TROPICAL STORM EFFECT WITH RESPECT TO WEATHER OVER THE INDONESIAN REGION*

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SARI

Badai tropis muncul di laut dengan temperatur permukaan lebih besar dari 26°C dan dikaitkan dengan *thermal ridge*. Tulisan ini membahas dua badai tropis di belahan bumi selatan, yaitu badai tropis ERROL yang muncul pada 13 Januari 1982 kemudian menghilang pada 20 Januari 1982, dan badai tropis BRUNO yang muncul pada 15 Januari 1982 dan berkurang intensitasnya, kemudian menghilang pada 20 Januari 1982.

Data klimatologis menunjukkan bahwa beberapa stasiun hujan di Indonesia bagian selatan ekuator yang terletak dekat dengan lintasan badai tropis mengalami kenaikan curah hujan antara 123% dan 355% dari harga curah normalnya. Di beberapa stasiun, kecepatan angin juga meningkat melebihi 20 knot selama periode badai tropis.

ABSTRACT

Tropical storms emerge in the oceans with surface temperature greater than 26°C and the emergence of tropical storm is related to thermal ridge. This paper presents two tropical storms in the southern hemisphere, i. e.: tropical storm ERROL emerged on January 13, 1982, then dissipated on January 20, 1982, and tropical storm BRUNO emerged on January 15, 1982 and it decreased in intensity, then dissipated on January 20, 1982.

Climatological data have shown that some rainfall stasions in Indonesia, south of the equator, which are located near the tropical storm track, showed an increase in rainfall ranging from 123% to 355% of its normal rainfall values. In some stations, wind speeds also increase beyond 20 knots during the tropical storm periods.

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1 Introduction

The Indonesian archipelago, which is situated approximately between 7°N and 10°S, can be considered "free from tropical storm track". However, the effect of the tropical storms can influence the weather condition in some parts of the Indonesian region.

A tropical depression is the initial disturbance in the tropical region before it develops into a tropical cyclone. In the tropical depession, wind velocity generally is about 10 ms^{-1}. When the wind velocity reaches to about 15 ms^{-1}, the depression becames a tropical storm, and then it develops into a tropical cyclone when its velocity increases up to 30 ms^{-1} or more.

Palmen (1948) stated that a tropical storm emerges in the region in which the sea temperature is greater than 26°C. Thus, the high ocean thermal energy and the humid air in the lower layer are among the several conditions for the formation of a tropical storm.

2 Equation governing the cyclonic air flow

In the case of a cyclone, the combination of coriolis and centrifugal forces is balanced by pressure gradient force and the wind blows counter clockwise in the northern hemisphere. Figure 1 shows the balance of forces acting on air parcel of one unit mass in the cyclonic air flow.

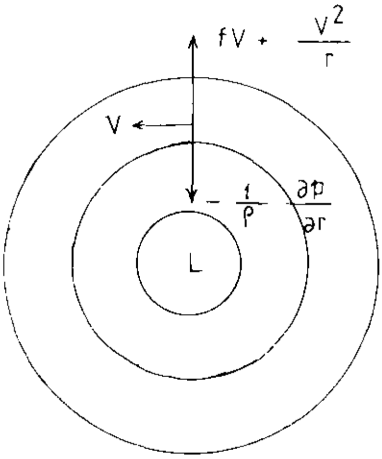

Figure 1 The balance of force in the cyclonic air flow.

Cyclonic air flow, could be expressed as follow:

$$fV + \frac{V^2}{r} = -\frac{1}{\rho}\frac{\partial p}{\partial r}$$

or

$$fV + \frac{V^2}{r} + \frac{1}{\rho}\frac{\partial p}{\partial r} = 0 \qquad (1)$$

where :

- f : parameter of coriolis
- V : wind velocity
- r : radius of the air parcel path
- ρ : air density
- p : air pressure
- L : low pressure

Solution of the equation (1) in V is:

$$V_{gr} = -\frac{fr}{2} \pm \sqrt{\frac{f^2 r^2}{4} - \frac{r}{\rho}\frac{\partial p}{\partial r}} \qquad (2)$$

where V_{gr} is the velocity of gradient wind.

By substituting numerical value of positive pressure gradient and the boundary condition, the gradient wind velocity should be equal to zero, if the pressure gradient is equal zero. Thus the required solution for cyclonic air flows is:

$$V_{gr} = -\frac{fr}{2} + \sqrt{\frac{f^2 r^2}{4} + \frac{r}{\rho}\frac{\partial p}{\partial r}} \qquad (3)$$

It is shown from the equation (3) that the term in the root sign is always positive, which means that theoretically there is no boundary for the gradient wind velocity.

The pressure gradient force is not influenced by the friction force because it is independent on the air flow. On the contrary the coriolis force is influenced by the friction force and it becomes small due to the decrease of wind velocity. That is why in the cyclonic air flow, the friction force causes the air flow crosses the isobars toward the low pressure, so that the wind system becomes convergent. Its circulation is counter clockwise in the northern hemisphere or clockwise in the southren hemisphere (see figure 2).

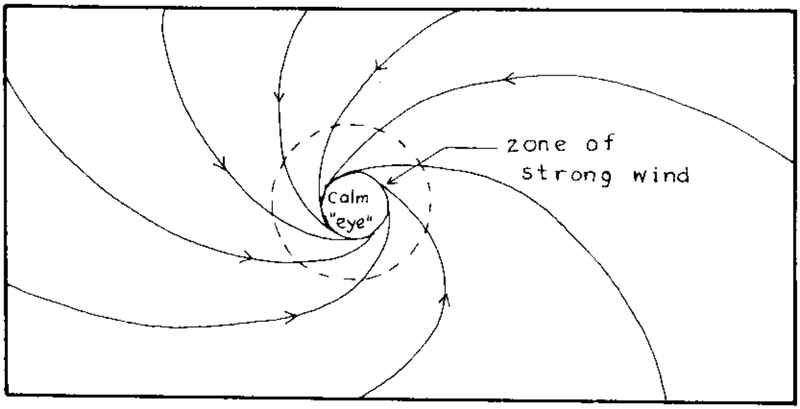

Figure 2 Cyclonic air flow in the northern hemisphere emphasizing the friction effect.

3 Data analysis

Data of the sea surface temperature was obtained from the Monthly Report of Meteorological Satellite Center published by the Meteorological Satellite Center, Tokyo, Japan, for the period of January 1982. The report contains the results of GMS observations and consists of sea surface tempetature, etc. From the sea surface temperature data, the isolines of sea surface temperature called "the sea surface isotherm" could be drawn, then from the isotherm pattern the position of the thermal ridge i. e. the line connecting hot cells on

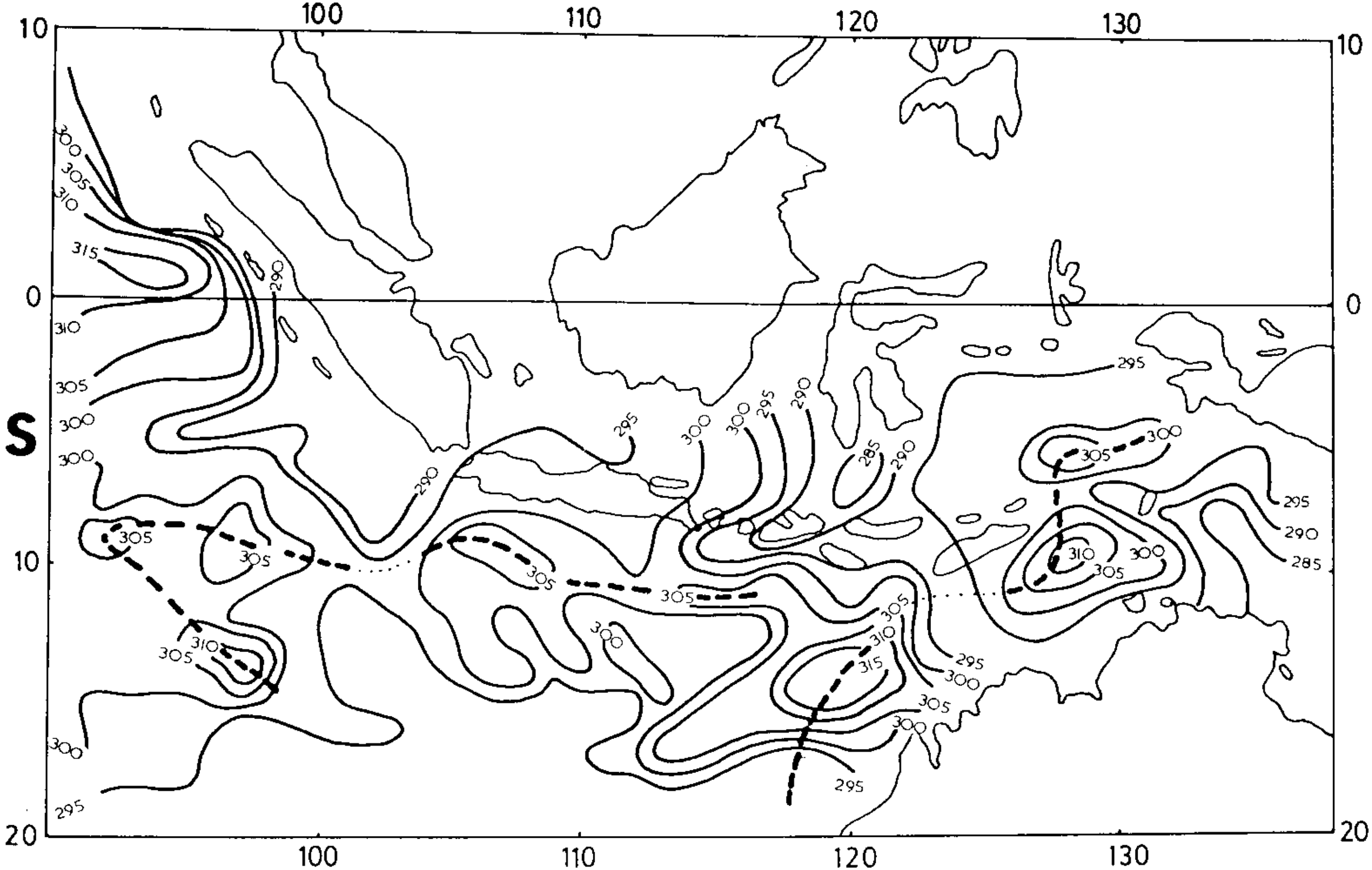

Figure 3 Sea surface isotherm in 1/10°C (——), and thermal ridge (– – –)

the sea surface was determined. In northern Australia, it was found that the sea surface temperature was hot enough, about 30.0 to 31.5°C, then hot cells developed to the western direction and reached to 95°E. The hot cells were situated in the position between 8° and 13°S. (Fig. 3).

Synoptic data and synoptic map were abtained from observations in the month of January 1982 executed by the Meteorological and Geophysics Agency, Jakarta. Isobaric pattern was taken for every six hours and based on this pattern the surface stream lines was drawn as shown in figure 4.

3.1 Sequence of the tropical storms

Sequence of the tropical storm was started by the emergence of tropical storm called ERROL on January 13, 1982 at 12.5°S and 112.2°E. On the 18th of January 1982 at 0.00 GMT, the storm increased its intensity and became tropical cyclone ERROL in the position of 12.5°S and 99.8°E, and at 12.00 GMT the cyclone weakened. On January the 19th at 0.00 GMT, the cyclone decreased in intensity and became tropical storm ERROL again in the position of latitude 12.8°C and longitude 105.3°E. Ultimately on the 20th of January at 0.00 GMT the intensity of the storm decreased more and more and was located at 14.5°S and 106.5°E, then dissipated southward.

In northern Australia, tropical depression emerged on the 15th of January 1982 in the position of latitude 14°S and longitude 140°E. Then on the 18th of January at 0.00 GMT the depression increased in intensity and it became tropical storm BRUNO in the position of latitude 15°S and on the 19th of January at 0.00 GMT the storm increased to toprical cyclone BRUNO in the position of latitude 19.5°S and longitude 117.9°E. On the 20th of January at 6.00 GMT the cyclone weakened again and it became tropical storm BRUNO in the position of latitude 25°S and longitude 111°E on which disipated southward (Fig. 5).

3.2 Tropical storm effects with respect to rainfall, wind, and wave

Based on the report on Climate, Weather, and Earthquake, No. 3, published by the Meteorological and Geophysics Agency, Jakarta, some informations regarding the weather conditions in the second decade of January 1982, a period from 11th to 20th concerning to the emergence of tropical storms ERROL and BRUNO in the southern hemisphere waters was obtained.

Some of the rainfall stations were affected indirectly by the water conditions of the Indonesian ocean in which tropical storms emerge in the second decade of January 1982 (Table 1). Table 1 shows, that in the second decade of January 1982, the considered rainfall stations accept rainfall about 123% to 355% of the one third of the monthly normal rainfall.

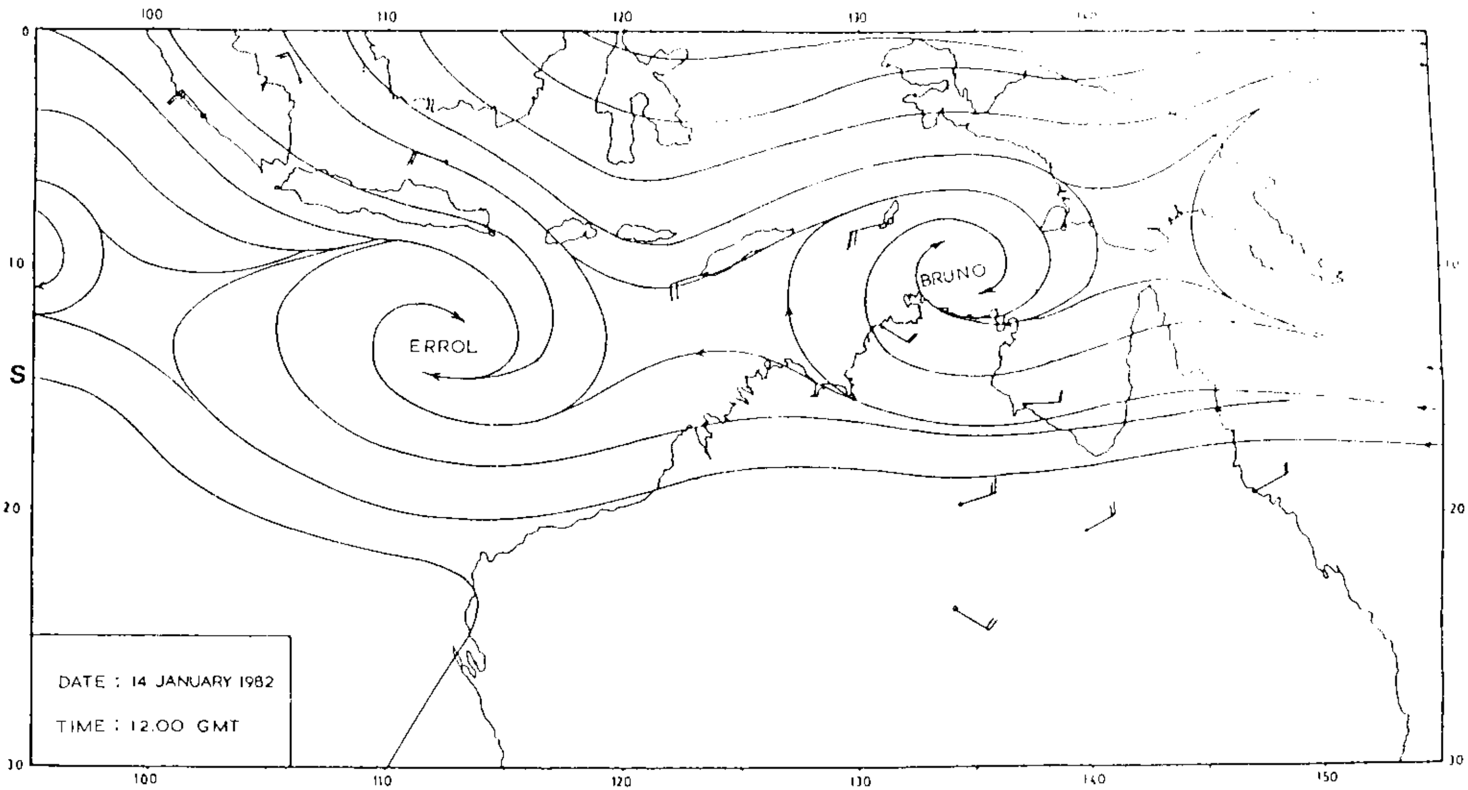

Figure 4a Surface stream lines at 12.00 GMT, January 14, 1982.

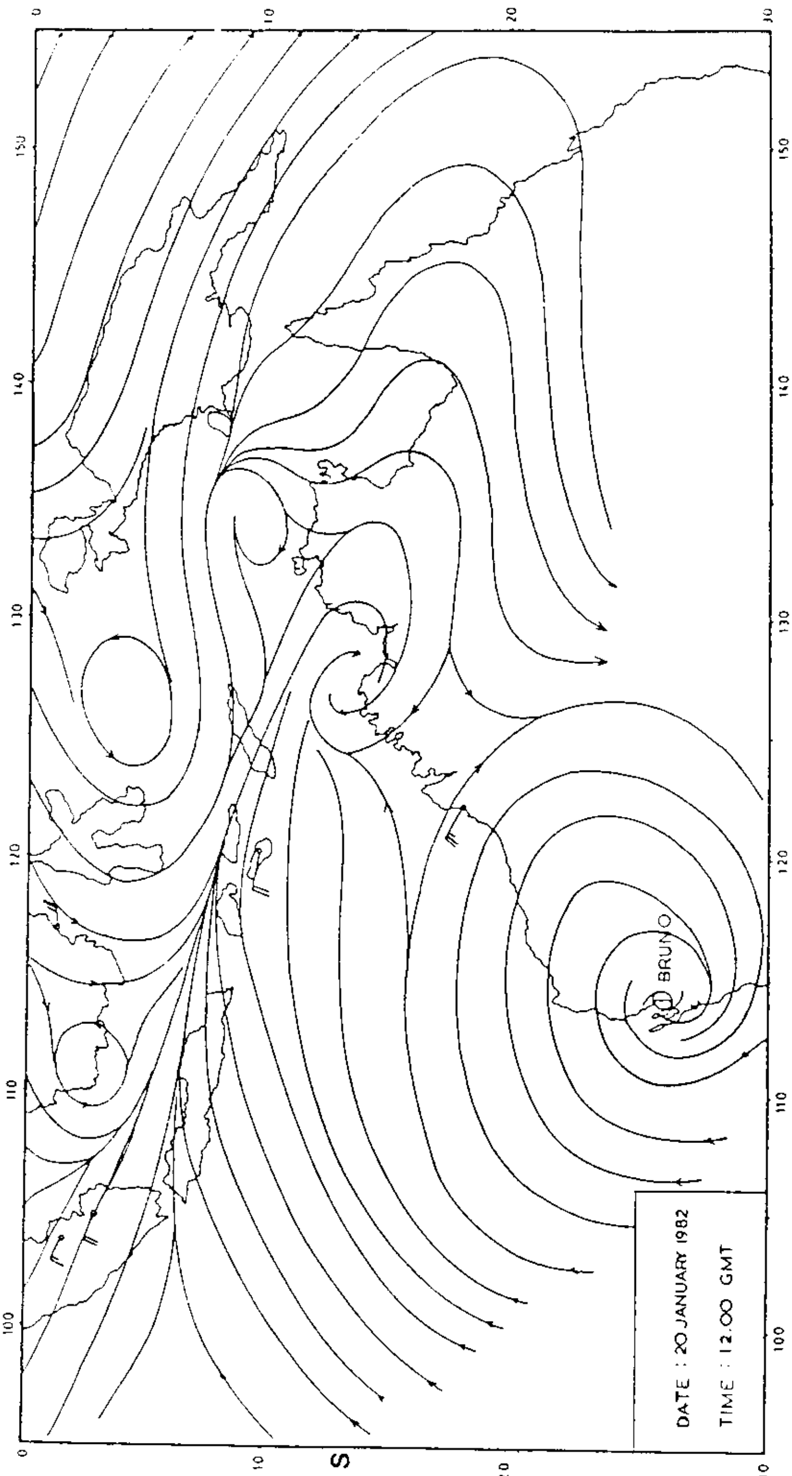

Figure 4b Surface stream lines at 12.00 GMT, January 20, 1982.

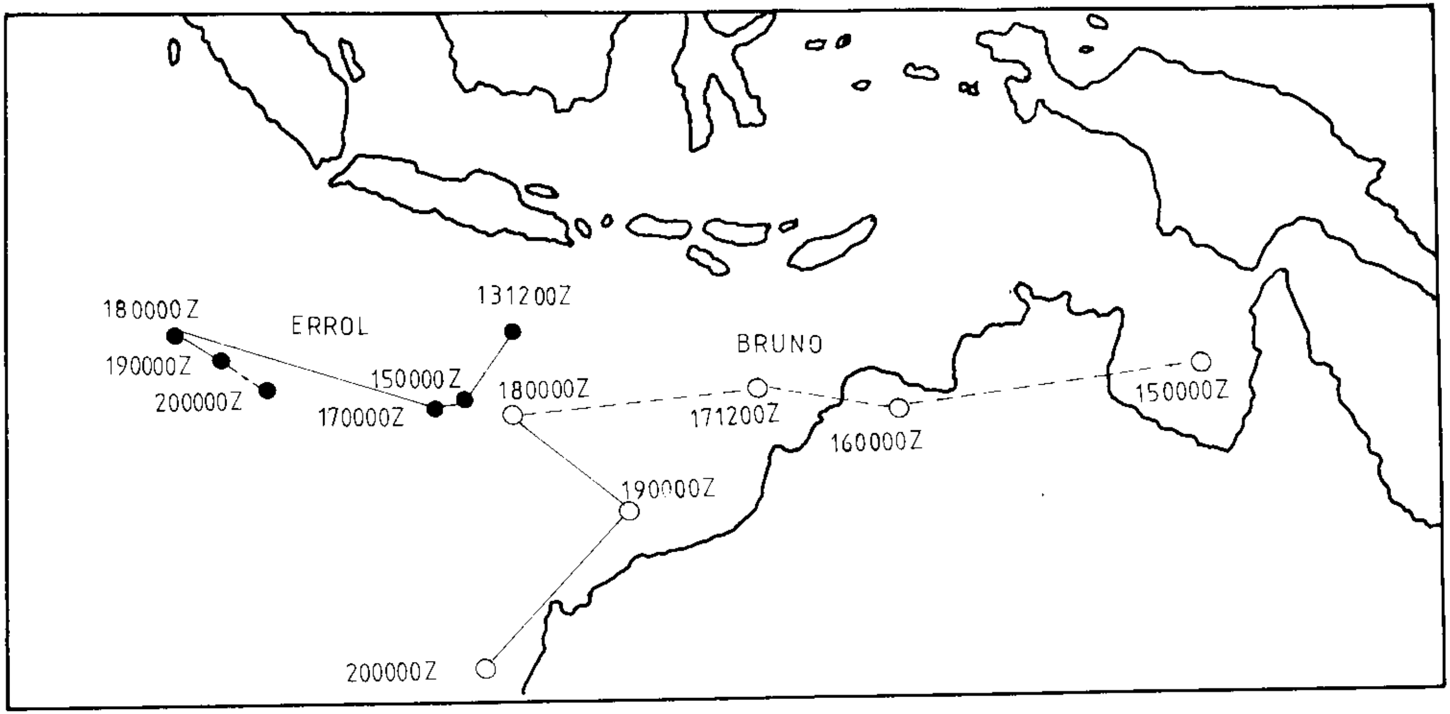

Figure 5 Track of the tropical disturbance in January 1982.

——— : track of the tropical storm/cyclone

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131200Z : January 13, 1982, at 12.00 GMT.

150000Z : January 15, 1982, at 00.00 GMT.

Table 1 Rainfall (mm) for some of the rainfall stations (Fig. 6) in the second decade of January 1982.

No.	Name of Station	Rainfall in second decade	Monthly normal rainfall	Percentage against the one third of normal rainfall
1	Padang	199	355	168%
2	Bengkulu	125	306	123%
3	Tg. Karang	138	268	155%
4	Banyuwangi	128	179	215%
5	Sumbawa Besar	303	320	284%
6	Ternate	215	208	310%
7	Amahi	123	104	355%
8	Manokwari	290	311	280%
9	Sarmi	183	227	242%
10	Jayapura	179	339	174%

Wind at the south of the equator was generally westerlies (South West – North West) with velocity of about 20 knots. The synoptic map shows that some of the meteorological stations in the southern hemisphhere had recorded wind velocities exceeding 20 knots.

During the second decade of January 1982, waves in the south of the equator occured from the direction of South West–North West with wave height about 2.0 m to 5.0 m. This wave height was heigher than the one at the north of the equator which reached only about 1.2 m to 2.1 m (Table 2).

Table 2 Ocean condition in Indonesian waters, January 1982*

Date	Time (GMT)	Position	Wind velocity (knots) and direction (degrees)	Wave height (m) and direction (degrees)
12	00.00	11.42 S– 96 E	37/120°	5.0/120°
17	00.00	09.42 S–106 E	24/320°	4.0/320°
19	00.00	0 7.24 S–105 E	16/250°	2.0/310°

* Source: Report of Climate, Weather, and Earthquake, No. 3, Meteorological and Geophysics Agency, Jakarta, January 1982.

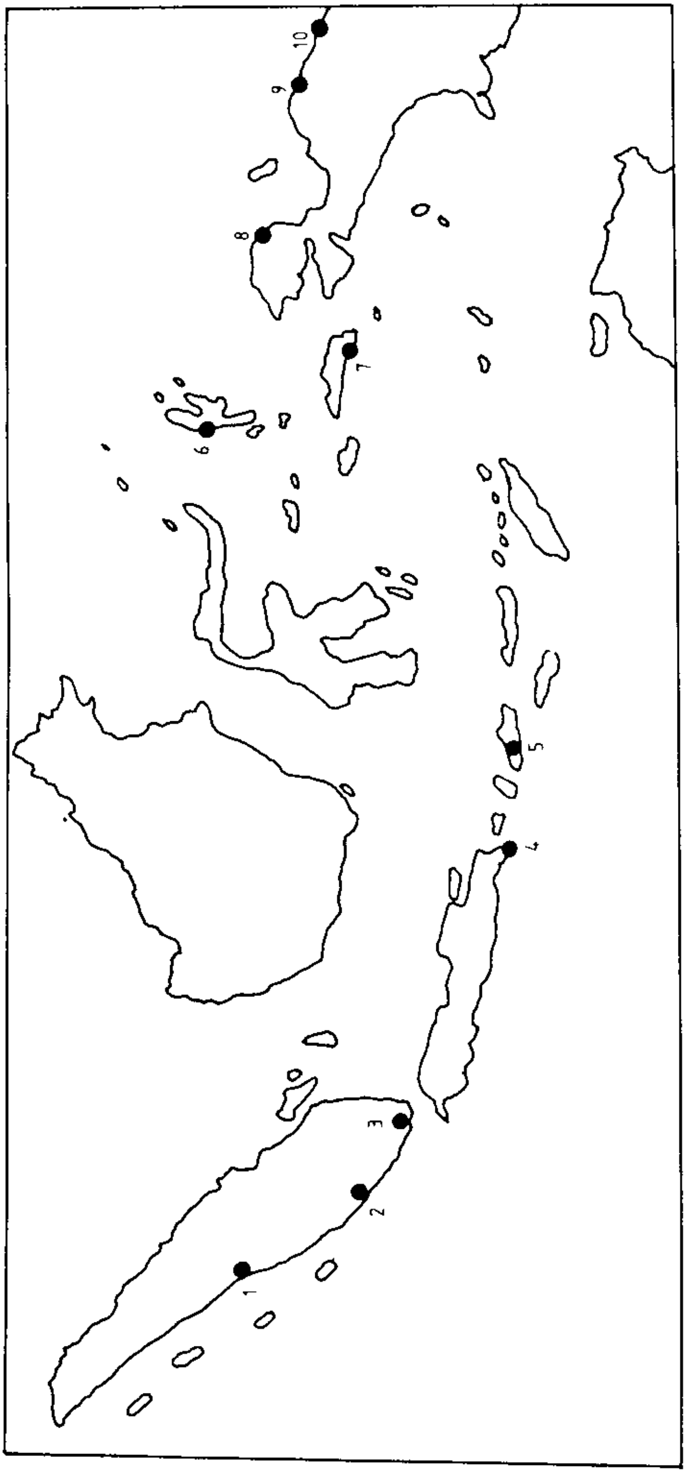

Figure 6 Location of the rainfall stations.

4 Discussion and conclusions

Tropical storms emerge in the regions of hot sea surface temperature of more than 26°C. In this context the region is situated in the north of Australian continent and it extends westward. There is a tendency that the emergence of tropical storm is related also to the thermal ridge. Another important condition of the tropical storm formation is that the Coriolis parameter must be bigger than a certain minimum value, which is the value at the latitude about 7°N or S. If the Coriolis force is weak, then there is no possibility of tropical storm formation. This Coriolis force be expressed as:

$$F_{co} = 2\,\Omega \sin\phi .\, V$$

where Ω is the angular velocity of the earth rotation, ϕ is the geographical latitude, and V is the wind velocity.

In cases of tropical storm ERROL and BRUNO, they emerge for the first time at latitude 12.5°S and 14.0°S respectively. The life times of these storms are eight days for ERROL ans six days for BRUNO.

Although the Indonesian archipelago is theoretically free from tropical storms (because it is situated between 7°N and 10°S), the weather in some parts of this region which is situated near the tropical storm track can be affected, especially rainfall, wind velocity and sea wave.

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