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The Double Passage of the Intertropical Convergence Zone in Sabah and Sarawak

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ABSTRAK

Objektif kajian ini adalah bagi menentukan perubahan hujan berkaitan dengan "Intertropical Convergence Zone" di Malaysia Timur. Factor utama (sekunder) yang mempengaruhi taburan bulanan kerdasan ialah laluan tahunan ITCZ (monson). Didapati, hasil kajian kami adalah bertepatan dengan kajian-kajian yang terawal. Hasil-hasil lain yang penting dari kajian ini adalah: (i), dalam empat bulan pertama setiap tahun, Sarawak mencatatkan lebih banyak kerdasan daripada Sabah; (ii), jumlah kerdasan tahunan adalah maksimum di Kuching, dan berkurangan ke utara; dan (iii), corak kerdasan tahunan di pantai barat Sabah dan Sarawak adalah sama dengan yang di pantai timur Semenanjung Malaysia.

ABSTRACT

The aim of this investigation was to determine the rainfall variability due to the passage of the intertropical convergence zone in East Malaysia. It is shown that the principal (secondary) role of the monthly distribution of precipitation is given by the annual migration of the ITCZ (monsoon winds). In this regard, our investigation is in perfect agreement with a previous study. Other important results of this study are: (i), during the first four months of the year, Sarawak registers considerably more precipitation than Sabah; (ii), the total annual amount of precipitation is maximum in Kuching, decreasing further northwards; and (iii), the annual precipitation pattern of the west coast of Sabah and Sarawak is similar to that of Peninsular Malaysia's east coast.

Keywords: Sabah, Sarawak, precipitation, southwest and northeast monsoon, inter-tropical convergence zone

INTRODUCTION

Due to the Earth's rotation, winds at low latitudes blow westward. A surface low pressure system known as the intertropical convergence zone (ITCZ), at approximately the equator, is enhanced. A high pressure system, known as the subtropical highs, at approximately 30 degrees in both hemispheres, is recorded.

Air moves from a high to a low pressure system. As a consequence of this, the wind flow in the tropics in the northern (southern) hemisphere is from the northeast (southeast). This wind system is known as the northeast (southeast) trade winds of the northern (southern) hemisphere. Because the proportion of water to land in the southern hemisphere (4:1) is greater than in the northern hemisphere (1.5:1), the average location of the ITCZ is 5°N (Necco 1980; Pickard and Emery 1990).

The Coriolis force deflects an air parcel to the right in the northern hemisphere. Upon crossing the equator into the northern hemisphere, the southeast trade winds are deflected in a southwesterly direction. The direction of both the northeast (NE) and the southwest (SW) monsoon winds is thus explained.

Sabah and Sarawak are sometimes referred to as East Malaysia. We will make use of both terms indiscriminately.

The aim of this investigation was to better understand the rainfall distribution in East Malaysia, in continuation of a previous study (Camerlengo *et al.* 1996). Briefly, the main results of that study were:

1) the predominant role of the monthly distribution of precipitation is given by the double passage of the ITCZ, and
2) monsoon winds play a secondary role in the rainfall distribution.

In this study, records of precipitation from ten meteorological stations were analysed. The results of our investigation are quite conclusive:

1) the total annual amount of precipitation is maximum in southern Sarawak. It diminishes further northward, and
2) during the first four months of the year, Sarawak registers more rainfall than Sabah.

DATA

Monthly values of precipitation in Kuching, Sri Aman, Sibu, Bintulu, Miri (in Sarawak), Labuan, Kota Kinabalu, Sandakan, Kudat and Tawau (in Sabah) were obtained from the *Monthly Summary of Meteorological Observations*, published by the Malaysian Meteorological Service (1964-1993). The location of the meteorological stations as well as the years of monthly records are given in *Fig 1.* The most relevant maps of monthly distribution of precipitation in East Malaysia are presented. Therefore, the monthly distribution of rainfall of January, February, March, September, October, November and December, as well as the annual distribution of precipitation, are shown (*Fig. 2 – 9*).

RESULTS AND DISCUSSION

It is convenient to consider a fixed Earth. The sun is in its southernmost position on 21 December. Therefore, the sun is in the southern hemisphere during both January and February. The convective area associated with the intertropical convergence zone (ITCZ) follows the motion of the sun. However, due to the irregular land mass distribution in both the northern and the southern hemispheres, the ITCZ fluctuates mostly in the northern hemisphere.

Maximum precipitation, recorded in southern Sarawak during January,

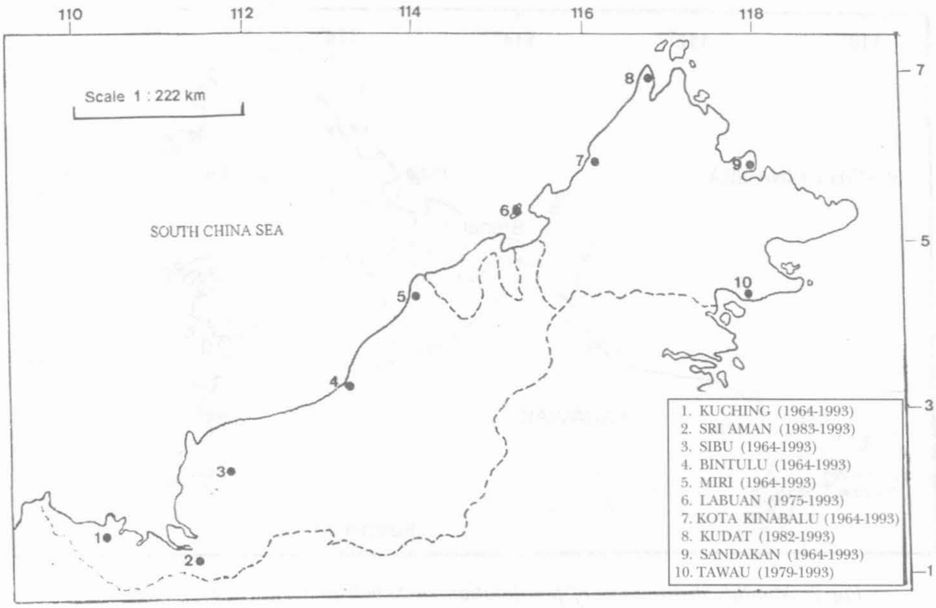

Fig 1. Location of precipitation stations analysed. The years of records are indicated in parenthesis.

may be attributed to the southward displacement of the ITCZ (*Fig. 2*). Secondary maximums of rainfall in Kudat and Sandakan may be solely explained by the exposure of these two locations to the northeast (NE) monsoon winds.

Decrease in precipitation is observed at all stations during February (*Fig. 3*). This may largely be attributed to two causes: (1) the ITCZ is in the southern hemisphere and (2) the NE monsoon season is coming to a close.

Southern Sarawak shows a slight increase in precipitation in March (*Fig. 4*) because the sun crosses the equator on 21 March. The convective area associated with the ITCZ is responsible for increasing precipitation in the southern half of Sarawak. On the other hand, minimum precipitation is registered in Sabah. Furthermore, monthly evaporation values in Sabah during March are greater than its monthly rainfall values (Camerlengo *et al.* 1997).

The same situation as in March prevails in April. Maximum values of precipitation are recorded in Sarawak while minimum values are observed in Sabah. The same rationale as in March applies. Furthermore, because April represents a transitional month between the NE and the SW monsoon seasons, light and variable winds are noted during this month. Thus, air mass from the South China Sea does not discharge its humidity into Borneo.

While precipitation records remain unchanged in Sarawak, during May an increase in rainfall in Sabah (with the single exception of Kudat) is reported. This increase should largely be explained by the northward motion of the ITCZ, as well as by the onset of the SW monsoon season. The higher values of

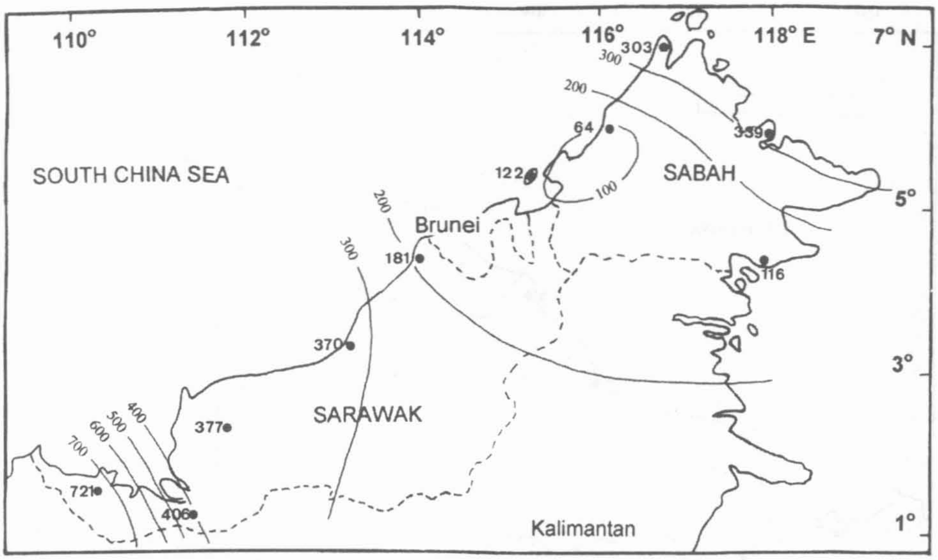

Fig 2. Monthly distribution of precipitation in Sabah and Sarawak in January

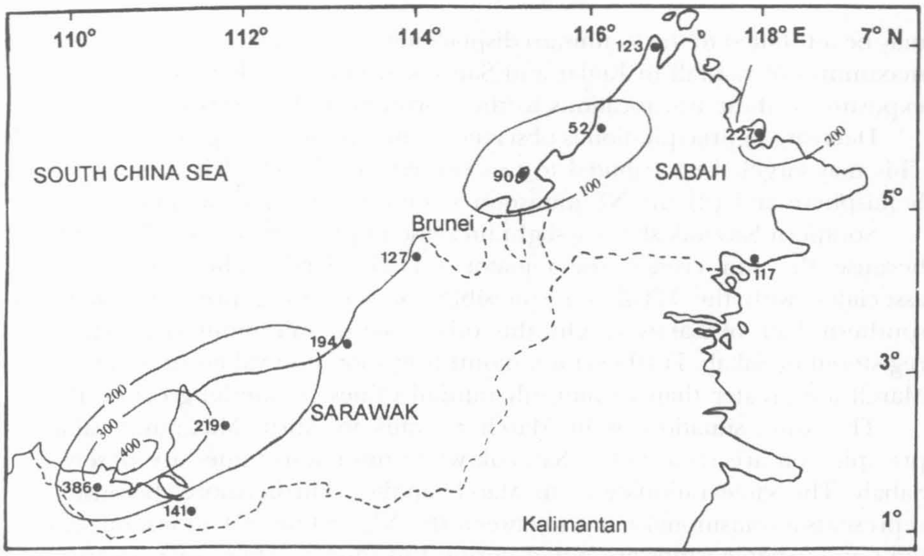

Fig 3. Monthly distribution of precipitation in Sabah and Sarawak in February

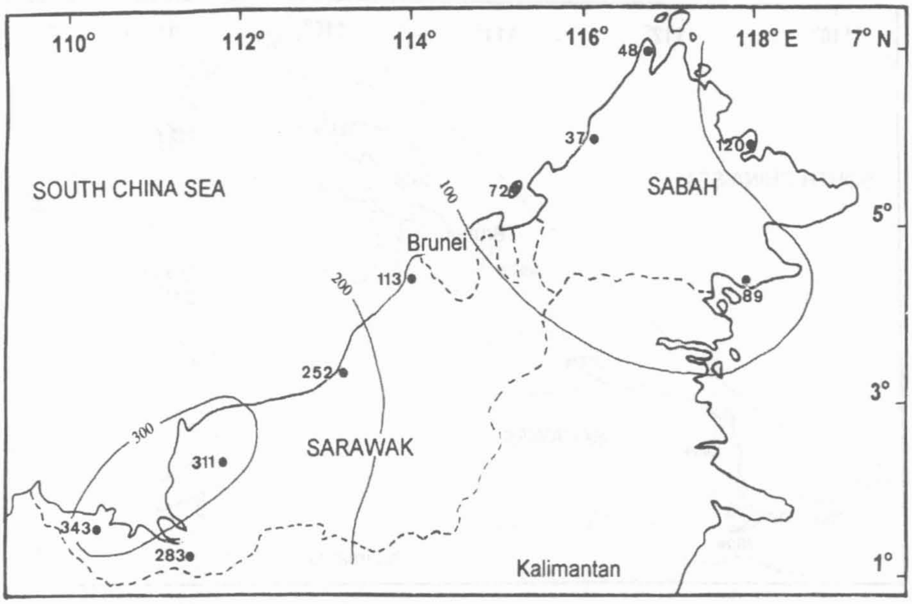

Fig 4. Monthly distribution of precipitation in Sabah and Sarawak in March

precipitation in western Sabah than eastern Sabah may be attributed to the fact that air mass from the South China Sea (SCS) discharges its humidity in East Malaysia, induced by the SW monsoon winds. In particular, Sandakan and Tawau register less than 40% of the monthly rainfall recorded in Labuan and Kota Kinabalu. May represents the first month of the year where monthly totals of precipitation for Sabah are comparable (or even higher in some cases) to those in Sarawak.

The same situation as in May prevails in June, with higher values of rainfall in Sabah than in Sarawak. Again, this effect may be explained by poleward migration of the ITCZ.

Similar total amounts of precipitation are registered in Sabah and in Sarawak during July and August. This may largely be attributed to two causes: (1) the equatorward motion of the ITCZ and (2) the discharge of humidity of the air mass from the SCS into East Malaysia, induced by the SW monsoon winds.

Because the sun crosses the equator on 21 September, the convective area associated with the ITCZ is closer to East Malaysia than in the two previous months. This explains the increasing rainfall observed during September at all stations in East Malaysia (*Fig. 5*). As before, maximum rainfall observed on the west coast may be explained by the effect of the SW monsoon winds.

October represents a transitional month between both monsoon seasons (Mohd. Nasir and Marghany 1996; Nasir *et al.* 1996). In spite of the variable and light winds rainfall values are higher than in the previous month (*Fig. 6*). This may largely be attributed to the southward motion of the ITCZ.

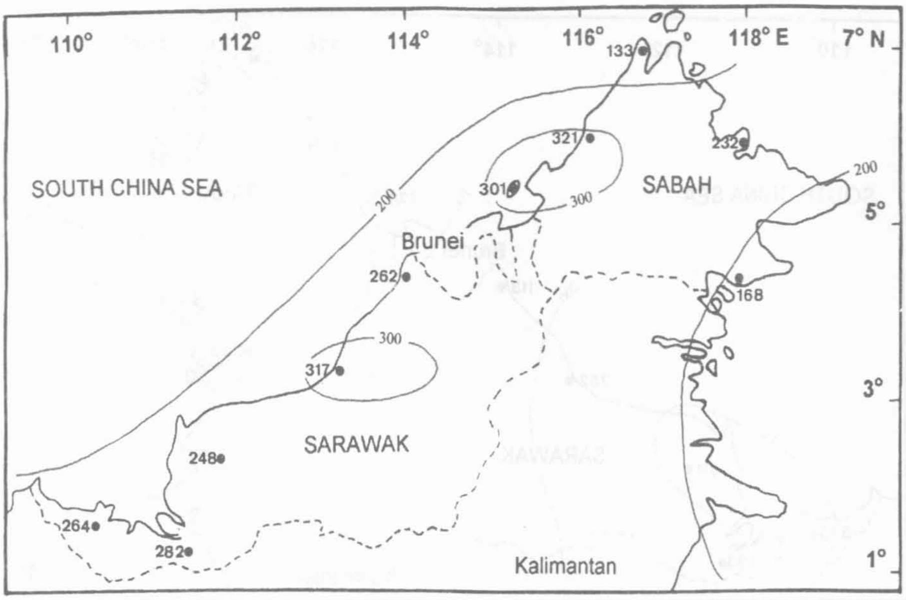

Fig 5. Monthly distribution of precipitation in Sabah and Sarawak in September

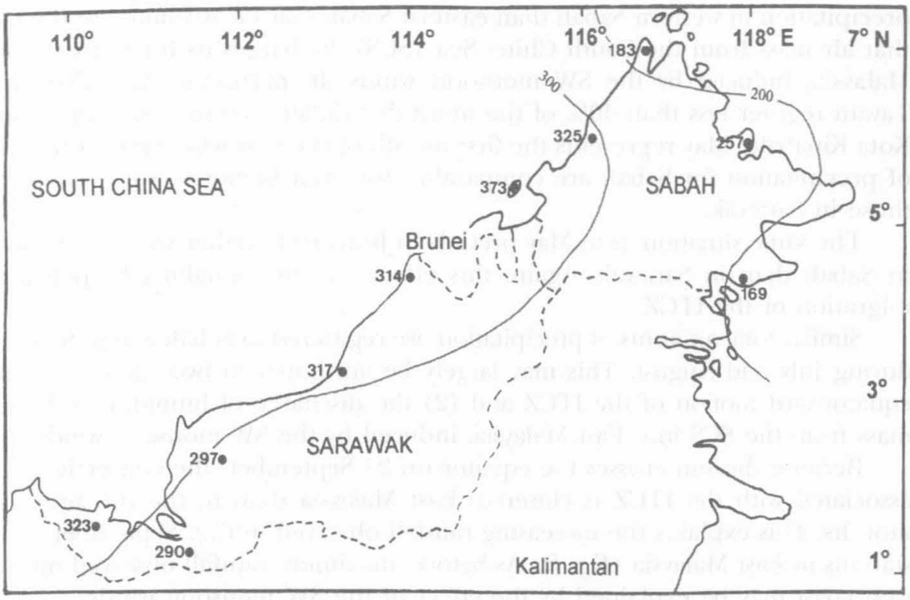

Fig 6. Monthly distribution of precipitation in Sabah and Sarawak in October

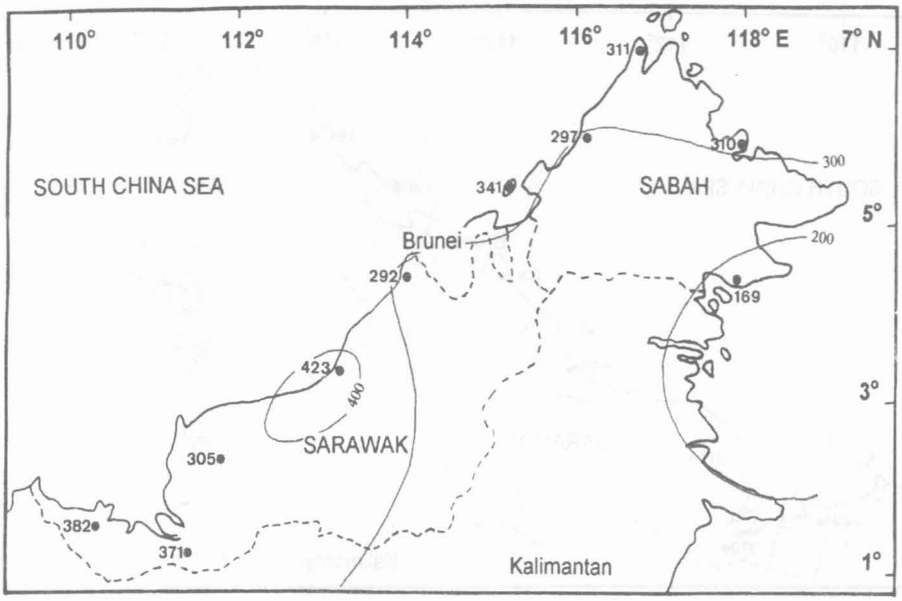

Fig 7. Monthly distribution of precipitation in Sabah and Sarawak in November

The onset of the NE monsoon season is in November. Higher rainfall values than in the preceding month may be explained by this effect (*Fig. 7*). That is, air mass from the South China Sea discharges its humidity in Borneo, induced by the NE monsoon winds.

The situation in December is similar to the preceding month (*Fig. 8*). However, during December monthly totals of precipitation are higher in Sarawak. This may be justified by the further southward migration of the ITCZ.

The annual distribution of precipitation shows that Sarawak registers more rainfall than Sabah (*Fig. 9*). This may largely be attributed to the fact that Sarawak is closer to the equator. That is, on an annual basis, the double passage of the ITCZ occurs over a longer period of time in Sarawak than in Sabah. In particular, Kuching registers double the annual amount of precipitation in Tawau.

The annual precipitation pattern of the west coast of East Malaysia resembles that of the east coast of Peninsular Malaysia (Camerlengo *et al.* 1998). However, extremes are more prominent in Borneo. For example, the annual difference in rainfall observed between Kuching and Kudat (or Kota Kinabalu) is far greater than the annual difference in rainfall recorded between Kota Bharu and Johor Bahru.

CONCLUSION

Our results show that the principal (secondary) role in the distribution of precipitation is given by the double passage of the ITCZ (monsoon winds).

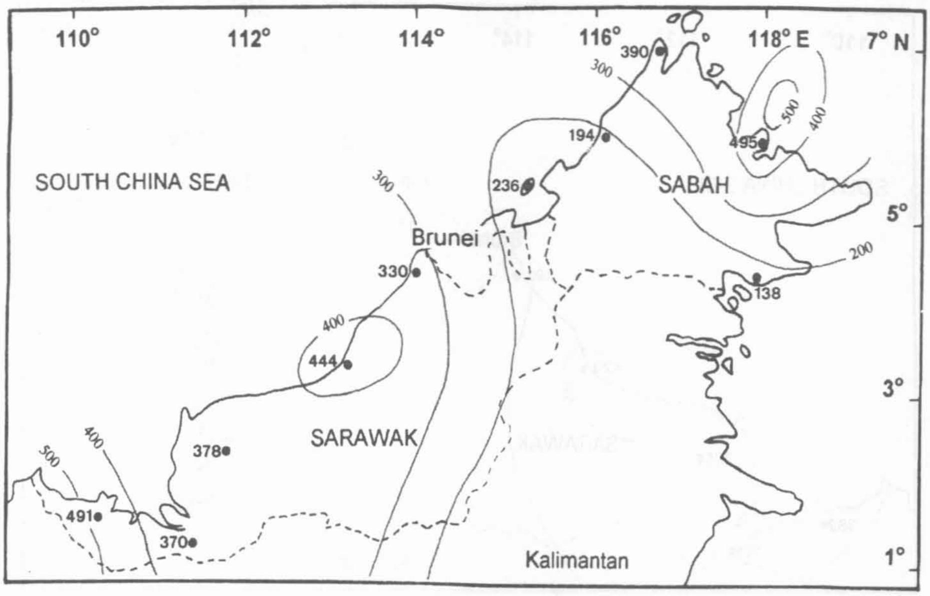

Fig 8. Monthly distribution of precipitation in Sabah and Sarawak in December

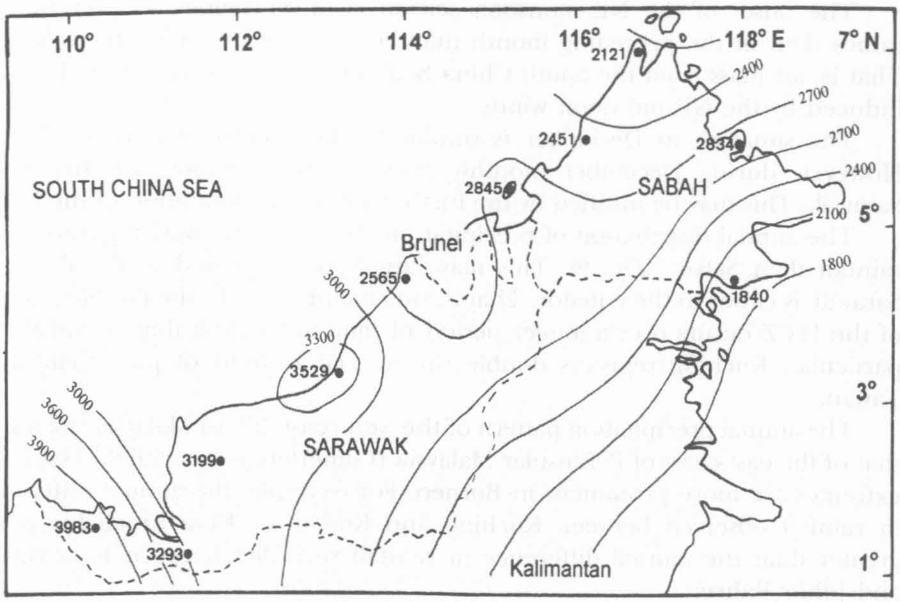

Fig 9. Annual distribution of precipitation in Sabah and Sarawak

Therefore, our results agree with the previous investigation (Camerlengo *et al.* 1998).

Other salient features of this particular study are:

1) Sarawak registers more precipitation than Sabah during the first four months of the year,
2) the total annual amount of precipitation is maximum in Kuching, decreasing further northward, and
3) the annual rainfall pattern of the west coast of Sabah and Sarawak is similar to the annual rainfall pattern of Peninsular Malaysia's east coast.

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REFERENCES

CAMERLENGO, A.L., M. NASIR S. and M. HISHAM R. 1996. Monthly distribution of precipitation in Sabah and Sarawak. *J. of Phys. Sci.* **8**: 57-63.

CAMERLENGO, A.L., M. NASIR S. and M.R. OTHMAN and M.H. RUBANI. 1997. On evaporation and insolation in Sabah and Sarawak. *J. of Phys. Sci.* **8**: 1-19.

CAMERLENGO, A.L., MOHD. NASIR SAADON, AHMAD SHAZLI AZIZ and MOHD ROSNI OTHMAN. 1998. Monthly distribution of precipitation in Peninsular Malaysia. *Pertanika J. of Sci. Technol.* 6: 59-70.

MALAYSIAN METEOROLOGICAL SERVICE (1964-1993). *Monthly Summary of Meteorological Observations.*

MOHD. NASIR SAADON and MEGED MAHMOUD MARGHANY. 1996. Surface circulation off Kuala Terengganu in the transitional period between the northeast and the southwest monsoons. *Pert. J. Sci. Technol.* **4**: 141-148.

NASIR, M.S., A.L. CAMERLENGO and A.H. YASIN. 1996. Response of the South China Sea in the early stages of the northeast monsoon. *Malay. J. of Trop. Geogr.* **27(2)**: 47-50.

NECCO, G. 1980. *Curso de Cinematica y Dinamica de la Atmosfera.* Buenos Aires: Eudeba.

PICKARD, G.L. and W.J. EMERY. 1990. *Descriptive Physical Oceanography: An Introduction.* 5th edn. Pergamon Press.