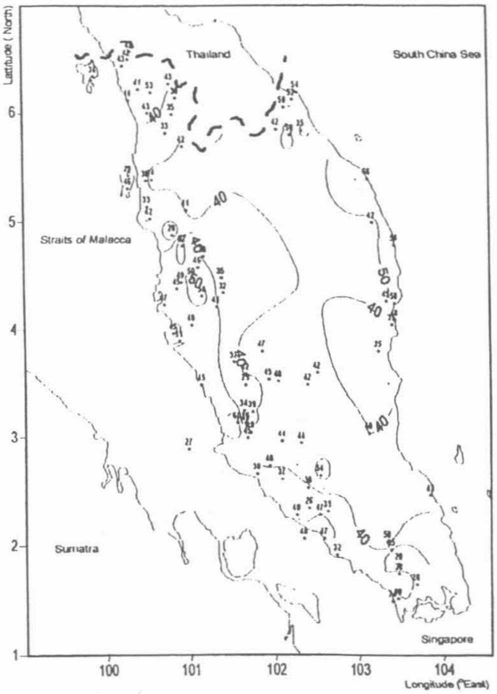

Fig 4. Idem as Fig 2, but for May

one of the transitional inter-monsoon seasons. Therefore, one of the two monthly maximums of precipitation is observed in May. (The other one is observed in October). Due to this effect, a decrease of rainfall variability in the eastern half compared to the previous month is noticeable.

June (not shown) represents the second driest month in Peninsular Malaysia (Camerlengo and Somchit 1998). However, a minor increase in the rainfall variability is only observed at the western half compared to the preceeding month while no change of variability is observed at the eastern half. This result contradicts the statement that rainfall variability is the greatest during the month with the lowest rainfall (Dale 1959; Nieuwolt 1981).

July average precipitation (not shown) is larger than the one of the antecedent month (Camerlengo *et al.* 1996). In spite of this, not a significant change in the coefficient of variability pattern is observed

August rainfall average is slightly larger compared to July. Contrary to expectations, a larger coefficient of variability is observed at the western half of the peninsula (*Fig. 5*).

A similar pattern of the coefficient of variability compared with the prior month (namely, larger values at the western half and smaller values at the eastern half) is observed in September (not shown). However, the rainfall variability in September is lower than the one recorded in the previous month. This may be attributable to the retreat of the South-west (SW) monsoon.

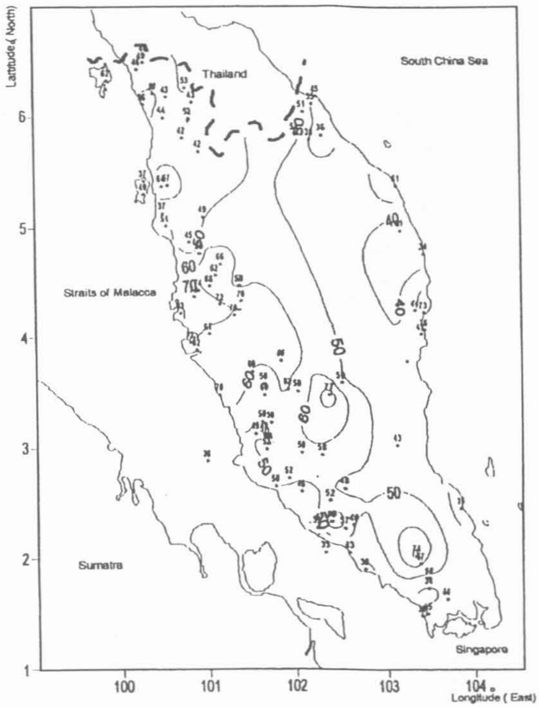

Fig 5. Idem as Fig 2, but for August

The retreat of the SW monsoon as well as the equatorward migration of the NE monsoon enhances the formation of a broad area of convergence, which in turn favours convection. October represents the other inter-monsoon transitional period. This may help explain the fact that October has the lowest rainfall variability all across the peninsula (*Fig. 6*).

There is a sharp contrast between our results at the eastern half of the peninsula, for this particular month, from previous ones. We strongly believe that this is due to the fact that we are analyzing a larger number of stations for the same period of time.

November represents the onset of the NE monsoon (Nasir and Camerlengo 1997). Our results show a considerable larger variability (than previously recorded) at the east coast (*Fig. 7*). This may be explained by the annual variation of the equatorward migration of the NE monsoon.

Thirty percent of the annual precipitation in the states of Kelantan and Terengganu is recorded in November (Camerlengo *et al.* 1996). Larger variability is observed in these two states during November. Our results are in sharp contradiction with previous ones. This is due to the fact that we are analysing a larger number of stations. We feel that our results represent a better resolution of the November variability than earlier ones.

In spite of the fact that larger amounts of precipitation are recorded in December in the eastern half of the Peninsula compared with the western half,

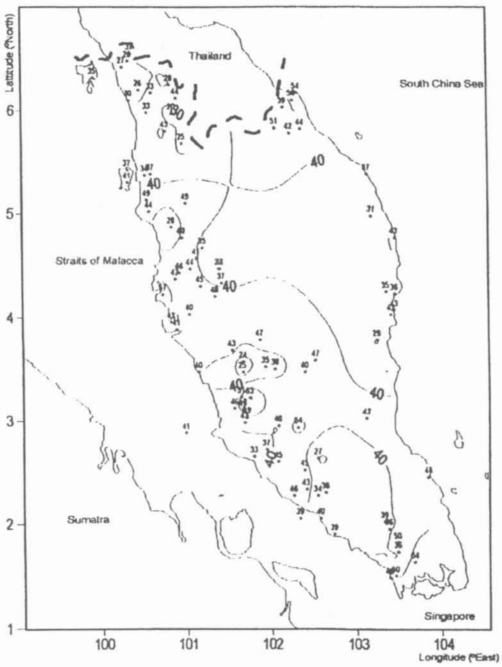

Fig 6. Idem as Fig 2, but for October

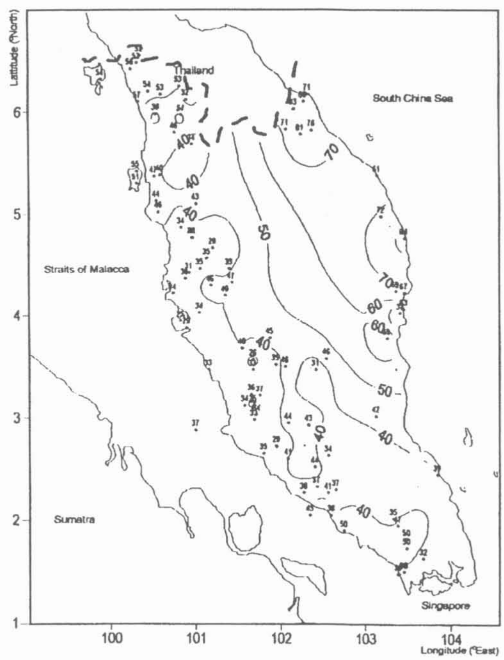

Fig 7. Idem as Fig 2, but for November

the coefficient of variability is strikingly similar all across the peninsula (*Fig. 8*). This represents a sharp departure from earlier results; a larger departure from normal values at the eastern half of the peninsular during December (Dale 1959) has been observed.

On an annual basis, larger values of rainfall are observed at the eastern half (Camerlengo *et al.* 1996). As a consequence of this, larger variability is observed in that particular area (*Fig. 9*). Lesser variability is observed in the northwestern sector of the peninsula where lesser rainfall is also observed annually.

CONCLUSION

Using a different and (we feel) a better methodology, previous results are confirmed while others had to be disregarded. It is confirmed that the annual rainfall variability at the eastern half is larger than at the western half. Our results show that the statement in the sense that larger variability occurs whenever lowest rainfall is recorded at the western side (of the peninsula) is rather questionable at best. It certainly does not hold true for the east coast where almost 30 % of the annual precipitation is recorded in November and (following our results) a large variability is attained for that particular month.

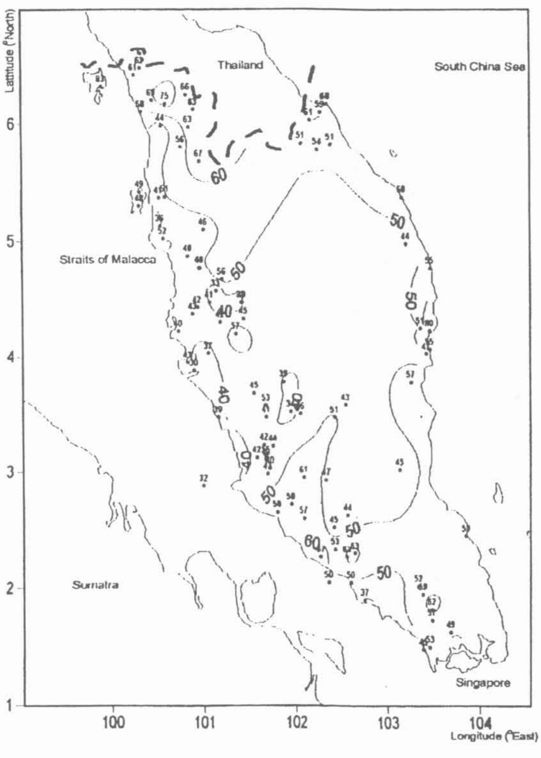

Fig 8. Idem as fig 2, but for December

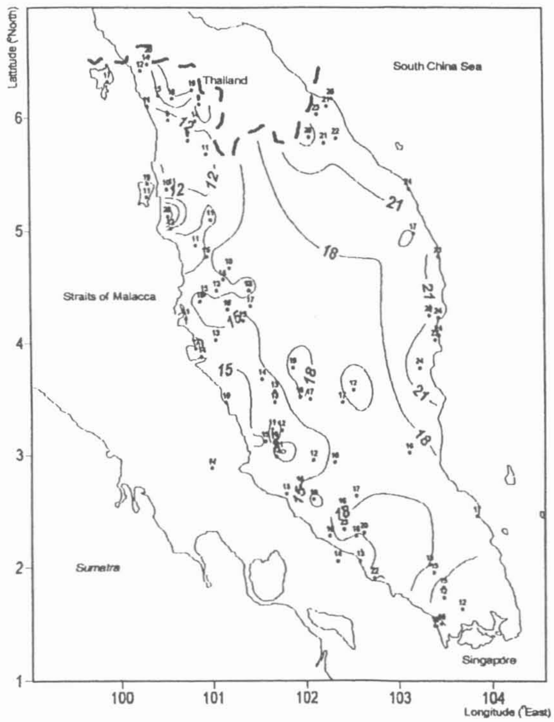

Fig 9. Annual coefficient of variability of precipitation (in %)

ACKNOWLEDGMENTS

This study was supported by an IRPA grant which we acknowledge. Our thanks are also extended to the Malaysian Meteorological Service for providing us the necessary data to carry out this investigation.

Comments made by an anonymous reviewer contributed to improve this manuscript. The authors gratefully acknowledge this contribution.

REFERENCES

CAMERLENGO, A,. L., M. R. HISHAM and S. M. NASIR. 1996. On the passage on the Intertropical Convergence Zone in Peninsular Malaysia. *Malay. J. of Physics* **17(4)**: 155-162.

DALE, W. L. 1959. The rainfall in Malaya, Part I. *J. Trop. Geogr.* **13**: 23-37.

Malaysian Meteorological Service: Monthly Summary of Meteorological Observations (1982-96) issued under the authority of the Director General, Malaysian Meteorlogical Service, Petaling Jaya, Malaysia.

NASIR, M. S. and A. L. CAMERLENGO. 1997. Response of the ocean mixed layer, off the east coast of peninsular Malaysia during the north-east and the south-west monsoon. *Geoacta* **22**: 122-133.

NIEUWOLT, S. 1981. The climates of Continental Southeast Asia, chapter 1. *In World Survey of Climatology*, ed. Takahasi & Arakawa, p. 1-37. Elsevier Scientific Publishing Co.