the beaches are interrupted by wide muddy river mouths whose seaward shores generally are covered with mangrove and dry about ¾ mile at low water. An example of the nature of the shoreline in the vicinity of the river mouths is shown on the aerial photograph of the village of Kaukenau (FIGURE III - 194). The beaches in the intervening areas are backed by a belt of firm sand of varying width.

Continuing east from Kaukenau, the sandy beaches gradually become muddy and wider until in the area between Timika and Aika the muddy shore in places dries about 1⅔ miles at low water. Eastward of Aika as far as the Eilanden River small areas of sandy beach have been reported to exist, but generally the shore is low, muddy, and covered with mangroves.

South of the Eilanden River to the northern entrance to Princess Marianne Strait there are a few sandy beaches such as the very conspicuous beach which surrounds De Jongs Point. Generally, however, this coast is low, with muddy shores and stretches of mangrove predominating.

Frederik Hendrik Island, which is separated from the mainland by Princess Marianne Strait, is generally low and marshy. Although the northern shore of the island is muddy, there are a few sand beaches. Little is known about the west coast of the island except that the flat, muddy shore is backed by low, wet land. The southern shore of the island is muddy and thickly covered with mangroves and other timber. The seaward shore of Komoran Island, which lies immediately eastward of Frederik Hendrik Island, is low and marshy.

Continuing eastward to the mouth of the Wamal River the shore is generally muddy and covered with mangroves, but at a point a short distance east of the mouth of the river the shore becomes sandy and is backed by coconuts. Offshore from this beach area the bottom is soft mud and sand. East of Wamal River to the village of Onggaja the shore is generally low, muddy, and covered with mangroves, especially at the river mouths.

In the vicinity of Merauke a sand beach lies on both sides of the mouth of the Merauke River. The upper 100 to 150 feet of the foreshore is composed of hard smooth sand, capable of supporting motor vehicles; the area to seaward dries out about 2 miles at low tide and is soft and muddy. Behind the beach is an area of sand dunes with coconut trees. Although this area is exposed to the wind of the southeast monsoon, the short steep waves that are encountered in the open sea break well offshore and reduce progressively in height before they strike the beach.

Southeast of the village of Onggaja to the Netherlands New Guinea border the foreshore is muddy with mangroves, especially at the river mouths. Seaward of the foreshore the bottom is soft and muddy, but behind the foreshore lies an old beach ridge backed by sand dunes and coconut trees.

(*d*) *Terrain inland and on flanks of beach.* The entire coast in this area is backed by low, almost featureless, swamps and plains except near the western end where Boeroe Mt., elevation 4,557 feet, descends sharply to the sea. This ridge is separated from the high mountain chain that extends eastward by a valley with hilly ground. The plain between these mountains and the coast is of variable width, narrow near the western border of the area and widening markedly to the east and southeast (Chapter II) and (FIGURE II - 47). To a large extent these plains are low and swampy, bordered in many places by extensive mud flats extending far out to sea. They are cut by innumerable rivers and inland waterways. Locally, there are low clay cliffs, and in the southeastern portion near Merauke sand dunes line parts of the coast. In places there is a firm sandy area behind the sandy beaches. The largest area of this kind along the coast from the Omba River to beyond the Digoel River, is on Timika Island, (FIGURES III - 195 to III - 200) where a landing strip has been constructed (Chapter XI, Topic 113). A wedge of low hills separates the Digoel River and the Fly River near the southeastern end of the area.

The vegetation reflects conditions along the coast, and in general two kinds predominate in the coastal belt. The beaches have casuarina trees and coconut plantations, whereas the low muddy parts of the coast are bordered by mangrove swamps. Inland these areas grade to sago forests along the South New Guinea Plain west of the Digoel River, grassy swamps on Frederik Hendrik Island, and shrubby grasslands or savanna along the Merauke Plain.

Communications in this area are limited, being restricted largely to footpaths along the beaches, and occasional trails leading to interior villages. In the Merauke area some of the trails may be used by autos in dry weather. To a large extent travel is by small boat along the shore and in the numerous river channels, but coastwise travel is seriously hindered or impossible, especially during the southeast monsoon (Chapter VI).

Appendix

The following rough sketches and descriptive notes were furnished from memory in January 1944 by Mr. A. J. Coops, a Dutch shipmaster. From 1935-1938 Mr. Coops sailed the coastal waters of Netherlands New Guinea as master of the M.S. *Soedoe*, a vessel of 200 tons with a draft of 8 feet 6 inches, owned by the Netherlands New Guinea Petroleum Company. Anchorages indicated on the sketches are for a ship of that type; landings described were effected by a motor dinghy about 23 feet long and 6½ feet wide, with a maximum draft of 3 feet. The sketches are purely schematic, and are neither accurate nor to scale. (FIGURES III - 218 to III - 227.)

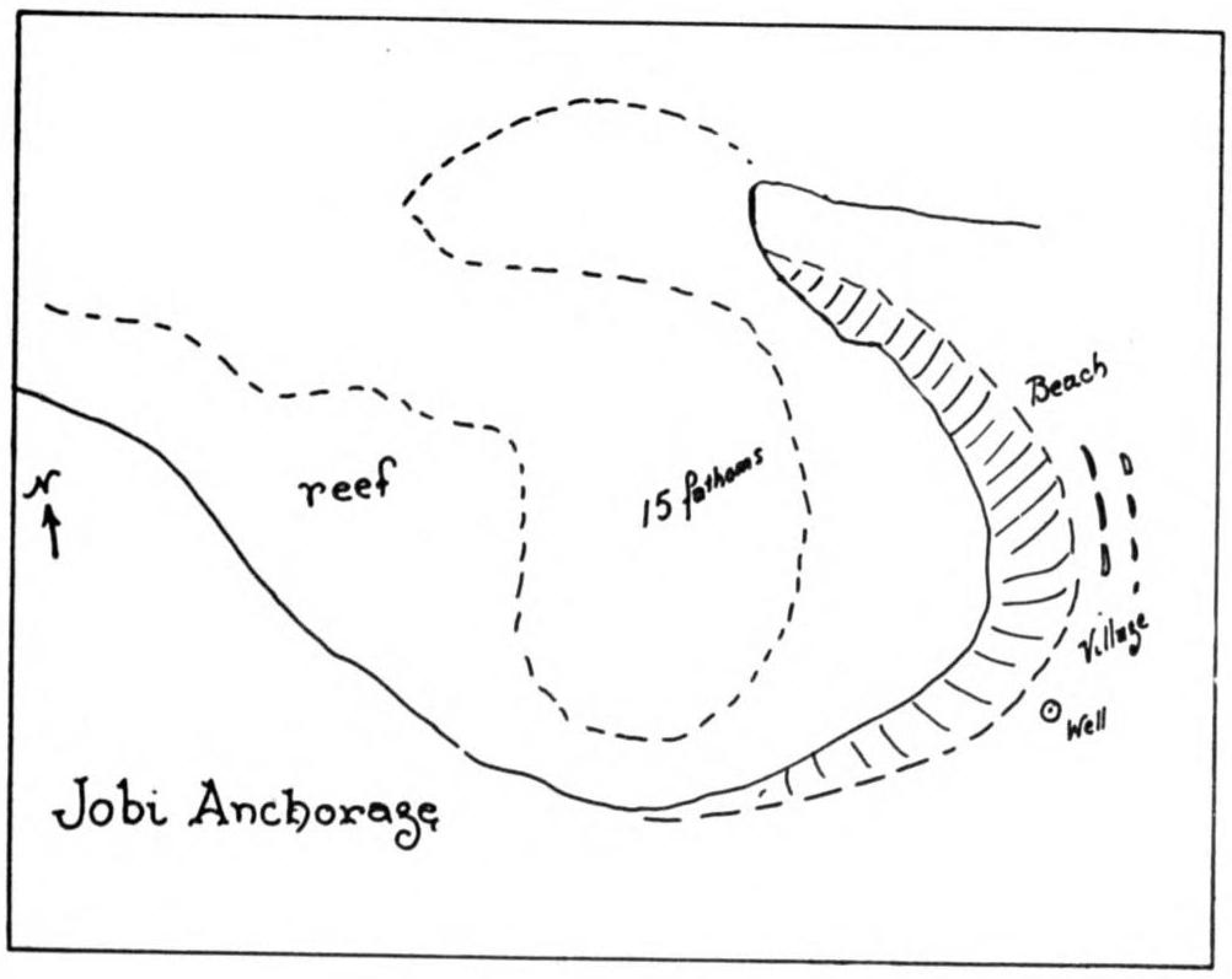

FIGURE III - 218.
Jobi anchorage, N coast Japen Island near E end. (PLAN III - 5.)
"Near Tanjung Jobi there is a large native village and a bay sheltered from north winds. In entering the bay great care must be exercised to keep clear of the northern reef at the point where the southern reef broadens and leaves only a narrow channel. There is a beach about 5 miles long sloping slightly, but the coastal reef is about ¾ of a mile broad and dries at low water. At high water the coastal reef has 4 to 5 feet of water. The anchorage is safe except for north west winds. There would be room for 2 or 3 destroyers, for example."

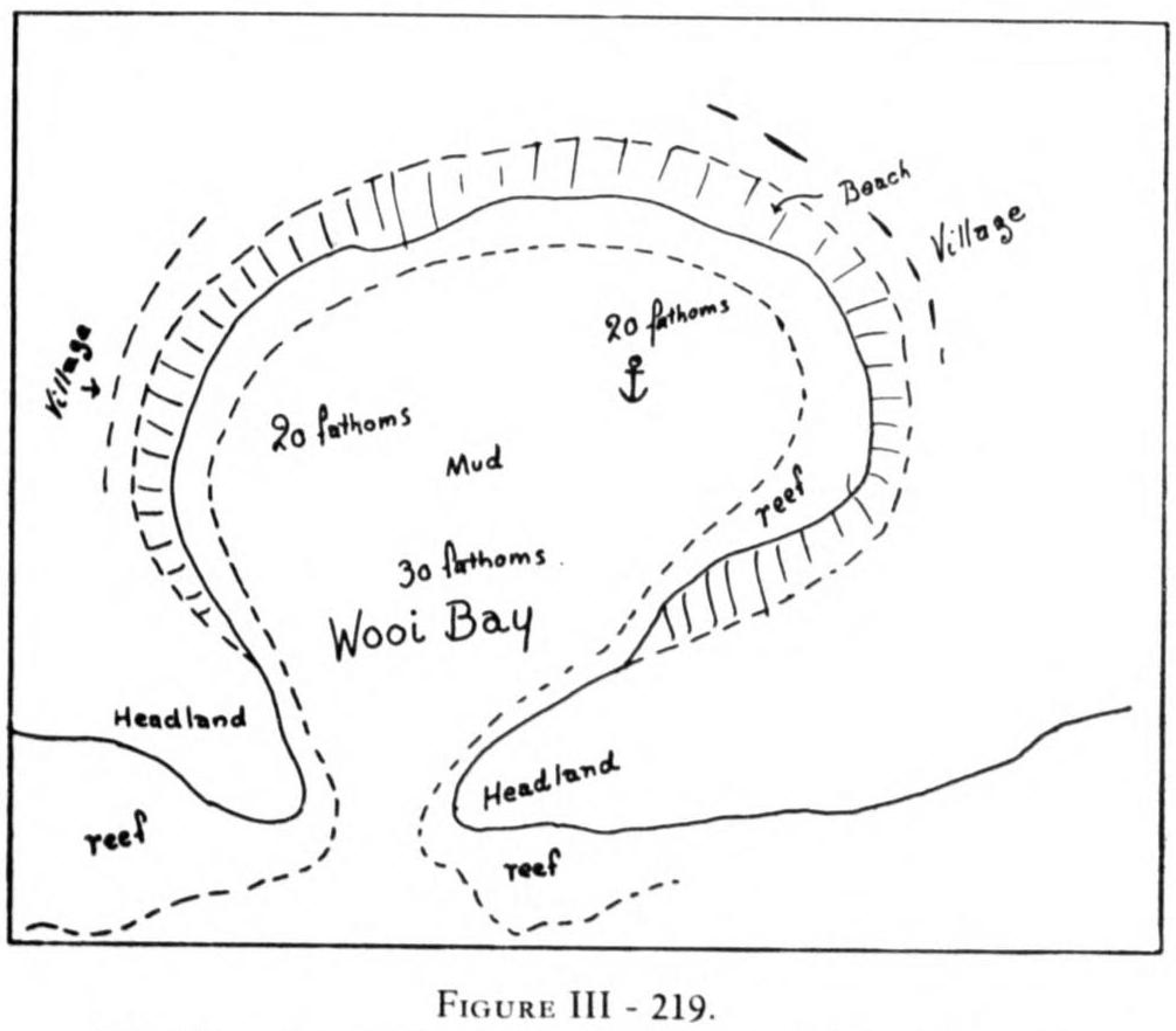

FIGURE III - 219.
Wooi Bay, S coast Japen Island near W end. (PLAN III - 6.)
"Wooi Bay is a good sheltered bay. The entrance is rather narrow, through 2 high stone headlands. Then the bay broadens and has a broad sandy beach, about 50 to 75 yards wide, all around the bay. Anchorage is about ½ mile beyond the 100 yards wide coastal reef in 20 fathoms of water; mud. There is practically no current in the bay. There are 3 fresh water wells. The village is one of the more important ones and is connected overland by trail with Seroei. The entrance to the bay is not easily recognized from seaward. In entering due attention must be given to the fact that there always is a suction current across the entrance of the bay. At very slow speed a ship cannot enter, and so with a fairly good speed a ship must enter exactly in the middle of the entrance when the double peak of Marai is 38° true."

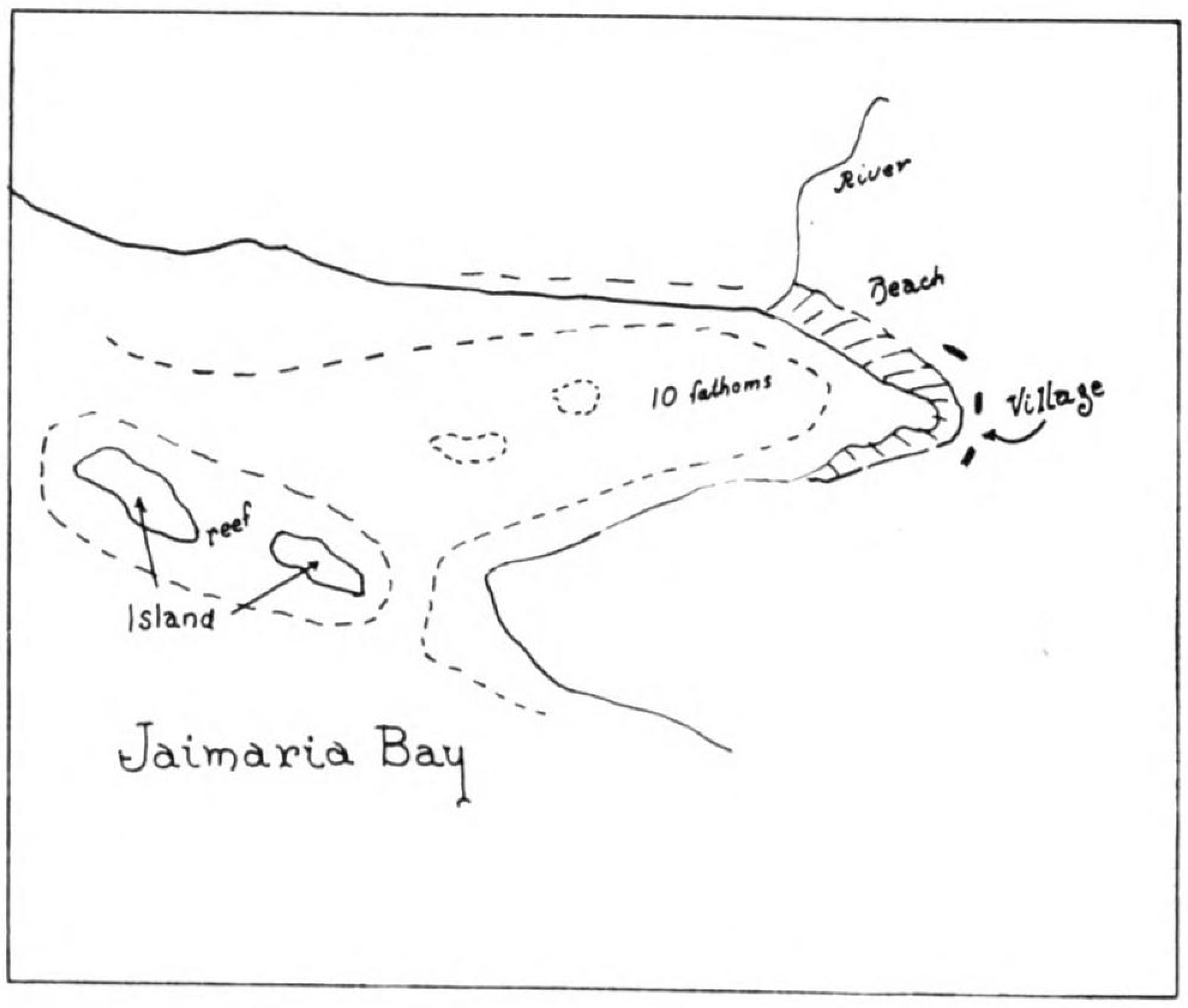

FIGURE III - 220.
Jaimaria Bay, S coast Japen Island near W end. (PLAN III - 6.)
"Jaimaria Bay has a good anchorage for small ships in 10 fathoms of water. The steep white sandy beach is 15 to 20 yards wide and about 3 miles long. The village has a small river which has clear drinking water. Around the bay is a coastal reef which dries in patches at low water but has 4 to 5 feet of water at high water. The entrance is rather difficult as the channel between the land and the islands is narrow. The reefs extend farther than the charts show. There are a couple of shoals in the bay but they can be seen easily."

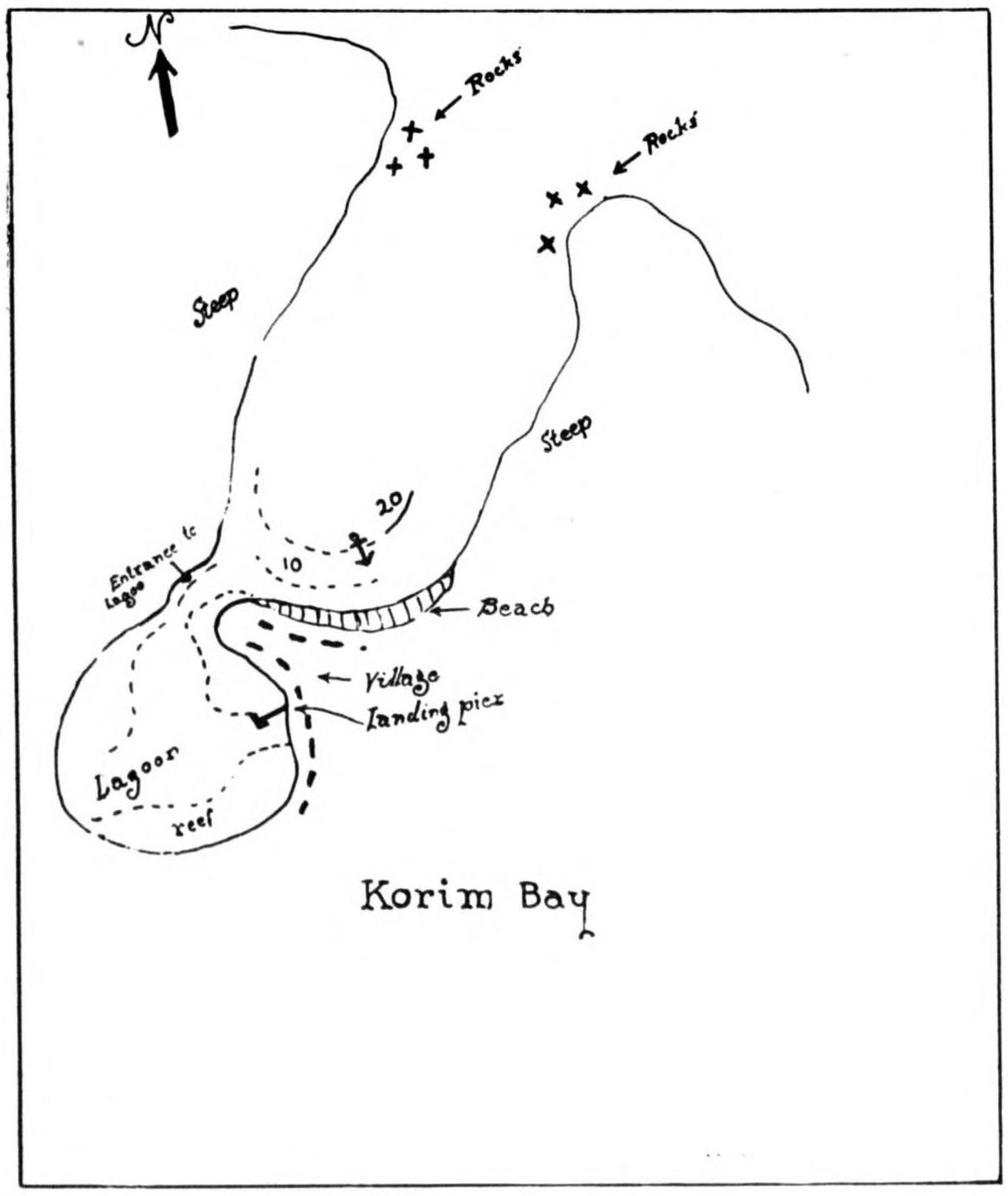

FIGURE III - 221.

Korim Bay, N coast Biak Island near E end. (PLAN III - 8.)

"Korim Bay is a deep bay with a sand beach about 2 miles long, rising steeply from a narrow coastal reef which dries at low water. The beach is at the end of the bay. The entrance is about ½ mile wide but there are groups of rocks on each side. The bay gradually gets more shallow and good anchorage is ½ mile from shore in 12 fathoms of water. Near the entrance the coast is steep. The bay is clean. Fresh water is available from a small stream. On the inner side of the bay there is a channel with about 6 feet of water at high water, which leads into a lagoon. There are 3 reefs laying in this lagoon. The beach in the lagoon is muddy but has 3 firm patches, about 2 to 4 feet above high water level, where the village is situated. Over the reef leads a landing jetty which is the usual feeble Papuan affair. The village stands on firm, clay ground. The 3 firm patches are each about 10 yards long, and between them the coast of the lagoon is muddy. No ship can come into the lagoon but it affords shelter for a number of barges."

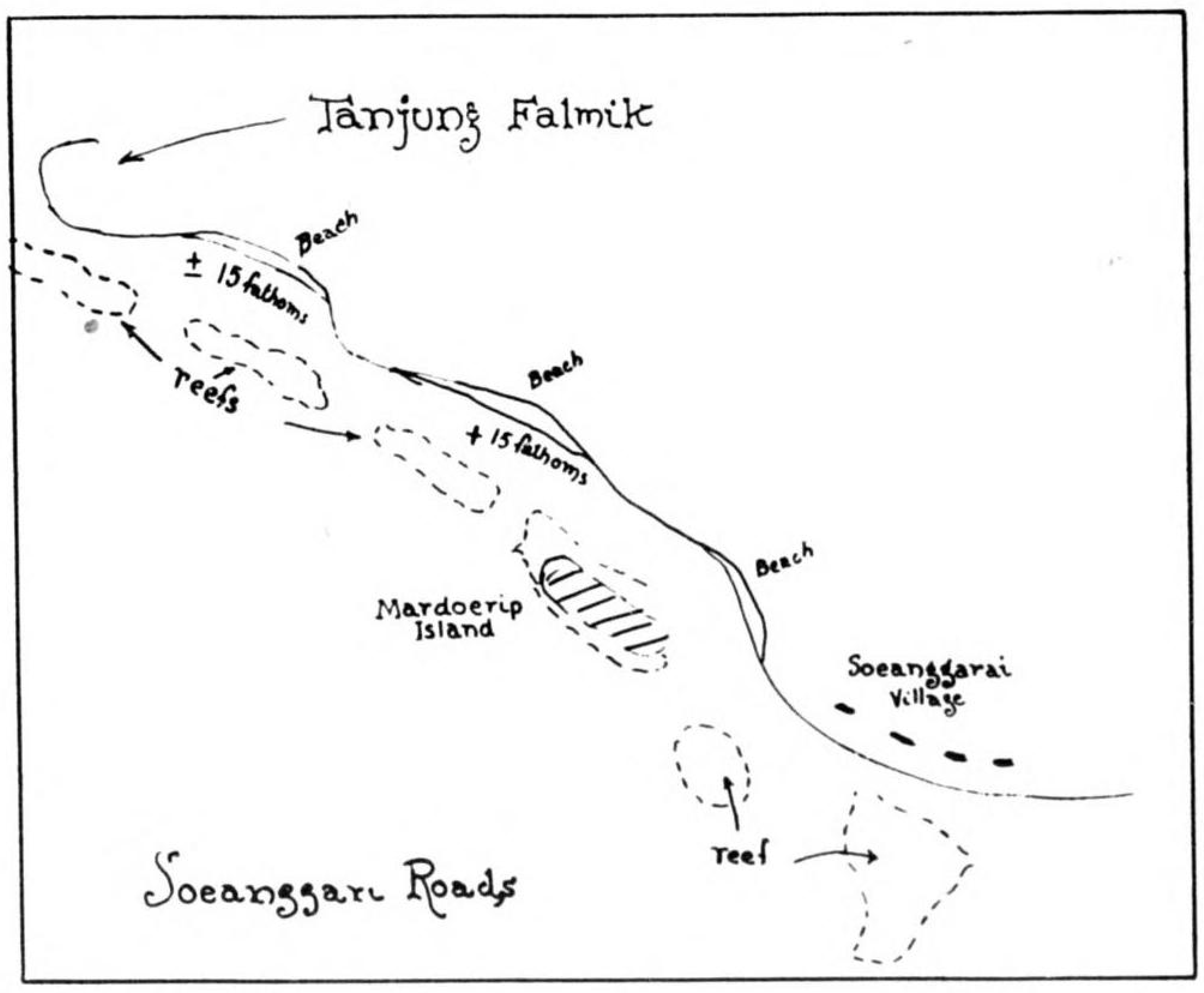

FIGURE III - 222.

Soeanggarai Roads, S coast Biak Island near E end. (PLAN III - 8.)

"About 4 miles to the west of Bosnik is Soeanggarai with a safe anchorage. The coast is protected by a chain of drying coastal reefs and a small island named Mardoerip. Behind the reefs small ships anchor in about 15 fathoms of water. There are 3 beaches, each about 1 to 2 miles long but rather narrow (only 10 yards) rising very steeply from the sea. In approaching them care must be used to avoid the numerous coastal reefs through which the channels, however, are clearly visible. Even with southwest winds the anchorage is fairly safe. There is a well at Soeanggarai village."

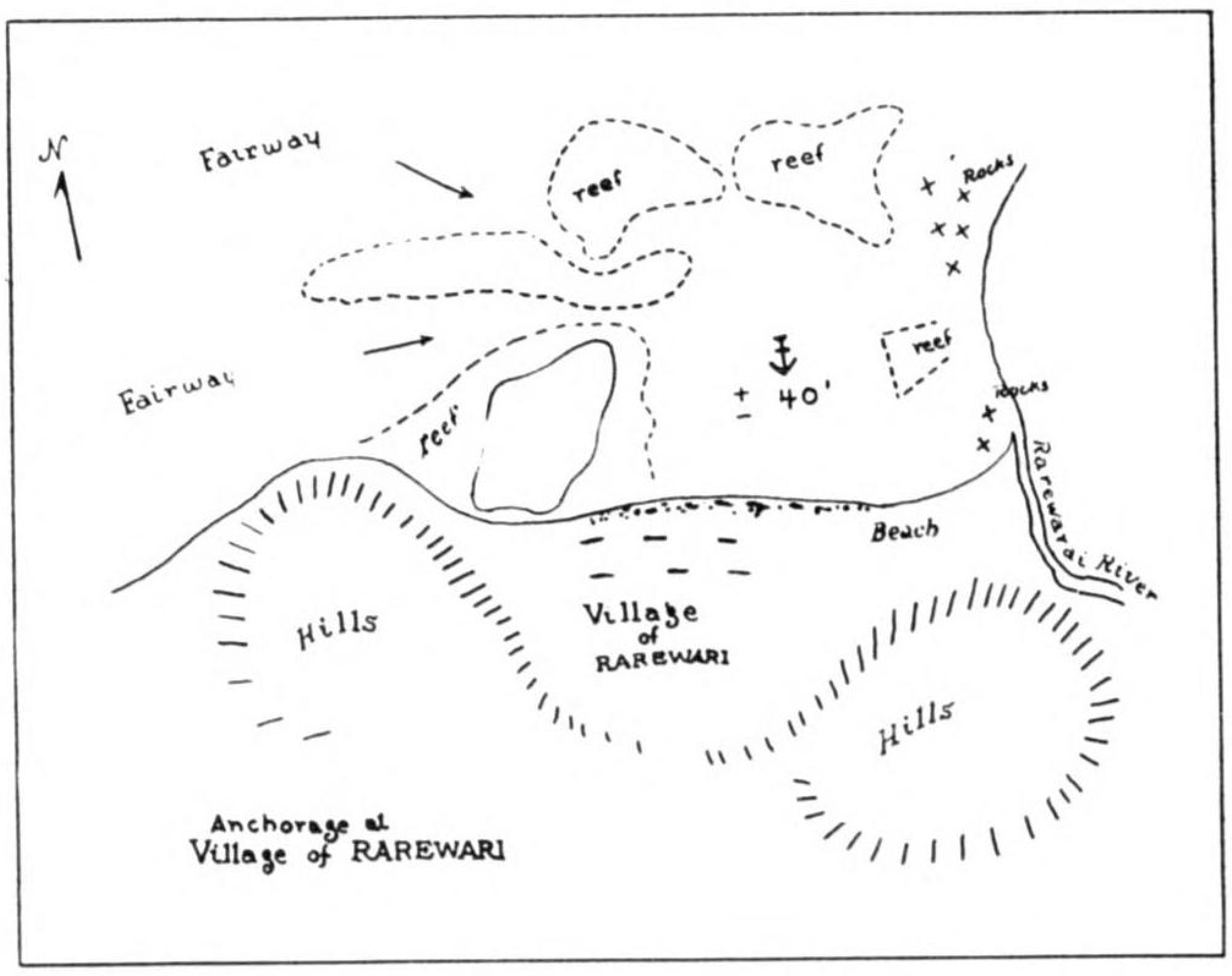

FIGURE III - 223.

Rarewarai village, E side of Geelvink Bay. (PLAN III - 11.)

"Rarewarai has a small beach of pebbles about 10 yards wide. A few coral reefs lie in front, through which 2 channels lead to the beach. Both channels are from 12 to 36 feet deep and about 30 to 40 yards wide. Beach is steep sloping. Local knowledge is necessary to go through the reefs, if not enough time is available to put up marks. Rarewarai is a village built on firm ground with hills at the back of it. Small craft find a safe anchorage behind the reefs. Length of the beach is about 1 mile."

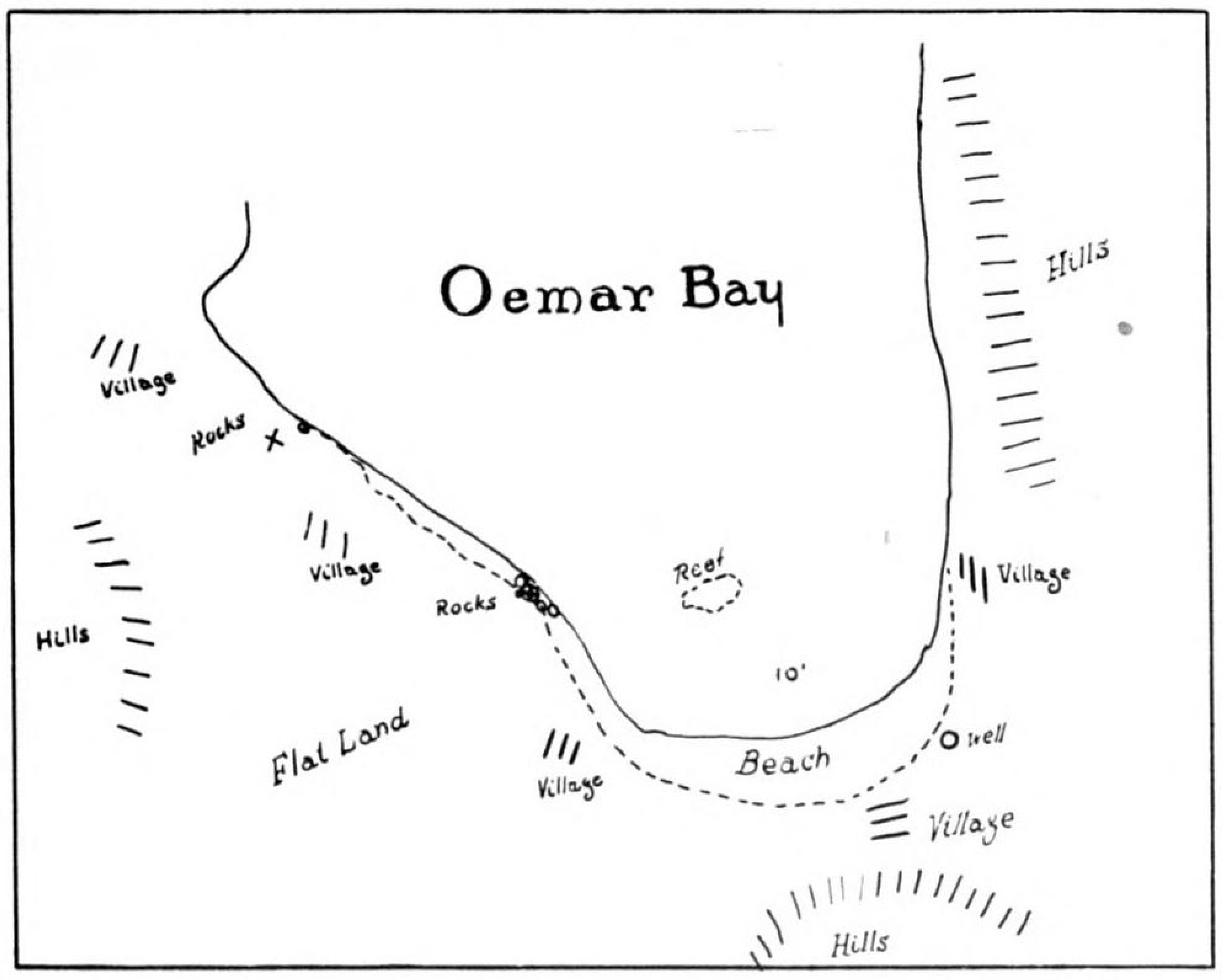

FIGURE III - 224.
Oemar Bay, W side Geelvink Bay. (PLAN III - 12.)
"Firm land; the east and west sides steep. In the south a large white sand beach with a few rocky parts in 2 places. Length of beach is about 5 miles, width about 50 to 80 yards. It slopes fairly steeply. Anchorage about 2 miles out in 10 fathoms of water. There are a lot of villages around the bay. At the south eastern part of the bay there is a well."

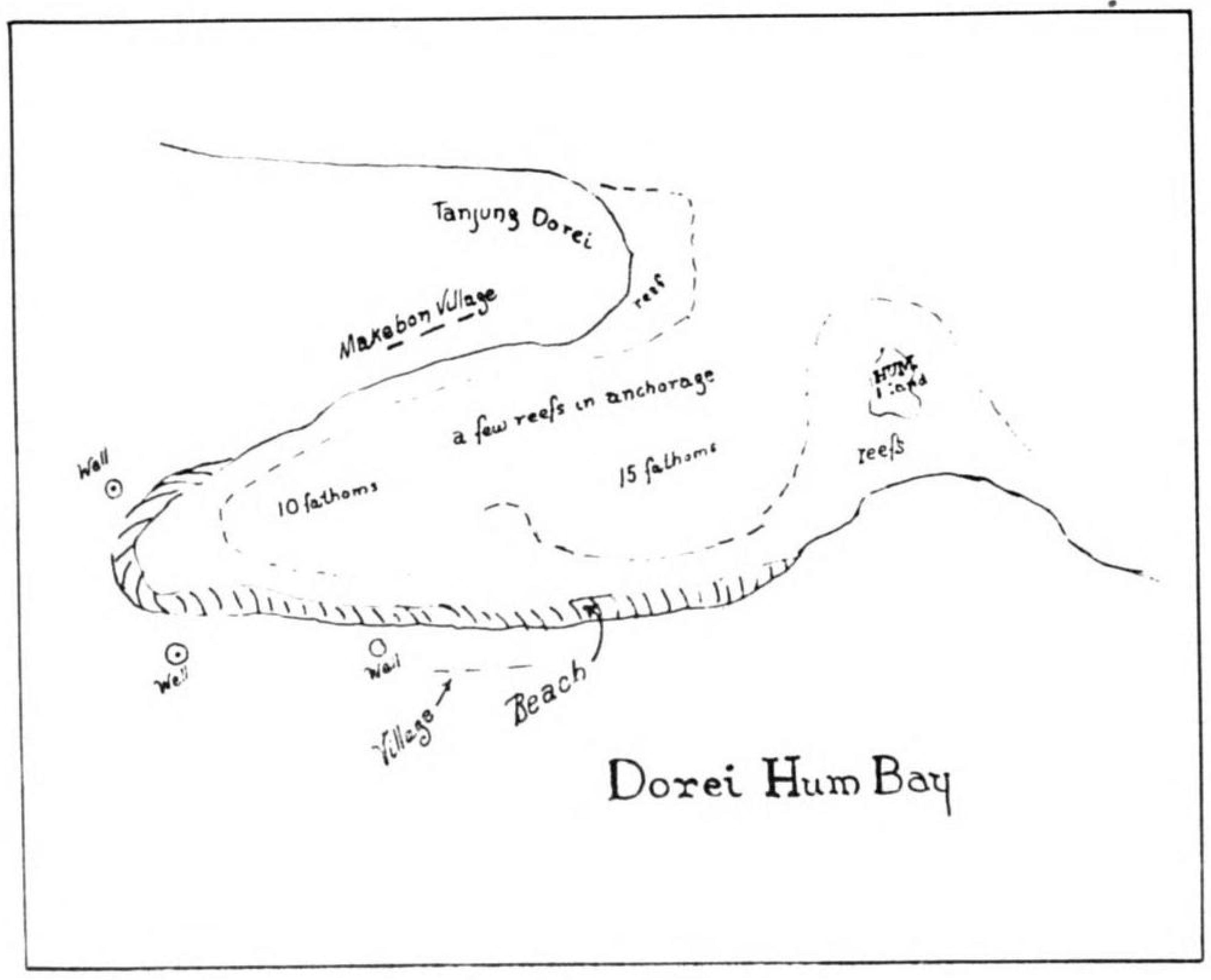

FIGURE III - 226.
Dorei Hoem Bay, N coast of Vogelkop. (PLAN III - 19.)
"The existing Netherlands chart gives all information to enter this bay which gives a splendid anchorage for small craft in 10 fathoms of water. The entrance is somewhat difficult on account of the 3 reefs in front of the bay. In the west end there is a long beach of white sand about 5 miles long and as much as 50 yards wide. Behind it the ground is flat with coconut palms and a fairly big village. There are 3 good fresh water wells near the beach. In front of the beach there is a coral reef covered at high water with from 12 to 6 feet water but even at low water there are navigable channels through it to the beach. These channels can be clearly seen standing in the boat as the water is very clear. The slope is steep enough to enable the boats to reach the sand and still be afloat at the stern. The anchorage is the only one on this coast which affords a sheltered anchorage during the North Monsoon, and in my opinion landing in the bay would be possible in this monsoon provided local knowledge is available to enter the bay through the reefs when there is a high swell and sea. I visited this bay in both monsoons and had no difficulty with the shore communication. The Dutch chart of the bay is fairly reliable."

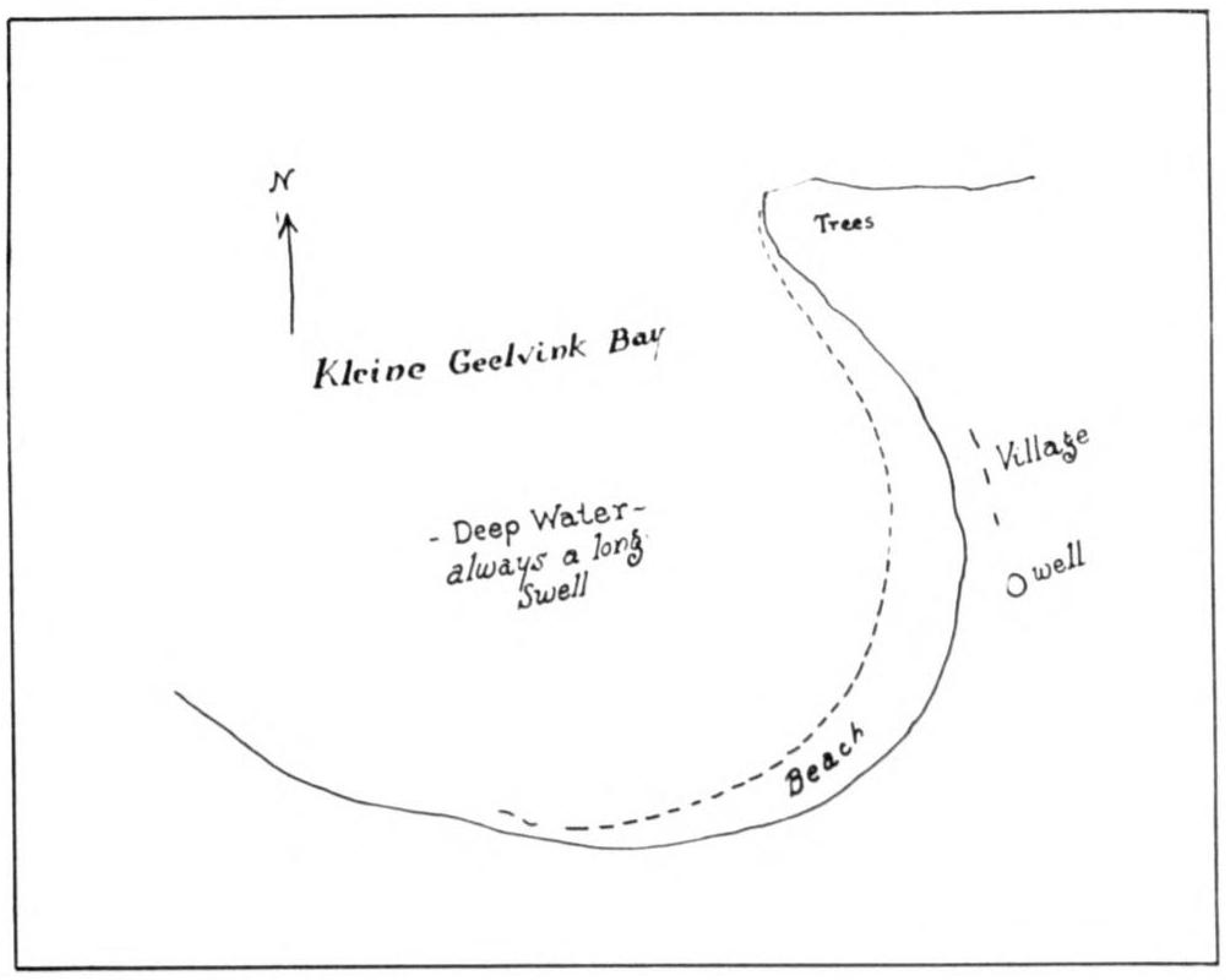

FIGURE III - 225.
Kleine Geelvink Bay, N coast of Vogelkop. (PLAN III - 17.)
"Kleine Geelvink Bay is a small bight with a good white sand beach in the shape of a half-moon, about 5 miles long and 100 yards wide. The bay is clean, but the slope of the ocean floor is very steep and there is always a long swell. I found it impossible to anchor so kept the ship going up and down while the motorboat was ashore. The bay is heavily wooded. There is a fishing village located on the bay. A boat with her bow on the beach had 12 feet clearance at the stern. It is impossible to land during the north monsoon."

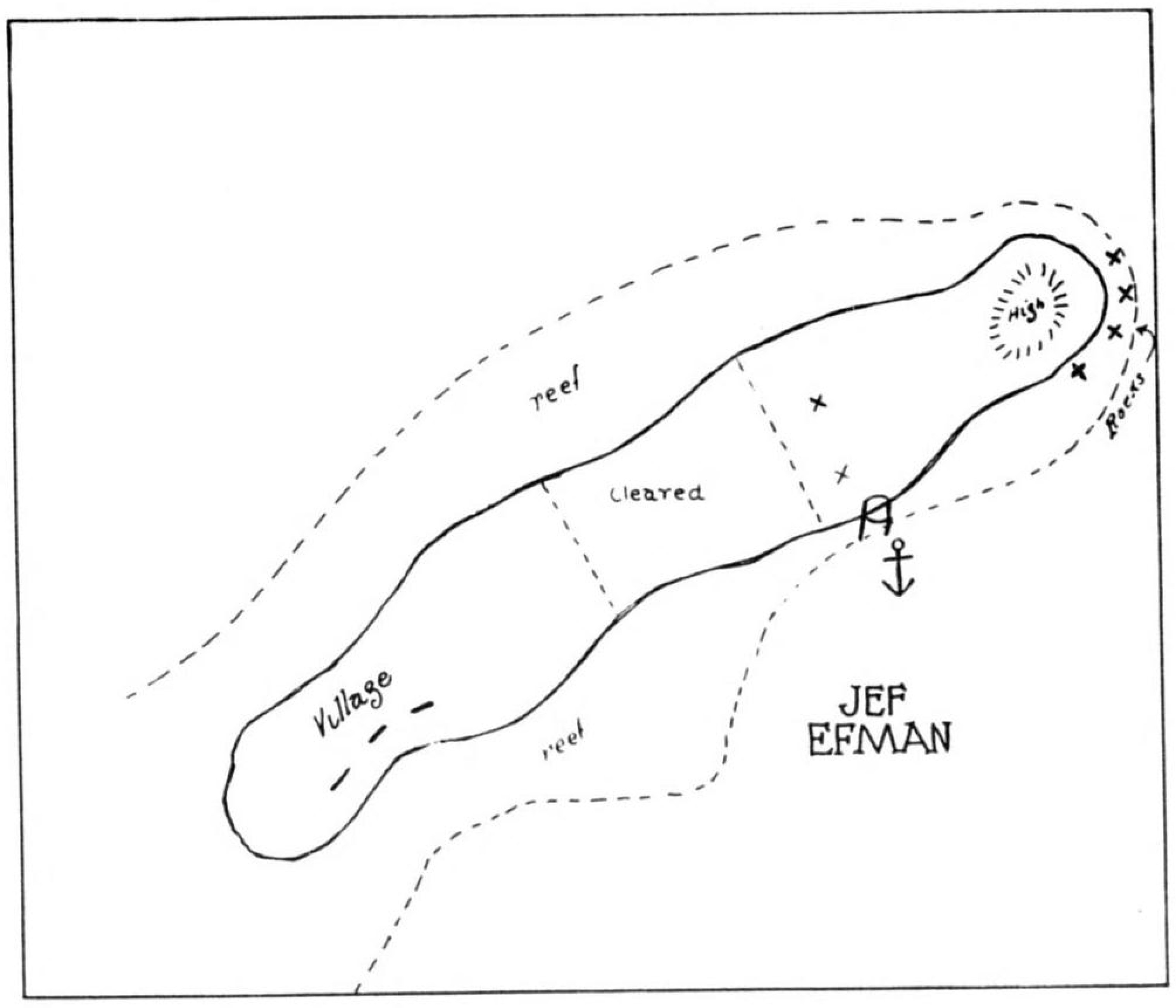

FIGURE III - 227.

Efman (Jefmaan) Island, W of Vogelkop. (PLAN III - 19.)

"In the western part of the north entrance of Sele Strait lies Jef Efman, a long island lying in a north-northeasterly direction. As the middle of the island was levelled by our company and cleared of vegetation for an airfield, I'll give a detailed description of the island. The northeast part is high and steep. Rocks come to the sea, and north of it, on the very narrow coastal reef, are rocks. The western shore is flat but has a broad coastal reef which dries at low water and extends from ½ to 1 mile outward. At high water there is about 3 to 4 feet of water on the reef. The eastern part has a narrow coastal reef from about 200 yards, in the middle of which is a channel through which our motorboat could land at low water. At high water landing was possible everywhere. Except in the northeast part the island has a narrow white sand beach, varying in width from 5 to 10 yards. The northern part is hilly, the middle part cleared, and the southern part flat with coconut palms. The middle part was cleared and levelled to make a flying field for our photographic planes. I am unable to give the exact dimensions but think the width of the clearing was 800 meters. All tree roots were taken out. Best landing was near area marked "A" on sketch, where the coastal reef was narrow. Ships anchored off this point in 8 to 12 fathoms of water. The coastal reef is level and has no slope. There is a well of fresh water at 2 places marked "X" on sketch. In the southern part there is a native village. In both monsoons landing is possible. During the south monsoon it is often necessary to land on the western shore. The tidal currents run parallel to the shore, north-northeastward for flood, and south-southwestward for ebb. The rise and fall is from 6 to 8 feet. The passage near the southwest point is impossible to use as the reef is connected with the next island."

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NETHERLANDS NEW GUINEA

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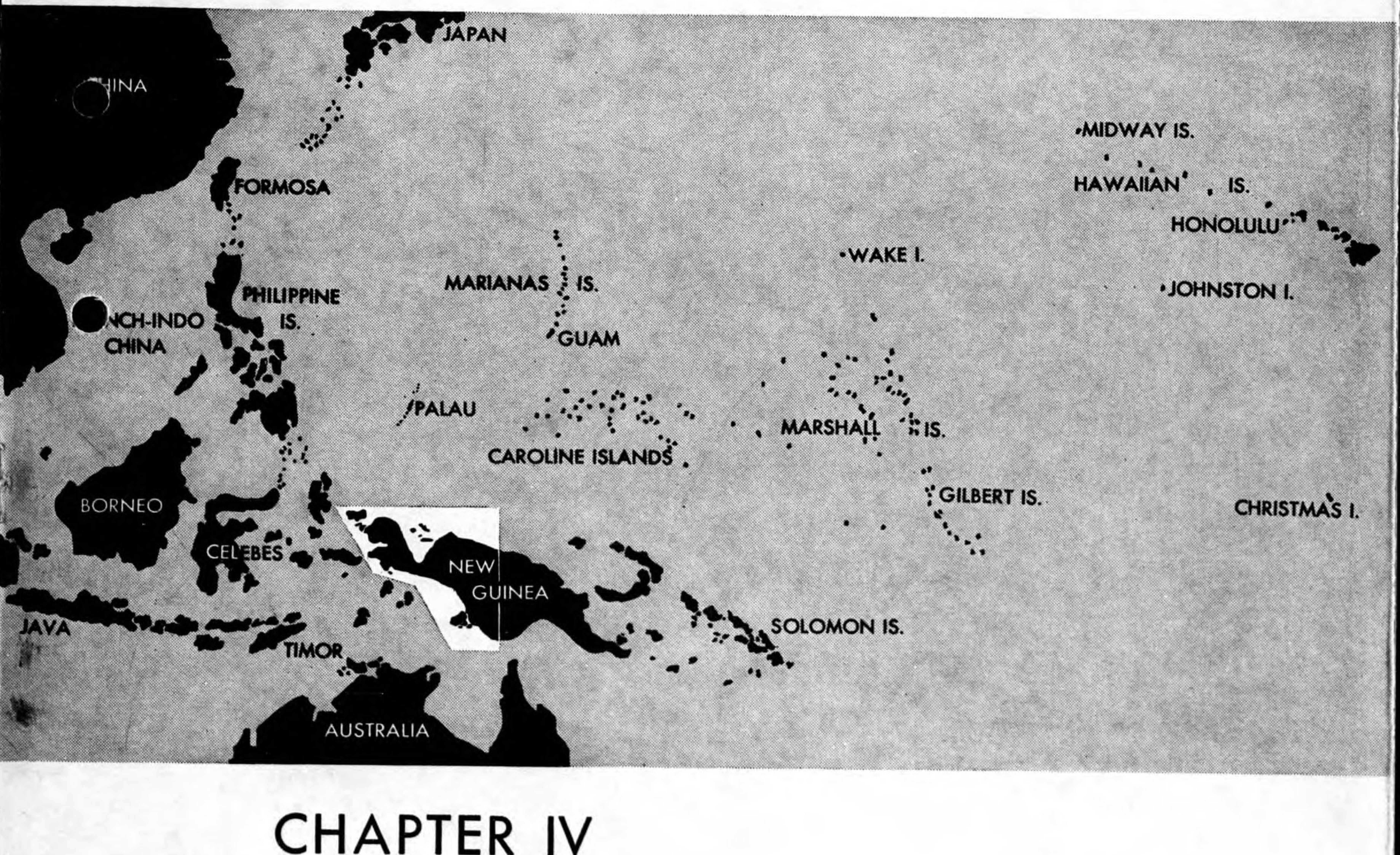

CHAPTER IV

CLIMATE AND METEOROLOGY

MARCH 1944

Table of Contents

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CLIMATE AND METEOROLOGY

40. *General Description*

The lowlands of Western New Guinea have wet tropical climate, oppressive and muggy. The temperature, monotonously uniform throughout the year, averages about 80° F., and heavy, frequent rainstorms occur at all seasons except in the far south. In the far south there is a distinct dry season from June to November. The interior uplands have temperate, healthful climate at about one mile above sea level, and extreme cold near the summits.

Little quantitative information exists concerning the details of climate and weather. Most weather observations have been limited to rainfall. Even the rainfall observations are confined chiefly to coastal areas. Only a highly generalized treatment can be given, particularly for the interior. The meager local data have been supplemented by some data from neighboring areas, in order to present the broad picture of conditions.

The subject is approached from the climatic and from the synoptic viewpoints. The climatic approach considers average conditions, emphasizing periodic variations in weather which past records indicate can normally be expected. This approach is intended primarily as an aid in long-range planning—anticipating the characteristic weather conditions in different seasons, at different times of day, and in different portions of the area.

The synoptic approach considers typical weather situations, emphasizing non-periodic variations which appear at irregular intervals. Since weather situations can be predicted accurately only a few days in advance, this approach is intended primarily as an aid in short-range planning—anticipating weather conditions on a particular day.

A. Climatic conditions.

In addition to the general picture presented here, details of the individual climatic elements are given under the appropriate headings in Topic 41.

(*1*) *Seasonal variation.*

Throughout the year, 2 great air streams dominate the general surface circulation over the Southwest Pacific. One of these streams starts as a northeasterly trade wind in the Northern Hemisphere and becomes northwesterly as it approaches New Guinea after crossing the equator; the other is the southeast trade reaching New Guinea as a southeasterly wind. In the equatorial trough, the 2 streams converge along a zone known as the equatorial front or doldrum belt.

The northwest stream, known locally as the west monsoon, prevails over New Guinea from January through February, when the equatorial trough usually lies to the south of the island (FIGURE IV - 1).

The southeast stream, known locally as the east monsoon, prevails from May through early November when the equatorial front lies north of New Guinea (FIGURE IV - 2).

In the transition periods—March through April and late November through December—neither of the 2 major air streams is consistently present over Western New Guinea. In these periods, the equatorial trough normally lies across the island (FIGURE IV - 3), but it shifts considerably to north and south (FIGURE IV - 4). Winds are highly variable, periods of calm or light winds being interrupted by periods in which each of the major air streams dominates during oscillations of the trough.

In spite of the complete reversal of wind flow from season to season, the climate of most of Western New Guinea is monotonously uniform in other respects. Both the east and west monsoons have generally had sufficiently long journeys over tropical seas to be warm and moist by the time they reach New Guinea. Over the land, all seasons are characterized by gentle winds, remarkably high temperature and humidity, good visibility, much cloudiness, and, except in the far south, frequent heavy rainshowers. In the southern lowlands, between the lower Digoel River and the coast, there is a well-marked dry season when the east monsoon prevails, May to November. The east monsoon reaches this area as a dry, dusty wind off Australia after a relatively short sea journey across Torres Strait. Along the coasts, winds tend to be strongest when blowing onshore. Thus, northwest coasts are subject to strong winds during the west monsoon, south coasts during east monsoon.

(*2*) *Daily variation.*

There is large daily variation in most weather elements because of heating of the land during the daytime and cooling at night. For most weather elements, the magnitude of the regular daily variation is generally greater than the seasonal variation. Thus, lowest temperature, highest humidity, least wind and least turbulence ordinarily occur about sunrise; greatest rainfall, cloudiness and turbulence are to be expected in the afternoon (except at sea).

Land and sea breezes are well-developed along sheltered portions of the coasts. On exposed parts of the coast, the land and sea breeze tendencies may merely alter locally the velocity or direction of the major air flows.

(*3*) *Areal differences.*

Except for the contrast between the far south, with one dry season, and the rest of Western New Guinea, without any dry season, the principal areal differences in climate are related to the configuration of the land.

Differences in elevation produce significant climatic contrasts. The extensive lowlands are constantly hot, with gentle winds and frequent rainshowers. The mountain slopes at medium elevations are much cooler, with stronger winds, more cloud, more mist, and more rain. The higher mountain peaks are cold, with frequent frost and snowfall, but have less cloud and rain than at medium elevations. Some of the ranges have permanent snow fields and glaciers.

Other differences are related to contrasting exposures. Windward slopes tend to have more rainfall and cloud than leeward slopes. Thus, the southeast slopes of the central mountains are wettest during the season of southeast winds, driest during the season of northwest winds.

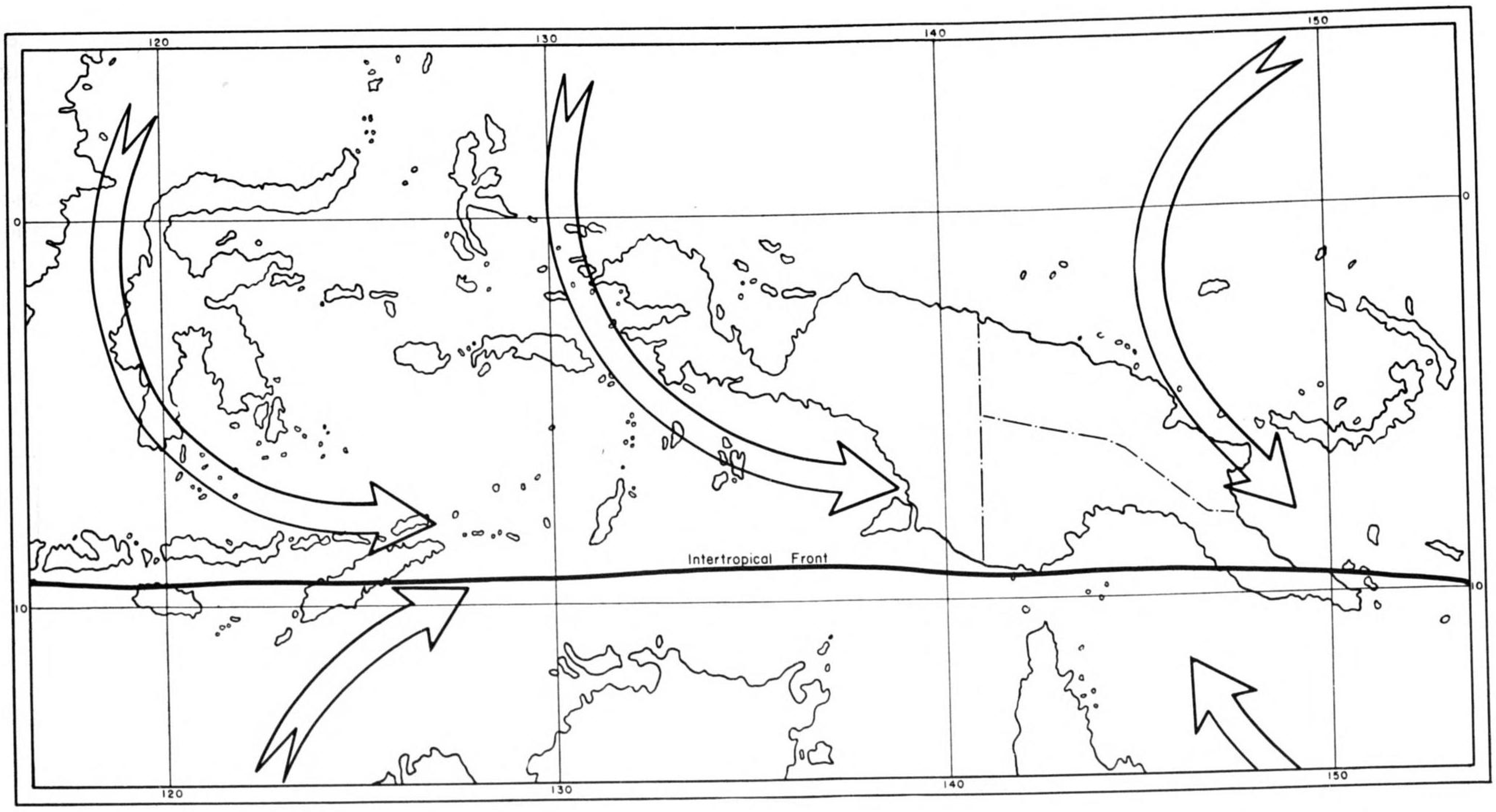

FIGURE IV - 1.
Mean air flow in January. (Northwesterly Type.)

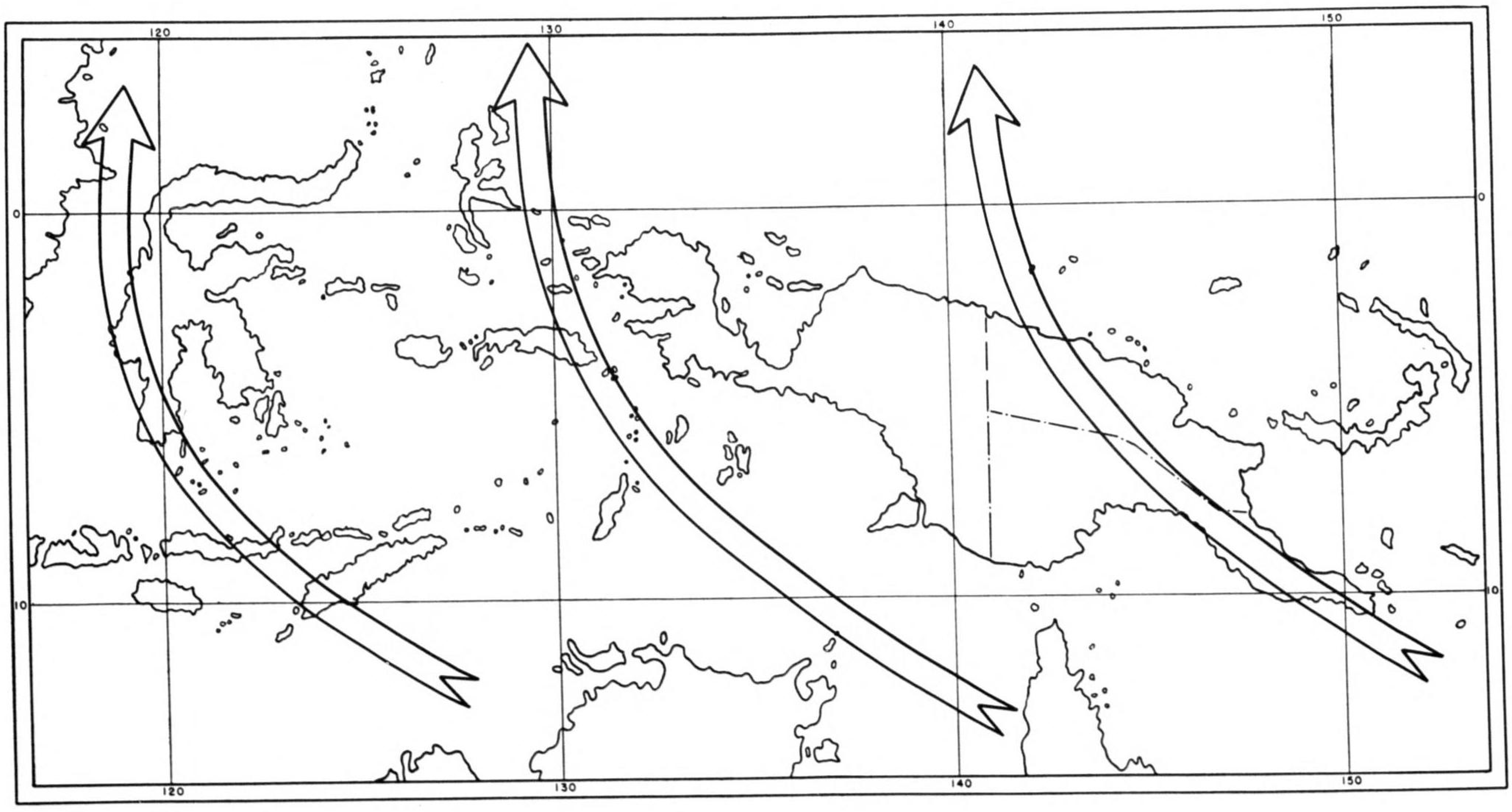

FIGURE IV - 2.
Mean air flow in July. (Southeasterly Type.) Intertropical front lies to the north, outside of area shown.

B. Weather types.

In contrast to the fairly slow and regular climatic changes described above, the changes of weather from day to day are rapid and irregular.

No actual weather maps are available for Western New Guinea, since there was no network of synoptic stations before the Japanese occupation. However, the principal types of weather likely to be encountered can be broadly described on the basis of the main air flows and their fronts. These types are synoptic in the sense that they represent weather situations at a particular moment, rather than average conditions. The descriptions are based partly upon climatic data for Western New Guinea, partly upon weather maps of neighboring regions. On all figures, the indicated air flows and frontal positions are merely diagrammatic. Actually, great variation in the details of air flow and frontal position occurs within the types.

(*1*) *Northwesterly Type* (Figure IV - 1).

During the Northwesterly Type of weather, Western New Guinea is blanketed by a great air flow from the Northern Hemisphere. This type prevails almost continuously in January and February, but it may be expected at intervals from late November until March.

Winds are mostly from the northwest quarter, but local breezes prevail along sheltered stretches of coast and in interior valleys. Wind is usually gentle, though there are strong gusts in thundersqualls, and exposed portions of the north and west coasts are windy. Turbulence, convective currents, broken cumulus clouds and local rainshowers are prevalent over the whole area, with heaviest cloudbanks and longest rainy spells on northwest-facing slopes. Temperature and humidity are normal or higher. Visibility is good except in rainshowers and in clouds on the mountain slopes.

(*2*) *Southeasterly Type* (Figure IV - 2).

During the Southeasterly Type of weather, Western New Guinea is blanketed by a great air flow from the Southern Hemisphere. This type prevails almost continuously from May through October, but it may be expected at intervals from late March until November.

Winds are mostly from the southeast quarter, but there is much local variation. Winds are usually moderate or fresh in the southern lowland, gentle in the north, with stronger gusts in thundersqualls. In much of the area the frequency of turbulence, convective currents, cumulus clouds and local rainshowers remains about as great as during the Northwesterly Type of weather. On mountain slopes facing southeastward there may be more convective activity. However, in the southern lowlands, there is a marked diminution of convection, cloudiness and rainfall during weather of the

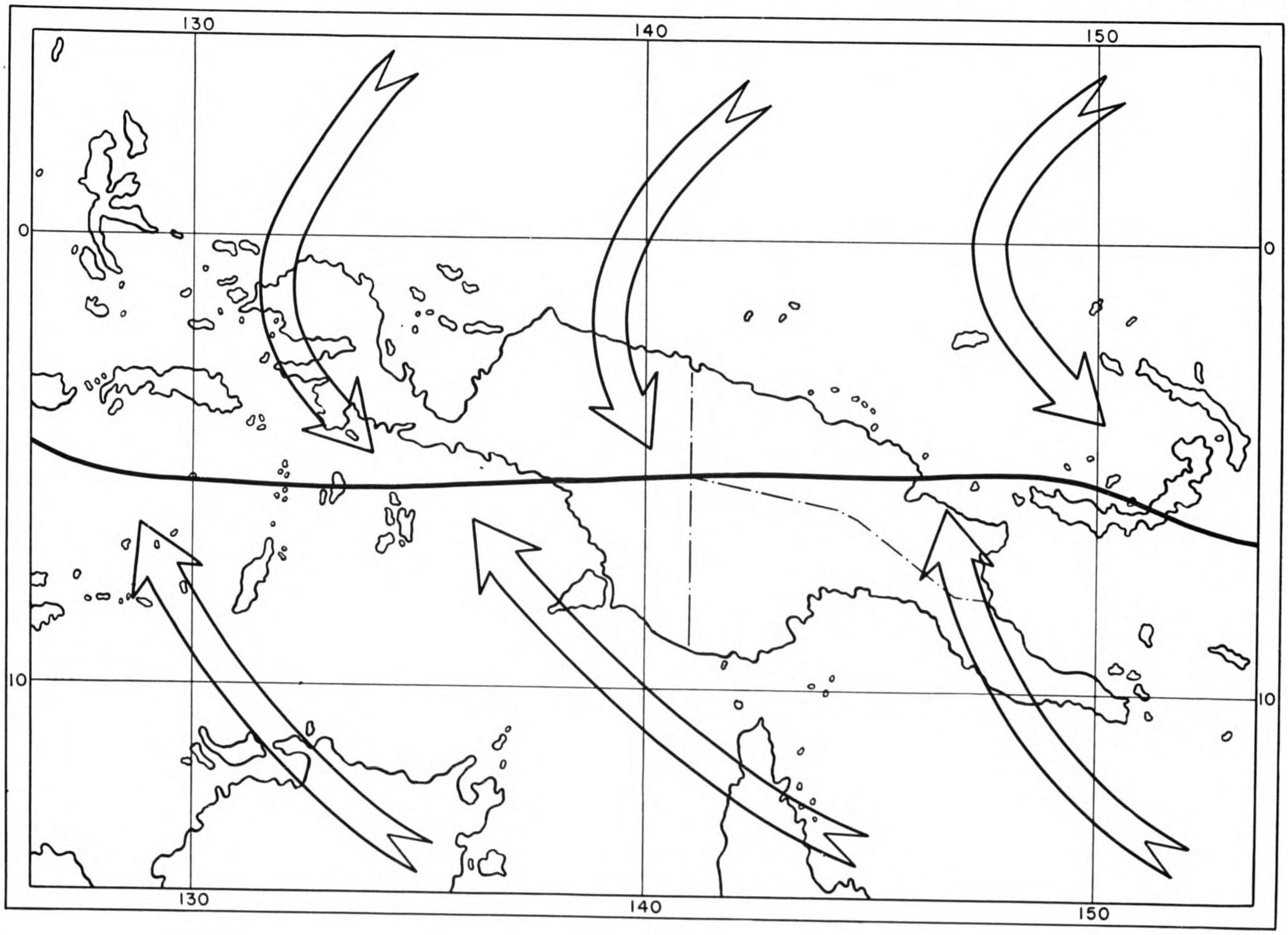

Figure IV - 3.
Intertropical Front Type weather pattern.

Southeasterly Type. Temperatures are below normal on the southeastern coast, about normal on the north coast. Dust and smoke carried from Australia cause frequent widespread haze on the south coast. This effect is less apparent on the north coast.

(3) *Intertropical Front Type* (FIGURE IV - 3).

In this type of weather pattern, the northwesterly and southeasterly streams of air meet in New Guinea along a line known as the equatorial or intertropical front. This type occurs most frequently in November-December and March-April, during the transition period between the 2 main wind seasons; but it occurs at intervals any time from late October until May.

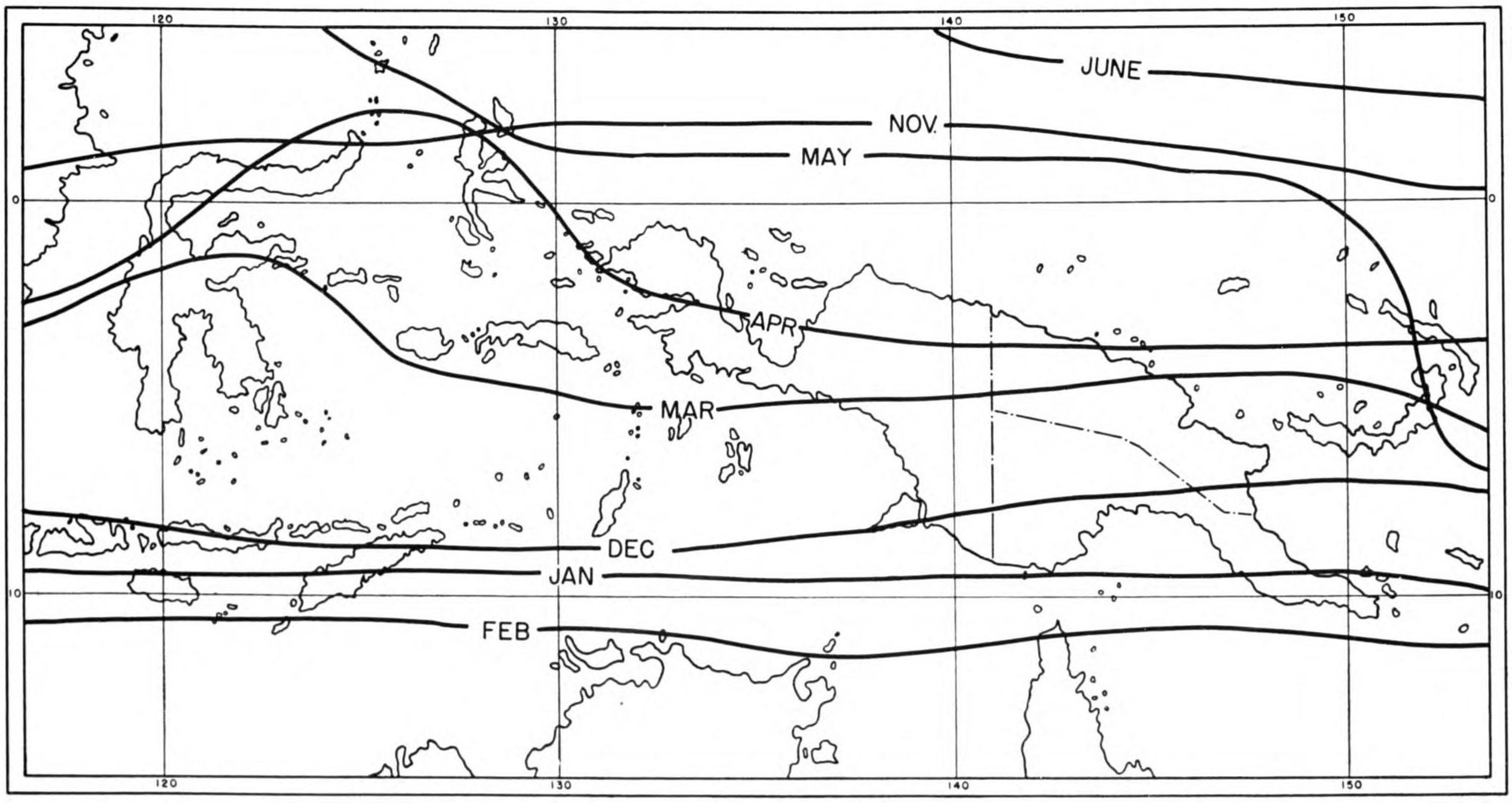

FIGURE IV - 4.
Estimated mean positions of the Intertropical Front. During months for which no position is indicated the front lies to the north, outside of area shown.

The character of the front varies from day to day, depending upon the intensity of the 2 air streams. Moreover, the front shifts its position rapidly and irregularly. The northward or southward shift may amount to as much as 200 miles in the course of a day.

North of the front, the Northwesterly Type of weather prevails; south of the front, the Southeasterly Type. Near the front, winds are light and variable, except in squalls. When the front is not strongly developed, it has little effect on weather, except to intensify local convection. Where there is strong frontal activity, the front is often marked by a wide belt of severe thunderstorms, with violent turbulence, heavy cumulonimbus cloud and downpours of rain.

(4) *Doldrum Type* (FIGURE IV - 5).

This type develops from the Intertropical Front Type and may revert to that type at any time. It occurs at the same time of year. When there is a weakening of the major air flow on one or both sides of the front, the front becomes a zone of stagnant air. This zone, the doldrum belt, is bounded by fronts of the neighboring air flows.

The edges or fronts of the belt may move very rapidly when the type is developing or disappearing, but once the belt has become established the fronts usually persist for many days, with only minor shifts.

Within the doldrum belt, winds are light and variable. Calms and local breezes predominate. Skies are relatively clear, with fair-weather cumulus clouds. The semistationary fronts at the edges of the belt are often accompanied by cloud, rain and thunderstorms.

(5) *Meridional and Orographic Front Types* (FIGURES IV - 6, 7).

Meridional fronts are fronts which develop within the major air streams. These fronts may result from intrusions of air masses from higher latitudes, in which case they are in the nature of cold fronts; or they may result from convergent wind flow within a major air stream. The northern subtype (FIGURE IV - 6) occurs most frequently from December through February; the southern subtype (FIGURE IV - 7) from April through October. The subtypes may occur simultaneously.

Meridional fronts are often persistent and slow-moving, sometimes semistationary. When well-developed, they are characterized by a line of squalls, turbulence, cloudbanks and heavy rain. A weak meridional front develops merely a belt of altocumulus cloud.

Orographic fronts, resulting from the convergence of air flow in the lee of elevated land masses (FIGURE IV - 20), have weather much like that of meridional fronts. Orographic fronts are nearly stationary but may appear and disappear suddenly with a shift in direction of the major air flow.

41. *Weather and Operations*

A. Air operations.

(1) *Low-level bombing operations.*

Weather conditions in Western New Guinea are on the whole favorable for low-level bombing operations. Ceiling, visibility, icing, and wind conditions are satisfactory most of the time over the lowlands and the coasts, though local turbulence is common. In the mountainous interior, one or more of these factors would interfere with operations much of the time.

(*a*) *Ceiling.* Ceilings low enough to interfere with low-level bombing are rare over lowland areas and the sea. In the elevated interior, low ceilings are frequent. Although cloud formation is heavy throughout Western New Guinea at all seasons, the bases of the lower clouds generally lie about 2,500 feet above sea level, and only occasionally descend below 1,500 feet. There is great local variation, dependent upon site and exposure. Great belts of deep clouds usually cover the windward slopes of the mountains, while the lee slopes have broken cloud cover.

Low ceilings are most frequent during the northwesterly air flow and the transition seasons, though the seasonal contrast is not great. When the northwesterly type of weather prevails, during Southern Hemisphere summer, there is heavy but irregular cloud formation, closely related to local topography. Low ceilings can be expected over northwest-facing hill and mountain slopes. During the Southeasterly Type of weather, cloud formation is almost as heavy; low ceilings can be expected over southeast-facing slopes. Similar local effects can be expected within the major air streams during the other weather types.

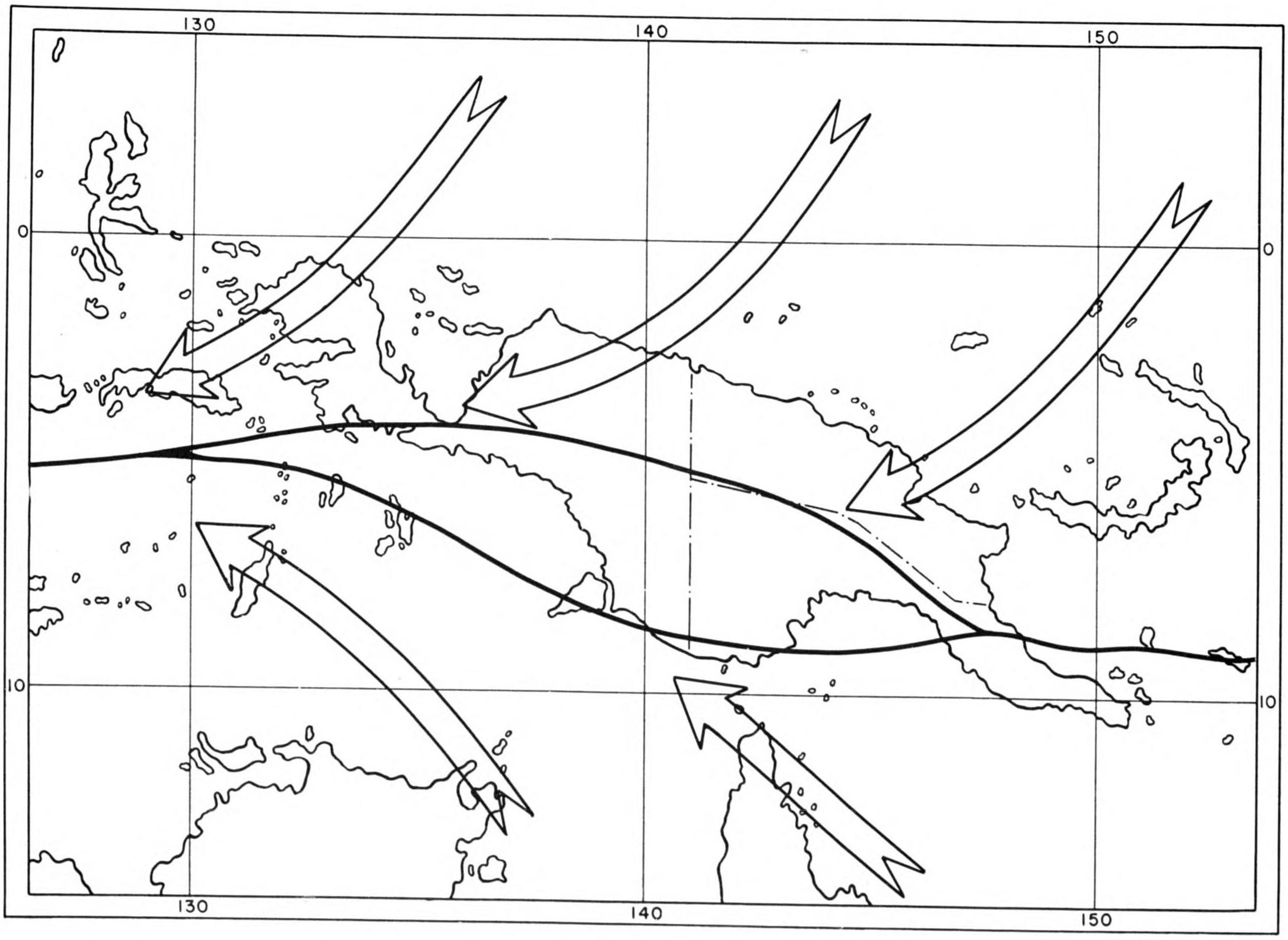

FIGURE IV - 5.
Doldrum Type weather pattern.

Along intertropical and meridional fronts, and the edges of a doldrum zone, a belt of low clouds is encountered. These frontal clouds are heaviest over the mountains, but even over the lowlands and the sea, their ceilings are occasionally very low. The width of the frontal zones varies from a few miles to several hundred miles. Within the stagnant zone of the Doldrum Type of weather, relatively clear skies can be expected.

The areal extent of cloudiness is discussed in Topic 41, A, (2), (a).

(*b*) *Visibility.* Horizontal visibility is generally good in this area, but is sometimes limited by fog, cloud, haze or rain.

Fog is rare over the sea and along the coasts. In the interior, morning fog is frequent at all seasons over river valleys, lakes, and marshes. Its occurrence is most probable on clear, quiet nights, such as are especially characteristic of the stagnant zone of Doldrum Type of weather in March-April and November-December.

Clouds cause very bad visibility conditions on mountain slopes in all seasons. On windward slopes above the condensation level, which usually lies at about 2,500 feet, the frequent thick cloudbanks have the same effect as mist or fog. Cloudiness is usually heaviest in the afternoon.

During the frequent rainstorms, visibility is usually reduced to less than 4 miles. In torrential downpours, visibility may be practically nil. A detailed discussion of rainfall is given in Topic 41, D, (1).

(*c*) *Icing conditions*. The freezing level is normally at about 15,000 feet. In all seasons and during all weather types, icing conditions can be avoided by flying at lower levels. Over the higher mountains, aircraft forced to fly above the freezing level may encounter severe icing conditions (as well as violent turbulence) if they attempt to fly through clouds.

(*d*) *Turbulence*. Severe turbulence in cumulonimbus clouds

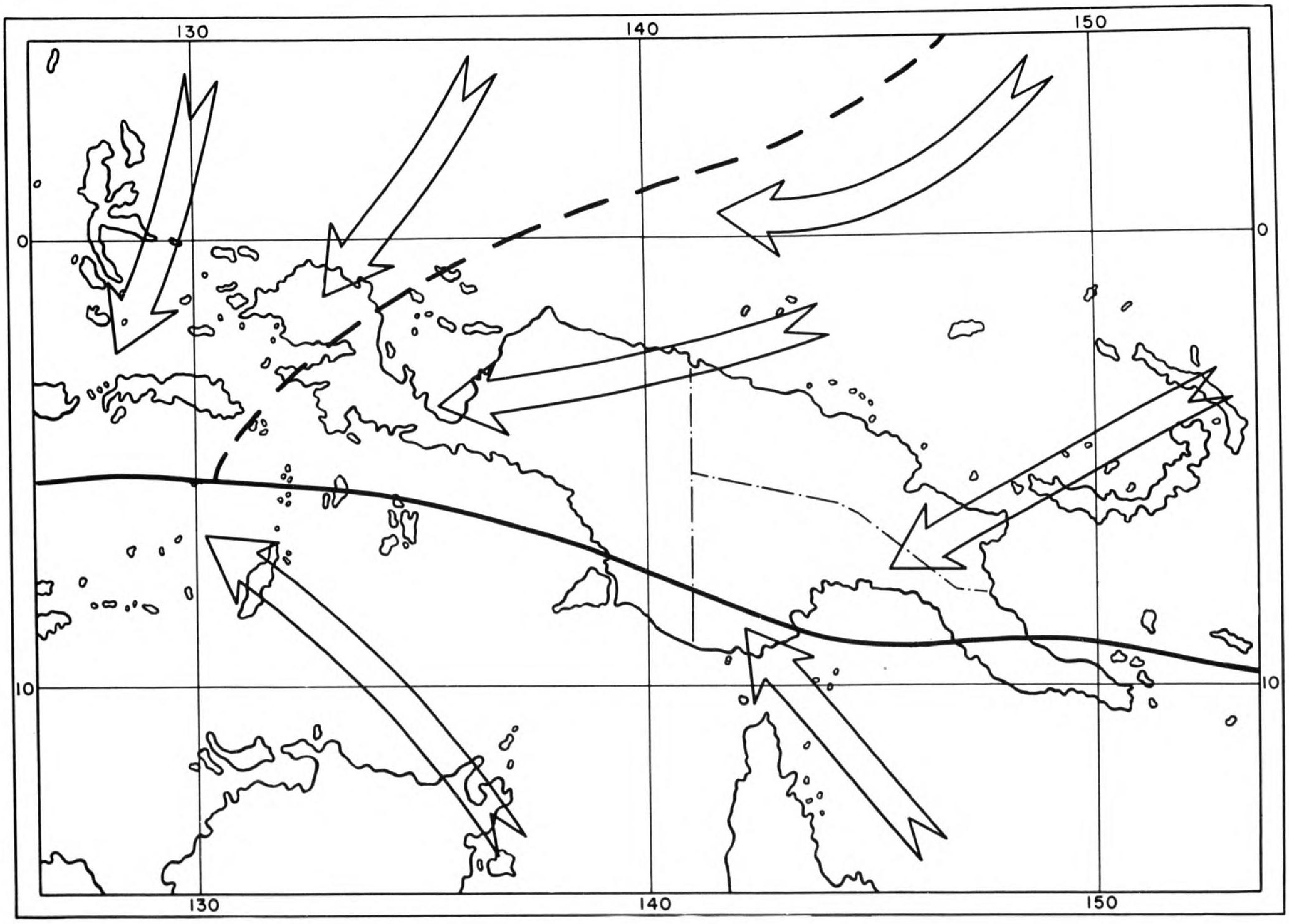

FIGURE IV - 6.
Meridional Type weather pattern. (Northern subtype.)

and thunderstorms is frequent everywhere in Western New Guinea at all seasons.

In the major northwesterly and southeasterly air streams, turbulent conditions can be expected in local cumulus clouds over the sea and lowlands and in cloud belts over the mountains. Along fronts, there are zones of severe turbulence. Fliers can usually avoid dangerous turbulence over the sea and lowlands by flying around the local thunderstorms or beneath the cloud bases in frontal storms.

Instability is so great in the moist air masses characteristic of this area that any slight forced ascent of the air is likely to set off convective activity. For this reason bad flying conditions are more frequent over hill country than over the

Haze affects all of Western New Guinea, but is worst in the southeastern part of the area. It is associated with the southeasterly wind flow, and is most common in September and October. It generally reduces horizontal visibility to 8 or 10 miles, sometimes to 3 or 4. The density of haze tends to increase with an increase in wind speed. Very dense haze is sometimes blown to New Guinea from extensive fires or dust storms in Australia.

Haze is confined to the lower layers of the atmosphere. Usually it is densest between 3,000 and 6,000 feet, with a sharp upper boundary below 10,000 feet. Above the haze layer, visibility is excellent. Haze is rare during the west-monsoon season.

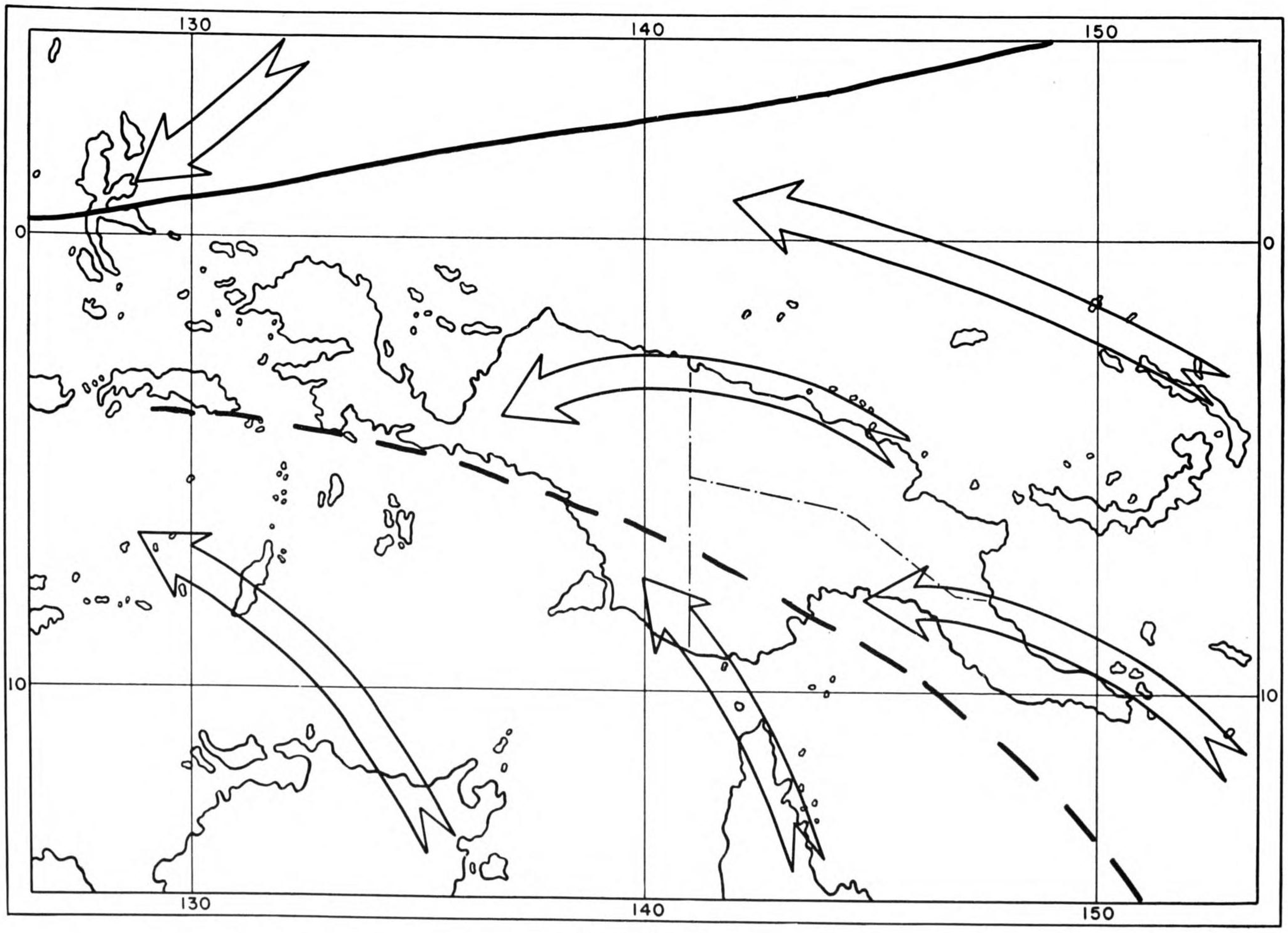

FIGURE IV - 7.
Meridional Type weather pattern. (Southern subtype.)

plains. The worst flying conditions are found on the windward slopes of the great mountain ranges, where violent turbulence and thick rain clouds can be expected. Continuous masses of towering cumulonimbus clouds, some with summits above altitudes of 40,000 feet, often build up. In flying over the mountains, it is commonly impossible to avoid severe turbulence.

Within the stagnant belt of the Doldrum Type of weather, relatively smooth flying conditions prevail.

The mean number of days per month with thunderstorms at Manokwari, on the north coast, is as follows:

West monsoon (Jan.-Feb.)	Transition seasons (Mar.-Apr., Nov.-Dec.)	East monsoon (May-Oct.)
9	13	9

Turbulence is normally worst over the sea at night, over the land in the afternoon.

(*e*) *Surface winds*. Wind directions shift with the seasons, as shown in FIGURES IV - 1 to 7. Thus, northwest winds prevail in January and February, southeast winds from May through October. In the transition months, winds are more variable, but northwest winds prevail over the northern parts of the area, southeast winds over the southern parts (FIGURES IV - 3, 4). Within the stagnant belt of the Doldrum Type of weather, variable winds, daily breezes, and calms predominate.

Along the coast there is a tendency toward regular daily variation in wind direction. On exposed portions of the coast, this tendency produces only a slight change in direction or speed of the prevailing monsoon. Thus, onshore winds are particularly strong when the monsoon is reinforced by the sea breeze tendency. In sheltered bays, local breezes often completely dominate air circulation. The land (offshore) breeze sets in during the evening and usually abates about 0900. It normally occupies a shallow layer from the surface to about 500 feet. The sea (onshore) breeze sets in around midday and abates after sunset. It is generally between 1,000 to 3,000 feet deep. The land breeze is perceptible only within a few miles of the coast; the sea breeze is sometimes perceptible for a distance of over 50 miles on both sides of the coast line, but is usually strongly developed only within 20 miles.

Topography causes great local differences in wind direction. In the mountains, winds of the main air streams are funnelled through valleys and passes. Even minor topographic features cause local variations in the characteristically weak air flow.

Many valleys experience daily shifts in wind direction. Mountain breezes (downslope) blow at night, valley breezes (upslope) in the daytime. On the lee sides of mountains, strong downslope winds can be expected when the main air flow is reinforced by the mountain breeze tendency.

At sea and along the coasts, wind speeds are moderate. On the north coast, speeds are normally on the order of a light air or light breeze (1 to 7 m.p.h.), and fresh breezes (over 18 m.p.h.) are infrequent. On the south coast speeds are greater, normally on the order of a gentle breeze (8 to 12 m.p.h.) and frequently of fresh breeze force. Speeds are usually greatest when the main air flows are directed toward the land: along the north coast during the west monsoon, and along the south coast during the east monsoon.

Over interior plains and valleys, calms and light airs predominate at all seasons, though on the plain between the Digoel River and the south coast the main northwesterly and southeasterly winds blow freely. Strong gusts may occur in thunderstorms at any season, but are most frequent along meridional and intertropical fronts.

On exposed mountain peaks, speeds are relatively high. Throughout the area, speeds occasionally exceed 30 m.p.h. in thundersqualls. However, wind speeds of as much as 40 m.p.h. are very rare, except in the mountains. Where daily breezes are well developed, wind speeds are lowest around sunrise and sunset, highest in the afternoon and at night.

(*f*) *Upper winds.* Judging by wind conditions of neighboring areas (FIGURES IV - 8 to 11), upper winds during the west-monsoon season in January and February, are predominately from the northwest quarter, becoming more westerly aloft. During the east-monsoon season, from May through October, winds are predominately from the southeast quarter in the lower levels, with westerly winds more frequent at higher levels. In the transition months, southeast winds are dominant in the south, northwest winds in the north. At all seasons speeds are usually less than 30 knots (36 miles).

(2) *High-level bombing operations.*

High-level bombing is seriously hindered a majority of the time by the prevalence of intermediate and low cloudiness. The frequent turbulence is another adverse factor. Most other weather elements are favorable for high-level bombing most of the time.

(*a*) *Cloudiness.* High-level bombing operations would be restricted by cloudiness a majority of the time over all parts of Western New Guinea. Cloudiness is greater during the season of moist northwesterly air flow than during the season of drier southeasterly air flow. In January, a month dominated by the northwesterly winds, cloudiness along the north coast of Hollandia averages about 75% of sky covered. The least mean cloudiness in January, about 65%, prevails over the southeastern lowland, Bomberai, and the northern and southern coasts of Vogelkop. In July, a month of southeasterly wind, the north coast has a mean cloudiness of about 55%, and the least cloudiness (45%) is found over the southeastern lowland and southern Bomberai.* At Manokwari, on the north coast, the mean per cent of sky covered by clouds is as follows:

West monsoon (Jan.-Feb.)	Transition seasons (Mar.-Apr., Nov.-Dec.)	East monsoon (May-Oct.)
75%	68%	59%

Over the axis of the central mountains, the sky averages more than 90% cloud-covered during both northwesterly and southeasterly monsoons. On the northern and southern slopes of the mountains, however, cloudiness varies with wind direction. When northwesterly winds are blowing, cloudiness is greater on the northern than the southern slopes. When the southeasterly winds are blowing, the southern slope is cloudier than the northern.

*The approximate percentages of cloudiness are based upon sketch maps in Engineer Research Office No. 51, Vol. 6, Part 1.

Over the land, morning is usually the clearest time of day. Cloudiness usually increases during the daylight hours. Normally, the mountains are well-covered with clouds by 0900 or 1000. Over the lowlands, early morning stratus clouds sometimes form under stable air conditions. Small cumulus clouds begin to form during the morning and grow rapidly until late afternoon.

Following are the values of mean annual cloudiness at different hours of the day at Manokwari:

0730	1300	1700
58%	63%	72%

Over the sea, cloudiness is generally greatest at night. Air photography is even more restricted by cloud than is high-level bombing. The recent aerial survey of Western New Guinea was severely hampered by clouds. It was found that photo strips could be flown in a clear sky at 13,000 feet only 4 or 5 times a month, and then usually only in the morning hours before 0900 or 1000, or in the evening after 1600. Conditions on the south coast were found to be least restrictive in November and December.

(*b*) *Other factors.* Icing, wind and horizontal visibility conditions are favorable for high-level bombing, but turbulence is widespread and severe, as has been discussed in Topic 41, A, (1), (d).

(3) *Parachute operations.*

The prevailingly low wind velocities favor parachute operations, though visibility is not often poor enough to permit surprise daylight landings.

(*a*) *Surface-wind speeds.* In all seasons and in all parts of the area, surface-wind speeds are frequently low enough for safe parachute landings. Ideal conditions can be expected in the stagnant zone of Doldrum Type of weather. Windier conditions prevail along the coasts than inland, but at many places there is a period of calm around sunrise or sunset between the daily breezes. Wind speed is discussed in detail in Topic 41, A, (1), (e).

(*b*) *Visibility.* Visibility low enough to mask parachute landings effectively is infrequent in most of this area. Fog can be expected over interior lowlands on calm mornings, especially during Doldrum Type of weather which is most frequent in March-April and November-December. Haze would occasionally produce effective concealment during Southeasterly Type of weather which is most frequent from May through October. Visibility is discussed in detail in Topic 41, A, (1), (b).

(4) *Incendiary bombing.*

Weather conditions, including heavy rainfall, low wind velocity, and high humidity, are relatively unfavorable for incendiary bombing in Western New Guinea, except in the south during the dry season (May-October).

(*a*) *Rainfall.* Over most of the area, rain falls on more than one-third of the days at all seasons and during all types of weather pattern. Rainfall is heavy, with over ½ inch falling on an average rainy day.

The driest area is the southeast, which has a dry season from June through October. Occasional periods of drought, usually lasting from 4 to 8 days, occur during the Southeasterly Type of weather on Geelvink Bay and over the Schouten and Padaido Islands. It is likely that similar droughts occur elsewhere, especially to the lee of mountain barriers. Rainfall is discussed in detail in Topic 41, D, (1).

FIGURE IV - 8
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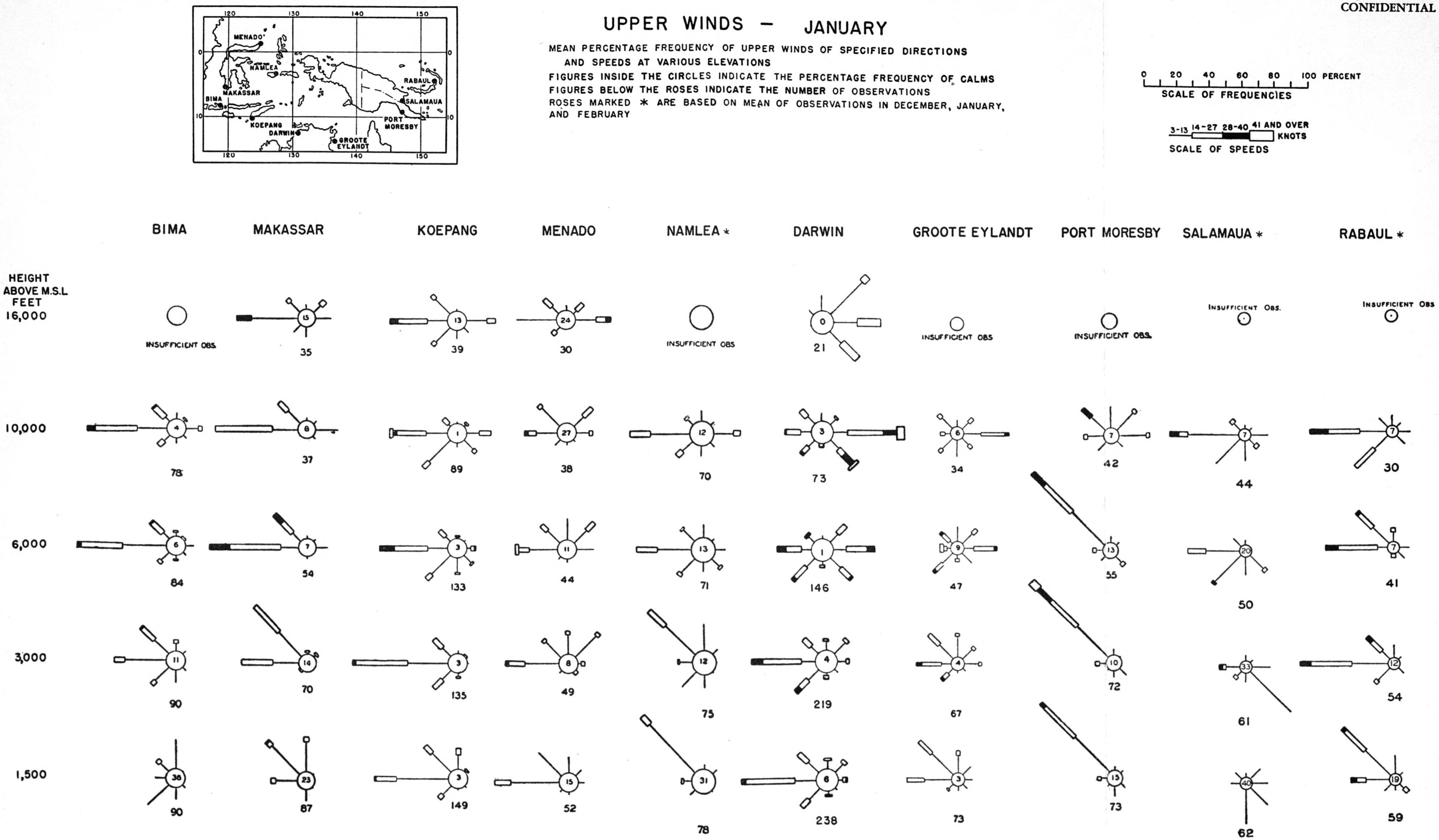

Figure IV - 8.
Upper winds—January.

FIGURE IV - 9
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CONFIDENTIAL

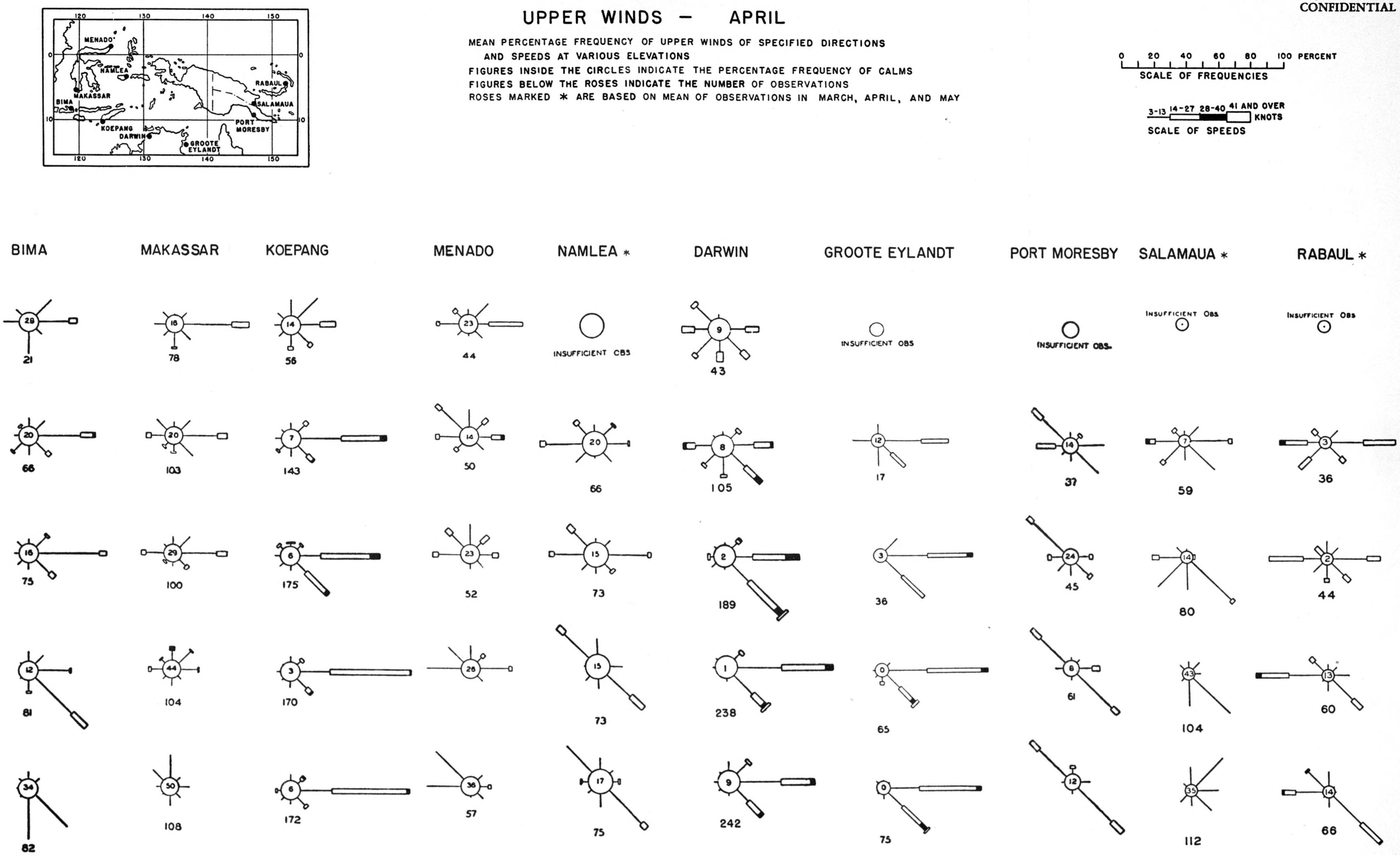

Figure IV - 9.
Upper winds—April.

FIGURE IV - 10
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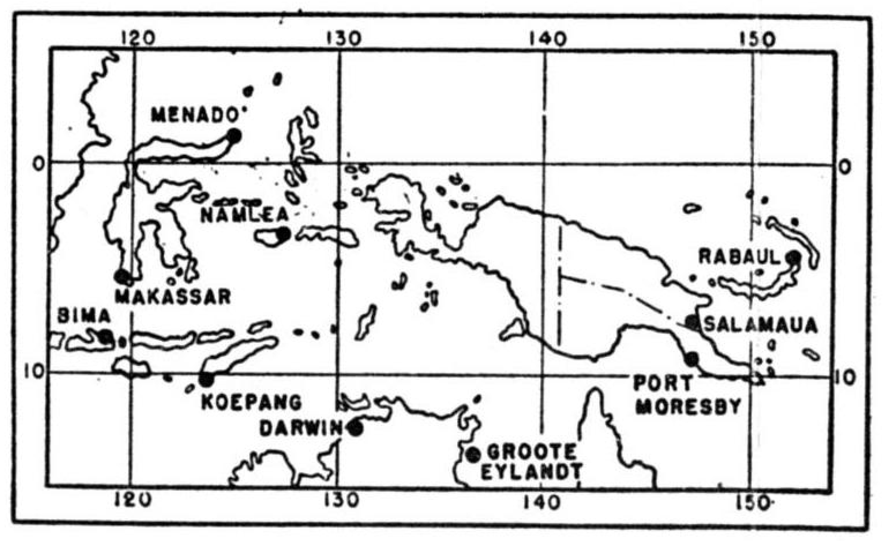


UPPER WINDS — JULY

MEAN PERCENTAGE FREQUENCY OF UPPER WINDS OF SPECIFIED DIRECTIONS AND SPEEDS AT VARIOUS ELEVATIONS

FIGURES INSIDE THE CIRCLES INDICATE THE PERCENTAGE FREQUENCY OF CALMS

FIGURES BELOW THE ROSES INDICATE THE NUMBER OF OBSERVATIONS

ROSES MARKED * ARE BASED ON MEAN OF OBSERVATIONS IN JUNE, JULY, AND AUGUST

0 20 40 60 80 100 PERCENT
SCALE OF FREQUENCIES

3-13 14-27 28-40 41 AND OVER KNOTS
SCALE OF SPEEDS

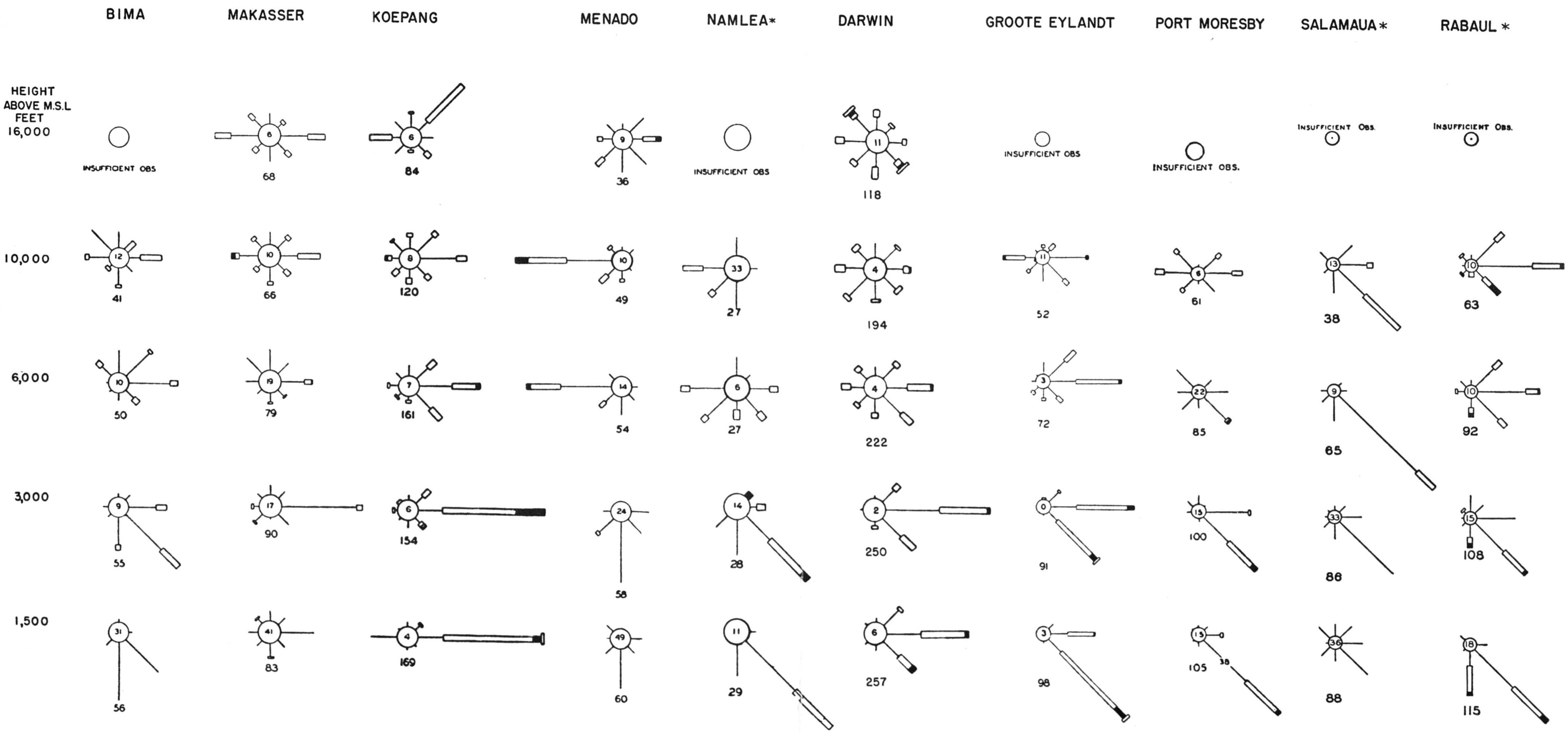
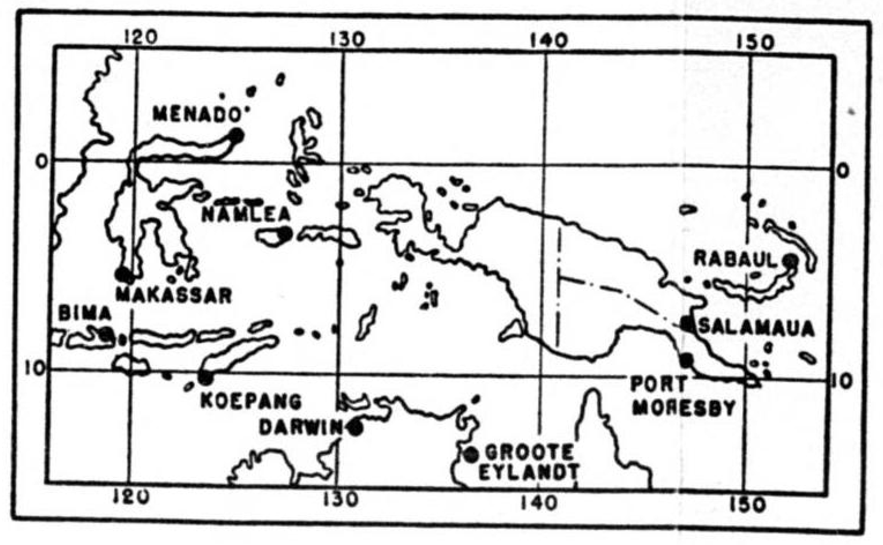


FIGURE IV - 10.
Upper winds—July.



UPPER WINDS — OCTOBER

MEAN PERCENTAGE FREQUENCY OF UPPER WINDS OF SPECIFIED DIRECTIONS AND SPEEDS AT VARIOUS ELEVATIONS

FIGURES INSIDE THE CIRCLES INDICATE THE PERCENTAGE FREQUENCY OF CALMS

FIGURES BELOW THE ROSES INDICATE THE NUMBER OF OBSERVATIONS

ROSES MARKED * ARE BASED ON MEAN OF OBSERVATIONS IN SEPTEMBER, OCTOBER, AND NOVEMBER

0 20 40 60 80 100 PERCENT
SCALE OF FREQUENCIES

3-13 14-27 28-40 41 AND OVER KNOTS
SCALE OF SPEEDS

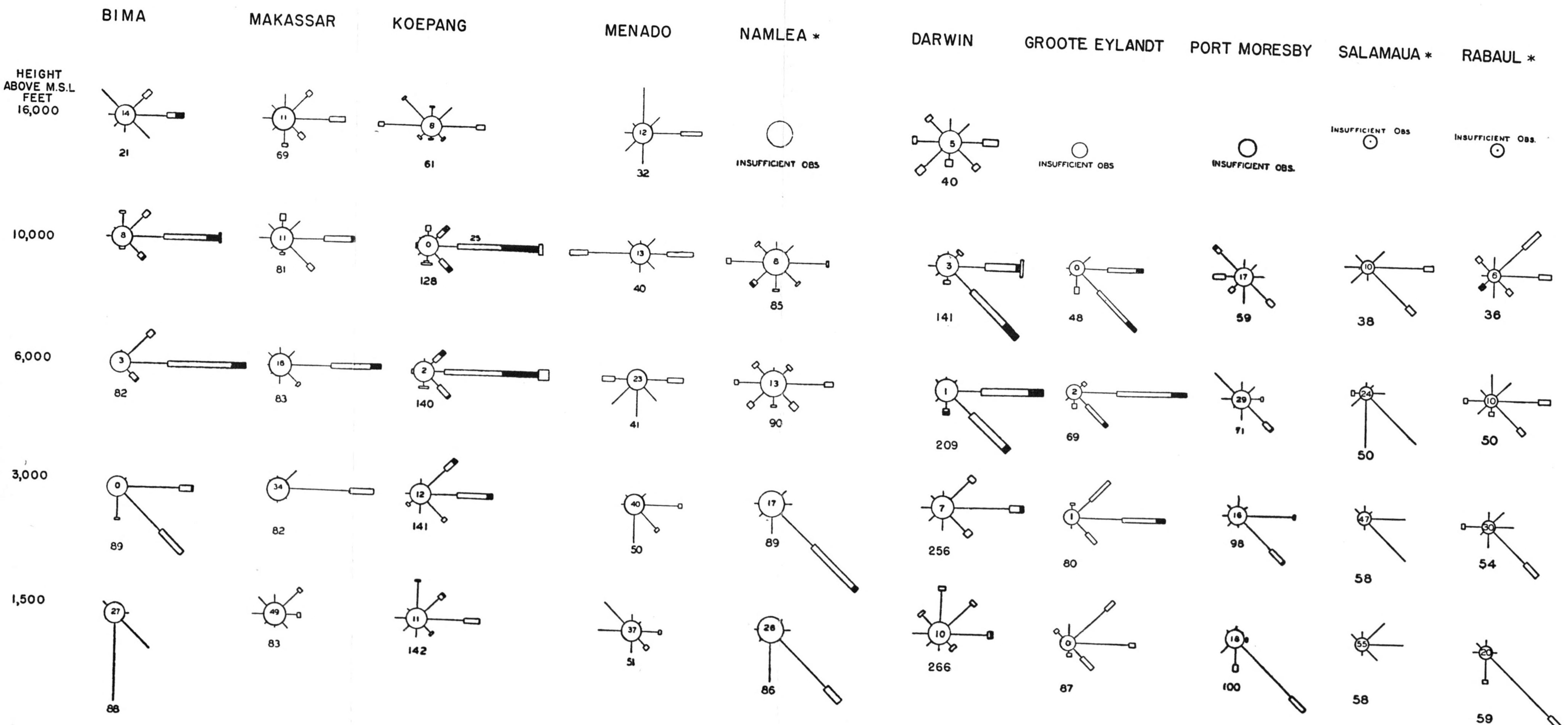


FIGURE IV - 11.
Upper winds—October.

(*b*) *Humidity*. Humidity is extremely high in all seasons. Relative humidities of over 90% can be expected nearly every day. An exception occurs in the dry season in the southeast. Localities in the lee of mountains also have occasional spells of dry air.

Low humidity accompanies the drought periods over the Schouten and Padaido Islands during the Southeasterly Type of weather. Humidity is discussed in detail in Topic 41, D, (3).

(*c*) *Wind speed*. Wind speeds are generally too low to produce satisfactory incendiary burning conditions, though along the coasts onshore winds are often fresh. Wind speed is discussed in detail in Topic 41, A, (1), (e).

(5) *Erosion and airfields.*

The heavy rainfall of Western New Guinea necessitates special precautions against destruction of airfields by erosion. Most damage is caused by concentrated downpours in which several inches of rain fall within 24 hours. Except in fields underlain by permeable coral or limestone rock, elaborate systems of drainage ditches are necessary to prevent severe gullying. Detailed descriptions of soil and terrain conditions of airfields are given in Chapter XI, 113, 115.

B. Naval operations.

Naval operations in the seas surrounding Western New Guinea are favored by the usually mild wind and gentle sea and swell. Fog is too rare either to aid surprise or to hamper navigation or accurate gunfire. Abundant clouds furnish some concealment from high-altitude planes, but also provide protection for enemy planes attacking at low levels. High humidity and frequent heavy rainfall necessitate special care of equipment.

(1) *Wind.*

At the sea and just off the coast, wind velocities are moderate. Off the north coast, velocities are normally from 1 to 7 m.p.h., and winds of over 20 m.p.h. are infrequent. Off the south coast velocities are normally 8 to 12 m.p.h. and winds of 20 m.p.h. are frequent. Throughout the area, velocities occasionally exceed 30 m.p.h. in thundersqualls. Winds of 40 m.p.h. are very rare. Where daily breezes are well-developed, near the coast, wind velocities are lowest around sunrise and sunset, highest in the afternoon and at night.

(2) *Sea and swell.*

Sea, caused by local winds, and swell, caused by distant winds, vary seasonally near New Guinea. The prevailing winds, averaging only 5 or 10 m.p.h., are normally too gentle to cause seriously disturbed sea conditions.

Off the north and west coasts sea and swell are most severe during the season of northwesterly winds, especially December to February. In January, about 75% of the observed sea was moderate or higher. In the calmest months, May and October, the sea was calm or low more than 95% of the time. Occasional distant hurricanes may produce severe swell off the north coast in any weather.

Off the south coast, the southeasterly winds produce the most serious seas, especially from April to August, when moderate seas or rougher prevail 1/3 to 1/2 the time. In December and January, the seas are calm or low practically all the time. Details of sea and swell are discussed in Chapter III, 31, D.

(3) *Horizontal visibility.*

Visibility poor enough to affect naval operations is infrequent in most of this area. Fog is rare over the sea and off the coast. Haze occasionally reduces visibility below 5 miles and is most frequent in September and October and in the southeast. During rains, visibility is usually reduced to less than 4 miles, but in torrential downpours it may be practically nil.

(4) *Cloudiness.*

Cloud cover is often sufficiently heavy to conceal naval operations from high-flying planes. However, ceilings below 1,000 feet are rare, so that clouds cannot be expected to provide protection against low-level bombing attacks.

(5) *Humidity.*

Humidity is extremely high at all seasons. Relative humidity of over 90% can be expected almost every day.

C. Amphibious operations.

On the north coast, the worst time of year for landing operations is the season of northwesterly winds from December to February, when onshore waves and wind are at their height. The best months are probably May and October, when sea is calm or low most of the time. On the south coast, the season of southeasterly winds—April to October—is worst, and the December-January period is ideal. Because of the varied trends of the coast, great local differences can be expected in suitability of conditions for landing. Visibility is rarely low enough to aid surprise landings. Cloud cover, while screening landing operations from high-level observation planes much of the time, is seldom low enough to prevent low-level attacks.

(1) *Wind and sea.*

The prevailing winds, averaging only 5 or 10 m.p.h., are normally too gentle to cause disturbed sea conditions. Seriously disturbed sea conditions are most frequent when the prevailing winds are onshore and are reinforced by the daily afternoon sea breeze.

On shores exposed toward the north and west, moderate or rough sea or swell is frequent only from December through February, when northwesterly winds are dominant. On shores exposed toward the south and east, serious sea or swell is frequent only from April through October, when southeasterly winds dominate. The low speeds of the prevailing winds are reflected in the low frequency of heavy swell.

Disturbed sea conditions are possible in any season during a thundersquall, when wind velocities sometimes exceed 30 m.p.h. Occasional distant hurricanes may produce swell on the north coast in any month, on the south coast between April and October.

There are great local differences in landing conditions, due to the varied exposure of different portions of the coast to the wind. The south shores of the Schouten and Padaido Islands opposite the mouth of Geelvink Bay are rendered unapproachable by small boats at frequent intervals from June to October by severe southeasterly wind and sea conditions. This dry, hot wind, which blows in spells of 4 to 8 days at a time, is known locally as the "wam-brau."

Night or early morning are more likely to have calm sea and offshore wind than other times of day.

Winds are treated in detail in Topic 41, A, (1), (e); sea and swell, in Chapter III, 31, D.

(2) *Visibility.*

Visibility poor enough to conceal landing operations effectively is infrequent in this area. Sea fog and coastal fog are rare. Haze occasionally reduces visibility below 5 miles, most frequently in September and October. Visibility is poorest during the frequent rainstorms. Visibility is discussed in detail in Topic 41, A, (1), (b).

(3) *Cloudiness.*

Cloud cover is often sufficiently heavy to conceal landing operations from high-flying planes. However, ceilings below 1,000 feet are rare, so that clouds cannot be expected to provide protection against low-level attacks. Ceilings are discussed in more detail in Topic 41, A, (1), (a).

D. Ground operations.

In most parts of Western New Guinea abundant rainfall in short intense showers occurs on nearly half the days at all seasons, and converts poorly-drained soil into deep mud. In the interior uplands, rainfall is even heavier, amounting to 200–400 inches per year. Only the south coastal area has a distinct dry season, from June to November.

In the lowlands, high temperature and humidity make the days oppressively hot and the nights muggy.

Food and matériel are subject to rust, mildew or rot. Temperate climate prevails in the interior uplands, pleasant to someone accustomed to conditions in the United States, but dreaded by natives of the hot New Guinea lowlands.

(1) *Precipitation.*

(*a*) *Type of precipitation*. Over the lowlands, all precipitation falls as rain. Snow and hail occur on the mountains above an elevation of 10,000 feet.

(*b*) *Weather patterns*. During the Northwesterly Type of weather (December-March), numerous local rainshowers can be expected over all of New Guinea, with continual heavy rain on the northwest slopes of the mountains. During the Southeasterly Type (April-November), there are only scattered rainshowers over the plains around Merauke, but there is continual heavy rain on the southeast slopes of the mountains. On the north coast, during this type of weather, there are occasional dry periods of a week or longer, although local rainshowers are frequent. During the Intertropical Front, Doldrum and Meridional Front Types of weather, similar local effects can be expected within the major air streams, while zones of persistent heavy rainfall prevail along the fronts. Dry conditions prevail within the stagnant belt during the Doldrum Type. Description of the main types of weather pattern is given in Topic 40, B.

(*c*) *Areal differences* (FIGURE IV - 12). On the lowlands, average precipitation is moderately heavy, ranging from less than 50 to over 150 inches a year. A relatively dry area of considerable size is located in the southeastern coastal area, around Merauke. There are great regional differences controlled largely by local relief and exposure to the main air flows. Rainfall is much heavier on mountain slopes than over the lowlands. On windward slopes above 2,000 feet, annual rainfall probably exceeds 200 inches, and at about 6,000 feet, probably exceeds 300 or even 400 inches. At 6,000 feet on the mountain slopes above the Lorentz River basin, an expedition measured 40 inches of rain in a single month. Above 6,000 feet, the amount of rainfall probably decreases gradually. Leeward slopes are drier than windward.

(*d*) *Seasonal variation* (FIGURE IV - 12). Over most of the lowlands, there is a tendency for rainfall to decrease during the east-monsoon season, from May through October. In the southeast there is a well-marked dry season. Elsewhere, rainfall decreases only slightly during this season. At a few lowland places, local topography causes an actual increase in rainfall during the east monsoon. In the mountains, seasonal variation depends upon exposure. Slopes facing northwestward tend to have heaviest rains in January and February; slopes facing southeastward have heaviest rains from May through October.

(*e*) *Daily variation*. Rain falls at all hours of the day. Over the interior, rainfall is usually heaviest in the afternoon. This tendency toward an afternoon maximum extends to the coast when the wind is blowing offshore. When the wind is onshore, there is a tendency toward a night or early morning maximum in rainfall. TABLE IV - 1 indicates the mean monthly amounts of rainfall in inches at Manokwari (Vogelkop area) during different parts of the day:

TABLE IV – 1

MANOKWARI, MEAN MONTHLY RAINFALL

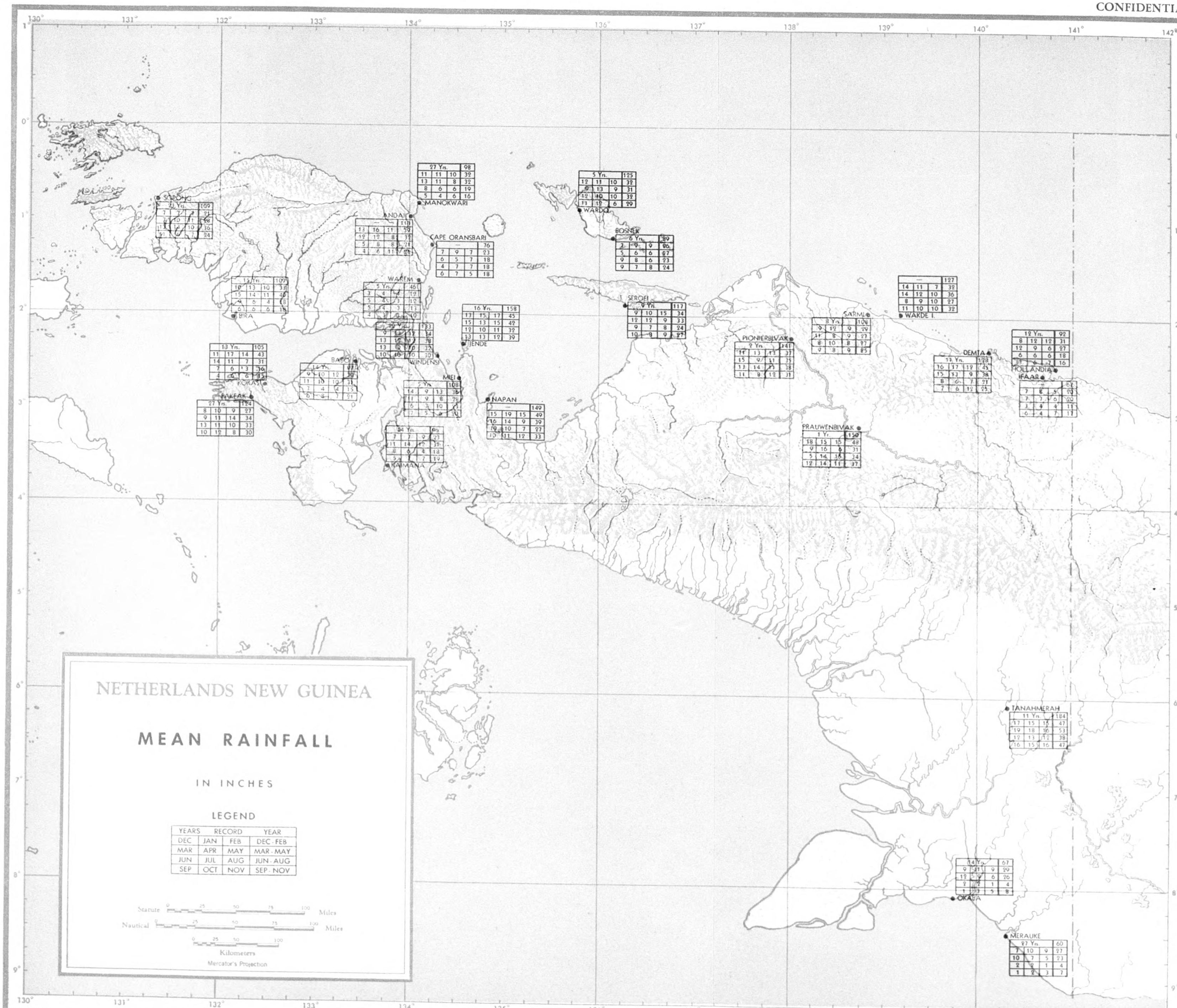
HOURS (LOCAL TIME)	MAR.	JUNE	SEPT.	DEC.
	INCHES			
0000–0400	1.9	1.2	0.3	1.1
0400–0800	1.1	1.3	1.0	0.9
0800–1200	0.8	2.0	1.2	1.5
1200–1600	3.0	1.7	0.6	2.8
1600–2000	2.6	0.7	0.5	3.5
2000–2400	3.4	0.9	0.4	2.2
Total	12.8	7.8	4.0	12.0

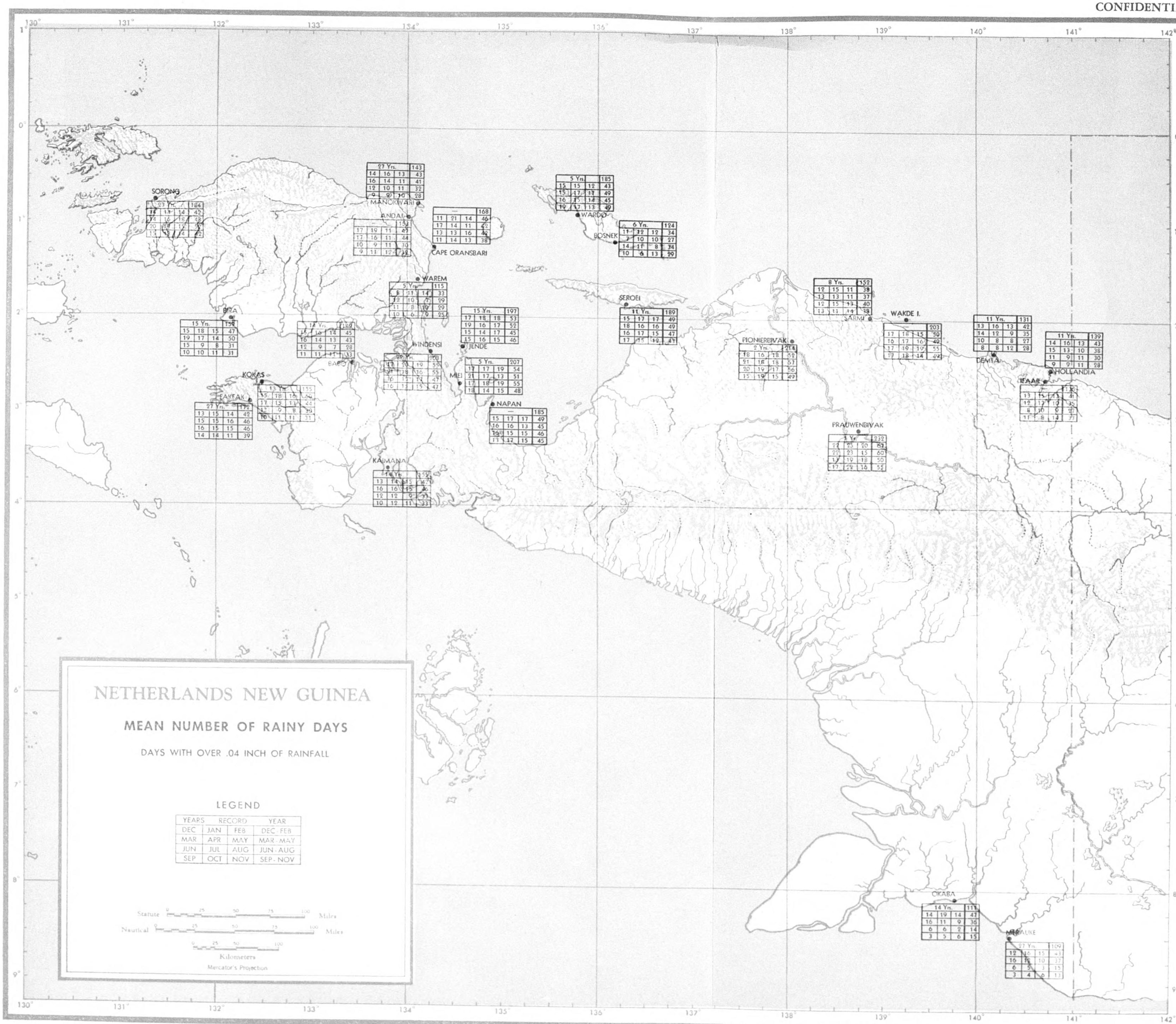
The effect of the east monsoon, which prevails from May through October, is evident in the values for June and September. This wind, onshore at Manokwari, is accompanied by a morning maximum in precipitation. A similar effect is noted at Merauke, where night and early morning rains are dominant during the season of southeasterly (onshore) winds, and afternoon rains are dominant during the season of northwesterly (offshore) winds.

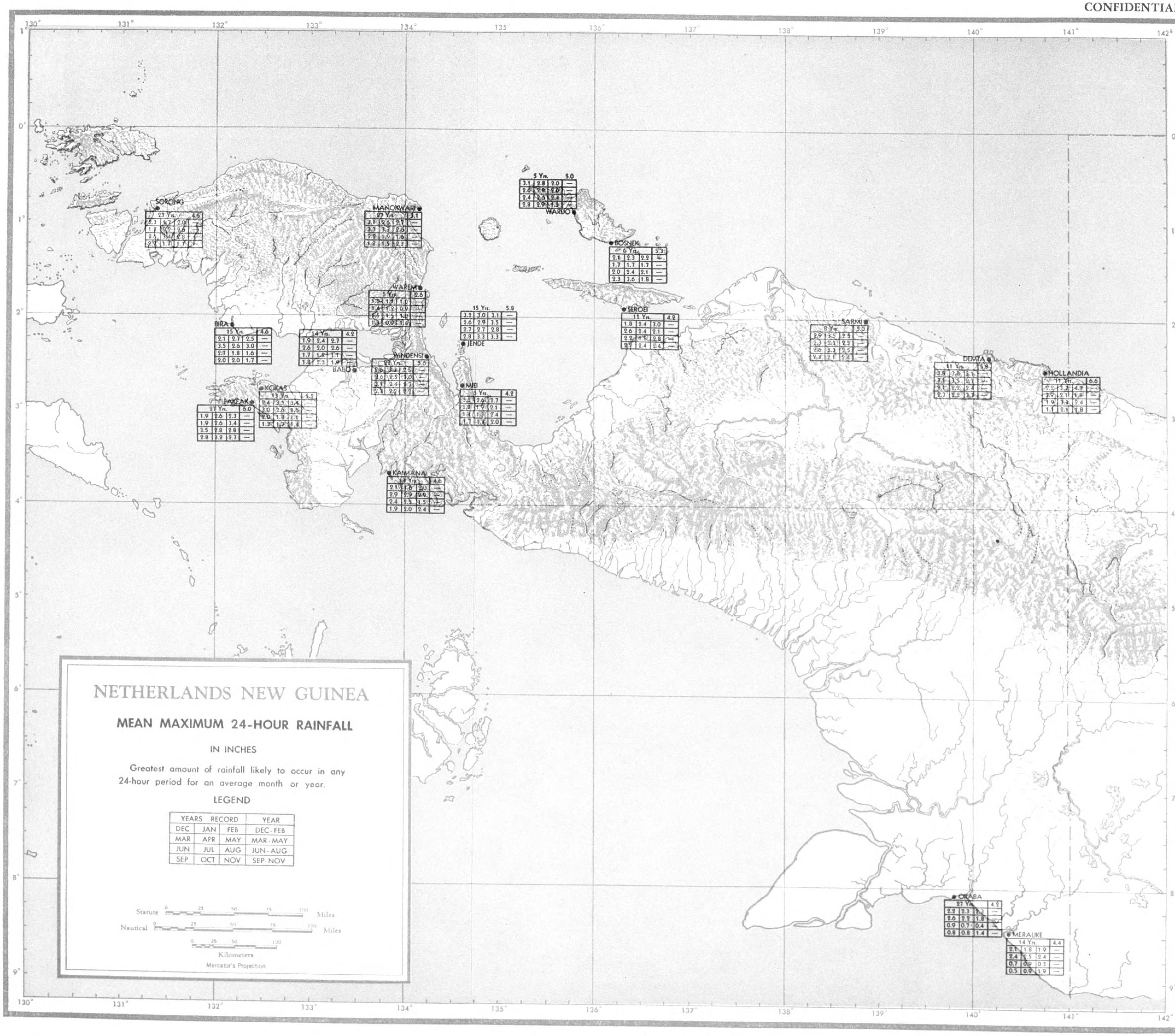
(*f*) *Year-to-year variation*. In individual years, significant departures from average rainfall conditions occur, though rainfall in a given month is rarely more than twice the normal. Rainless or nearly rainless months are extremely rare in most of the area. TABLE IV - 2 gives the extreme rainfall amounts, in inches, recorded at various stations.

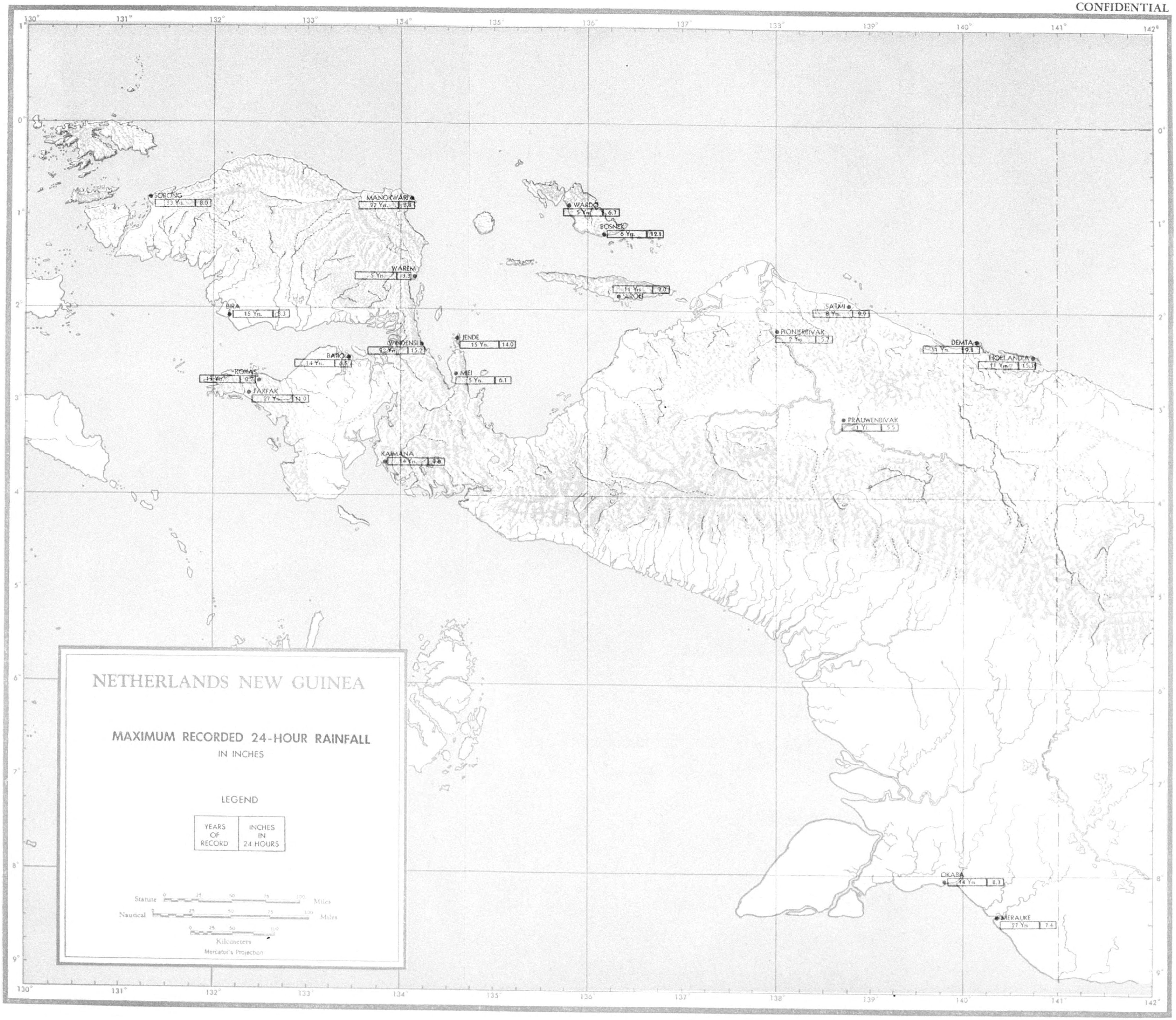
(*g*) *Frequency* (FIGURE IV - 13). On the lowlands, rain normally falls on 100 to 200 days a year. In much of the mountain region, rain falls almost every day. An expedition which spent 45 days at 10,000 feet on Doorman Peak reported rain on 41 days. Rainfall frequencies have areal, seasonal, diurnal, and year-to-year variations very similar to those of rainfall amounts.

(*h*) *Duration*. On the lowlands, rain is usually in the form of brief showers. At Manokwari, rain falls for an average of 650 hours a year. In the mountains, rain is more persistent, sometimes lasting for days with only brief letups. Duration of rainfall is usually greatest in the months when amounts are


NETHERLANDS NEW GUINEA
MEAN RAINFALL
IN INCHES
LEGEND
YEARS RECORD YEAR
DEC JAN FEB DEC-FEB
MAR APR MAY MAR-MAY
JUN JUL AUG JUN-AUG
SEP OCT NOV SEP-NOV
Statute Miles
Nautical Miles
Kilometers
Mercator's Projection
SORONG
MANOKWARI
ANDAI
CAPE ORANSBARI
WARDO
BOSNEK
WAREMI
BIRA
SEROEI
SARMI
WAKDE I.
PIONIERBIVAK
DEMTA
HOLLANDIA
IFAAR
WINDENSI
JENDE
MIEI
NAPAN
BABO
FOKAS
FAKFAK
KAIMANA
PRAUWENBIVAK
TANAHMERAH
OKABA
MERAUKE


NETHERLANDS NEW GUINEA
MEAN NUMBER OF RAINY DAYS
DAYS WITH OVER .04 INCH OF RAINFALL
LEGEND
YEARS RECORD YEAR
DEC JAN FEB DEC-FEB
MAR APR MAY MAR-MAY
JUN JUL AUG JUN-AUG
SEP OCT NOV SEP-NOV
Statute Miles
Nautical Miles
Kilometers
Mercator's Projection
SORONG
MANOKWARI
ANDAI
CAPE ORANSBARI
WARDO
BOSNEK
WAREM
SEROEI
SARMI
WAKDE I.
DEMTA
HOLLANDIA
IFAAR
PIONIERBIVAK
PRAUWENBIVAK
BIRA
BABO
WINDENSI
JENDE
MEI
NAPAN
KOKAS
FAKFAK
KAIMANA
OKABA
MERAUKE


NETHERLANDS NEW GUINEA
MEAN MAXIMUM 24-HOUR RAINFALL
IN INCHES
Greatest amount of rainfall likely to occur in any 24-hour period for an average month or year.
LEGEND
YEARS RECORD | YEAR
DEC | JAN | FEB | DEC-FEB
MAR | APR | MAY | MAR-MAY
JUN | JUL | AUG | JUN-AUG
SEP | OCT | NOV | SEP-NOV
Statute Miles
Nautical Miles
Kilometers
Mercator's Projection
SORONG
MANOKWARI
WARDO
BOSNEK
WAREN
SEROEI
SARMI
DEMTA
HOLLANDIA
BIRA
BABO
WINDENSI
JENDE
MEI
KOKAS
FAKFAK
KAIMANA
OKABA
MERAUKE


NETHERLANDS NEW GUINEA
MAXIMUM RECORDED 24-HOUR RAINFALL
IN INCHES
LEGEND
YEARS OF RECORD
INCHES IN 24 HOURS
Statute Miles
Nautical Miles
Kilometers
Mercator's Projection
SORONG 23 Yrs. 8.0
MANOKWARI 27 Yrs. 8.8
WARDO 5 Yrs. 6.7
BOSNEK 6 Yrs. 12.1
WAREM 5 Yrs. 3.3
SEROEI 11 Yrs. 7.0
BIRA 15 Yrs. 8.3
JENDE 15 Yrs. 14.0
WINDENSI 22 Yrs. 15.2
BABO 14 Yrs. 6.5
KOKAS 8.2
FAKFAK 27 Yrs. 11.0
MIEI 5 Yrs. 6.1
KAIMANA 14 Yrs.
SARMI 8 Yrs. 9.9
PIONIERBIVAK 2 Yrs. 5.7
DEMTA 11 Yrs. 9.8
HOLLANDIA 11 Yrs. 15.3
PRAUWENBIVAK 1 Yr. 5.5
OKABA 14 Yrs. 8.3
MERAUKE 27 Yrs. 7.4

greatest. For example, at Manokwari there is an average of 81 hours of rain a month during January and February, 33 hours a month during July, August and September.

(i) Intensity (FIGURES IV - 14, 15). On the lowlands rainfall is usually in the form of intense showers. On an ordinary rainy day, more than ½ inch of rain falls. One or more days with over 2 inches of rainfall occur nearly every month; days with more than 4 inches of rainfall occur nearly every year. The greatest rainfall recorded in one day is over 15 inches. On the lower slopes of the mountains much greater intensities probably occur. Above 6,000 feet, the intensity gradually decreases, and drizzle becomes more frequent. Maximum intensities generally occur in the months which have the greatest average amounts of rainfall.

(j) Soil trafficability and rainfall. Saturation of the soil by the frequent heavy rains seriously hampers ground movement in Western New Guinea. The sandy and coarse-textured soils and those underlain by limestone dry out quickly after a rainstorm, but low-lying poorly-drained valleys or plains form permanent or semi-permanent marshes, impassable to motor transport. Valley floors are also subject to flooding by rivers. A detailed description of soil trafficability is given in Chapter II, 23.

(2) *Temperature.*

(a) Lowlands. All the lowlands of New Guinea have tropical temperatures throughout the year. There is little change from month to month, regardless of the season or of the type of weather pattern prevailing. On the north coast, the mean temperature is about 80° F. in all months; on the south coast, a little above 80° F. from December to May, a little below 80° F. from July to October.

The drop of temperature during the night gives only slight relief from the oppressive heat of the day. Thus, at Manokwari the mean daily maximum temperature is 86° F.; the mean minimum, 74° F. At some localities the sea breeze makes the afternoon heat more bearable. During an entire 5-year period the highest and lowest temperatures recorded at Manokwari were 93° F. and 68° F. TABLE IV - 3 shows the mean daily maximum and minimum temperatures, in ° F., for 4 localities.

TABLE IV - 2

NETHERLANDS NEW GUINEA, EXTREME RAINFALL

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Yr.
							Inches						
Hollandia (Northeast). 8-year record.													
Maximum	19	20	21	13	10	10	14	30	6	12	10	10	111
Minimum	3	3	8	5	2	4	3	3	2	3	4	4	72
Manokwari (Northeastern Vogelkop). 31-year record.													
Maximum	25	27	28	27	30	19	13	12	10	10	16	30	173
Minimum	3	3	4	2	2	3	0	1	1	1	1	3	58
Sorong (Western Vogelkop). Length of record unknown.													
Maximum	13	13	16	17	21	24	22	28	25	20	14	14	159
Minimum	2	2	3	6	5	7	1	*	1	1	2	2	77
Merauke (Southeast). 19-year record.													
Maximum	22	17	26	12	16	6	9	3	4	13	6	20	79
Minimum	2	3	4	2	1	0	0	0	*	0	*	1	35

*Amount greater than zero but less than ½ inch.

TABLE IV - 3

NETHERLANDS NEW GUINEA, MEAN DAILY EXTREMES OF TEMPERATURE, °F.

Location	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yr.
Prauwenbivak (3° 15′ S, 138° 35′ E, Northeastern Netherlands New Guinea). 2-year record.													
Maximum	84	85	87	85	87	88	88	89	87	87	89	87	87
Minimum	75	74	75	74	75	75	75	74	73	74	74	74	74
Pionierbivak (2°17′ S, 138°02′ E, Northeastern Netherlands New Guinea). 2-year record.													
Maximum	87	91	89	89	89	89	87	87	88	89	90	89	89
Minimum	74	75	73	74	74	74	73	73	73	73	74	74	74
Manokwari (Vogelkop). 5-year record.													
Maximum	85	85	85	85	86	85	85	86	86	87	87	86	86
Minimum	73	73	74	74	74	74	74	74	74	74	74	74	74
Merauke (Southeastern New Guinea). Length of record unknown.													
Maximum	89	88	88	87	86	84	82	82	83	86	87	89	86
Minimum	76	78	77	75	76	75	72	70	72	71	74	74	74

(*b*) *Uplands.* In the interior uplands temperature decreases with increasing elevation. As in the lowlands, temperatures in the highlands vary but little in the course of the year. It is estimated that the approximate mean temperatures at various altitudes in Western New Guinea are as follows:

Elevation (Feet)	Temperature (°F.)
16,000	29
12,000	44
9,000	53
6,000	61
3,000	69
Sea Level	81

At an elevation of a mile above sea level the temperature is fairly comfortable for Europeans or Americans, but too cool at night for natives from the hot lowlands. At this altitude afternoon temperatures of about 70° F. and pre-dawn temperatures of about 60° F. are to be expected.

Intense alpine cold prevails in small summit areas (Chapter II, 23) above elevations of 14,750 feet. Temperature is below freezing much of the time, snow accumulates on the ground and there are said to be glaciers on some of the highest peaks.

(*3*) *Humidity.*

Humidity is extremely high at all seasons during all types of weather, and adds to the oppressiveness of the heat. On the north coast, relative humidity averages over 80% throughout the year. During Southeasterly Type of weather, abnormally low relative humidities sometimes occur over the north coast when there is a dry wind blowing down from the mountains. However, humidity very rarely drops below 50%. On the south coast humidity is equally high from November through April, but decreases slightly from May through October. Relative humidity increases with increasing elevation, averaging more than 90% at medium elevations on the mountains.

Daily variation is greater than seasonal variation. On an average day, relative humidity varies from 70% to 97% at Manokwari with the higher figure occurring at night. Following are the mean annual values of relative humidity (in per cent) at different hours of the day at Manokwari:

0200	0400	0600	0800	1000	1200	1400	1600	1800	2000	2200	2400
93	93	94	86	79	76	77	79	88	93	93	93

E. Chemical warfare.

Chemical warfare would be aided by the low wind speeds and high temperatures of Western New Guinea, hampered by the prevalence of turbulence and high humidity.

(*1*) *Surface-wind speed.*

High surface-wind speeds are unusual in this area. Over the lowlands, wind speeds are normally on the order of a gentle breeze or less. Calms are frequent. Details of wind speed are given in Topic 41, A, (1), (e).

(*2*) *Turbulence and instability.*

Turbulence and instability of the surface air are very frequent in this area. A high degree of convective instability is characteristic of all seasons. Instability and turbulence are at a minimum immediately before sunrise. Daily heating of the land surface causes great convective activity in the afternoon. Details of turbulence are given in Topic 41, A, (1), (d).

(*3*) *Low temperatures.*

Temperatures low enough to interfere with chemical warfare are unknown over the lowlands. Frost can be expected only on the higher mountains. Temperature is discussed in detail in Topic 41, D, (2).

(*4*) *Humidity.*

Very high humidity is characteristic of this area. Absolute humidity probably averages over 20 grams per cubic meter. Relative humidities above 50%, which reduce the effectiveness of some chemical agents, prevail practically all of the time. Other details concerning humidity are given in Topic 41, D, (3).

42. Meteorological Facilities

The meteorological service of Western New Guinea, like that of all the Netherlands Indies, was administered by the Royal Magnetic and Meteorologic Observatory at Batavia (Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia). Statements in this section refer to the situation under Dutch administration, before the Japanese occupation.

A. Observations.

(*1*) *Surface observations.*

Before 1866, when the central observatory at Batavia was established, meteorological observations in the Netherlands Indies consisted mainly of sporadic efforts by a few amateurs. In 1879 the central observatory began organizing a widespread net of rainfall stations in Java and the Outer Provinces. Few rainfall records were kept on New Guinea until after 1900. In 1912 observations of elements other than rainfall were started at various secondary stations in Java and the Outer Provinces, including Manokwari in New Guinea. The station at Manokwari was abandoned in 1922 because of difficulty in obtaining a dependable observer.

By 1939 the entire system reporting to the central observatory from New Guinea consisted of the following stations:

About 20 stations equipped with rain gauges.

Several stations with "sunshine meters" (source of "cloudiness" data).

One station (Merauke) equipped with a barometer and a dry bulb thermometer.

One temporary camp equipped with wet and dry bulb thermometers.

Observations were entrusted to European personnel, usually minor government officials, who were paid a fee in return for keeping weather records. They were allowed to assign the work to subordinate personnel.

(*2*) *Upper air observations.*

As late as 1938 no regular radiosonde ascents were made anywhere in the Netherlands Indies. Kite and pilot balloon soundings were begun in Java in 1908, but were not initiated in the Outer Provinces until after 1920. By 1939 there were 16 stations in Java and the Outer Provinces making soundings with 50-gram pilot balloons. None of these stations was on New Guinea.

B. Forecasts.

(*1*) *Long-range forecasting.*

For many years the central observatory at Batavia has issued predictions as to the relative dryness or wetness of the ensuing east-monsoon season, based chiefly on long-term barometric tendencies. These predictions were usually worded in very general terms.

(2) Short-range forecasting.

Daily forecasting in the Netherlands Indies began in 1935, in response to the needs of the airways. The first weather maps were drawn in September 1935. They were based on radio reports in International Code from 13 stations in the Netherlands Indies including Merauke on New Guinea, and from various stations in northern Australia, Malaya, Thailand, Indo-China, China, the Philippines and Japan. By 1939, reports from British India had been added, and the number of synoptic stations in the Netherlands Indies had increased to 26. Merauke remained the sole synoptic station on Western New Guinea. Sixteen of the Netherlands Indies stations were reporting pilot balloon observations, either two or three runs per day.

The central observatory prepared 3 maps per day based on reports at 0700, 1300, and 1700. (Not all of the Netherlands Indies stations reported more than twice a day.) Surface reports were entered according to the international notation on 1:10,000,000 maps. In addition, maps were prepared of upper winds at various levels.

During 1938 the government service furnished 685 forecasts for regular air routes, as well as occasional forecasts for military planes. Only the latter would have required forecasts for New Guinea.

At the present time the U.S.A.A.F. maintains a base weather station at Merauke. The station has been in full operation only since 30 September 1943. Surface observations are taken hourly, pilot balloon observations 4 times per day. Synoptic reports are transmitted and received by radio. One trip forecast and 2 route and terminal forecasts are made daily.

C. Aids to forecasting.

Since there was no network of synoptic stations in Western New Guinea before the Japanese occupation, no weather maps or local forecasting rules can be presented for this region. Local information concerning forecasting for the southeast may soon be available from the U.S.A.A.F. weather station at Merauke.

Considerable information is available concerning forecasting in nearby areas, though the techniques of forecasting in this part of the world are still in the pioneering stage. The sparse network of synoptic stations permits only an incomplete understanding of the nature of air masses and fronts, effects of local topography, and types of synoptic situations. A brief outline of some of the known phenomena is presented in this section.*

(1) Nature of air masses.

The northwesterly air mass, known locally as the west monsoon, originates in the subtropical high cells of the North Pacific. Carried southward by the northeast trades and deflected upon crossing the equator, this air mass arrives over New Guinea from the northwest. It has had a long maritime trajectory and is classified NTp (Modified Tropical Pacific).

Southeast trade air, known locally as the east monsoon, originates in the high cells of the Southern Hemisphere. Southeast trade air which has had a long maritime trajectory is classified NTm (Modified Tropical Maritime); that which originates over the Australian continent and has had a short maritime trajectory is classified NTc (Modified Tropical Continental).

Convective instability is characteristic of all air masses affecting this area. Instability is generally greatest in NTp air, least in NTc air. Soundings at Batavia give the following mean values for absolute humidity in grams per cubic meter:

TABLE IV - 4

BATAVIA, ABSOLUTE HUMIDITY

ELEVATION	NOV.-MAY	JUNE-OCT.
FEET	GRAMS PER CU. METER	
25,000	1	½
20,000	2	1
16,000	3	2
12,000	5	4
9,000	7	6
6,000	10	10
3,000	15	14
Sea level	22	21

These soundings indicate only a slightly lower moisture content in the southeast trade air (dominant from April to November) than in the northwesterly air (dominant from December to March). The contrast is probably greater over New Guinea. Moisture content of the air masses is subject to irregular variations that are at present unpredictable.

(2) Nature of fronts.

The intertropical or equatorial front forms the boundary between northwesterly and southeast trade air. Since these 2 air masses have quite similar characteristics in the lower levels, this front is not a strong density discontinuity, as in extratropical disturbances, but rather a pressure trough and a wind discontinuity.

The intensity of the intertropical front varies greatly according to the intensity and orientation of the northwesterly and southeast trade air flows. With weak, nearly parallel flows, the front deteriorates into a doldrum zone. There is disagreement as to the slope of the front. It appears that the discontinuity is nearly vertical when adjacent northwesterly and southeast trade air streams move in the same direction, while with oppositely directed streams, the slope in the lower levels is on the order of 1:200 or 1:400. The vertical type of front is most frequent in this region when the front is near the equator, the gently-sloping type when the front is farthest from the equator. The intertropical front moves northward and southward irregularly, acting as either a warm or cold front. The southeast trade air tends to act as a cold mass in opposition to northwesterly air. Accurate predictions of variation in intensity and position of the intertropical front require extensive surface reports and soundings from the entire western Pacific area, including southeastern Asia and Australia.

Another type of front is formed by convergence within the northwesterly or southeast trade air stream. In some cases, such fronts are associated with a trough or frontal boundary moving into the equatorial zone from the higher latitudes of either hemisphere. Prediction of the occurrence of these fronts requires synoptic reports from high latitudes. Such fronts have been reported as slow-moving but well-defined cold fronts, with a slope of 1:200 or 1:300. Often they move erratically or become quasi-stationary, with no well-defined

*A more comprehensive discussion of forecasting is given in Day, J. A. c. 1942. SYNOPTIC ANALYSIS IN THE TROPICAL PACIFIC.

slope. In other cases, sharply-defined fronts within major air streams result from convergent flow on the leeward side of a land body. The height of the front is limited to the height of the land mass. This type of front is often persistent and quasi-stationary, although it may appear and disappear rapidly with slight shifts in the orientation of the major air flow.

(3) *Effects of topography.*

Local topography causes wide differences in weather from place to place. Because of the instability of both northwesterly and southeast trade air, orographic lifting is the critical factor in convection and condensation. Topography also modifies the movements and morphology of fronts of all types.

The resulting weather conditions are exceedingly complex. Slight contrasts in slope or exposure may produce quite different kinds of weather. For this reason, meteorologists require intensive, first-hand knowledge of local peculiarities within the area for which they are required to forecast. Acquaintance with local topographic effects is essential even in forecasting for patrol areas over the sea, since orographic effects may extend far out to sea.

(4) *Synoptic situations.*

Synoptic types and the associated weather which may be expected in Western New Guinea are presented in Topic 40, B. FIGURES IV - 16 to 21 illustrate the frontal and barometric conditions associated with each synoptic type. Because analysis of weather over Western New Guinea is based largely upon speculation, the types selected here are simple. Much more detail and refinement in typing synoptic situations would be required for accurate forecasting.

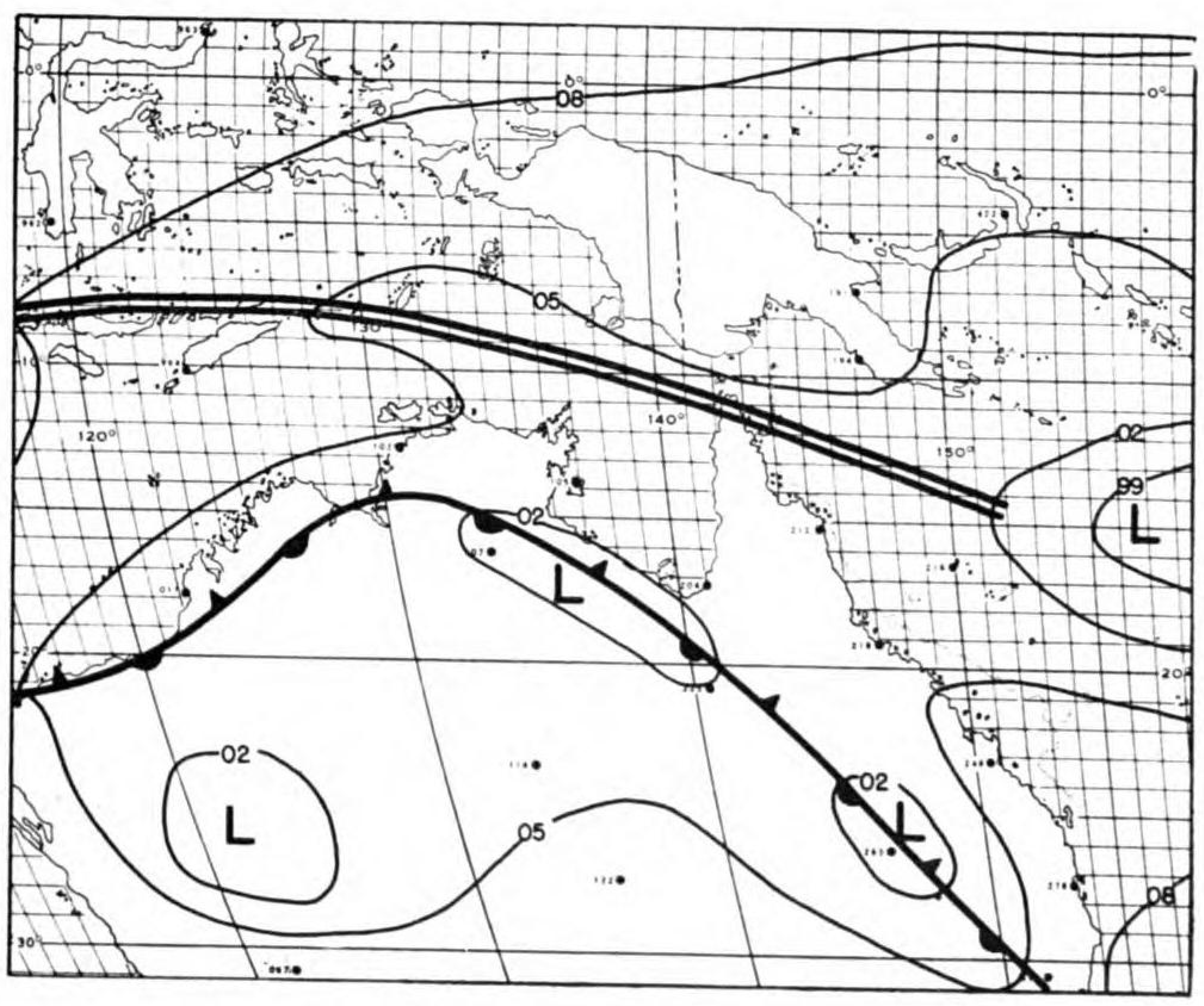


FIGURE IV - 16.
Synoptic example of Northwesterly Type. (0630Z 13 January 1944)

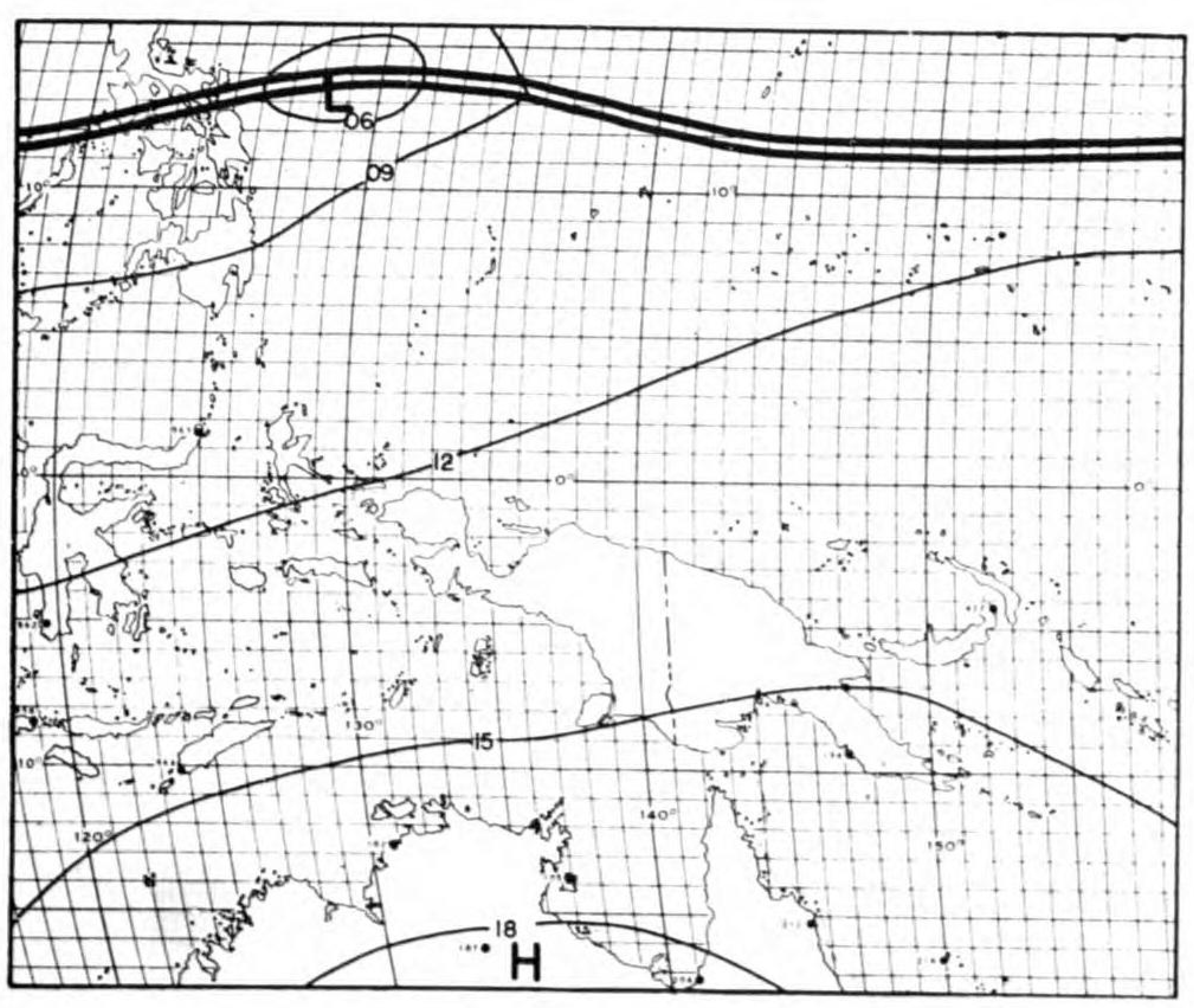


FIGURE IV - 17.
Synoptic example of Southeasterly Type. (0000Z 25 July 1940)

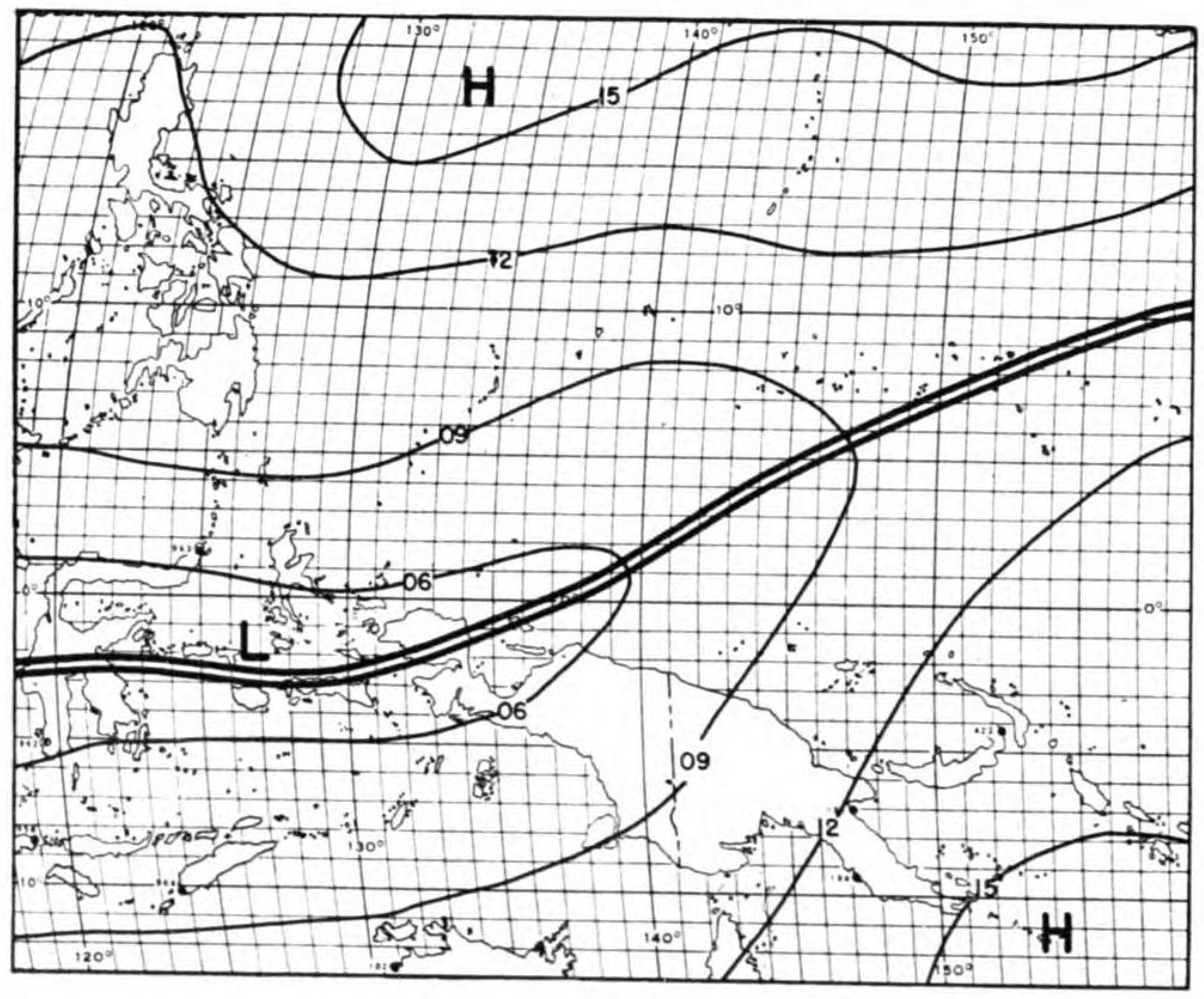


FIGURE IV - 18.
Synoptic example of Intertropical Front Type. (0000Z 4 May 1941)

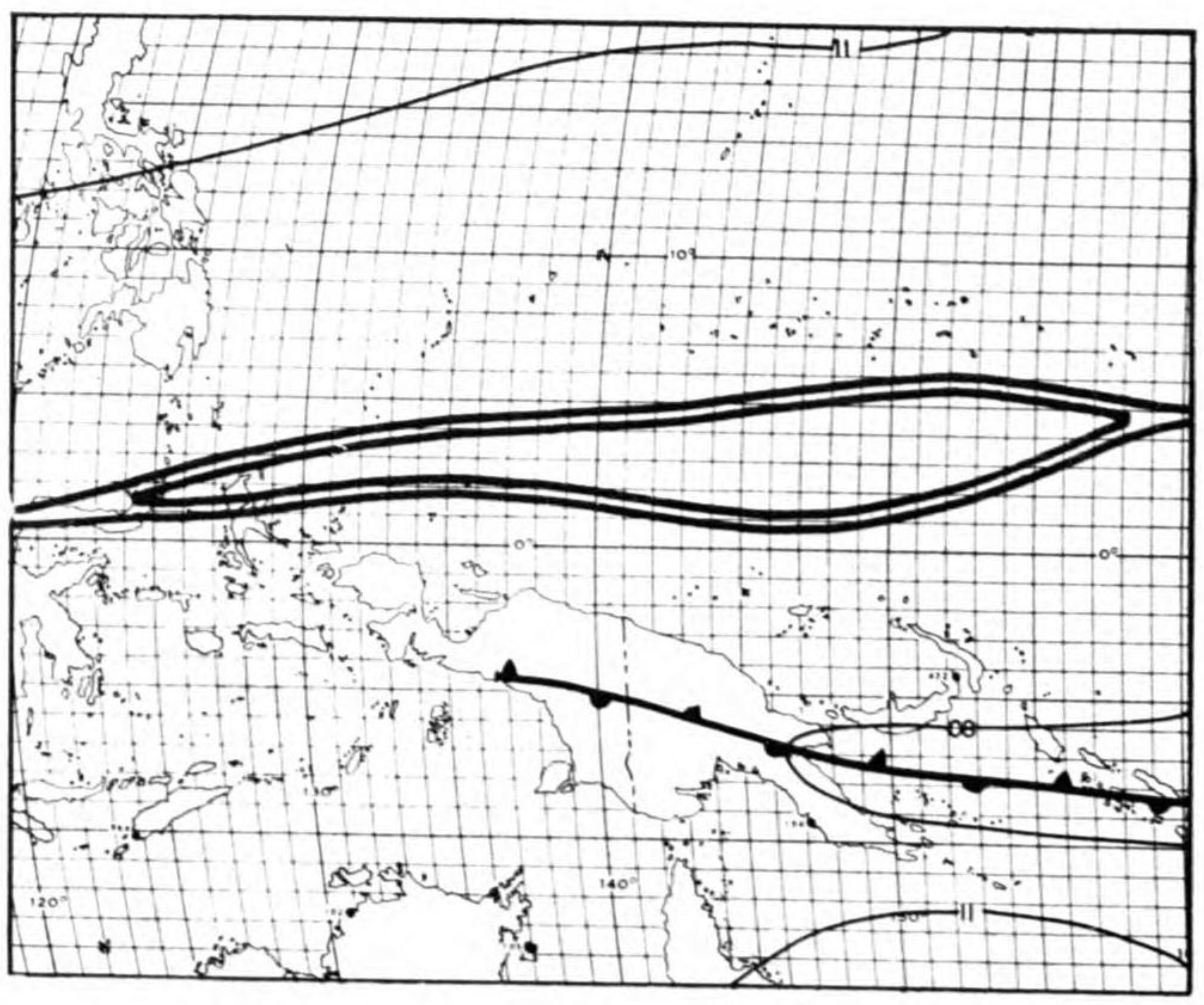


FIGURE IV - 19.
Synoptic example of Doldrum Type. (2200Z 26 November 1943)

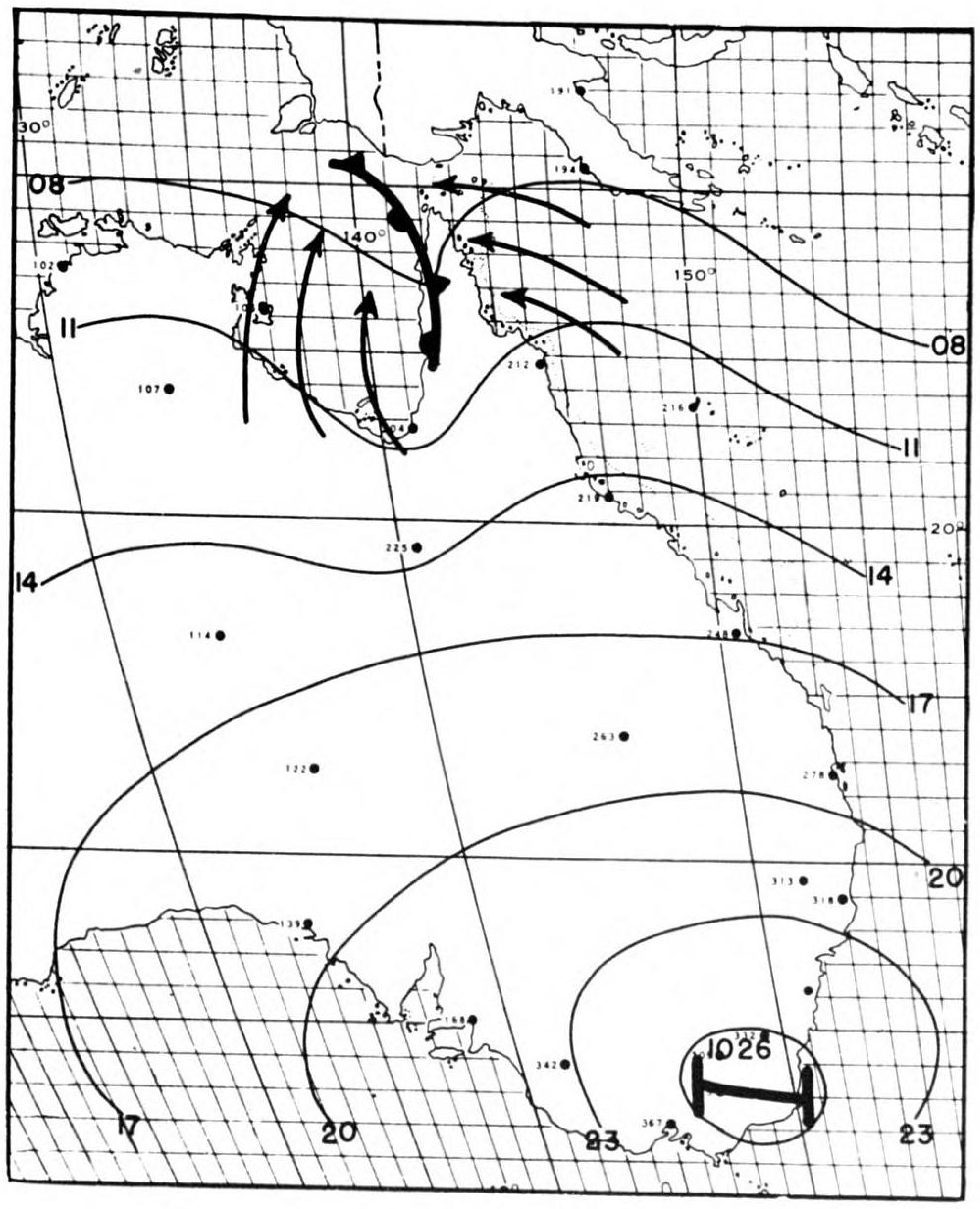


FIGURE IV - 20.
Hypothetical synoptic example of orographic front.

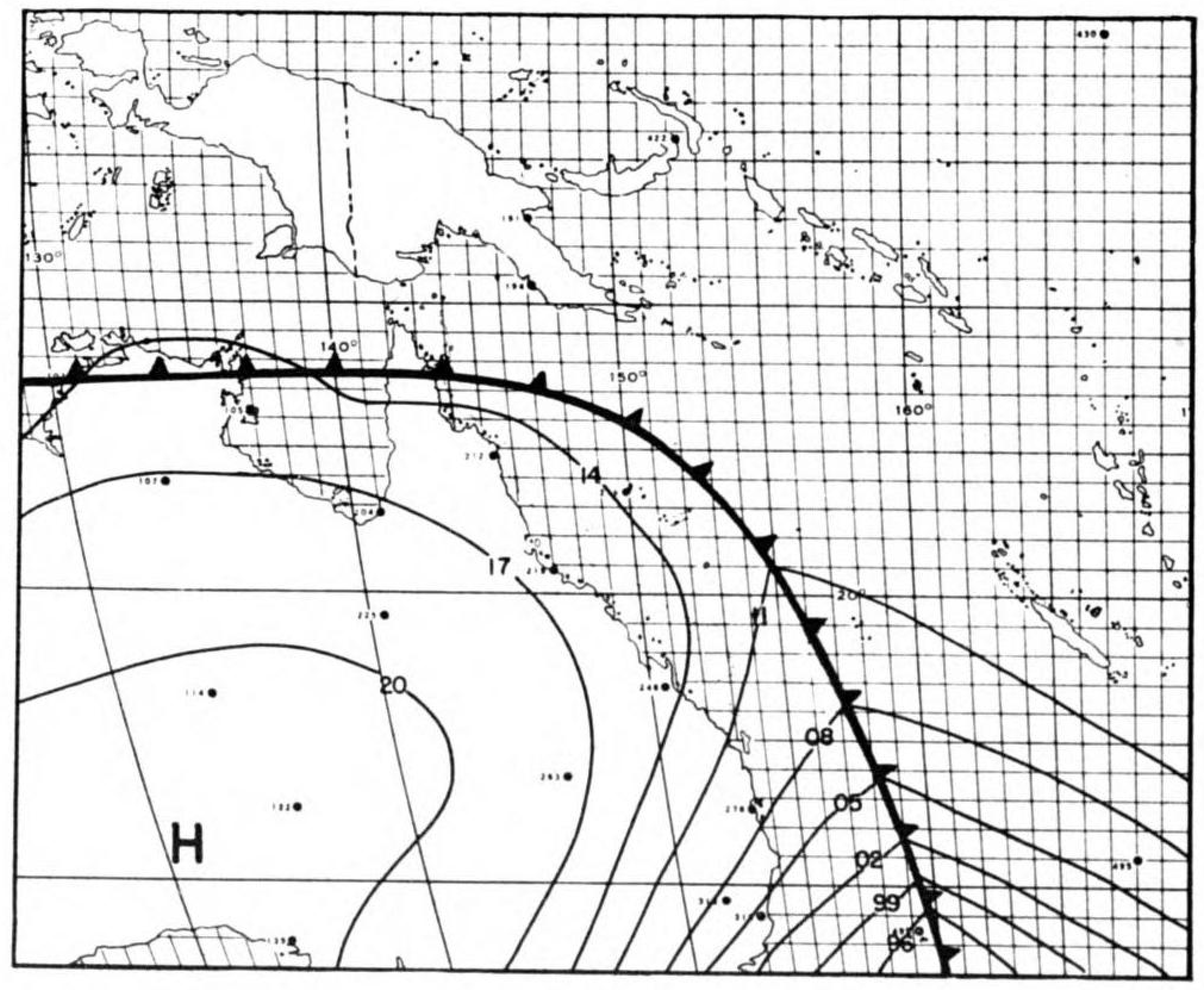


FIGURE IV - 21.
Synoptic example of Meridional Type. Southern subtype.
(1700Z 9 June 1941)

43. *Climatic Tables*

The absence of observational data for most categories of weather elements in Western New Guinea makes it impossible to compile an adequate set of tables. The following few tables include the bulk of the available numerical data not already given in the figures. Miscellaneous additional data, largely derived from fragmentary records of exploring parties, are incorporated in the text.

The validity of some of the data in this section is questionable, because of either a short period of record or doubtful methods of observation. This is particularly true of TABLE IV - 6.

TABLE IV - 5
MANOKWARI, CLIMATIC DATA
01° 10′ S, 134° 20′ E, 62 feet above mean sea level

Month	Wind** Percentage Frequency									Temperature °F.				Relative Humidity			Mean % of Sky Covered by Cloud	Mean Number of Days With Thunder
	N	NE	E	SE	S	SW	W	NW	Calm	Mean Daily Maximum	Mean Daily Minimum	Maximum Recorded	Minimum Recorded	Mean Daily Maximum	Mean Daily Minimum	Minimum Recorded†		
Jan	0	0	6	0	0	32	29	32	0	85	73	91	68	98	66	52	79	10
Feb	0	4	4	0	0	19	19	54	0	85	73	90	70	97	65	52	71	7
Mar	0	29	11	0	0	14	21	25	0	85	74	91	69	96	67	52	72	14
Apr	5	11	24	3	0	8	40	11	0	85	74	91	70	96	72	49	70	16
May	3	9	53	6	6	3	6	12	3	86	74	91	70	95	69	51	52	12
June	0	6	68	0	0	6	16	3	0	85	74	88	70	96	70	51	62	5
July	0	16	42	3	0	6	23	6	3	85	74	90	68	96	71	55	65	6
Aug	0	11	39	11	0	11	29	0	0	86	74	91	70	96	70	51	64	11
Sep	0	13	23	0	0	17	33	10	3	86	74	92	70	97	70	54	57	9
Oct	0	15	29	10	0	17	24	2	2	87	74	92	70	98	72	54	53	13
Nov	11	23	6	3	0	20	9	29	0	86	74	93	70	98	71	47	51	11
Dec	0	4	7	0	0	11	36	36	7	86	74	91	71	99	73	49	77	12
Year	2	12	27	3	1	14	24	17	2	86	74	93	68	97	70	47	64	126
Yrs. Rec.	1	1	1	1	1	1	1	1	1	5	5	5	5	5	5	5	3	4

**Wind observations taken on island of Mansinam, about 5 miles southeast of Manokwari.
†Maximum recorded relative humidity is 100% in all months.
Note: Rainfall data for Manokwari are presented in FIGURES IV - 8 to 11.

TABLE IV - 6

NETHERLANDS NEW GUINEA, CLIMATIC DATA FOR OCEAN AREAS

Mean frequencies of specified weather elements, based on observations taken 6 times daily on board ships off the coasts of Netherlands New Guinea.

(*a*) *Geelvink Bay and North Coast*—Ocean area from 0° latitude to the north coast; from 132° to 140° E longitude.

		Wind											Weather					
		Percentage Frequency											Percentage Frequency					
Month	Number of Observations**	Mean Speed in M.P.H.	N	NE	E	SE	S	SW	W	NW	Variable	Calm	Clear	Overcast	Haze	Fog and Mist	Thunderstorms	Squalls
Jan.	26	10	4	0	0	0	0	0	24	72	0	0	30	38	8	0	0	0
Feb.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mar.	86	7	6	9	3	2	10	11	13	37	6	3	45	30	1	0	0	0
Apr.	62	6	10	11	2	6	5	21	21	11	5	8	69	24	2	0	2	0
May	158	8	5	15	31	17	5	8	5	5	8	1	35	41	1	0	1	0
June	28	8	2	19	41	19	6	1	1	0	8	3	23	55	4	0	0	0
July	74	4	1	12	24	15	7	9	4	9	7	12	61	7	0	0	4	3
Aug.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sep.	14	8	10	10	0	5	20	21	29	5	0	0	56	15	0	0	6	0
Oct.	17	7	3	20	46	10	4	5	4	2	6	0	71	0	0	0	0	0
Nov.	15	7	35	5	5	0	0	3	43	6	0	3	70	11	0	0	6	6
Dec.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Year	480	7	8	11	17	8	6	9	16	16	4	3	51	24	2	0	2	1

— Insufficient data.
**Minimum number of observations. Additional observations were used in computing frequencies of some of the elements.

(*b*) *Ceram Sea and West Coast of Vogelkop*—Ocean area from 0° to 2° 20′ S latitude, from 127° to 132° E longitude.

Month	Number of Observations**	Mean Speed in M.P.H.	N	NE	E	SE	S	SW	W	NW	Variable	Calm	Clear	Overcast	Haze	Fog and Mist	Thunderstorms	Squalls
Jan.	272	8	19	7	1	1	1	2	14	39	14	2	42	30	2	0	0	0
Feb.	394	8	22	5	2	1	1	3	16	31	17	2	33	37	3	0	1	*
Mar.	377	7	21	5	2	3	7	6	12	29	12	3	51	27	2	0	1	0
Apr.	253	7	9	8	5	9	6	9	18	13	19	4	36	31	3	0	*	*
May	276	7	5	2	7	25	14	4	8	5	27	3	45	30	*	0	*	0
June	293	7	6	7	6	20	26	5	9	5	11	5	44	29	1	0	0	0
July	420	8	4	1	4	36	28	7	3	3	13	1	44	33	2	0	0	0
Aug.	314	8	1	1	4	25	43	11	2	1	11	1	45	32	8	0	1	0
Sep.	308	8	2	2	2	16	46	8	3	1	18	1	52	28	4	0	1	0
Oct.	268	7	2	6	7	29	20	10	9	2	12	3	41	36	6	0	0	*
Nov.	172	7	9	4	4	11	21	17	5	10	16	3	37	40	4	0	2	0
Dec.	351	7	8	4	1	3	4	2	10	47	20	1	52	26	2	0	0	0
Year	3698	7	9	4	4	15	18	7	9	16	16	2	44	31	3	0	1	*

*Frequency greater than zero, but less than ½ of 1%.
**Minimum number of observations. Additional observations were used in computing frequencies of some of the elements.

(*c*) *Arafoera Sea and South Coast*—Ocean area from the south coast to 10° S latitude, from 132° to 140° E.

Month	Number of Observations**	Mean Speed in M.P.H.	N	NE	E	SE	S	SW	W	NW	Variable	Calm	Clear	Overcast	Haze	Fog and Mist	Thunderstorms	Squalls
Jan.	116	7	17	4	1	0	3	12	19	37	2	5	34	46	0	0	1	2
Feb.	168	8	3	4	2	3	4	4	30	42	6	3	24	43	1	0	1	2
Mar.	450	6	4	2	13	10	5	8	29	10	9	12	49	26	*	0	*	1
Apr.	455	8	6	5	19	38	7	3	5	3	12	2	40	35	1	0	1	*
May	198	7	3	7	10	43	10	9	3	3	9	2	50	18	1	0	*	1
June	114	8	1	3	14	65	12	2	1	1	1	1	50	17	2	0	0	0
July	106	11	0	0	15	79	4	1	0	0	1	0	59	32	1	0	0	2
Aug.	34	10	0	1	16	73	8	0	2	0	0	0	53	35	3	0	0	0
Sep.	19	7	2	0	20	30	42	3	0	0	0	3	75	20	5	0	0	0
Oct.	101	6	4	2	37	39	2	4	5	4	1	2	55	21	4	0	1	0
Nov.	93	6	3	2	14	39	8	9	4	14	2	5	60	29	3	3	0	0
Dec.	311	7	7	3	2	2	4	8	21	48	3	2	26	41	1	0	1	3
Year	2165	8	4	3	14	35	9	7	10	14	4	3	48	30	2	*	*	1

*Frequency greater than zero, but less than ½ of 1%.
**Minimum number of observations. Additional observations were used in computing frequencies of some of the elements.