

## INTRODUCTION

With the increased tempo of U.S. Navy operations in the Indian Ocean, there has been a matching increase in concern over the environmental support available to the Fleet meteorologists. As part of the NAVENVPREDRSCHFAC effort to improve that support, this Command has reprinted a series of meteorological handbooks -- collectively titled Weather In The Indian Ocean -- that were originally issued by the British Government in the 1940-44 time frame.

These handbooks, published as three volumes in a total of twelve parts, were prepared by the Meteorological Office, Air Ministry, in cooperation with the Naval Meteorological Branch, Admiralty, London. Titles of all volumes/parts in the series are given below.

Because the series has long been out of print, the NAVENVPREDRSCHFAC has obtained permission to reprint and distribute the handbooks to U.S. Navy units. As in the original publication, this new reprinting ultimately will comprise twelve individual books, each marked with volume and part number; the reprint set is distributed as NAVENVPREDRSCHFAC Technical Bulletin 80-02, April 1980. The books are three-hole-punched for collection into ring binders. There has been no editing or changing of the original material.

Users of the series should be alert to the fact that a number of place names used in the original writing have changed over the intervening years.

### Volumes/parts titles in the series are as follows:

- Vol. I ---- Weather In The Indian Ocean - General Information (in one part)
- Vol. II --- Weather In The Indian Ocean to Latitude 30<sup>0</sup>S and Longitude 95<sup>0</sup>E including the Red Sea and Persian Gulf (in nine parts; see parts titles below)
- Vol. III -- Weather In The Indian Ocean - Aids To Forecasting (in two parts:  
1, Indian Ocean; and 2, North Indian Ocean)

### Parts titles, Volume II (local information):

1. Red Sea
2. The Gulf of Aden and West Arabian Sea to Longitude 00<sup>0</sup>E
3. The Persian Gulf and Gulf of Oman
4. The Makran Coast from Gwadar to Karachi and the West Coast of India to Latitude 20<sup>0</sup>N
5. West Coast of India from Latitude 20<sup>0</sup>N to Cape Comorin, with an Appendix on Conditions at Bombay
6. A. East Coast of India from Cape Comorin to the Ganges Delta -- B. Ceylon
7. The Coast of Burma
8. The South Indian Ocean to Latitude 30<sup>0</sup>S.
9. Coast of East Africa from the Equator to Cape Delgado

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## CONTENTS

## PART 6A

PART 6A  
EAST COAST OF INDIA  
FROM  
CAPE COMORIN TO THE  
GANGES DELTA  
INCLUDING  
THAT PORTION OF THE BAY OF BENGAL AND INDIAN OCEAN  
WITHIN THE AREA 0°-22° N., 77° 33'-90° E.

PART 6B  
CEYLON

	<i>Page</i>
I. GENERAL .. .. .	9
Summary of typical weather conditions at Madras and Calcutta .. .. .	13
II. DEPRESSIONS AND TROPICAL CYCLONES .. .. .	17
1. Western depressions .. .. .	17
2. Tropical cyclones and depressions .. .. .	18
General .. .. .	18
Annual frequency .. .. .	18
Seasonal frequency .. .. .	19
Place of origin and tracks of storms in the Bay of Bengal in the different months .. .. .	19
III. WIND .. .. .	23
1. Surface winds .. .. .	23
Seasonal variation .. .. .	36
Land and sea breezes .. .. .	42
Gales, strong winds and squalls .. .. .	46
Nor'westers .. .. .	47
2. Upper winds .. .. .	49
General .. .. .	62
Seasonal variation .. .. .	62
IV. VISIBILITY .. .. .	67
V. CLOUD .. .. .	68
General .. .. .	71
Seasonal and diurnal variation .. .. .	71
Height .. .. .	73
VI. RAIN AND HAIL .. .. .	74
1. Rain .. .. .	74
General .. .. .	74
Annual rainfall .. .. .	75
Seasonal variation .. .. .	75
Annual variation in the number of rain-days .. .. .	79
Extremes of annual and monthly rainfall .. .. .	80
Maximum rainfall in 24 hours .. .. .	81
2. Hail .. .. .	81
VII. TEMPERATURE .. .. .	81
1. Air temperature .. .. .	81
General .. .. .	82
Seasonal variation .. .. .	82
Diurnal variation .. .. .	83
2. Upper air temperature .. .. .	86
3. Sea temperature .. .. .	87
Seasonal variation .. .. .	88
4. Relative values of sea and air temperature .. .. .	89

CONTENTS—*continued*

VIII. HUMIDITY .. .. .	89
General .. .. .	89
Seasonal variation .. .. .	90
Diurnal variation .. .. .	91
Humidity in the upper air .. .. .	91
Wet-bulb temperature .. .. .	92
IX. MISCELLANEOUS .. .. .	
1. Thunderstorms .. .. .	93
2. Sea and swell .. .. .	93
3. Waterspouts .. .. .	94

## PART 6B

	<i>Page</i>
I. GENERAL .. .. .	131
Summary of typical weather conditions at Colombo	132
II. TROPICAL CYCLONES AND DEPRESSIONS .. .. .	133
III. WIND .. .. .	
1. Surface winds .. .. .	135
Seasonal variation .. .. .	136
Diurnal variation of wind speed at Colombo	137
Land and sea breezes .. .. .	138
Gales and squalls .. .. .	140
2. Upper winds .. .. .	141
General .. .. .	141
Seasonal variation .. .. .	142
IV. VISIBILITY .. .. .	152
V. CLOUD .. .. .	153
Seasonal variation .. .. .	153
Diurnal variation .. .. .	154
Height .. .. .	155
VI. RAIN AND HAIL .. .. .	
1. Rain .. .. .	155
General .. .. .	156
Seasonal variation .. .. .	157
Diurnal variation .. .. .	162
Extremes of annual and monthly rainfall .. .. .	162
Maximum rainfall in 24 hours .. .. .	165
Intensity of rainfall .. .. .	165
2. Hail .. .. .	165
VII. AIR TEMPERATURE .. .. .	166
Seasonal variation .. .. .	166
Diurnal variation .. .. .	167
Extremes of temperature .. .. .	167
Variation of temperature with height .. .. .	167

CONTENTS—*continued*

VIII. HUMIDITY .. .. .	167
Wet-bulb temperature .. .. .	169
IX. MISCELLANEOUS .. .. .	
1. Thunderstorms .. .. .	169
2. Sea and swell .. .. .	170
3. Waterspouts, whirlwinds and sand-devils .. .. .	170
BIBLIOGRAPHY .. .. .	184

## LIST OF ILLUSTRATIONS

## PART 6A

<i>Fig.</i>		<i>Page</i>
1.	The east coast of India and the island of Ceylon .. .. .	8
2-13.	Surface winds—monthly .. .. .	24-35
14.	Surface winds—morning and afternoon—January, April, July and October—Calcutta, Sagar island, Puri and Vizagapatam .. .. .	44
15.	Surface winds—morning and afternoon—January, April, July and October—Cocanada, Nellore, Madras and Negapatam .. .. .	45
16-19.	Upper winds—Madras .. .. .	50-3
20-23.	Upper winds—Vizagapatam (Waltair) .. .. .	54-7
24-27.	Upper winds—Calcutta .. .. .	58-61
28.	Monthly variation in mean cloud amount .. .. .	70
29.	Monthly variation of rainfall .. .. .	76
30.	Monthly variation in the frequency of rain-days .. .. .	77

## PART 6B

31.	The island of Ceylon .. .. .	130
32.	Surface winds—morning and afternoon—January, April, July and October—Colombo, Hambantota, Batticaloa and Trincomalee .. .. .	139
33-40.	Upper winds—morning and afternoon—Colombo .. .. .	144-51
41.	Monthly variation of rainfall .. .. .	158
42.	Monthly variation in the frequency of rain-days .. .. .	159
43.	Distribution of rainfall in 4-hour intervals at Colombo and Trincomalee .. .. .	163

## LIST OF APPENDED TABLES

## PART 6A

<i>Table</i>	<i>Page</i>
I. General climatological tables	
Pamban .. .. .	95
Negapatam .. .. .	96
Madras .. .. .	97
Cocanada .. .. .	98
Vizagapatam (Waltair) .. .. .	99
Puri .. .. .	100
Ságar island (Hooghly river) .. .. .	101
Calcutta (Alipore Observatory) .. .. .	102
II. Monthly frequency of wind direction and force at sea	
5° Areas,	
20°—25°N., 85°—90°E. .. .. .	103
15°—20°N., 80°—90°E. .. .. .	104
10°—15°N., 80°—90°E. .. .. .	105
5°—10°N., 80°—90°E. .. .. .	106
0°—5°N., 80°—90°E. .. .. .	107
III. Monthly frequency of wind direction at coastal stations	
Nellore and Masulipatam .. .. .	108
IV. Monthly frequency of winds of different forces at coastal stations	
Pamban, Negapatam, Madras, Cocanada, Vizagapatam, Puri, Ságar island and Calcutta .. .. .	109
V. Monthly frequency of wind direction and speed in the upper air and of cloud motion	
Madras .. .. .	110-3
Vizagapatam (Waltair) .. .. .	114-7
Calcutta .. .. .	118-21
VI. Visibility at coastal stations	
Pamban, Negapatam, Madras, Cocanada .. .. .	122
Vizagapatam (Waltair), Puri, Ságar island, Calcutta .. .. .	123
VII. Monthly frequencies of different amounts of cloud	
Pamban, Negapatam, Madras, Cocanada .. .. .	124
Vizagapatam (Waltair), Puri, Ságar island, Calcutta .. .. .	125
VIII. Monthly frequency of different states of the sea	
Pamban, Negapatam, Madras, Cocanada .. .. .	126
Vizagapatam, Puri, Ságar island .. .. .	127

LIST OF APPENDED TABLES—*continued*

## PART 6B

IX. General climatological tables	
Colombo .. .. .	172
Galle .. .. .	173
Trincomalce .. .. .	174
Diyatalawa .. .. .	175
Nuwara Eliya .. .. .	176
X. Monthly frequency of wind direction at coastal stations	
Hambantota, Little Basses, Batticaloa .. .. .	177
XI. Monthly frequency of wind direction and speed in the upper air up to 16,500 feet and seasonal frequency at 20,000 and 30,000 feet in the morning	
Colombo .. .. .	178-81
XII. Monthly frequency of wind direction and speed in the upper air in the afternoon	
Colombo .. .. .	182-3

PART 6A  
 EAST COAST OF INDIA  
 FROM  
 CAPE COMORIN TO THE  
 GANGES DELTA

(52737)

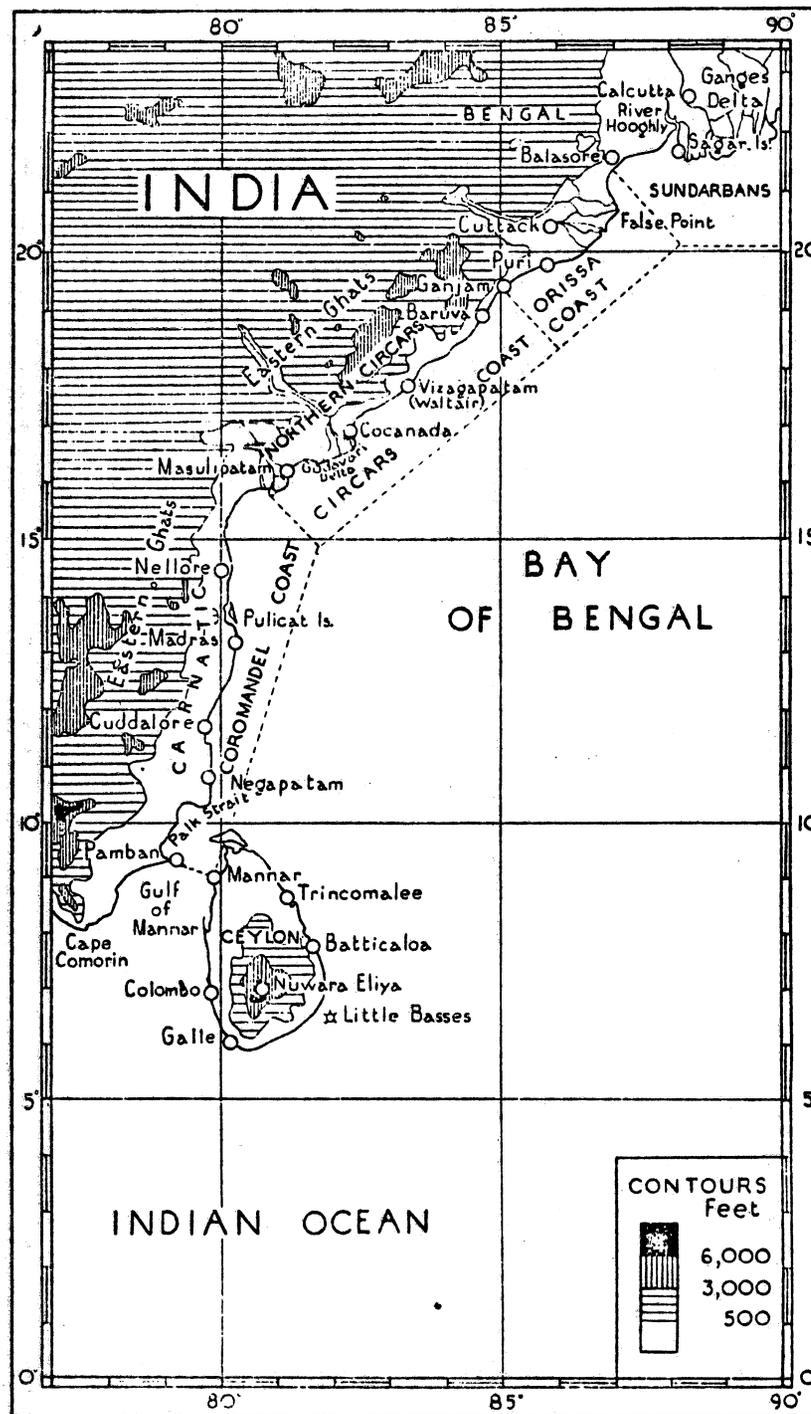


FIG. 1.—THE EAST COAST OF INDIA AND THE ISLAND OF CEYLON

# EAST COAST OF INDIA

FROM

## CAPE COMORIN TO THE GANGES DELTA

INCLUDING

THAT PORTION OF THE BAY OF BENGAL AND INDIAN OCEAN  
WITHIN THE AREA 0°-22° N., 77° 33'-90° E.

### I—GENERAL

The east coast of India from Cape Comorin to the mouths of the Ganges has a coastline about 1,300 nautical miles in length. It consists of the Carnatic region, the coast of the northern Circars, a strip of the Orissa coast and the Ganges delta or Sundarbans.

The Carnatic region is the broad coastal plain in the southern part of the east coast of India between the sea and the eastern Ghats, it stretches from Cape Comorin to about Lat. 16° N. The coast of the Carnatic region can be divided into two parts. In the south there is the west coast of the Gulf of Mannar which lies between Cape Comorin and Pamban (9° 16' N., 79° 18' E.) and in the north there is the Coromandel coast from Pamban to about Lat. 16° N. North of the Coromandel coast is situated the Circars coast which lies between about Lat. 16° N. and Ganjam (19° 23' N., 85° 04' E.), and north of that the Orissa coast which stretches from Ganjam to the entrance of the Hooghly river; the Ganges delta or Sundarbans extends from there to 90° E. These divisions of the coast are shown by the broken lines in the Frontispiece, Fig. 1.

The eastern Ghats south of the Godavari river are not nearly so well-defined or continuous as the western Ghats of the west coast of India, they are also situated farther from the coast, there being a broad strip of low-lying land between them and the coast of the Bay of Bengal. The width of this coastal plain is very variable. To the north of Pulicat island (13° 25' N., 80° 20' E.) the hills advance to within 30 miles of the sea, but to the south of Madras (13° 04' N., 80° 15' E.) the coastal plain has an average breadth of about 80 miles.

The intersection of the eastern Ghats by the various rivers that flow into the Bay of Bengal causes the hills to form into independent hill groups which rise from 2,000 to 4,500 feet in height. These hill groups occupy the centre of the southern part of the Indian peninsula as far south as the Cauvery valley in about Lat. 11° N.

This latitude coincides with the southern limit of the Nilgiri hills on the west coast where is situated what is known as the Palghat gap. The Palghat gap is continued as a valley right across the southern end of the Indian peninsula from west to east and influences the weather of the Carnatic region to a certain extent, as it affords a comparatively unobstructed passage for the winds of both the SW. and NE. monsoons.

Along the northern Circars coast, north of the Godavari river (16° 30' N., 82° E. approx.) the eastern Ghats are well-defined and approach close to the sea, the two highest peaks here being nearly 5,000 feet in height. The coast of Orissa north of Ganjam consists of the wide delta of the mouths of the Mahanadi river, and the district near the coast is low-lying with a few isolated hills standing in the plains, the highest being 2,500 feet in height. The remainder of the coastline to Long. 90° E. consists of the delta of the Ganges, the Hooghly river being its western and most important mouth. The country here is generally very low-lying and there is no high land in the vicinity; near the mouths of the rivers forming the delta there are forests and swamps known as the Sundarbans. These low-lying swamps are between the sea and the cultivated areas further inland.

The climate of the region is dominated by the SW. and NE. monsoons. In the south of the Bay of Bengal the SW. monsoon sets in about the last week of May and lasts until October; in the northern part of the Bay it begins about the first week of June and withdraws from there towards the end of September. In the northern area the NE. monsoon begins to blow towards the end of October and lasts until March, whilst in the south it is not felt until November.

Whilst the SW. monsoon is the rainy season in the northern part of the Bay of Bengal, in the south most rain is experienced on the withdrawal of the SW. monsoon and during the establishment of the NE. monsoon in October and November.

The area north of about Lat. 20° N. from November to May may occasionally be affected by western depressions which are similar in type to the depressions of temperate latitudes. The other type of depression that may be experienced at times over any part of the region is a tropical depression, and with these are included tropical cyclones.

The year has been divided into the following four seasons:—

- (i) The cool season, December to March.
- (ii) The hot season, April and May.
- (iii) The SW. monsoon, June to September.
- (iv) The post SW. monsoon period, October and November.

During the cool season, from December to March, NE. monsoon conditions prevail over the whole area and the surface winds are mainly from a northerly or easterly direction. In the north the

average cloud amounts are small being on the average between 2 and 3-tenths but the amount gradually increases southwards until near the equator it is between 5 and 6-tenths. This is a dry season except on the Coromandel coast and in the Gulf of Mannar in December when on the average as much as 150 to 190 mm. (6 to 7.5 in.) of rain falls. In December and January at the head of the Bay of Bengal, near Calcutta, the average temperature is about 67° F., and the temperature gradually increases southwards to about 75° F. at Madras and to about 80° F. near the equator. In the extreme south of the Indian peninsula the name cool season for these months is really a misnomer as the average temperature there is about the same as that in southern Italy in summer.

At Madras in January the early mornings are often misty but this clears off by 0800 and the day is then clear and sunny with a few detached clouds, there is heavy dew in the evenings. The wind is north-easterly and moderate, but occasionally strong NE. winds lasting for two or three days with heavy rain may be experienced. The maximum temperature is between about 80° and 90° F. and the minimum between about 60° and 70° F.

In the hot season of April and May the NE. monsoon has withdrawn, the winds become very variable and land and sea breezes prevail. Tropical storms or depressions and sometimes in the northern part of the Bay of Bengal squalls known as "Nor'westers" may be experienced. The SW. monsoon may begin to be felt in the southern part of the area in May and sometimes there may be a temporary incursion even at the end of April. The cloud amount in April is least on the north Coromandel coast and increases both towards the Orissa coast and towards Ceylon. Towards the end of the season, with the advance of the SW. monsoon, cloudiness gradually increases especially in the south. The rainfall in this season is chiefly associated with local thunderstorms and is very irregularly distributed; although not of long duration, it may at times be very heavy. In the extreme south of the Indian peninsula thunderstorms are fairly frequent in April whilst further north they become frequent in May. The temperature over the whole region increases during these months and May is the hottest month of the year on the east coast of India. The average temperature over the Bay of Bengal in May is between 83° and 85° F. and it is slightly warmer at the head of the Bay than in the south; on the coast the average temperatures are higher and are between 85° and 91° F. At Madras in May the wind is variable from a SW. to SE. direction with land and sea breezes prevailing. The land wind is very hot and dry. The sky is cloudless and there is little rain. The maximum temperature is between 95° and 110° F. and the minimum temperature between 75° and 85° F.

During the SW. monsoon south-westerly winds are blowing over the whole area, in the south the monsoon gains in strength towards the end of May, but in the north at the head of the Bay of Bengal

the SW. winds of the monsoon do not usually begin to blow until the first or second week of June. After the first burst of the monsoon the winds generally moderate, but the strength varies considerably throughout July and August. Towards the end of September the SW. monsoon withdraws from the northern part of the Bay of Bengal but it still holds in the south. The cloud amount in this season is very high. July is the cloudiest month with amounts between 7 and 9-tenths, except at Pamban in the extreme south where the amount is only about 4-tenths. In September the cloud amount shows a slight decrease to between 6 and 7-tenths. The SW. monsoon is the rainy season in the northern part of the region, the heaviest rainfall occurring on the Bengal and Orissa coasts with a gradual decrease in amount southwards until in the extreme south there is very little rain. There is a fall in temperature in this season from that of May, and in July the average temperature on the Bengal and Orissa coasts is about 84° F.; further south the average temperatures are a little higher, being between 84° and 87° F. on the Circars and Coromandel coasts. The temperature falls slightly as the season advances and in September it is usually 2° or 3° F. cooler than in July. In September thunderstorms are fairly frequent on the northern part of the coast to as far south as Madras.

At Madras in July the wind blows strongly from the SW. especially towards the end of the day but it generally falls at night. The sky may be overcast all day and sometimes for several days at a time. The humidity is high but there is very little rain. The days may often be fine but heavy thunder clouds may accumulate and give heavy rain locally. The maximum temperature is between 85° and 105° F. and the minimum temperature is between 75° and 85° F.

In October and November, the interim period between the SW. and NE. monsoons, the danger of severe cyclonic storms occurring is greater than at any other time of the year, any part of the Bay of Bengal may be crossed by them and no part of the east coast of India is immune. The SW. monsoon has withdrawn from the northern part of the Bay of Bengal and fine weather frequently prevails there for considerable periods with land and sea breezes predominating. In the south the SW. monsoon does not finally depart until the end of October. By November the SW. monsoon has entirely disappeared from the whole region and NE. winds, which in October were confined mainly to the northern part of the Bay of Bengal, spread southwards to all parts of the Bay indicating that the NE. monsoon has become established. There is a decrease in the cloud amounts during this period in the north, but not in the south, as this is the wet season on the east coast of India to the south of the coast of Orissa and some of the highest rainfalls of the year occur here when the SW. monsoon is retreating. It is not until the end of October or beginning of November that any appreciable fall in temperature occurs and cooler conditions begin to set in, the

average temperatures being about 80° F. in the south and between 73° and 75° F. in the north. In October and November thunderstorms are fairly frequent on the southern part of the coast.

At Madras in November the wind is usually strong and from the NE. and there may be rough seas for days at a time. The sky is often covered with heavy clouds and heavy rain may fall, but fine weather sometimes lasts for weeks. The relative humidity is high, and the maximum temperature is between about 80° and 90° F. with a minimum temperature between about 65° and 75° F.

**Summary of typical weather conditions at Madras and Calcutta during the NE. monsoon or cool season, the hot season and the SW. monsoon**

The following are descriptions of the type of weather likely to be experienced at Madras and Calcutta on typical days during the NE. monsoon or cool season, the hot season and the SW. monsoon:—

**Madras.—Weather on a day about the middle of November with a strong NE. monsoon.**—Heavy rain falls in the early morning and a gusty E. wind blows which drives the low clouds towards the land. The sea is rough with a moderate swell of average length. The sky is so gloomy that it appears as if the heavy rain is likely to continue throughout the morning, but shortly after sunrise the sky clears considerably and the rain stops for about an hour between 0620 and 0720, after which light rain sets in again.

There is no change in the weather during the forenoon except that the wind drops a little and the clouds lift and become thinner between 1000 and noon; fractonimbus clouds appear towards midday and the wind increases in force and becomes gustier.

Intermittent slight rain continues until nightfall and the wind backs to ENE. with occasional strong gusts. Towards evening the rough sea has a long and heavy swell.

The wind between 1700 and 1900 increases to about Beaufort force 7, but later drops to force 5, and after midnight to force 2 or 3. The rain stops between 1800 and 2100, after which slight rain begins to fall and continues at intervals throughout the night.

Typical observations taken during the day are:—

Time	Temp. °F.	Rel. hum. %	Wind Dirn.	Force	Visi-bility	Cloud, tenths	Present weather
0800	77	95	E.	6	5	Fn. 8, As. 2	intermittent rain
1230	80	86	E.	5	7	Ns. 4, Fn. 6	intermittent rain
1700	77.5	93	ENE.	6	4	Fn. 10	

Min. temp., 73°F.; Max. temp. at 1255, 80°F.

Rain: past 24 hours, 82 mm. (3.2 in.); 0800-1230, 2.8 mm. (0.11 in.); 1230-1700, 3.3 mm. (0.13 in.).

**Weather on a day about the middle of May in the hot season.**—In the early morning a thin veil of cirrus cloud covers the whole sky and a gentle breeze blows from SSW. Sunrise is at about 0545 from which time the temperature rises rapidly and the wind increases slightly in force and veers to WSW.

During the forenoon the wind veers more to the west and at about 1100 the cirrus clouds begin to disappear, by noon the hot westerly wind drops to calm and the temperature rises rapidly to about 108° F. Shortly after midday the sea breeze sets in with a gust from ESE., this immediately checks the rise in the temperature which begins to fall within about half an hour.

During the afternoon the sea breeze gains in strength and the cirrus clouds almost disappear. Towards evening the direction of the breeze shifts to between SE. and S., and a bank of cumulonimbus cloud is seen to form slowly on the distant horizon to the west where it remains.

The sea breeze continues to blow until 2200, the wind then veers more to S. and later to SW. when it blows from off the land. The sky during the night is clear until the early morning when a layer of altocumulus begins to spread from westward.

Typical observations taken during the day are:—

Time	Temp. °F.	Rel. hum. %	Wind Dirn.	Force	Visi-bility	Cloud, tenths
0830	94	47	WSW.	4	8	Ci. 9
1230	99	40	ESE.	4	8	Ci. 4
1700	92	60	S.	4	8	Ci. 1, Cb. trace

Min. temp. 85°F.; Max. temp. at 1205, 108°F.

**Weather on a day about the middle of July during the SW. monsoon.** In the early morning a gentle westerly breeze blows and it is moderately bright although the sky is overcast with a layer of altocumulus cloud. Within an hour of sunrise, which is at about 0550, the altocumulus layer begins to break up and cirrostratus clouds appear through the clear spaces.

During the forenoon the chief feature of the weather is the variable aspect of the sky, the clouds gradually changing to altostratus and stratocumulus; the wind increases in force and towards midday has risen to about Beaufort force 5 or 6.

In the afternoon the wind drops and thicker stratocumulus clouds spread across the sky.

After 1700 lower clouds (nimbostratus and fractonimbus) come up from SW. and cover the sky. Light rain starts to fall at about 1830, which is followed shortly afterwards by a sudden squall with gusts of Beaufort force 8, the squall, however, only lasts for a few minutes. The rain stops in less than an hour, the amount

being only about 1.5 mm. (0.06 in). The air becomes cooler after the squall has passed and the wind drops to a light breeze, the sky, however, continues overcast throughout the night but there is no more rain.

Typical observations taken during the day are :—

Time	Temp. °F.	Rel. hum. %	Wind		Visi- bility	Cloud, tenths
			Dirn.	Force		
0800	84	59	WSW.	3	8	Ac. 8, Cs. 2
1230	93	41	WSW.	5	8	Sc. 2, As. 4
1700	93	71	SW.	4	8	Sc. 10

Min. temp., 78°F.; Max. temp. at 1530, 95°F.

**Calcutta.**—*Weather on a day at the end of December during the NE. monsoon.*—In the early morning it is misty and the mist thickens into a fog at about 0600, this fog becomes still thicker after sunrise when the visibility decreases to about 1 on the visibility scale, i.e. objects visible at only 50 yards.

Shortly after 0800 the fog begins to lift so that the visibility on the ground improves while it becomes worse aloft, and by 0900 a light breeze from NW. sets in which causes the fog to dissipate quickly, leaving a clear atmosphere and a cloudless sky. The temperature now begins to rise quickly and the relative humidity falls, the sky continuing clear and the breeze increasing slightly in strength and veering towards north.

During the afternoon the breeze drops until by about 1600 it is calm, the sky, which continues to be cloudless, now begins to appear hazy.

Daylight begins to fade at about 1730 when the sky becomes misty, a pall of smoke also begins to spread over the crowded parts of Calcutta further thickening the mist, which in a short time envelops the city; this mist persists throughout the night as there is no wind to disperse it.

Typical observations taken during the day are :—

Time	Temp. °F.	Rel. hum. %	Wind		Visi- bility	Cloud, tenths
			Dirn.	Force		
0740	60	99	calm		1	Fog
1230	79	34	NW.	2	6	nil
1700	72	51	calm		5	nil

Min. temp., 53°F.; Max. temp. at 1535, 83°F.

*Weather on a day towards the end of April in the hot season with a typical "Nor'wester" in the evening.*—In the early morning between about 0445 and 0600 the sky is almost cloudless with a light breeze blowing from SSW., but by about 0630 a bank of

altocumulus cloud appears in the sky to the west to be followed shortly afterwards by cumulus clouds drifting up from the south-west. The wind which drops after sunrise increases again in force at about 0700.

During the forenoon the wind backs to S. and the clouds begin to dissipate until by about 0930 the sky is practically cloudless and the temperature begins to rise rapidly. Towards midday the wind begins to drop and the air becomes sultry.

In the afternoon until about 1600 the hot sun and the high temperature are very trying; the temperature, however, begins to fall at about this time, owing to the setting in of a moderate sea breeze from SSE., and a dark cumulonimbus cloud appears in the sky to the north-west.

The cumulonimbus cloud in the sky to the north-west, which slowly develops until by about 1800 it covers the whole of the western sky, indicates the onset of a "Nor'wester." For a time it appears as if this cloud might dissipate but by about 1830 the wind veers rapidly to WSW., the pressure rises by about 5 mb. and the relative humidity falls to about 38 per cent. The cloud at 1850 then thickens and approaches the zenith and in about 10 minutes spreads across the whole sky. At 1900 the wind veers suddenly to NW. to be followed by several squalls in quick succession during which the wind at times attains a speed of about 34 knots. Lightning is now seen and is followed by loud peals of thunder. During the thunderstorm there is a sharp shower of rain followed by a drop in temperature of about 10° F. and a rise in the relative humidity of about 25 per cent. A few minutes after the rain stops the wind suddenly drops but the sky remains overcast and gloomy with occasional flashes of lightning.

After the storm has passed a gentle breeze sets in and continues to blow until about midnight, the sky then clears considerably. Throughout the night after a "Nor'wester" it is moderately cool.

Typical observations taken during the day are :—

Time	Temp. °F.	Rel. hum. %	Wind		Visi- bility	Cloud, tenths
			Dirn.	Force		
0740	87	79	SW.	2	6	Cu. 5, Ac. trace
1230	100	44	SW.	1	6	nil
1700	96	53	SSE.	3	6	Cb. 1

Min. temp., 86°F.; Max. temp. at 1430, 102°F.

*Weather on a day at the end of July during the SW. monsoon.*—In the morning it is calm, the sky being overcast with dark nimbostratus clouds, and, although the time of sunrise at Calcutta in this month is at about 0430, it continues gloomy until about 0700,

when a light SW. wind starts to blow. Almost continuous slight to moderate rain has been falling all night, from about 2200 the previous day until about 0745.

During the forenoon the wind increases slightly and blows from between SW. and WSW. and rain falls at intervals in heavy showers when a thicker bank of cloud drifts across the zenith.

In the afternoon the sky remains overcast and gloomy and it continues to rain at intervals with a heavy shower between about 1530 and 1630.

In the early evening the clouds decrease for a time and the rain stops. At about 2100 a bank of cumulonimbus clouds appears in the west and soon spreads across the sky, distant thunder being heard as the clouds are spreading. Rain starts to fall again at about 2200 and slight to moderate showers continue to occur throughout the night.

Typical observations taken during the day are:—

Time	Temp. °F.	Rel. hum. %	Wind Dirn. Force	Visi- bility	Cloud, tenths	Rain, mm.
0745	80	98	SW. 2	5	Ns. 10	26.2
1230	80	98	SW. 2	5	Ns. 10	6.6
1700	78	99	— —	5	Fn. 2, Ns. 8	32.5

Min. temp., 79°F.; Max. temp., 81°F.

## II—DEPRESSIONS AND TROPICAL CYCLONES

A more detailed description of the tropical cyclones of the Bay of Bengal and Indian ocean, their origin, formation and size is given in Volume I.

Most of the area under consideration is too far south to be affected by the usual type of depression of more temperate latitudes, but depressions of that type, which are called western depressions as they come from the west, may affect the area north of latitude 20° N. The other type of depression is the tropical depression and when these become intense they are called tropical cyclones.

The India Meteorological Department uses the term tropical "depression" for those cyclonic circulations in which the wind is Beaufort force 7 or less, the depression becomes a tropical cyclone when the wind in a part of the cyclonic area has risen to gale force, *i.e.* Beaufort force 8; when the wind is of force 10 or more then the storm is said to be severe.

### 1—WESTERN DEPRESSIONS

During the six months from November to May depressions not infrequently approach India from the west and these are known as western depressions.

After entering India these depressions generally travel eastwards; they take 3 to 5 days to reach Bengal and sometimes extend into north Burma. Those disturbances which take a northerly course give rain in Kashmir and usually, after travelling for three days in Tibet, affect the weather in Assam. The time taken may sometimes be as long as five days but generally it is less. Those that take a more southerly track give rain in the central parts of northern India and in Orissa and squally weather off that coast and the Sundarbans.

The paths of the depressions vary considerably from year to year and appear to be related to changes in the position of the Asiatic winter anticyclone.

According to the most recent data the number of western depressions which have had some effect on the weather of northern and north-eastern India during the 10 years 1927-36 is no less than 460 or an average of 46 a year, varying from 35 in 1929 to 55 in 1934. Out of this total there were only 85 that affected the weather of north-east India and these were confined entirely to the six months from November to May and were most frequent in January and February. The distribution of the frequency of the depressions over the several months in north-east India is given in the following table, the depression has been allocated to the first month in which it was identified.

### North-east India.—AVERAGE FREQUENCY OF WESTERN DEPRESSIONS Period: 1927-36

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
2.4	2.2	1.4	1.4	0.2	0	0	0	0	0	0.1	0.8	8.5

Authority:—Bibliography No. 114.

### 2. TROPICAL CYCLONES AND DEPRESSIONS

**General.**—Tropical cyclones and depressions are much more frequent in the Bay of Bengal than in the Arabian sea. They may occur at any season of the year but they are least frequent in the cool season from January to March. The months of greatest frequency for severe storms are before and after the SW. monsoon, namely, in May and in October and November; severe storms have, however, been recorded in all months of the year except January and February. Tropical depressions, on the other hand, are most frequent during the months of the SW. monsoon which is from mid-June to mid-September; in that season they are confined almost entirely to the head of the Bay of Bengal and only rarely develop into severe storms.

**Annual frequency.**—The average number of tropical cyclones and depressions likely to occur during the year is about twelve. This number, however, varies somewhat from year to year. On

the average about six during the year develop into storms with winds of gale force and of these two are likely to be fully developed tropical storms with winds of Beaufort force 10 and occasional squalls of hurricane force.

**Seasonal frequency.**—The average frequency of cyclonic disturbances in the several months is given in the following table. The first three lines give the average frequency of depressions, storms and severe storms respectively and the last line gives the total of all types. The figures are based on data extending over a period of nearly sixty years, 1877–1935; it is possible, however, that some depressions of small intensity may have passed unrecorded in the earlier years. In compiling the table for recent years a few disturbances of very feeble intensity and a few which formed over the land and did not appreciably affect the weather of the Bay of Bengal have been omitted.

**Bay of Bengal.**—AVERAGE NUMBER OF TROPICAL STORMS AND DEPRESSIONS  
Period: 1877–1935

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Depressions ..	0.2	0	0.1	<.1	0.2	0.7	1.1	1.3	1.3	0.7	0.3	0.2	6
Storms ..	0.1	0	<.1	0.1	0.2	0.4	0.6	0.5	0.5	0.6	0.5	0.2	4
Severe storms ..	0	0	<.1	0.1	0.3	0.15	0.2	<.1	0.15	0.3	0.5	0.2	2
All types ..	0.3	0	0.2	0.3	0.7	1.2	1.9	1.8	2.0	1.6	1.3	0.6	12

*Authorities.*—Bibliography Nos. 34, 114.

\* *Note.*—The data for January, February and March refer to 1913–35 only.

**Place of origin and tracks of storms in the Bay of Bengal in the different months.**—*Cool season (December to March).*—During this season when the winds of the NE. monsoon extend over most of the Bay of Bengal storms are comparatively infrequent, especially is this so in the latter part of the season from January to March when steady and moderate NE. winds persist, with fine weather.

In December the few storms which occur generally form in the south-west part of the Bay, moving W. or WNW., and pass over Ceylon or the Coromandel coast of Madras; they are not usually severe; but severer storms have been known to form east of Long. 85° E. and these have travelled northwards, recurving to the Arakan coast of Burma. In January the few storms with winds of gale force that have been recorded formed off Ceylon west of Long. 86° E. and they all moved in some direction between SSW. and NNW. In February no cyclonic disturbances have been recorded and in March they are rare but they may occasionally be severe.

*Hot season (April and May).*—During this transition period between the NE. and SW. monsoons the frequency of tropical

storms increases slightly; they are still infrequent, however, especially in April but when they do occur they are liable to be severe.

Most of the cyclonic disturbances in April form between latitudes 8° and 12° N. The majority of the storms move first towards NW. or N. and then recurve towards NE. and never reach the east coast of India which appears to be almost free of severe storms in this month.

The storms which form in the first fortnight of May are almost invariably due to a temporary advance of the SW. monsoon winds, and most of the storms in that period therefore have their origin south of Lat. 15° N. or in the Andaman sea; in the latter part of this month, however, they may form in almost any part of the Bay of Bengal.

The tracks of the storms in this month are such that any part of the Bay of Bengal may be crossed by a storm. In the early stages their direction of travel may be anywhere between W. and NNE. and after recurvature they not infrequently travel NE. or even E. The storms which move towards the west are usually those which form in the south-west part of the Bay of Bengal and strike the Coromandel coast. Those storms which form in the central part of the Bay usually travel in some direction between NW. and NNE. and most frequently recurve towards NE., although some move NW. and cross the Coromandel or Circars coasts and possibly recurve over the land, whilst others may persist on a more northerly path to the head of the Bay crossing the Bengal coast.

*SW. monsoon (June to September).*—The depressions which form during the transition periods before and after the SW. monsoon months are much more likely to develop into severe storms than those that form during that season, and although the frequency of cyclonic disturbances increases considerably during the months of the SW. monsoon, when the average is about two a month and in some years may be three or four, yet the chance of a severe storm is much less than in the transition months; in fact in August when the monsoon is at its height severe storms are rare. In spite of their rarity, however, the possibility of a severe storm occurring at the head of the Bay of Bengal even at the height of the SW. monsoon should not be lost sight of; very dangerous stormy weather with winds of hurricane force may occasionally be encountered.

The SW. monsoon winds are usually established over the whole of the Bay of Bengal in June, and after the monsoon is established nearly all the storms form near the head of the Bay north of Lat. 18° N., occasionally, however, they form slightly further south.

Many of the cyclonic disturbances form in front of the first rush of the SW. monsoon air; if for some reason the burst of the monsoon is not so vigorous as usual, the storms are often ill-formed and

follow very varied tracks. Most of the storms move WNW. or NW. and the chances of a storm crossing the Orissa or Bengal coasts are about even. Occasionally a storm moves NE. or NNE. immediately after its formation, and a few, especially those forming in the early part of the month, start moving NW. and then recurve towards NE. On one occasion a storm formed off the Sundarbans, moved NE. and then N., crossing the coast, and finally turned towards W. over north Bengal. A recurvature to the W., however, is very unusual.

On one occasion a depression that formed in the Bay of Bengal in this month passed across Central India into the Arabian sea, but it filled up soon afterwards.

It will be found that most of the storms in July are weak and although they occasion strong W. or SW. winds at the head of the Bay of Bengal a complete cyclonic circulation is seldom encountered. The disturbances are confined almost entirely to the northern part of the Bay, the majority forming north of Lat.  $20^{\circ}$  N., but a few have been known to form as far south as Lat.  $18^{\circ}$  N.

The tracks of these depressions are directed rather more towards the west than in June, nearly all the centres move W. or WNW. and cross the coast between Sagar island and False point, but a few pass over the Sundarbans.

Some of the depressions which affect the Bay of Bengal in July have travelled from the China sea across south China, usually between latitudes  $20^{\circ}$  and  $25^{\circ}$  N., and it has been ascertained that in July and August about 40 per cent. of the typhoons which strike the coast of south China and Indo-China affect the weather of India.

The majority of the depressions in August form north of Lat.  $19^{\circ}$  N. but a few form further south between latitudes  $16^{\circ}$  and  $19^{\circ}$  N., and, as in July, a few have travelled from the China sea across south China into the Bay of Bengal.

The direction of travel is usually between WNW. and NW. and is rather more towards the north than in July. The storms usually cross the coast of India between Sagar island and False point, a storm may occasionally, however, cross the coast slightly to the south of False point and sometimes one passes over the western part of the Sundarbans to the east of Sagar island. The tracks are for the most part fairly regular but occasionally a storm travels N. or NE. and then recurves towards NW.

In September, owing to the winds of the SW. monsoon being less strong and steady than in the preceding months, depressions form over a much wider area and also appreciably further south. Practically all the storms form between latitudes  $15^{\circ}$  and  $20^{\circ}$  N. and usually north of Lat.  $17^{\circ}$  N. Some of the cyclonic disturbances that appear in the Bay of Bengal in this month have had their origin in the China sea and the proportion may be as high as one

storm in four, the conditions for the westward travel of typhoons being very favourable in this month.

The tracks of the storms in September are much more irregular than in July and August. The most usual direction is towards NW., but they may move in any direction between W. and NNE. The majority of the storms cross the coast of India between Masulipatam and Sagar island, but a few may travel northwards to the head of the Bay of Bengal and pass over the Sundarbans, several of the most severe storms have taken this path. It has been found that usually about four out of five storms cross the coast of India between Balasore and Cocanada while the fifth travels in a more northerly direction to Bengal.

*Post SW. monsoon period (October and November).*—The danger of cyclonic storms in these two months is greater than in any other months of the year. The frequency of cyclonic disturbances is actually slightly less than during the SW. monsoon months, but the chances of a storm with winds of gale force are greater, and when a storm forms the chances are about even that it will be severe. Further, in October and November any part of the Bay of Bengal may be crossed by the track of a storm and no part of the coast of India is immune.

The storms in October may form in any part of the Bay of Bengal between latitudes  $8^{\circ}$  and  $20^{\circ}$  N. It is very rare for them to form at the head of the Bay north of Lat.  $19^{\circ}$  N. or in the extreme south-western part off the coast of Ceylon. The most frequent place of formation is over the centre of the Bay of Bengal—between the Andaman islands and the northern part of the Coromandel coast of India—or in the Andaman sea; they thus have a long travel over the sea in which to develop into severe cyclones before arriving on the coast of India. A few of the disturbances may be survivals of typhoons which have crossed over from the China sea and entered the Andaman sea after passing through Thailand (Siam) and over the Tenasserim hills.

The tracks of the storms are very irregular, most of them travel WNW. or NW. in their early stages, but a few move towards NNW. or N. and occasionally a storm which formed in the more northern part of the Bay, north of Lat.  $16^{\circ}$  N., has been known to travel NNE. immediately after its formation. There is a definite tendency for the storms to recurve in the later stages of their existence, usually about two or three days after their formation; the latitude of recurvature is very variable, sometimes they turn towards north in quite low latitudes whereas on other occasions they recurve only when they reach the north of the Bay. Not infrequently, however, the storms move towards WNW. or NW. straight across the Bay of Bengal and cross the Coromandel or Circars coast without recurving. Those storms which reach the Bay of Bengal from the China sea mostly travel WSW. over Indo-China between latitudes  $10^{\circ}$  and  $20^{\circ}$  N. and turn northwards after entering the Bay. Those

that reach the Bay in lower latitudes travel westwards with the equatorial easterlies and turn northwards only when they reach the Arabian sea.

In November the region of formation of storms is considerably further south than in October. Almost all the storms form south of Lat.  $16^{\circ}$  N. and rather more than half of them south of Lat.  $12^{\circ}$  N. though occasionally a storm may form north of Lat.  $16^{\circ}$  N. The extreme south-western part of the Bay of Bengal, off the coast of Ceylon, which is free of storms from about June to October, is now no longer immune. Storms continue to reach the Bay of Bengal from the Andaman sea as in October; some of these have originated in that sea whilst others are re-developed typhoons that have crossed the Malay peninsula, the frequency of this occurring in November, however, is rather less than in September and October. The latitude of the tracks of these re-developed typhoons in this month lies between the parallels of  $10^{\circ}$  and  $15^{\circ}$  N.

The tracks of the storms in November are very irregular and any part of the Bay of Bengal north of Lat.  $8^{\circ}$  N. may be visited. The majority of the storms which form in the southern part of the Bay south of Lat.  $12^{\circ}$  N., and especially those that form in the south-western part, move WNW. or NW. and cross the Coromandel coast, frequently just south of Madras; occasionally, however, a storm may travel due west or even slightly south of west and cross the island of Ceylon. Some of these storms may cross the Indian peninsula into the Arabian sea and such storms are generally severe.

The remaining storms after travelling WNW. or NW. in the early stages of their existence turn northwards ultimately recurving to the NE. and crossing the north and north-east coasts of the Bay of Bengal; in fact these coasts are more liable to storms in November than in any other month of the year.

Those coasts which are most free from storms in this month are the Circars and Orissa coasts between Vizagapatam and Sagar island; storms rarely if ever pass inland over these coasts in November, although occasionally they travel almost parallel to the coast during recurvature.

### III—WIND

#### 1—SURFACE WINDS

Wind-roses for each of the twelve months are reproduced in Figs. 2-13. On the roses for the sea areas both the direction and force of the wind are indicated but for the places on the coast information of the direction of the wind only is available. The roses for the coastal places are for 0800 (local time) and owing to the large changes in the direction of the wind during the day they cannot be regarded as representative of conditions at other hours. A comparison of the wind-roses for the morning and afternoon in each of the four seasons is given in Figs. 14 and 15 on pages 44-5.

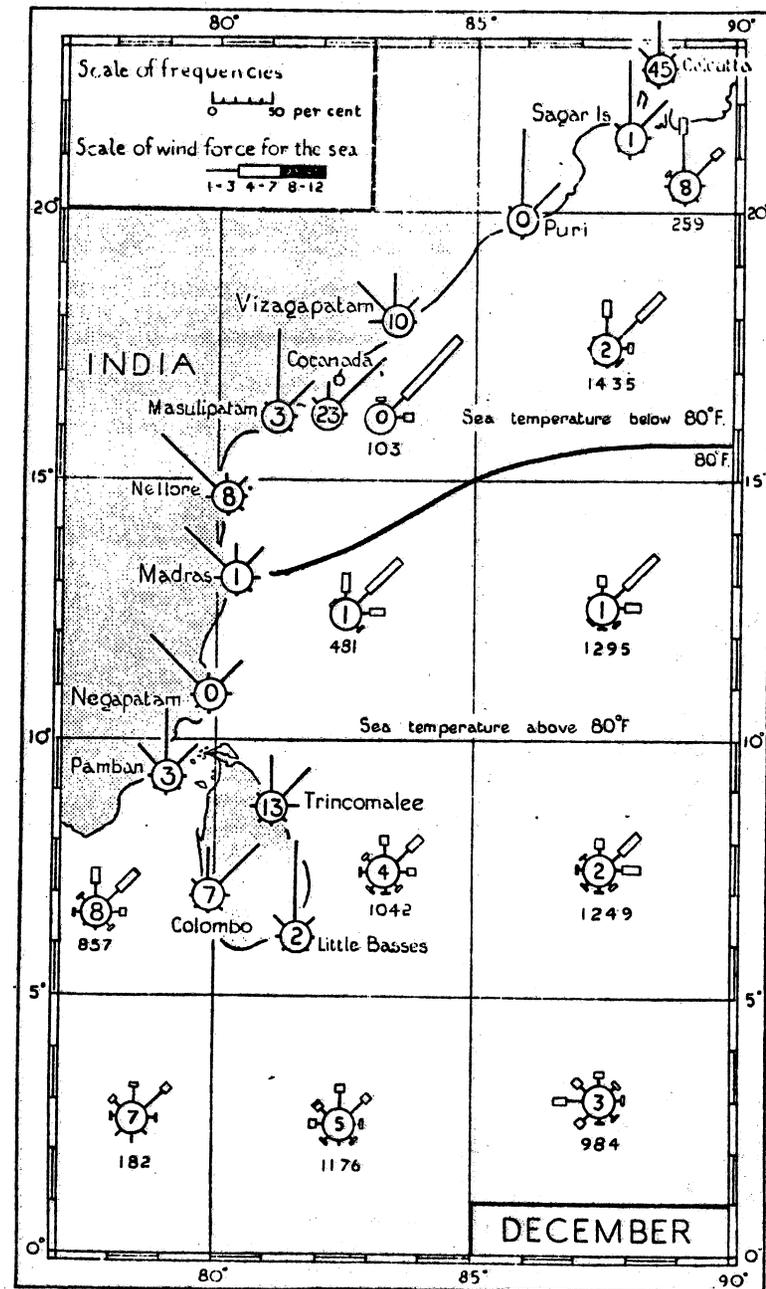


FIG. 2.—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon. The wind-rose for Cocanada is displaced slightly to the south.

The isotherm of sea temperature for 80° F. is indicated by the thick line.

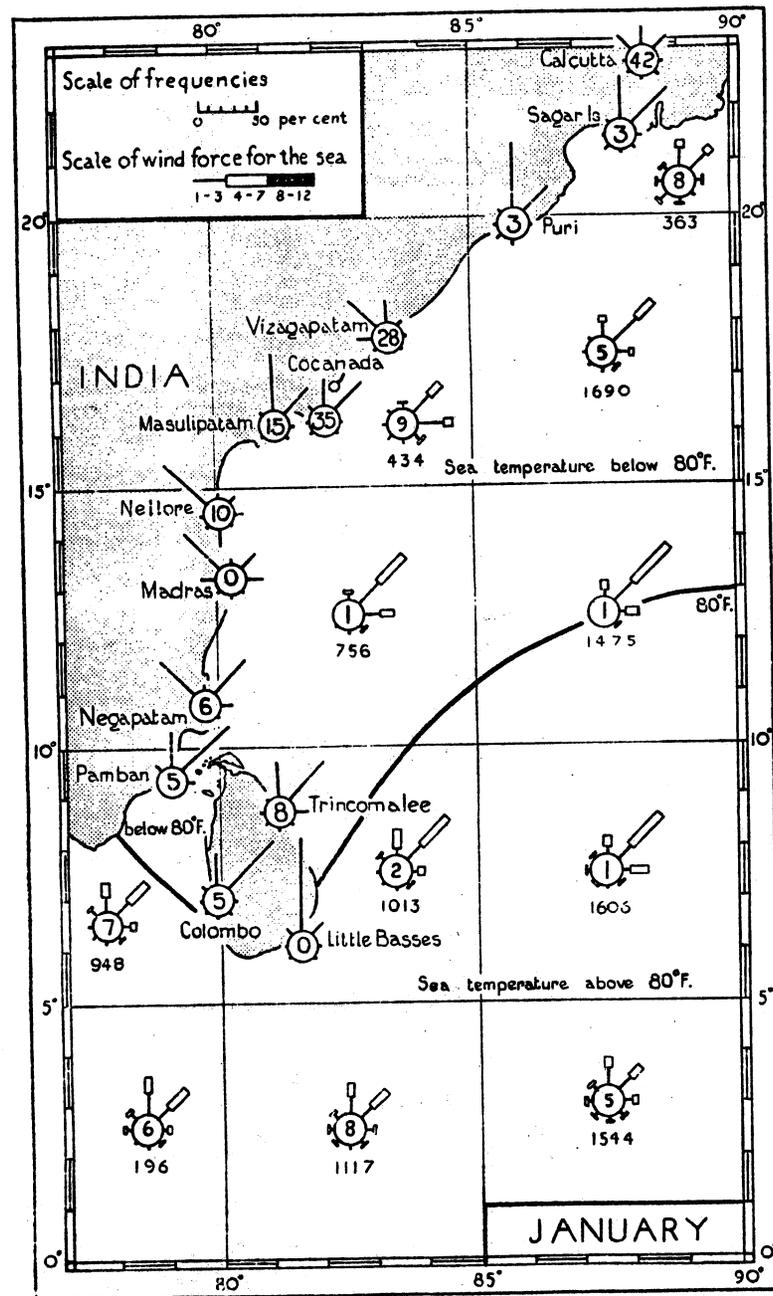


FIG. 3—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon. The wind-rose for Cocanada is displaced slightly to the south.

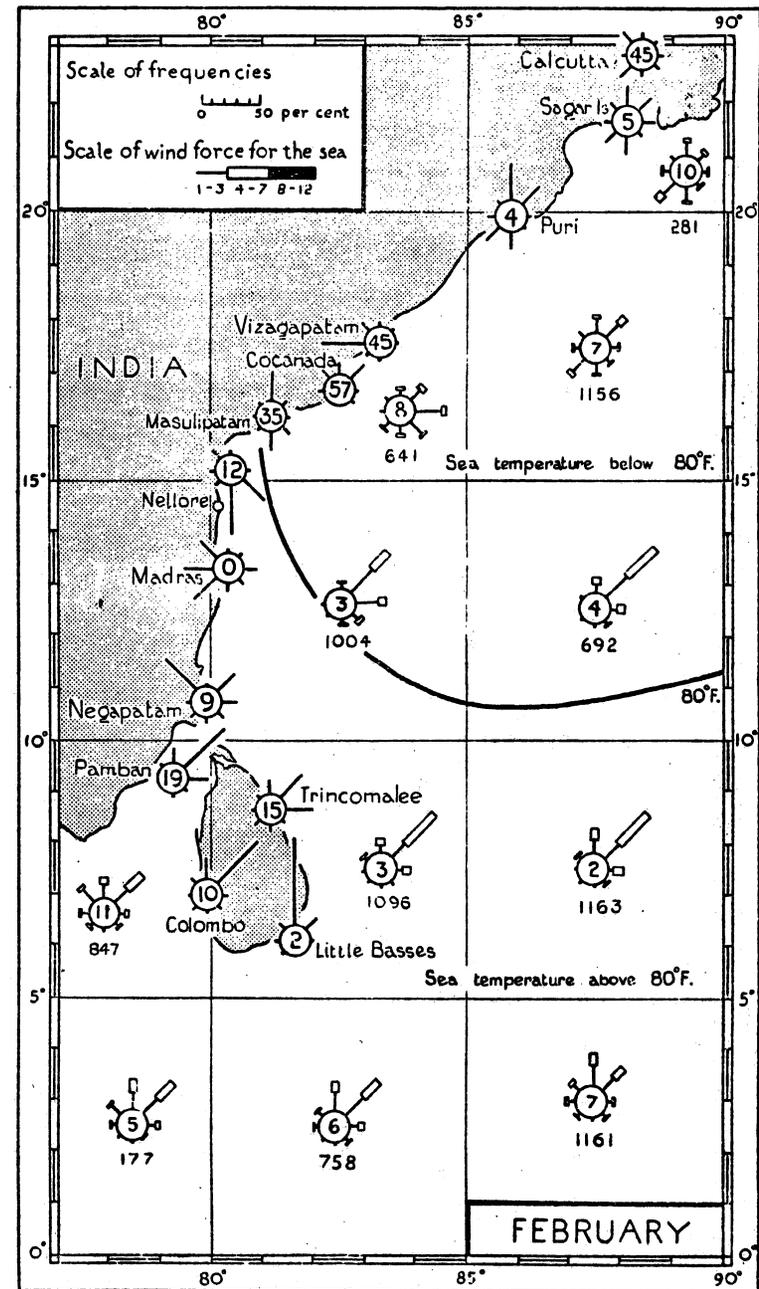


FIG. 4—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon.



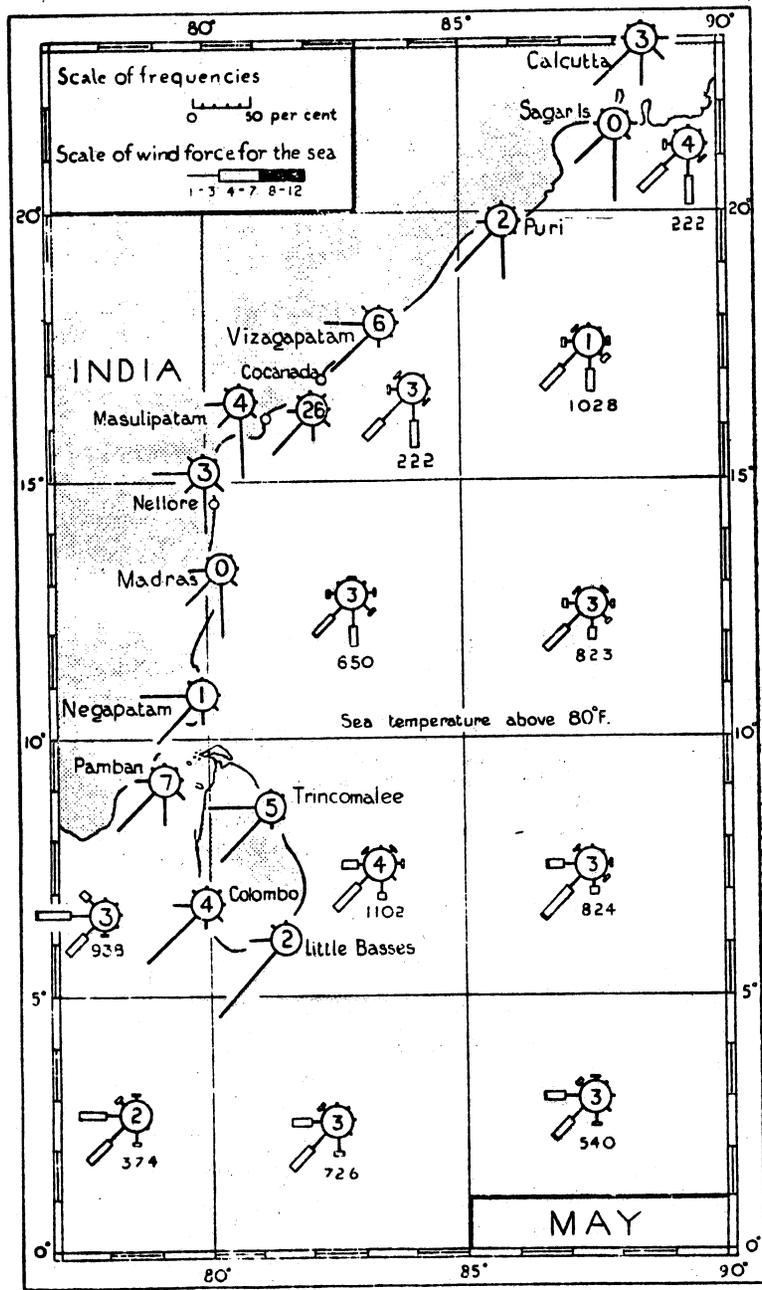


FIG. 7—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon. The wind-roses for Masulipatam and Nellore are displaced

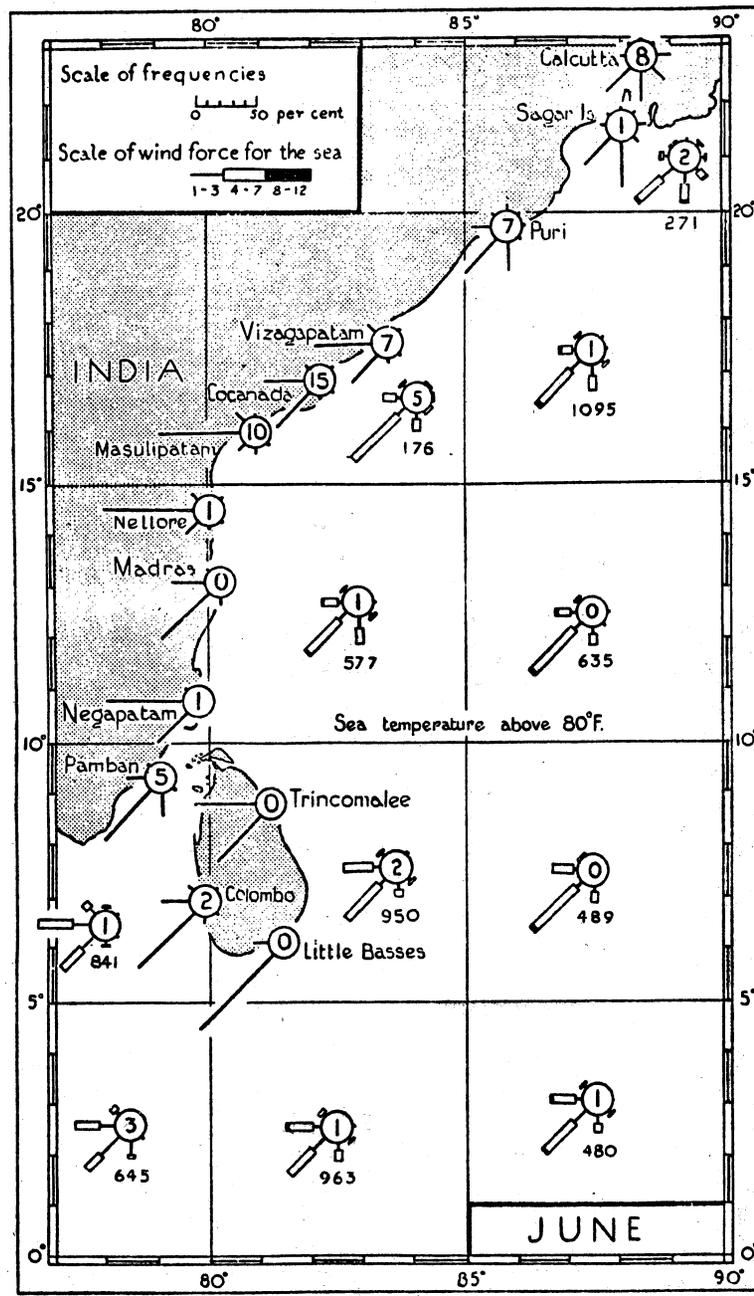


FIG. 8—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India

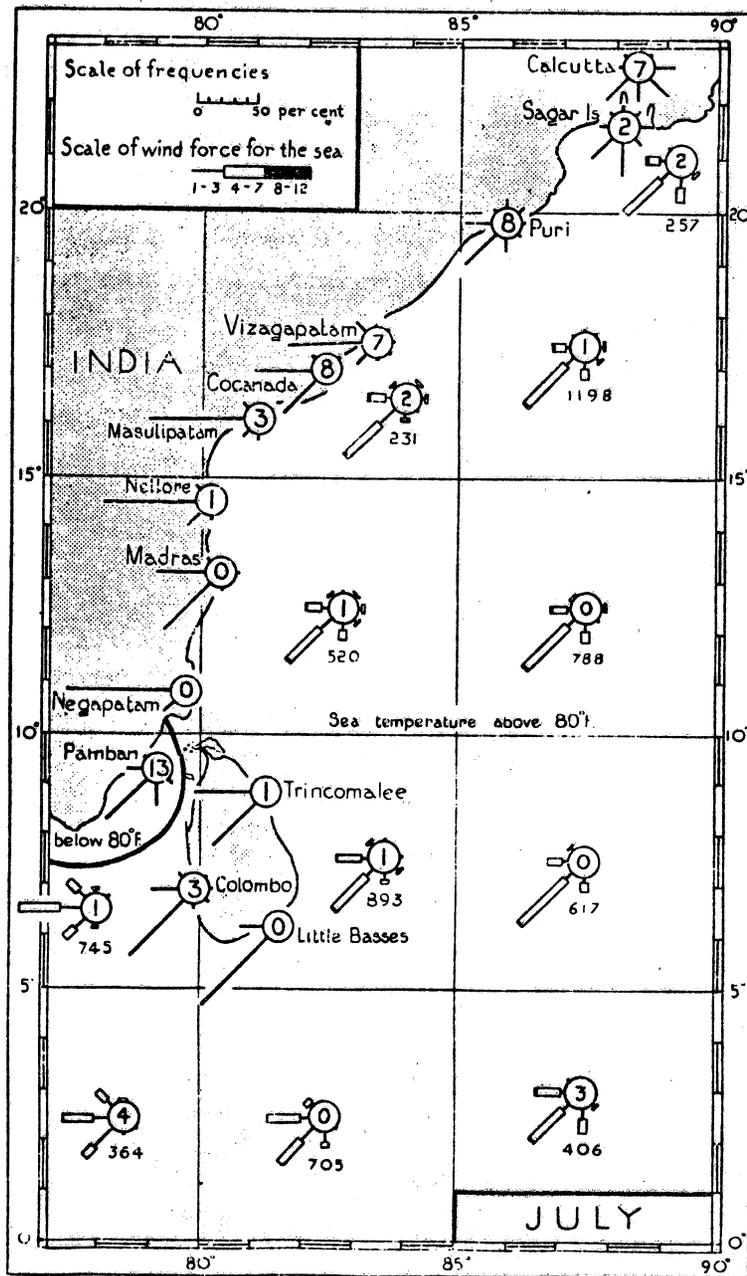


FIG. 9—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon.

The isotherm of sea temperature for 80° F. is indicated by the thick line.

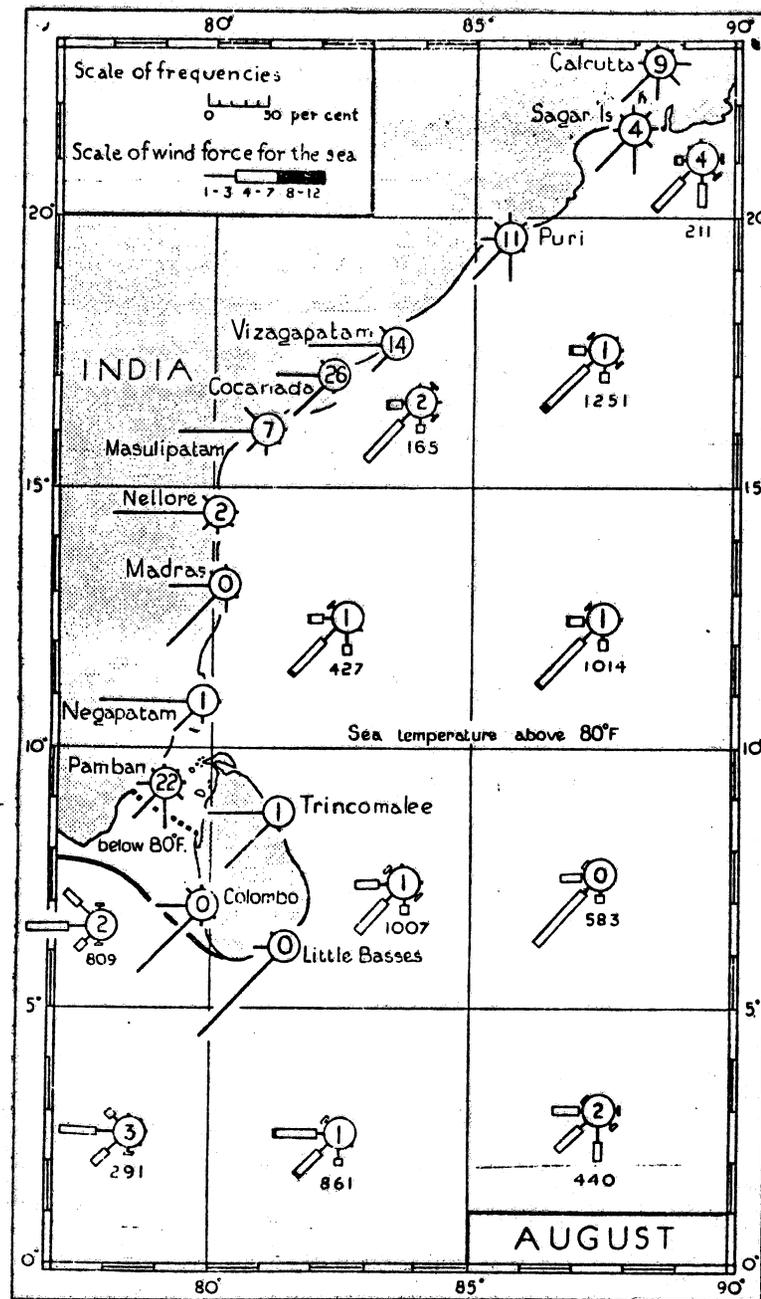


FIG. 10—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon.

The isotherm of sea temperature for 80° F. is indicated by the thick line; where its position is doubtful the line is dotted.

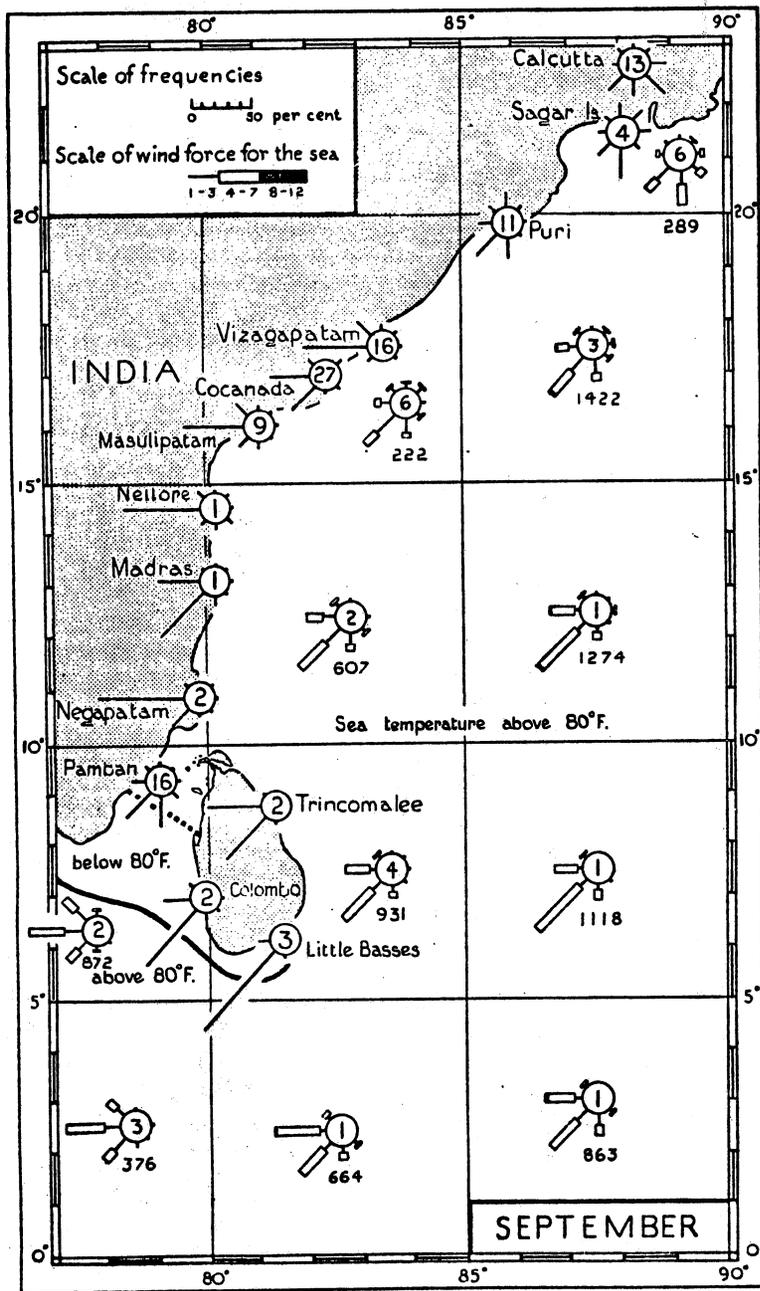


FIG. 11—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon.

The isotherm of sea temperature for 80° F. is indicated by the thick line;

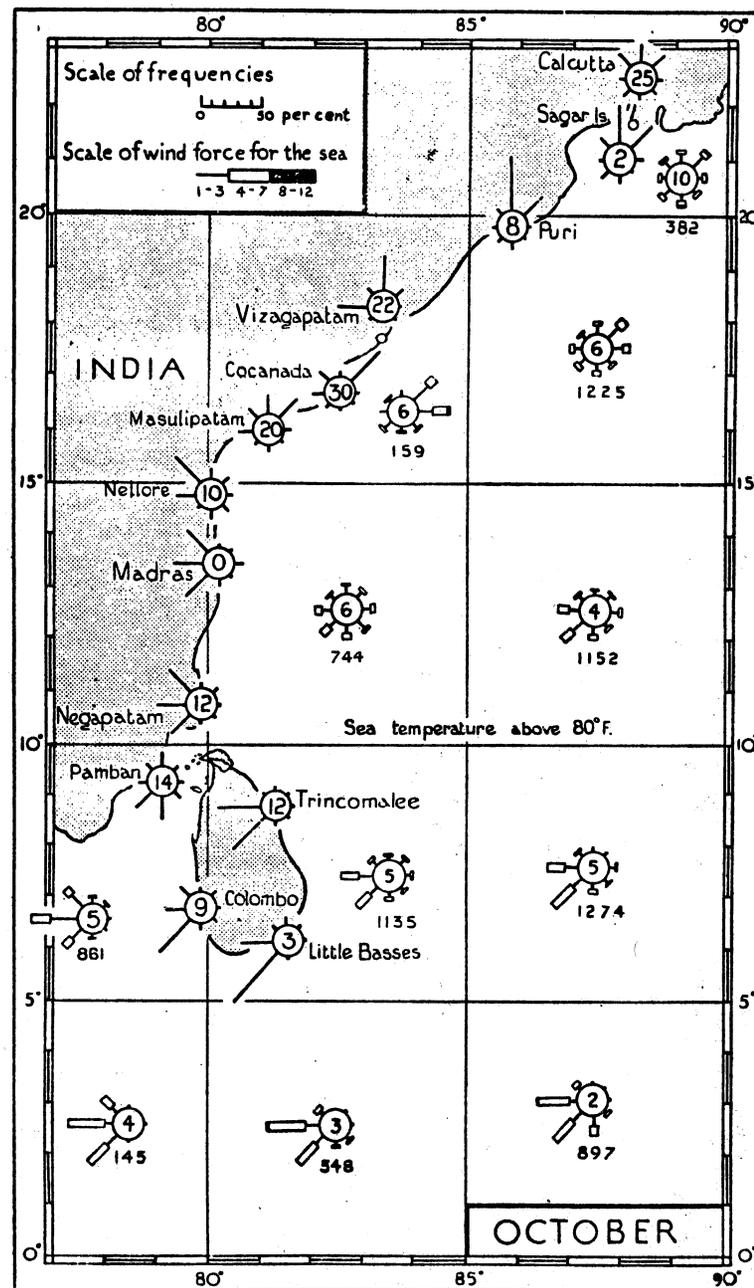


FIG. 12—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon. The wind-roses for Sagar Island and Vizagapatam are displaced slightly to the south and north respectively.

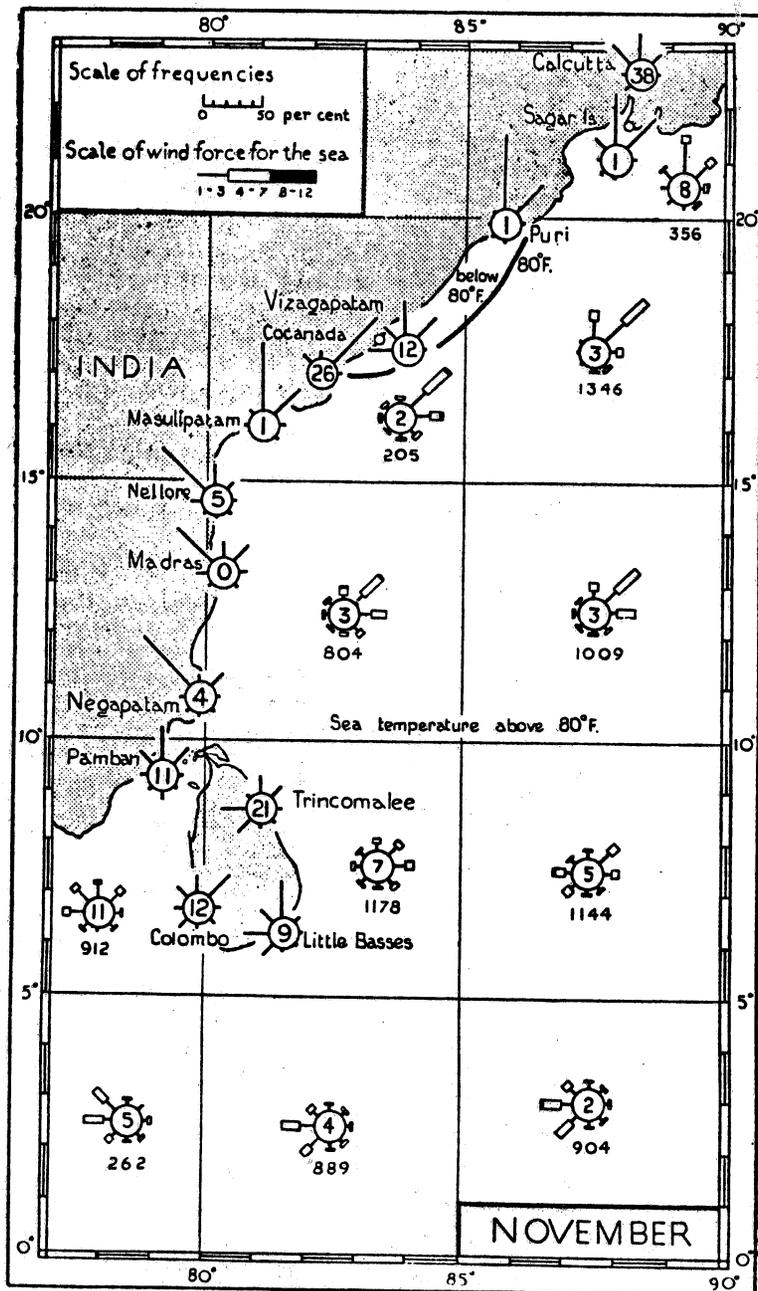


FIG. 13—SURFACE WINDS—MONTHLY

The figures inside the circles indicate the percentage frequency of calms and those below the roses for the sea areas the number of observations. The roses for the land stations are for 0800 local time on the east coast of India and for 0930 in Ceylon. The wind-rose for Vizagapatam is displaced slightly to the east.

The isotherm of sea temperature for 80° F. is indicated by the thick line.

The corresponding data for the sea are given in Table II on pages 103-7, and for the coastal places in the general climatological tables and in Table III on pages 95-102 and 108. The tables for the coastal places include also the frequencies for the afternoon hour of observation where they are available.

The speed of the wind at coastal places is included also in the general climatological tables. At Madras and Calcutta the speed is for the morning and afternoon hours separately and at the other places is the mean taken over the 24 hours. The frequency of winds of different forces for Negapatam, Madras, Cocanada, Vizagapatam, Puri, Sagar island and Calcutta at 0800 (local time) and at 1700 (Z-5½) and for Pamban at 0800 (local time) is given in Table IV on page 109.

The surface winds of the Bay of Bengal and the east coast of India are dominated by the NE. and SW. monsoons. The NE. monsoon prevails throughout the months of November to March and the SW. monsoon throughout June to September. The direction and strength of these monsoons vary in the different localities. The north-easterly and easterly winds of the NE. monsoon actually begin to blow in the northern part of the Bay of Bengal in October but they are not fully established until November, and in the southern part, which includes Ceylon, not until the middle of that month. The SW. monsoon is not fully established over the Bay of Bengal until the middle of June but in the southern part and in the vicinity of Ceylon it begins to blow about the middle of May and occasionally there may be a temporary invasion before the end of April. South-westerly winds are experienced in the northern part of the Bay of Bengal in March, April and May but these are not the winds of the SW. monsoon proper but are due to the heating up of the land areas to the north and east which causes a flow of air from the sea towards the land.

In the interim periods between the two monsoons the winds over the whole area under consideration are variable.

#### Seasonal variation

**Cool season (December to March).—**NE. monsoon conditions prevail over the whole area throughout this season. In the following table will be found the southern limits to which the NE. monsoon extends in the longitudes of the Bay of Bengal and that portion of the Indian ocean dealt with in this Part.

SOUTHERN LIMITS OF THE NE. MONSOON IN THE BAY OF BENGAL AND INDIAN OCEAN

Longitude	Nov.	Dec.	Jan.	Feb.	Mar.
80°E.	10½°N.	3°N.	Latitude 1½°N.	2½°N.	6°N.
90°E.	11½°N.	4°N.	3°N.	4°N.	7°N.

Authority.—Bibliography No. 47.

*Sea areas.*—In December and January NE. winds prevail generally but north of Lat. 20° N. the mean direction of the wind is more northerly than elsewhere. Over the sea areas the north and north-easterly winds in December extend to about Lat. 5° N. whilst in January they extend to between about latitudes 1½° and 3° N. The weather in these months over the Bay of Bengal is steadily fine and the force of the wind in the northern and central parts of the Bay usually varies between about Beaufort force 3 and 4, but gale force or just under may be reached at times in the central part of the Bay in December; south of Lat. 5° N., where the direction of the winds is more variable, their force is generally between 2 and 3 of the Beaufort scale but force 6 may occasionally be reached. The average force of the wind increases southwards to about Lat. 5° N. and then decreases towards the equator.

The NE. monsoon winds continue to prevail steadily over the Bay of Bengal during February but owing to the increasing heat over the Indian peninsula the wind becomes more easterly west of about Long. 85° E. whilst to the east of that longitude the mean directions are slightly more northerly than in January. North of Lat. 20° N. the direction is variable with frequent SW. winds. In the south the NE. winds extend to between latitudes 2½° and 4° N. and the winds there are mainly NE. The winds over the whole area are slightly lighter in force than in January, they are also much steadier and somewhat stronger between Lat. 5° and 15° N. than further north.

By March owing to the increasing temperature of the land and consequent change in the general distribution of pressure the NE. monsoon winds become less steady; in fact north of Lat. 15° N. the winds are mainly southerly or south-westerly though south of that latitude, to about Lat. 5° N., the NE. winds of the monsoon still prevail. Between the equator and Lat. 5° N. the winds again become very variable. Off the coast of India the winds have become more easterly south of Lat. 15° N. but to the north they are mainly from a direction between S. and SW. The mean force of the wind over the whole area is very uniform in this month generally varying between 2 and 3 of the Beaufort scale though there may be occasional wind forces between 4 and 7. Squalls which cause a high sea are sometimes experienced in the north-western angle of the northern part of the Bay.

*Gulf of Mannar.*—The NE. monsoon blows here until the end of January and the direction of the wind is NNE. to NE.

*Coromandel coast.*—Northerly to easterly winds prevail until the middle of February. The winds become less steady and strong in February when the normal direction at Madras during the day is easterly. During March south-easterly winds predominate and become very strong during the day.

*Circars coast.*—In December the mean winds are generally NE. and veer round to E. in January, becoming ESE. to SSE. in February and the first half of March. There is a pronounced change in the predominating winds by the end of March when they become southerly to south-westerly.

*Orissa and Bengal coasts.*—In December dry land winds blow from NNW. to NW. and until the middle of December cyclonic storms may affect the winds and weather. In January and during the greater part of February dry northerly land winds with fine weather prevail as a rule, except during the brief periods when western depressions cross north-east India. The winds during these depressions alter to a southerly direction and the weather becomes cloudy with occasional squalls. In early March there is a feeble indraught of local sea breezes across the Bengal coast.

*Hot season (April and May).*—This is a season of very variable winds in which tropical storms or depressions and sometimes "Nor'-westers" may be experienced; land and sea breezes also prevail and the SW. monsoon may begin to be felt in the southern part of the area in May, and sometimes a temporary advance may take place at the end of April.

*Sea areas.*—In April the northerly winds have practically disappeared from the Bay of Bengal and the mean directions are now south-easterly off the Coromandel coast and south-westerly over the northern part of the Bay, and westerly in the south near the equator. The chief features of the weather in the Bay of Bengal in April are the steady SW. winds in the north and the unsteady and variable winds in the south. Owing to the heating up of the land in this month there is a well marked area of low pressure over Bihār and Bengal at the north-western part of the Bay which causes the air to flow from the sea towards the land and is the reason for the SW. winds in the northern part of the Bay of Bengal. These south-westerly winds are not the winds of the SW. monsoon proper as the monsoon has not yet begun to blow in the south and it arrives in the southern part of the area first and then gradually extends northwards.

The mean force of the wind is light and usually varies between 2 and 3 of the Beaufort scale, but in the north-western part of the Bay the wind is stronger and the average lies between about Beaufort force 3 and 4.

In May in the northern and central parts of the Bay of Bengal fairly fine weather and moderate winds usually prevail but the weather is hot and sultry. The mean wind direction over the whole of the Bay of Bengal in this month is south-westerly as the winds of the SW. monsoon are beginning to blow in the southern part and are gradually extending northwards over the Bay; off the Coromandel coast and in the northern part of the Bay the wind tends to be more southerly. "Nor'-westers" are occasionally

experienced in this month off the Orissa and Bengal coasts, these "Nor'westers" are dealt with more fully on page 47. In May the mean force of the wind in most parts of the Bay generally varies between about 3 and 4 of the Beaufort scale but in the northern part the SW. winds may occasionally rise to gale force.

*Gulf of Mannar.*—Land and sea breezes prevail during April. After February the sea breezes have gradually become of longer duration and they continue to increase in force until the middle of May. Towards the end of April the winds at night become light and variable, and in May the wind begins to blow continuously from SW.

*Coromandel and Circars coasts.*—In April south-easterly winds predominate and become very strong during the day. They veer towards south as the season advances, blowing as "longshore winds" from almost due south. In May the average wind direction in Madras is SW. but it undergoes greater variations in direction and strength during the 24 hours each day in this month than at any other period of the year. Occasionally a westerly wind prevails throughout the day and the sea breeze is absent.

*Orissa and Bengal coasts.*—The feeble indraught of southerly local sea breezes which cross the Bengal coast early in March gradually strengthens in April and May and becomes vigorous and steady. These winds advance chiefly into northern and eastern Bengal and give rise to frequent afternoon and evening thunderstorms which sometimes develop into "Nor'westers."

**SW. monsoon (June to September).**—In these months the SW. monsoon winds are blowing over the whole area and they show their greatest strength and steadiness in the central and western parts of the Bay of Bengal. These winds are of maritime origin, with high humidity, and bring frequent and heavy rain to most of the area.

The SW. monsoon in the Bay of Bengal gradually extends northwards from the southern part of the Bay and on reaching the northern part is deflected by the Arakan hills and the Himalayas, first in a northerly direction to cross the Bengal coast and then towards the north-west up the Gangetic plain. During the advance of the SW. monsoon northwards cyclonic depressions may form at the head of the Bay of Bengal. During the season the strength of the monsoon varies considerably, at times it may blow strongly whilst at other times it moderates and a spell of fair weather may last for a few days or even weeks. It is towards the end of September that the SW. monsoon begins to withdraw in the extreme north of the Bay.

*Sea areas.*—In June over the greater part of the Bay of Bengal the mean direction of the wind is south-westerly, but in the extreme north of the Bay the wind tends to be more southerly and blows from between SW. and SSE. The advance of the SW. monsoon

towards the north of the Bay usually takes place during the first or second week of June. Before the arrival of the monsoon moderate to strong SW. winds prevail in the northern part of the Bay and rather unsteady winds in the central and southern parts. The weather at the beginning of the month in the southern part of the Bay consists of severe squalls and heavy rain, and cyclonic storms may sometimes occur. This area of disturbed weather advances northward ahead of the SW. monsoon until the whole of the Bay of Bengal is affected; after the monsoon has become fully established, however, strong winds from the SW. prevail generally and showers and rain squalls are not quite so frequent.

The mean force of the wind over the open sea is fairly uniform throughout the area when the SW. winds are blowing, but the strength of the wind decreases slowly from south to north, in the south the mean force is about 5 of the Beaufort scale whilst in the north it is about 4. Forces of between 6 and 7 are, however, frequently experienced when the monsoon is fully established and during a cyclonic storm the force may rise to 8 or 9.

In July and August over the Bay of Bengal the SW. monsoon holds steadily but the force of the wind varies considerably, periods of strong winds alternating with periods of light winds. The weather in the south and centre of the Bay is generally fine with strong winds and much cloud and there are occasional rain squalls. Over the whole Bay of Bengal the mean direction of the wind is steadily SW. but south of Lat. 5° N. the wind varies between SW. and W. The mean force of the wind is very uniform over the whole area of south-westerly winds, but it decreases slightly at the head of the Bay, the mean force over the south and centre of the Bay is between 4 and 5 of the Beaufort scale whilst in the north it is between 3 and 4. Strong winds may occur, however, from time to time and forces of 9 or 10 have been reached even when there are no cyclonic storms. As a rule heavy gales are not experienced to the south of Lat. 8° N. and near the equator the weather is cloudy, squally and showery, the force of the wind usually varying between 2 and 3 of the Beaufort scale during fine weather and between 6 and 7 during squalls.

In September the winds are still mainly SW. over most of the Bay but in the south in the vicinity of Ceylon they are more westerly and in the extreme north they are slightly more southerly. The general weather conditions are very similar to those of July and August, the sky is generally more or less cloudy, and isolated squalls may occasionally occur in all parts of the Bay, being most frequent south of Ceylon. There are periods of strong winds alternating with intervals of lighter winds; the intervals of lighter winds with fine weather are more prolonged in this month than in July and August. On the whole the mean force of the wind is slightly less than in August, in the extreme north it is about Beaufort force 3 and increases in the south to between about 4 and 5 of the Beaufort

scale. Wind forces of between 8 and 9 have, however, been occasionally reported, even when there was no evidence of a storm.

*Gulf of Mannar.*—The SW. monsoon gains in strength in June and fishermen seldom go to sea in this month. In July the weather is cloudy and hazy with generally a fresh breeze. The wind moderates in the northern part in the morning and blows strong again in the afternoon. Fresh south-westerly to west-south-westerly winds continue in August and September but the weather is generally fine, in the afternoon the breezes are strengthened and are accompanied by an occasional squall and rain.

*Coromandel coast.*—In June south-westerly winds prevail, they become weaker during July, August and September and towards the end of September calms are frequent.

*Circars coast.*—Steady SW. winds predominate during July and until the end of August.

*Orissa and Bengal coasts.*—Throughout the months of the SW. monsoon the predominating winds are south-westerly on the Orissa coast and southerly to south-easterly on the Bengal coast. The change over from the local southerly sea breezes to the winds of the SW. monsoon proper usually occurs in the first or second week of June and is generally ushered in by the advance of a cyclonic storm of moderate intensity in the rear of which the monsoon air currents are carried.

*Post SW. monsoon period (October and November).*—In October the SW. monsoon has withdrawn from the northern part of the Bay of Bengal, and the weather over the Bay is very different from that experienced during July, August and September. Fine weather frequently prevails for considerable periods in the northern and central parts, but occasionally severe cyclonic storms, giving winds with hurricane force, may occur, the weather is consequently very variable.

*Sea areas.*—In October over the central and southern part of the Bay of Bengal the mean direction of the wind is still SW. There is generally a marked tendency for very light airs and calms with cloudy, showery weather in the south of the Bay, but to the north of Lat. 15° N. the winds have become mainly north-easterly and easterly, as the NE. monsoon begins to appear. In the southern part of the area between the equator and about Lat. 8° N. the winds are mainly westerly.

The mean force of the SW. winds is about 3 or 4 of the Beaufort scale but it frequently increases to forces between 5 and 7. The north-easterly winds, however, vary between Beaufort force 2 and 3. If a cyclonic storm occurs winds of forces between 8 and 9 may be experienced. The average force of the westerly winds in the south is about 3. The weather in October is more variable and treacherous than in any other month of the year.

By November the winds of the SW. monsoon have entirely disappeared from the Bay of Bengal and the NE. winds which in October were confined to the north have now spread southwards to all parts of the Bay, though they are more frequent in the north than in the south. Between latitudes 10° and 5° N. the winds are very variable and from Lat. 5° N. to the equator westerly winds predominate. Along the east coast of India northerly and north-easterly winds are the most frequent. The mean force of the NE. wind is between 2 and 4 of the Beaufort scale but in all parts of the Bay of Bengal and especially in the centre and south strong winds of forces between 9 and 10 may sometimes be experienced. Fine weather during this month is likely to be experienced over most of the Bay except when it is disturbed by a cyclonic storm; but in the extreme south the weather may be showery and squally. An account of a violent squall that was experienced in the Bay of Bengal on November 25, 1937 is given on page 47.

*Gulf of Mannar.*—During November the winds are light and variable between NE. and WNW. and about the middle of the month the NE. monsoon winds start to blow. Heavy squalls may occasionally be experienced in this vicinity and an account of one that occurred on November 23, 1937 is given on page 46.

*Coromandel coast.*—During the first half of October calms are frequent but towards the end of the month northerly to easterly winds set in. Land and sea breezes are very weak and are least conspicuous in November. In November this coast is most liable to be affected by severe cyclonic storms which cause spells of strong winds.

*Circars coast.*—During October and November this coast gets squally weather in association with cyclonic storms of severe intensity. In October the winds change to a northerly direction and gradually the north-easterly winds of the NE. monsoon begin to appear and hold steadily. By the end of October or early in November feeble land and sea breezes set in and gradually increase in strength, but in November the winds are generally north-easterly.

*Orissa and Bengal coasts.*—The SW. monsoon usually withdraws in the first half of October, and in the middle of October these winds are replaced by light unsteady northerly to easterly winds. By November these northerly winds have increased in steadiness and strength and blow as dry land winds from NNW. to NW. Cyclonic storms, which affect the winds and weather on this coast, may occur at irregular intervals in October and November.

*Land and sea breezes.*—In Figs. 14 and 15 wind-roses are reproduced showing the winds at the morning and afternoon hours of observation, 0800 and 1700, in four representative months—January for the NE. monsoon, April for the hot season, July for the SW. monsoon and October for the interim period after the withdrawal

of the SW. monsoon. The corresponding data for all months of the year are included in the general climatological tables and for Nellore in Table III.

**Gulf of Mannar.**—Land and sea breezes are not noticeable on this coast until February, the sea breezes then gradually blow for longer periods and increase in force until about the middle of May, after which the winds of the SW. monsoon overcome any land and sea breeze effects.

At Pamban ( $9^{\circ} 16' N.$ ,  $79^{\circ} 18' E.$ ) during January and February, the north-easterly wind is light in the morning, but sets in strong about noon as a sea breeze, and falls again at sunset. In March the prevailing north-easterly wind is light and in the morning an easterly wind sets in which shifts southward later, but by noon it backs to the eastward, in which direction it lasts till sunset, when it gradually fails; occasionally southerly and south-westerly winds blow for a day or two.

**Coromandel coast.**—During the period from about mid-October to mid-February when north-easterly winds are blowing, land and sea breezes are very weak on this coast and they are least conspicuous in November. After February they strengthen, increasing rapidly in March and April, and are strongest on this coast from May to September except on those days when the SW. monsoon is strong. The land breeze blows in the morning hours after sunrise and the sea breeze begins to blow in the early afternoon.

At Madras in May the wind undergoes greater variations in direction and strength than at any other period of the year. Occasionally a westerly wind prevails throughout the day so that the sea breeze which usually sets in about midday does not appear at all, also in June when the SW. monsoon is strong the sea breeze either does not set in at all or only lasts for a very short time.

At Madras in July the prevailing wind direction at 0800 is WSW., and at 1600 it is SSW. backing to SE. later in the day; in October at 0800 it is WNW., and at 1600 it is ENE.

**Circars coast.**—During the cold season from December to March the land and sea breezes are well marked, after which they become lost in the predominating southerly and south-westerly winds until the end of October or early in November, when feeble land and sea breezes begin to appear again, and gradually increase in strength.

**Orissa and Bengal coasts.**—In November and December dry land winds blow from NNW. to NW. and these land winds prevail as a rule in January and the greater part of February. There is a feeble indraught of local sea winds across the Bengal coast early in March. These southerly winds gradually strengthen and are vigorous and steady in April and May and continue unchanged in

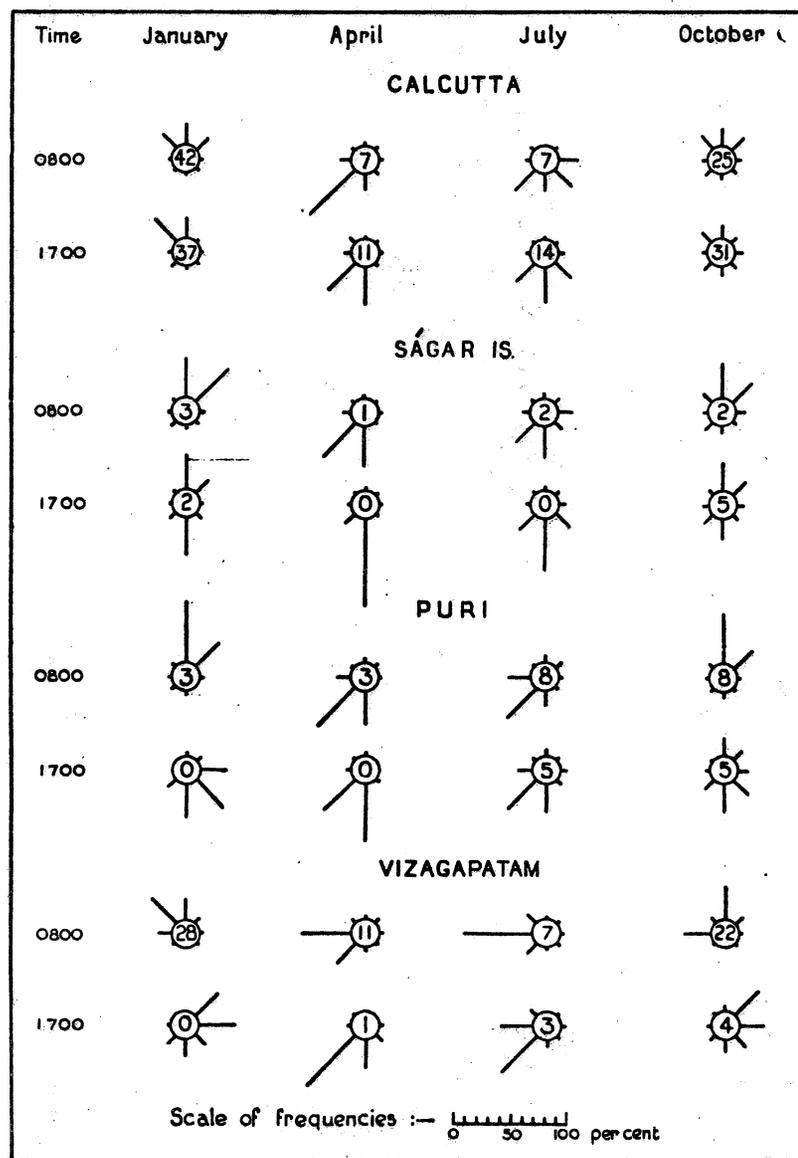


FIG. 14—SURFACE WINDS—MORNING AND AFTERNOON

Figures inside the circles indicate the percentage frequency of calms. The morning observations are at 0800 local time and the afternoon observations at 1700 Indian standard time, ( $Z 5\frac{1}{2}$ ), which differs from local time by less than half an hour.

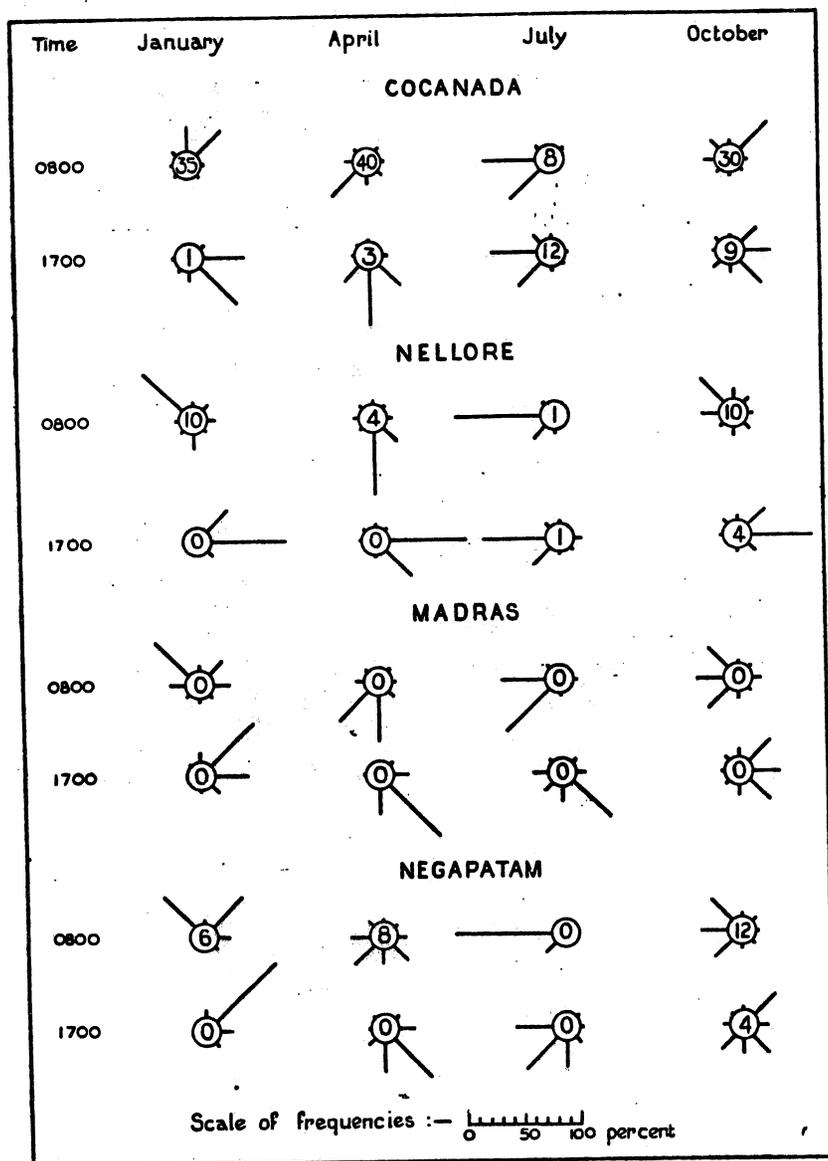


FIG. 15—SURFACE WINDS—MORNING AND AFTERNOON

Figures inside the circles indicate the percentage frequency of calms. The morning observations are at 0800 local time and the afternoon observations at 1700 Indian standard time, (Z-5½), which differs from local time by less than half an hour.

general character until the first or second week of June being sometimes of exceptional strength. These sea breezes advance chiefly into eastern and northern Bengal.

An advantage which Calcutta enjoys in the hot season is the southerly breeze, which, at the close of a hot day, often blows up the wide estuary of the Hooghly, bringing some hours of agreeable relief. It does not last beyond midnight, but it mitigates the heat in the evening.

At Puri (19° 48' N., 85° 49' E.) from the middle of November to the middle of March the sea breeze sets in about noon and blows moderately until 2100, the land wind then follows until daylight after which the wind is variable until noon. After the middle of February the sea breeze sometimes lasts all night and blows freshly for three days.

**Gales, strong winds and squalls.**—The percentage frequency of gales for the sea areas compiled from ships' observations taken over a long period of years is shown in the wind-roses of Figs. 2-13 and in Table II on pages 103-7.

Gales are most frequent in the months of the SW. monsoon from June to August and are rare during the NE. monsoon, especially in February. They occur more often in the interim period following the SW. monsoon than in the hot season and their frequency shows a secondary maximum in November.

The area 10°-20° N., 85°-90° E. is the region which is most liable to gales.

The strongest gales are associated with severe tropical cyclones which are, however, infrequent. The number of cyclones during the year that are likely to develop into storms with winds of gale force or hurricane force is given on page 19, in the section on "Depressions and tropical cyclones".

The occurrence of squalls in the area under consideration has already been described in the paragraphs on "Seasonal variation" on pages 36-42 which deal with the surface winds during the different months of the year. The following are descriptions of two heavy squalls that were experienced, one in the vicinity of the Gulf of Mannar and the other in the Bay of Bengal, towards the end of November 1937. These are followed by a description of the severe squalls known as "Nor'westers."

The S.S. *Matheran* gives the following account of a heavy squall which was experienced on November 23, 1937 whilst in the vicinity of the Gulf of Mannar, south of Cape Comorin, in approximate position 6° 36' N., 77° 21' E. :—

"At 0205 a heavy squall commenced. Wind backed suddenly from ESE. to NE. and freshened to a strong breeze. About 0210 the wind backed to NNE. and blew with hurricane force with torrential rain for about two minutes, when the wind fell away to calm for one minute, the rain continuing as before. The wind

then hauled to ENE. and blew steadily from that direction, force 4, rain moderating. Vivid forked lightning and thunder accompanied the squall, which had been threatening for over two hours. Rain continued with moderate ENE. wind until 0400 and during the passage of the squall the barometer pumped violently."

On November 25, 1937 the same ship experienced another violent squall in the Bay of Bengal in approximate position 13° 13' N., 84° 41' E.

"At 2132 a violent squall commenced. Wind hauled from NNE. to ENE. and blew with hurricane force, which continued to 2144. During this time torrential rain fell; visibility at the very best was 100 feet. Vivid continuous lightning and thunder accompanied the squall. At 2144 the wind eased to a gentle breeze, rain continuing as before. Rain suddenly ceased, wind backed to NNE. and blew steadily force 5. The barometer, which had been steady for the past 4 hours, also remained quite steady during and after the squall. Ten minutes after the squall had passed the ship passed through a warm current of air which lasted three minutes, after which the temperature was again normal at 76° F. In the evening masses of cumulonimbus clouds could be seen banking up in the NE."

**Nor'westers.**—This is the name given to a severe type of thunderstorm, accompanied by strong squalls, which occurs occasionally in Bengal and neighbouring regions during the hot weather. They derive their name from the fact that they usually approach from the north-west, although squalls from north and north-east are not unknown. The storms are locally described as "Kal-Baisakhi" or the "fateful thing" of the month of Baisakh (April 15—May 15). Although the nor'wester season is generally regarded as extending over the months of March, April and May, nor'wester squalls have been experienced in the latter half of February or as late as the middle of June. The arrival of the SW. monsoon puts an end to the storms.

"Nor'westers" may occasionally attain the intensity of a tornado and a few may actually develop into real tornadoes. They sometimes extend to about 100 miles out to sea off the coasts of Burma, Bengal and Orissa.

A well known characteristic of "Nor'westers", especially in April and May, is that they tend to occur in spells, sometimes setting in on four or five consecutive days at about the same time and place.

There is no information about the frequency of occurrence of "Nor'westers" over the sea areas of the Bay of Bengal and even over land it is difficult to give an estimate of the frequency of typical "Nor'westers," as a clear distinction between thunderstorms and "Nor'westers" cannot be made when dealing with past data. At Calcutta, the frequency of thunderstorms of any type based on 27 years' data is 2.2 in March, 4.7 in April and 6.1 in May.

The first sign of these storms is a low bank of dark clouds in the north-west the upper outline of which has the appearance of an arch. It approaches at first slowly and then more rapidly and arrives with a strong gust or squall. There is, frequently, thunder and lightning followed by downpours of rain and sometimes hail which is driven by the strong winds. On some occasions the winds blow with almost hurricane force. The greatest speed of the wind recorded in one of these storms is 100 knots.

These storms almost always occur in the afternoon or evening towards the end of a close, warm day although they have been known to occur sometimes at other times of the day; they rarely last more than three or four hours and are generally followed by cool and clear weather. At Calcutta they usually occur about or just after sunset. The following is a description of a severe "Nor'wester" that occurred there on May 24, 1926 :—

"At Calcutta the wind was blowing from S. or SW. until 1600 (local time) and had been gusty since noon. At 1600 the wind died down almost to a calm but fifteen minutes later a sudden gust sprang up from the north and reached its maximum speed of about 26 knots in the next few minutes. This was short lived and the wind again dropped and backed slowly to south. At 1645 the wind began once more to veer to the north and increase in speed; shortly after 1700 there was a gale from SW. which attained a wind speed of 52 knots at 1705. This whole gale lasted fortunately for only about three minutes and was followed by a few gusts of 9 to 13 knots till about 1745. The accompanying rainfall amounted to 24 mm. (0.93 in.). This storm was extremely localised and affected only the southern portions of Calcutta; in spite of its short duration, however, it did considerable damage to shipping in the river and also a large number of trees were blown down on shore."

Although "Nor'westers" are not normally experienced so early in the year, H.M.S. *Norfolk* experienced a "blow" characteristic of a "Nor'wester" at Calcutta on the night of March 1 and 2, 1939 and gave the following description of it :—

"On the evening of the 1st, the sky began to cloud over from the north-west with some thick stratus or cirrostratus. The wind which had been light from SW. by W., became gusty and shifted to W. The barograph showed a slight unsteadiness, which might have been due to the gusting of the wind past the instrument, but at 2130 it showed a sudden rise of pressure. Frequent flashes of lightning were observed.

"At midnight the wind became squally and appeared to be from NW. The barograph by this time was falling sharply with a jerky trace. The sky was 7-tenths covered with what appeared to be sheet cloud. At 0130 the wind increased suddenly, followed by a heavy rainstorm which lasted for about 20 minutes and then suddenly ceased. The wind died down, becoming gusty, with a light shower

TABLE I—GENERAL CLIMATOLOGICAL TABLES

Pamban. 9° 16' N., 79° 18' E. 37 ft.

Time of obs. : 0800 (local time).

Month	Pressure at M.S.L.		Air Temperature						Rain			Thunder heard	Wind										Poor visibility †	Relative humidity %	Cloud amount	Wet bulb temperature °F.				
	Average*	Daily range	Average*	Mean of		Mean of		Extreme	Average fall	No. of days ‡	Max. fall in 24 hours		Percentage of observations from																	
				Daily max.	Daily min.	Highest	Lowest						Highest	Lowest	N.	NE.	E.	SE.	S.	SW.	W.	NW.					Calm			
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	mm.	in.	days	mm.	in.	days	Observations at 0800 (local time)															
January ..	1013		78	83	74	85	72	92	69	54	2.1	3	128	5.0	0.2	8	28	52	7	0	0	0	0	0	8	5	0	85	3.8	74
February ..	1012		79	85	75	88	72	92	67	19	0.7	1	89	3.5	0	5	13	46	18	2	1	0	0	1	1	19	0	80	3.1	75
March ..	1011		81	89	76	91	73	94	69	13	0.5	1	37	1.4	0	4	3	21	29	13	6	2	1	1	1	24	0	77	2.8	76
April ..	1008		84	91	79	93	75	96	69	41	1.6	3	62	2.4	1	5	1	5	12	28	22	13	1	1	1	17	0	78	3.1	79
May ..	1006		85	91	81	94	77	95	70	21	0.8	2	54	2.1	0	8	2	1	2	10	23	42	11	2	7	0	79	3.1	80	
June ..	1006		84	90	80	93	77	99	69	3	0.1	0.4	15	0.6	0	10	0	0	0	3	18	57	16	1	5	0	78	3.3	78	
July ..	1006	Data not available	83	89	79	92	77	94	73	14	0.6	0.7	131	5.1	0	8	0	0	0	5	19	48	13	2	13	0	77	3.5	78	
August ..	1007		83	89	79	91	76	94	72	19	0.7	1	67	2.6	0.2	6	2	1	2	7	25	28	11	2	22	0	77	3.2	78	
September ..	1008		83	89	78	92	75	95	72	30	1.2	2	108	4.3	0.6	6	2	1	3	7	25	30	11	5	16	0	77	3.4	78	
October ..	1009		81	88	77	91	74	95	70	230	9.0	10	128	5.0	0.2	6	12	6	4	8	20	19	9	8	14	0	82	4.2	77	
November ..	1010		80	85	76	89	73	92	71	305	12.0	13	138	5.4	0.4	7	28	19	5	3	8	5	6	15	11	0	85	4.8	76	
December ..	1012		78	83	75	86	72	93	68	190	7.5	9	160	6.3	0.2	9	43	23	3	1	1	1	2	23	3	0.2	88	4.6	75	
Year ..	1009		82	88	77	94	71	99	67	939	36.8	46	160	6.3	3	7	11	15	7	7	14	20	7	6	13	0.2	80	3.6	77	

Table I—General climatological tables

Authorities.—Bibliography Nos. 16, 49, 114, 116.

Notes.—\* Corrected to mean of 24 hours.  
 ‡ Day with 2.54 mm. (0.1 in.) or more of rain.  
 †† Mean of 24 hours.  
 † No. of days with visibility less than 2 nautical miles.

Periods.—Pressure, temperature, rainfall and cloud amount, 30 years.  
 No. of days with thunder and poor visibility, 1933-7.  
 Wind (speed), 1881-1920; (direction), 20 years.  
 Relative humidity, 1891-1910.  
 Wet bulb temperature, 1928-37.

6 95

## IX—MISCELLANEOUS

## 1—THUNDERSTORMS

The average number of days a month on which thunder has been heard at eight places on the east coast of India is given in the general climatological tables on pages 95-102.

The regions of greatest thunderstorm activity during the year as a whole are in the extreme south of the Indian peninsula, including Ceylon, and at the head of the Bay of Bengal. A fuller discussion of thunderstorms in Ceylon is given in Part 6B on page 169.

The periods of maximum thunderstorm frequency for the most part take place when there are variable winds before and after the period of the maximum SW. monsoon activity, consequently they are not quite identical in the northern and southern parts of the coast. In the extreme south of the Indian peninsula, the months of maximum frequency are in April and in October and November. Further north the months of maximum frequency generally approach nearer one another and are in May and June and in September. December, January and February are the months when thunderstorms are most rare.

At Calcutta the most frequent time for thunderstorms is between 1800 and 2000 and the quietest time is roughly from 0500 to noon. At Madras the time of maximum occurrence is between 1400 and 1500, but although thunder occurs most frequently at these times it is not unknown for it to occur at other hours.

A detailed account of the thunderstorms associated with "Nor'westers" is given on page 47.

## 2—SEA AND SWELL

A table showing the percentage frequency of different states of the sea in the morning and evening at Negapatam, Madras, Cocanada, Vizagapatam, Puri and Sagar island and in the morning only at Pamban is given on pages 126-7.

The following are some local notes on the sea and swell that is experienced at various ports and anchorages on the east coast of India, taken from the Bay of Bengal Pilot, 1931, and other sources:—

**Gulf of Mannar.**—A swell from westward is experienced in this gulf towards the end of April.

**Coromandel coast.**—*Pondicherry* ( $11^{\circ} 56' N.$ ,  $79^{\circ} 50' E.$ ).—Rough seas are experienced here during the NE. monsoon and at other times of the year a stiff breeze generally blows from the south-eastward in the afternoon causing a choppy sea. The coast here is never free from breakers known as "Madras surf".

**Madras** ( $13^{\circ} 04' N.$ ,  $80^{\circ} 15' E.$ ).—There is considerable surf at Madras, when the wind is blowing from off the shore this surf is often very high. In ordinary weather the surf wave is from 2 to 4 feet in height, in rough weather 6 feet, and during a gale from 12 to 14 feet.

**Circars and Orissa coasts.**—*Pentakota* ( $17^{\circ} 13' N.$ ,  $82^{\circ} 29' E.$  approx.).—Pentakota is situated at the mouth of a river and during the SW. monsoon this river is closed owing to the heavy sea that rolls in.

**Vizagapatam** ( $17^{\circ} 42' N.$ ,  $83^{\circ} 18' E.$ ).—There is a considerable swell here which runs nearly all the year round.

**Puri** ( $19^{\circ} 48' N.$ ,  $85^{\circ} 49' E.$ ).—After the middle of February the sea breeze sometimes lasts all night and blows freshly for three days, causing a sea which makes boat work inconvenient.

**Sundarbans.**—*Hooghly river* ( $22^{\circ} 00' N.$ ,  $88^{\circ} 00' E.$  approx.).—Tidal bores are experienced on this river, they occur only on the highest or at alternate spring tides. During the NE. monsoon, if the wind which blows the water down the Bay is unusually moderate and the moon's parallax is high, there may be a high tide and with it a bore. With the SW. monsoon the current sets up the Bay, the sea level rises, the tidal rise is high and the tidal streams strong, and whenever the parallax of the moon is high at spring there will be bores; when there are also strong southerly winds, and freshets withheld, the height of the bores is increased. Although rare, bores occur during the night, those at night during the SW. monsoon are not so high as those during the day.

## 3—WATERSPOTS

Waterspouts are observed fairly frequently in the Bay of Bengal. During the period 1920-31, 16 waterspouts were seen in the area  $0^{\circ}$  to  $10^{\circ} N.$ ,  $80^{\circ}$  to  $90^{\circ} E.$  and 10 waterspouts in the area  $10^{\circ}$  to  $20^{\circ} N.$ ,  $80^{\circ}$  to  $90^{\circ} E.$

Waterspouts may be seen in any month of the year. The periods of greatest frequency are during the months before and after the SW. monsoon. March is the month of maximum and August that of minimum frequency.

The S.S. *City of Sydney*, during the afternoon watch on October 17th, 1937, sighted a waterspout in position  $13^{\circ} 20' N.$ ,  $84^{\circ} 50' E.$ , when the following features were noted:—"The water became agitated two minutes before and ended four minutes after the formation of the waterspout. Three minutes after the formation of the waterspout rain commenced to fall in its immediate rear. The estimated diameter of the column was 15 to 20 feet and the estimated height 1,300 feet, and it was about  $1\frac{1}{4}$  miles from the ship. The wind changed just before the occurrence of the phenomenon and afterwards remained steady at NE. The sky was clear except for the cumulonimbus cloud above the waterspout and for scattered fractocumulus cloud. The barometer reading was 1009.8 mb., air temperature was  $85^{\circ} F.$  and the sea temperature  $86^{\circ} F.$ ; both pressure and temperature remained steady during the phenomenon." (*Marine Observer*, vol. 15, 1938.)

**Diurnal variation.**—The relative humidity attains its highest value in the early morning hours between 0100 and 0800, and falls to its lowest value in the afternoon between 1200 and 1600. The averages for 0800 given in the general climatological tables are, therefore, not far below the highest values of the day, but those for 1700 are likely to be appreciably above the lowest values.

In the north on the Bengal and Orissa coasts the greatest daily range of relative humidity occurs in the dry season and the smallest range during the SW. monsoon, the difference between the two seasons being quite large. On the Coromandel coast and in the Gulf of Mannar, on the other hand, where the wet season occurs during the retreat of the SW. monsoon, the difference in the daily range of relative humidity from month to month is small. At Madras, for example, the daily range is about 30 per cent. from February to September and between 20 and 25 per cent. from October to January.

The following table for Calcutta, based on hourly observations, gives the time of occurrence and average value of the highest and lowest humidities during the day and also the difference between the two :—

**Calcutta.**—DIURNAL VARIATION OF MEAN RELATIVE HUMIDITY

Period : 1901-20

Month	Maximum		Minimum		Daily range
	Time	%	Time	%	%
January ..	0100-0700	87	1500	46	41
February ..	0200-0700	86	1500-1600	42	44
March ..	0400-0700	87	1500	41	46
April ..	0600	87	1400-1500	49	38
May ..	0500-0600	87	1400-1500	57	30
June ..	0300-0600	89	1400-1500	71	18
July ..	0500-0600	91	1300-1400	77	14
August ..	0500-0600	92	1200-1400	79	13
September ..	0300-0700	92	1400-1500	76	16
October ..	0200-0700	89	1400-1600	66	23
November ..	0200-0600	86	1400-1500	52	34
December ..	0000-0700	89	1500	45	44
Year ..	0500-0600	89	1400-1500	59	30

Authority.—Bibliography No. 18.

The table shows that at the time of maximum the relative humidity rises to about 90 per cent. in all months of the year. In the months of the SW. monsoon it falls to just under 80 per cent. in the early afternoon, whereas during the NE. monsoon it falls to about 40 per cent.

**Humidity in the upper air.**—The following table gives the relative humidity in the upper air over Madras, it is based on the same sounding balloon ascents as the table of upper air temperatures on

page 87. The humidity was obtained from records of the hair hygrometer which cannot be regarded as giving accurate results at temperatures below 0° F., so that above 25,000 feet the values cannot be relied upon in detail.

**Madras.**—RELATIVE HUMIDITY IN THE UPPER AIR  
Period : 1932-5

Height above M.S.L.	June	July	Aug.	Sept.	Oct.	Nov.
<i>feet</i>				<i>per cent.</i>		
30,000	72	77	55	54	63	53
25,000	74	78	60	55	66	53
20,000	78	83	66	60	76	53
15,000	87	89	77	64	86	54
10,000	89	89	78	76	84	61
8,000	87	88	82	84	83	65
6,000	81	83	83	85	88	72
4,000	70	75	82	80	90	79
2,000	63	67	77	75	86	80
1,000	61	63	75	75	84	79
500	61	61	73	74	82	79
Surface (34 ft.)	60	59	72	74	81	78
No. of obs. . .	9	11	17	15	12	24

Authority.—Bibliography No. 100.

The table shows that the relative humidity increases with height above the surface, reaches a maximum at a certain level, and then decreases. On the average the highest values of relative humidity are found between 8,000 feet and 15,000 feet in June and July, between 4,000 and 8,000 feet in August, between 5,000 and 8,000 feet in September, between 3,000 and 5,000 feet in October and at about 3,000 feet in November.

The humidity at all levels decreases between October and November when the winds of the NE. monsoon begin to affect Madras.

**Wet-bulb temperature.**—From October to March on all parts of the coast the average wet-bulb temperature at both 0800 and 1700 is below 78° F., a temperature above which continuous hard labour is regarded as impracticable. Throughout the months of the hot season and of the SW. monsoon the average wet-bulb temperature equals or exceeds 78° F. at both 0800 and 1700 on the Circars and Orissa coasts and the Sundarbans, and at 1700 on the Coromandel coast ; on the latter coast it reaches 78° F. at 0800 only in April and May.

At Calcutta the average wet-bulb temperature reaches its lowest value between 0400 and 0700 in all months, and its highest value some time between noon and 1800, usually between 1200 and 1400 during the months of the hot season and the SW. monsoon, and at 1700 or 1800 during the NE. monsoon. The range of the hourly values is about 3° F. during the SW. monsoon and 7° F. during the NE. monsoon.

equatorial regions. At the head of the Bay the temperature of the sea shows a well marked decrease between October and November, and by November the lowest sea temperatures are found in that region where they are between 80° and 81° F., elsewhere the sea temperature is very uniform being 82° F. over the whole area including the equatorial regions.

#### 4—RELATIVE VALUES OF SEA AND AIR TEMPERATURE

The difference between the temperature of the surface of the sea and that of the air is comparatively small at all times of the year and on the average is never more than 1° or 2° F. From October to February the sea is slightly warmer than the air, the largest difference being at the head of the Bay of Bengal in December when the sea is about 2° F. warmer than the air, this difference decreases during the succeeding months until in March the sea and air are at about the same temperature. Further south and in the equatorial regions the difference during this period is about 1° F.

In April the sea and air temperatures differ little from one another except in the south of the Bay of Bengal and in the equatorial regions where the sea is about 1° F. warmer than the air. In May, in the Bay, the air is slightly warmer than the sea but not by more than 1° F., but in the equatorial regions the sea is about 1° F. warmer than the air.

From June to September the air and the sea temperatures over the whole region are about the same but in October the sea becomes about 1° F. warmer than the air. In November the difference increases to about 1° to 2° F. in the north but remains at 1° F. in the south and in the equatorial regions.

#### VIII—HUMIDITY

The general climatological tables on pages 95–102 give the mean monthly relative humidity at two hours of observation, 0800 (local time) and 1700 (Z-5½), for seven places on the east coast of India and for Pamban at the morning hour, 0800 (local time), only. The mean monthly wet-bulb temperatures for the same times are also included in the tables.

The diurnal variation of relative humidity is large (see page 91) and in consequence in considering the distribution of relative humidity it is important to know the hour to which the observations refer.

**General.**—On the Circars coast and at the head of the Bay of Bengal the relative humidity at both 0800 and 1700 is highest during the months of the SW. monsoon and lowest during the NE. monsoon. The range in the monthly means for 0800 is about 12 per cent. but at 1700 the range is about twice that amount on the Orissa coast and the Sundarbans, and nearly three times that amount, 37 per cent., at Calcutta.

On the Coromandel coast and in the Gulf of Mannar the humidity is highest during the rainy season when the SW. monsoon is receding, namely, in October or November at Madras, in November at Negapatam and in December at Pamban; it is lowest in June or July. In contrast with conditions further north the range in the monthly means at 0800 is somewhat greater than at 1700.

#### Seasonal variation

The following seasonal notes are based on observations at 0800 :—

**Cool season (December to March).**—Over the whole of the Bay of Bengal and southwards to the equator it is estimated that the relative humidity in January is between 80 and 85 per cent. Along the coasts also the relative humidity is fairly uniform from place to place but it decreases with increasing distance inland from the coast. In December, at 0800, the lowest values of humidity of just over 70 per cent. are found on the Circars coast, and there is an increase northwards to 80 per cent. at the head of the Bay and southwards to 90 per cent. at Pamban. From January to March the humidity lies between 75 and 85 per cent. with a somewhat irregular distribution. In the Gulf of Mannar the relative humidity at 0800 decreases gradually through the season but elsewhere it tends to increase from December to February and then to decrease.

**Hot season (April and May).**—In April the relative humidity, at 0800, is between 75 and 80 per cent. over almost the whole coast. In May the humidity in the north shows little change, whereas on the Coromandel coast it falls to about 65 per cent., so that there is a fairly well marked decrease from the head of the Bay southwards with a tendency to increase again in the Gulf of Mannar.

**SW. monsoon (June to September).**—Over the open sea in July the relative humidity in the equatorial region south of Ceylon exceeds 85 per cent. In the Bay of Bengal the humidity increases eastwards from about 75 per cent. off the Coromandel coast to over 85 per cent. east of the meridian of 85° E.

At coastal places throughout the season the highest values of humidity are at the head of the Bay where the average values at 0800 are between 85 and 90 per cent.; there is a fairly regular decrease southwards to about 60 per cent. on the southern part of the Coromandel coast in June, and to about 70 to 75 per cent. during the rest of the season, and then an increase to over 75 per cent. at Pamban in the Gulf of Mannar.

**Post SW. monsoon period (October and November).**—Between September and November the humidity in the north decreases as the SW. monsoon recedes, whereas in the south it increases. In October the distribution is fairly uniform the average at 0800 lying between 75 and 85 per cent. In November the distribution is similar to that in December with the lowest values of about 70 per cent. on the Circars coast and the highest of over 85 per cent. at Pamban.

representative of the normal weather. The results are summarised in the following table:—

**Madras.**—AVERAGE TEMPERATURE OF THE UPPER AIR.  
Period: 1932-5

Height above M.S.L.	June	July	Aug.	Sept.	Oct.	Nov.
<i>feet</i>	<i>degrees Fahrenheit</i>					
30,000	-16	-17	-15	-17	-15	-22
25,000	4	4	4	3	4	-1
20,000	21	20	21	21	20	18
15,000	36	35	37	36	34	33
10,000	52	52	53	51	49	49
8,000	58	57	58	56	55	55
6,000	66	66	65	63	61	59
4,000	76	75	73	70	66	64
2,000	83	83	80	78	74	72
1,000	87	87	83	82	78	76
500	88	89	85	84	80	78
Surface (34 ft.)	89	90	86	85	82	79
No. of obs.	9	11	17	15	12	24

*Authority.*—Bibliography No. 100.

The table shows that above the level of 6,000 feet there is very little change of temperature from month to month during the period from June to October.

Comparison with results from Agra shows that during the period from June to September the temperature increases from Madras to Agra at all levels except below 5,000 feet in July. The greatest difference between the mean monthly temperature of the two places at any level is 10° F. The differences are greater in the later months of the monsoon because at Agra there is an appreciable rise in temperature during the monsoon whereas at Madras there is little change. In October there is very little difference in the mean upper air temperatures throughout the region between Agra, Poona and Madras indicating that there is practically no gradient of temperature from north to south in India between the longitudes of about 73° and 80° E.

### 3—SEA TEMPERATURE

The mean sea surface temperature in the Bay of Bengal is highest in May and lowest in February. At the head of the Bay of Bengal a small secondary maximum of sea temperature is also just noticeable in October after the withdrawal of the SW. monsoon, when colder water has ceased to flow into the Bay. After this secondary maximum in October the temperature of the sea decreases fairly rapidly in the northern part of the Bay owing to the decreasing altitude of the sun and the cooling effect of the NE. monsoon.

The position of the 80° F. isotherm of sea surface temperature, in the different months of the year, is shown on the monthly surface

wind charts of Figs. 2-13 on pages 24-35. No line is shown on the charts for April, May, June and October as the sea surface temperature during those months is above 80° F. over the whole region but the temperature does not exceed 86° F. anywhere in the area. In March the 80° F. line is situated in the extreme north-east corner of the Bay of Bengal off the Sundarbans, and in July, August and September it is in the south-west off the west coast of Ceylon and in the Gulf of Mannar.

### Seasonal variation

*Cool season (December to March).*—During this season the lowest sea temperatures are in the northern part of the Bay of Bengal off the Sundarbans where temperatures between 75° and 76° F. are experienced in December and January. In December the isotherm of 80° F. is situated between about latitudes 13° N. and 15° N. and in February when the area of colder water is greatest the line extends nearly as far south as Lat. 10° N. The average temperature in this month is 81° F. to the east of the island of Ceylon and it gradually decreases to 77° F. at the head of the Bay; in the equatorial regions it is between 82° and 83° F. In March the average temperature over the whole of the Bay is above 80° F. except in the extreme north-east corner where it is slightly below 80° F.; in the equatorial regions it is about 84° F.

*Hot season (April and May).*—In April the sea temperature is 83° F. at the head of the Bay and between 84° and 85° F. elsewhere. In May, the month with the highest average sea temperatures, the average is between 84° and 86° F. in the greater part of the Bay, decreasing to 82° or 83° F. off the south coast of Ceylon and between the north of Ceylon and Madras. In the equatorial regions the average is about 84° F.

*SW. monsoon (June to September).*—There is a slight fall in the sea temperature on the arrival of the SW. monsoon. The highest sea temperatures are at the head of the Bay where in June they are between 84° and 85° F. and off the Coromandel coast where the average is 83° F. The lowest sea temperatures in this month are found off the south and west coasts of Ceylon where they are between 81° and 82° F. In July the sea temperature in the Gulf of Mannar falls to just below 80° F. and this area of colder water extends to the west coast of Ceylon in August and September; elsewhere the average sea temperature both in the Bay of Bengal and in the equatorial regions is between 82° and 83° F.

*Post SW. monsoon period (October and November).*—In October there is a slight increase in the temperature of the sea in the Bay of Bengal and nowhere does it fall below 80° F. The warmest water is at the head of the Bay where the sea temperature is between 84° and 85° F. and the temperature decreases gradually southwards to about 81° and 82° F. in the vicinity of Ceylon and in the

region. Over the sea it amounts on the average to only about 1° F. but over the coasts it is somewhat larger and is much more conspicuous in the day temperatures than in the night. The overcast skies and moist air of the monsoon cause a much smaller daily range of temperature and this shows itself chiefly in a lowering of the day temperatures.

In July when the SW. monsoon is at its height the average temperature over the sea is from 81° to 84° F. and is rather higher in the north than in the south; on the coasts the average is about 3° F. higher than over the sea.

On the coasts of Bengal and Orissa the average is about 84° F. varying from just under 80° F. at night to just under 90° F. in the day. Owing to the cloudier skies the extreme range is much less than in the hot season; at Calcutta, for example, the temperature has never risen above 98° F. in July nor fallen below 68° F., and at Sagar island at the mouth of the Hooghly river the range is even less. In August the temperature shows a slight, though hardly appreciable, fall, but in September, after the monsoon has begun to retreat, the rainless intervals are of longer duration and, in consequence of the somewhat clearer skies, there is a slight rise in the day temperatures.

On the Circars and Coromandel coasts, especially on the latter, the temperatures in July are rather higher than at the head of the Bay of Bengal, the average being between 84° and 87° F. The sky is slightly less cloudy than at the head of the Bay and, in consequence the daily range is higher; during the day the average temperature in most parts exceeds 90° F. rising to over 95° F. in the neighbourhood of Madras, and during the night it falls to just below 80° F. Temperatures exceeding 100° F. are not infrequent and 109° F. has been recorded. The temperature falls slightly as the season advances but even in September it is only 2° or 3° F. lower than in July.

*Post SW. monsoon period—(October and November).*—In October the temperature falls, but not by very much, and the average is fairly uniform, being between 81° and 83° F. over the whole region including both the coastal and sea areas. In the north there is a decrease in the cloud amount and in the humidity, which causes a slight decrease in the night temperatures. The average variation over the whole coast is from between 75° and 77° F. at night to between 87° and 90° F. in the day. It is not until the end of October or early in November that any appreciable fall of temperature brings relief from the oppressive weather, and in the latter month cooler conditions begin to set in. The fall of temperature is much greater in the north than in the south and over the coast there is in consequence a well marked decrease of temperature from south to north, the average temperatures being about 80° F. in the south (70° to 75° F. at night and 85° F. in the day) and 73° to 75° F. in the north (65° to 67° F. at night and about 82° F. in the day). Over

the sea the temperature is uniform lying between 79° and 81° F., the higher values are south of Lat. 15° N. and the lower at the head of the Bay of Bengal.

*Diurnal variation.*—Over the open sea the daily range of temperature is probably not more than 2° or 3° F. On the coast the daily range is much larger than over the sea and is much greater in the dry season than in the wet. In the northern part of the area under consideration at Calcutta, for example, it exceeds 20° F. from December to March and decreases steadily to 10° F. or less from July to September, increasing again rapidly in November. The highest temperatures of the day at Calcutta occur on the average at about 1300 in July and August, at 1400 in May, June, September and October and not until 1500 in the months of the cool season. The lowest temperatures of the day occur at or just before sunrise which at Calcutta is at about 0700 in the cool season and at about 0500 from May to July.

On the Coromandel coast, at Madras, the daily range of temperature throughout the year is much more constant than in the north, it is least in October, November and December when it is between 12° and 14° F., and is greatest in February and March and in May and June when it is 18° F. The highest temperatures of the day generally occur at Madras between 1300 and 1400 local time, but in the hot-weather months they occur earlier, between 1200 and 1300 or even at 1200; the lowest temperatures of the day occur between 0530 and 0630, usually a few minutes before sunrise.

On the shores of the Gulf of Mannar the daily range of temperature is small and shows little variation through the year. At Pamban the average for the year is only 11° F. The months with the smallest range are December and January with 8° F. and the month with the largest is March with 13° F.

## 2—UPPER AIR TEMPERATURE

The only information about the temperature in the upper air over the region under consideration is for Madras, and is based on 88 observations of sounding balloons during the months from June to November in the period 1932-5. The ascents are limited to these months because in the remaining months the balloons would be carried away eastwards over the sea by the westerly winds prevailing at high levels. Most of the ascents were made between 1700 and 1900 (Z-5!) but a few were in the early morning between 0300 and 0400. It should be noted that the majority of the records in November relate to periods of disturbed weather when storms from the Bay of Bengal were crossing the peninsula in the neighbourhood of Madras, the temperatures in that month may not, therefore, be

The daily range of temperature over the open sea is very small, probably not more than 2° or 3° F. On the coasts, for the year as a whole, the average is about 15° F., but there is a large variation through the year the range being least (less than 10° F.) during the months of the SW. monsoon in those areas where the skies are overcast, and greatest (exceeding 20° F.) in the cool and hot seasons in those regions where the skies are clear. The daily range of temperature inland is considerably higher than on the coasts.

#### Seasonal variation

*Cool season (December to March).*—In the early part of this season the isotherms run roughly from west to east and there is a well marked fall of temperature from south to north. In December and January the average temperature in the equatorial regions is about 80° F. and the temperature falls to about 75° F. on the east coast of India just north of Madras and to about 67° or 68° F. in the north near Calcutta. Over the open sea, however, the average temperatures are higher than those on the coasts in the same latitudes. In the latitude of Madras the average temperature over the open sea is about 78° F. and at the head of the Bay of Bengal about 73° F. in these months.

As the season advances the temperature in the north increases much more rapidly than that in the south and by March the average temperature over the whole area both on the coast and over the open sea lies between 80° and 85° F. The average temperature at night is lower in the north than in the south but the day temperatures show no regular variation with latitude. The mean daily maximum and minimum temperatures given in the general climatological tables on pages 95-102 give an indication as to the temperatures that can be expected by day and by night on the coasts.

At the head of the Bay of Bengal, if Calcutta is taken as representative of that area, the cool weather sets in before the second week of November and lasts until the middle or latter part of February. For 10 or 12 weeks the weather is delightfully cool in the day and sufficiently cold at night to make a fire agreeable. The average daily maximum temperature in January is 77° F. falling to 56° F. at night. Owing to the clear skies and dry air the daily range is comparatively high, being about 20° F. The temperature usually rises well above 80° F. at some time in the month and has risen to 88° F., whereas, on the other hand, it usually falls to 50° F. or below and may fall as low as 44° F. During the passage of western depressions in January and February there are days of close cloudy weather with southerly winds followed by rain, but when the weather clears in the rear of the depression there is a fall of temperature and a renewal of the usual type of weather of the cool season. About the end of February the days begin to be appreciably warmer and by March punkahs are needed by day although the temperature after

midnight is still fairly cool. Temperatures exceeding 100° F. have been recorded at Calcutta in March but usually the temperature does not reach that figure, the temperature has been known to fall to 50° F. but such a temperature is quite exceptional and often the temperature does not fall below 60° F. at any time during the month.

On the Circars and Coromandel coasts the average temperature in January, which is the coolest month of the year, is about 75° F., ranging from about 68° F. at night to over 80° F. by day; there is a slight decrease from south to north. Temperatures of over 90° F. and below 60° F. have been recorded but in general the temperature throughout the month lies between 60° and 88° F. By March the average temperature slightly exceeds 80° F. varying from 70° to 75° F. at night to about 90° F. by day. The temperature in that month has never been known to fall below 60° F. whereas at most places it has exceeded 100° F. on some occasions and at Masulipatam a temperature as high as 108° F. has been experienced.

In the south of the Indian peninsula there is really no cool season as even in the coolest months of the year the day temperature is about 85° F. and the night temperature between 70° and 75° F. which is comparable with southern Italy in the summer. The extreme ranges of temperature are less than in the north; on the shores of the Gulf of Mannar the temperature in January rarely falls below 70° F. and has never fallen below 65° F. nor risen above 95° F.

*Hot season—(April and May).*—Over the whole region there is a further increase in temperature in April; and in most parts there is another but smaller increase in May. On the whole of the east coast of India May is the hottest month of the year. Over the open sea the average temperature in that month lies between 83° and 85° F., being slightly warmer at the head of the Bay of Bengal than in the equatorial regions. On the coast the temperatures are even higher, lying between 85° and 91° F. The hottest region on the coast is in the neighbourhood of Masulipatam and the isotherms run approximately parallel to the coast instead of east and west as in the cool season. The temperatures at night are very uniform over the whole coast being on the average about 80° F., whereas by day they vary from 90° to over 100° F., they are lowest at places such as Pamban in the Gulf of Mannar and Sagar island at the mouth of the Hooghly river which are well exposed to the sea, and highest at places which are sheltered and exposed to the hot winds of the interior. The temperature rarely if ever falls below 64° F. whereas on the hottest parts of the coast it has been known to rise to between 108° and 118° F. It is probable that the temperature at sea rarely exceeds 100° F.

*SW. monsoon—(June to September).*—The arrival of the SW. monsoon brings a fall of temperature over almost the whole of the

fell. Similarly at Masulipatam in 1876 no rain fell in October whilst in 1892 there was as much as 675 mm. (26.6 in.).

Madras also has had some very high rainfall in October and November, which are normally the months with the highest average. As much as 958 mm. (37.7 in.) and 1,088 mm. (42.8 in.) have fallen in those months, whilst in other years amounts have been only 11 mm. (0.4 in.) and 5 mm. (0.2 in.) respectively.

In the months with the lowest average rainfall there may also be a large variability from year to year. In a normally dry month there may be over 200 mm. (about 8 in.) in one year whilst often there is none at all.

**Maximum rainfall in 24 hours.**—The details of the maximum rainfall in 24 hours are given in the general climatological tables on pages 95-102. Extremely heavy rainfalls occur at times. Of the places in the general climatological tables Calcutta has the highest amount in 24 hours for the region under consideration with 369 mm. (14.5 in.) in September whilst a fall of 304 mm. (12 in.) has occurred there in June. On the Orissa and north Circars coasts the heaviest falls in the 24 hours shown in the tables have occurred in the months of the SW. monsoon, whereas on the south Circars and Coromandel coasts they have been recorded during the withdrawal of the monsoon in October, November or December. At both Sagar island and Purif the amount has exceeded 300 mm. (12 in.) but further south the extreme at most places is about 250 mm. (10 in.), with, however, a high record of 366 mm. (14.4 in.) at Negapatam. At Pamban the largest fall in 24 hours is only 160 mm. (6.3 in.), it is remarkable that at this place as much as 130 mm. (5.1 in.) has fallen in the 24 hours in July when the average fall for that month is only 14 mm. (0.6 in.). In the months from February to April the rainfall in 24 hours nowhere exceeds 130 mm. (5.1 in.) and at most places the highest values are much less than that figure.

## 2—HAIL

Hail is very infrequent on the coasts and probably never occurs over the open sea. Even in the north where it is most liable to occur the average is less than one day a year, and in the south, during a period of 38 years, it was never recorded at Pamban, and on only one occasion at Negapatam.

The only months when it is likely to be experienced are from March to May when it accompanies the thunderstorms which are associated with the "Nor'westers" that come down from the land on the Orissa and Bengal coasts. There are a few isolated records of the occurrence of hail in January, February and June but none from July to December.

## VII—TEMPERATURE

### 1—AIR TEMPERATURE

The data of the means and extremes of temperature are given in the general climatological tables on pages 95-102, and the table

below, compiled from ships' observations, gives the temperature of the air over the sea in the different 5 degree sea areas.

MEAN TEMPERATURE OF THE AIR OVER THE SEA IN THE DIFFERENT 5° AREAS

Areas	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	<i>degrees Fahrenheit</i>											
20-25° N.												
85-90° E.	73	76	80	83	85	85	84	84	84	83	79	74
15-20° N.												
80-85° E.	77	78	81	84	85	85	84	83	84	83	80	78
85-90° E.	76	77	80	83	85	84	83	83	83	83	80	77
10-15° N.												
80-85° E.	78	79	82	84	85	84	83	83	83	83	81	79
85-90° E.	79	79	81	85	85	84	82	82	82	82	81	80
5-10° N.												
75-80° E.	80	81	83	84	83	82	81	80	80	81	81	81
80-85° E.	79	80	82	84	84	83	82	81	81	82	81	80
85-90° E.	80	81	83	84	83	83	82	82	82	81	81	80
0-5° N.												
75-80° E.	80	81	83	83	83	83	81	81	81	81	81	80
80-85° E.	81	81	83	83	83	83	81	81	81	81	81	81
85-90° E.	81	82	83	83	83	82	82	82	81	81	81	81

Authority.—Bibliography No. 119.

**General.**—The average temperature of the year over the whole region is about 80° F., it slightly exceeds that value on the south Circars and Coromandel coasts where it is about 83° F., whilst it is lowest in the north, at the head of the Bay of Bengal, where the average is about 79° F.

Over the whole region the hottest months of the year are April, May and June, before the arrival of the SW. monsoon, and the coolest months of the year are December and January.

The average temperature in any month is liable to vary considerably from one year to another. At Calcutta the variation is greatest in the cool season. In February, for example, the mean temperature for the month in 1905 was 6° F. below the average whereas in 1900 it was 4° F. above; during the months of the SW. monsoon the variation is much less and the mean temperature in any month is usually within 2° F. of the average. On the Circars and Coromandel coasts in most months of the year the mean temperature of the month may differ from the average by 2° or 3° F. in different years.

Over the open sea, at the head of the Bay of Bengal, the average difference of temperature between the hottest and coolest months is about 12° F., it shows a regular decrease from north to south and in the equatorial regions, south of Lat. 5° N., it is only 2° or 3° F. On the coasts the range is greater, being about 18° to 20° F. off the Sundarbans, about 15° F. in the neighbourhood of Madras, and about half that amount on the shores of the Gulf of Mannar.

At Calcutta in the first or second week in June heavy and continuous rain ushers in the SW. monsoon, after which the monsoon rainfall is in the form of showers with an occasional rainless interval, rarely lasting more than a day or two, these follow each other throughout July and August until in September the rainless intervals become longer. The monsoon rain falls most frequently at Calcutta between 1300 and 1800, it rains twice as frequently at 1500 as at 2300.

On the Circars and Coromandel coasts and also in the Gulf of Mannar the rain during this season is in the form of showers, and over the Bay of Bengal and in the equatorial regions the rainfall is also of the squally, showery type.

*Post SW. monsoon period (October and November).*—Over the Bay of Bengal there is heavy rain when the Bay is disturbed by cyclonic storms especially in November. In the northern and central parts of the Bay there is little rain except during a cyclonic storm. Over the southern part of the Bay rain in the form of showers occurs in October and November and in November this showery weather extends southward to the equatorial regions.

The greatest rainfall in these months is on the southern part of the east coast of India. On the Bengal and Orissa coasts and at the head of the Bay of Bengal there is a considerable decrease in the rainfall in October, but to the south of the Orissa coast this is the wet season. On the Circars coast the highest amount of rainfall is in October, but on the Coromandel coast and on the coast of the Gulf of Mannar, although the rainfall in October is more than that on the Circars coast, the highest rainfall of the year is in November.

In the north on the Bengal and Orissa coasts the rain in October is usually of the showery type due to thunderstorms and there may be occasional heavy falls in association with cyclonic storms.

On the east coast of India south of the Orissa coast the high rainfall during October and November is due to the retreating SW monsoon air currents striking the coast as an easterly or north-easterly wind. The Coromandel coast is liable to be affected by severe cyclonic storms in November and these storms cause heavy rain-squalls. The rainfall from these storms may often begin when the storm is 200 or 300 miles from the coast.

*Annual variation in the number of rain-days.*—The annual variation in the number of rain-days corresponds very closely with the rainfall. The average number of rain-days a month is shown in the step diagrams in Fig. 30 and the data are given in the general climatological tables on pages 95-102.

Calcutta has the greatest number of rain-days in the year with an average of 84 days and the number decreases irregularly southwards until at Pamban in the Gulf of Mannar the average number is only 46.

On the Bengal and Orissa coasts the SW. monsoon months have the highest number of rain-days, particularly July and August.

At Calcutta each of these months has 18 rain-days. On the Circars coast, at Vizagapatam and Masulipatam, July to September are the months with the highest number of rain-days. The highest number at Vizagapatam is in September with 9 and at Masulipatam in August with 11. At both places, however, the highest rainfall occurs in October when there are on the average only 7 or 8 rain-days a month. At Madras on the Coromandel coast the highest number of rain-days is in October and November when there are on the average 10 and 11 respectively; during the height of the SW. monsoon from July to September the number of rain-days a month on the average does not exceed 8.

At Pamban in the Gulf of Mannar, October, November and December, the months with the highest rainfall, are also the months with the highest number of rain-days, with an average of 10, 13 and 9 respectively. During the SW. monsoon months the number of rain-days does not exceed 2.

*Extremes of annual and monthly rainfall.*—The following table gives the greatest and least amounts of rainfall that have occurred in each month and in the year at Calcutta, Vizagapatam, Masulipatam and Madras.

MAXIMUM AND MINIMUM MONTHLY AND ANNUAL RAINFALL  
The period over which the observations extend is given in brackets under each place.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
	<i>millimetres</i>												
Calcutta (1829-1930)	74 0(41)	202 0(26)	159 0(16)	185 0(2)	435 2	791 41	644 115	684 122	1,157 66	413 0(3)	142 0(44)	77 0(67)	2,370 1,000
Vizagapatam (1866-1930)	166 0(36)	122 0(36)	125 0(37)	193 0(18)	368 0(1)	361 11	275 7	393 17	560 30	767 0(2)	531 (6)	655 0(32)	2,019 435
Masulipatam (1863-1930)	80 0(42)	226 0(42)	158 0(51)	114 0(38)	242 0(6)	298 2	476 25	506 28	443 37	675 0(1)	527 0(5)	183 0(34)	1,765 542
Madras (1813-1930)	244 0(28)	163 0(76)	171 0(74)	191 0(55)	592 0(27)	219 0(2)	298 6	336 18	378 12	958 11	1,088 5	579 0(5)	2,246 469

*Authority.*—Bibliography No. 12.

*Notes.*—The figures in brackets indicate the number of times during the period that the particular month was rainless. The normal rainfall during the month is given in the general climatological tables.

From this table it can be seen that the rainfall may vary very much from year to year even in the normally wet months. At Calcutta in some years the SW. monsoon months have produced very little rain. June with an average fall of about 300 mm. (about 12 in.) had only 41 mm. (1.6 in.) in 1905 whereas in 1913 it had as much as 791 mm. (31.2 in.). In July and August with a similar average, only about 120 mm. (about 4.7 in.) have fallen in some years whilst in others the amount has exceeded 600 mm. (about 24 in.).

Similarly in October which is normally the wettest month of the year on the Circars coast no rain fell at Vizagapatam in the two years 1896 and 1909 whereas in 1886 as much as 767 mm. (30.2 in.)

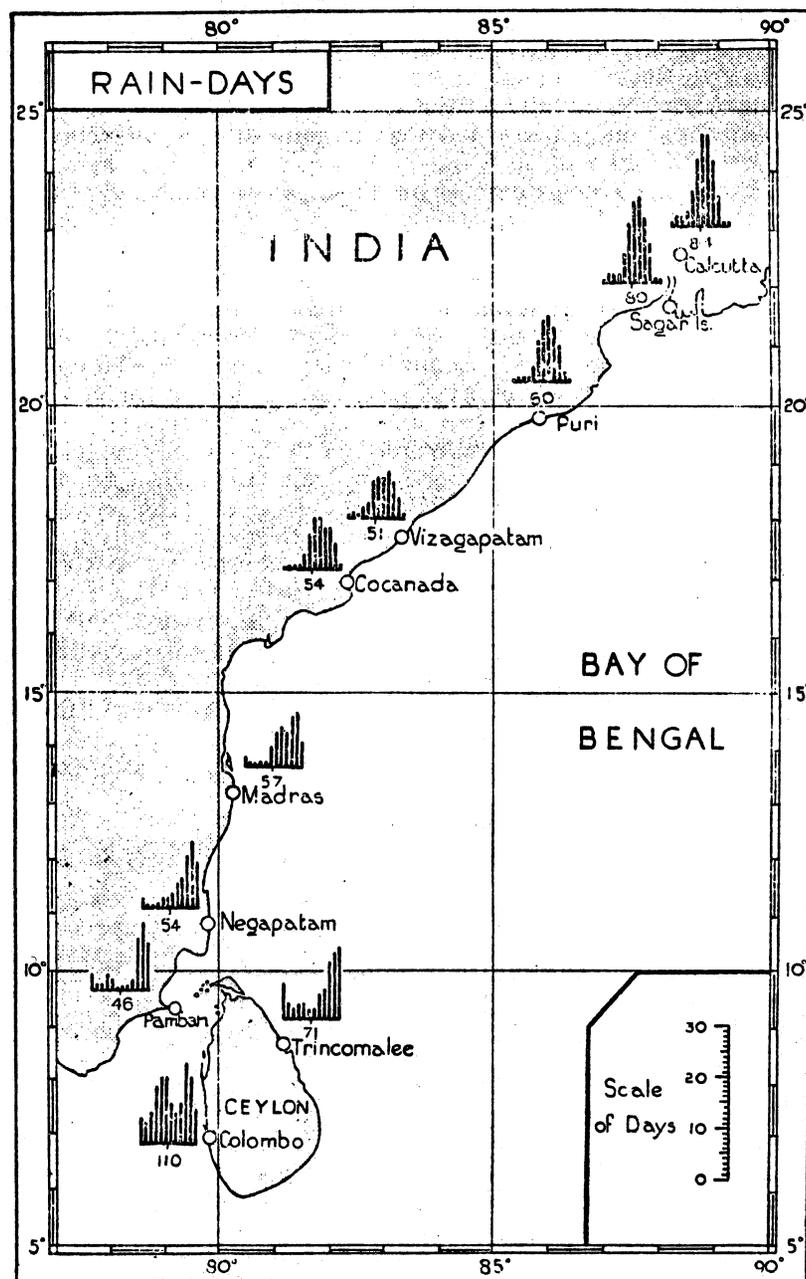


FIG. 30—MONTHLY VARIATION IN THE FREQUENCY OF RAIN-DAYS  
The figures below the step diagrams indicate the total number of rain-days in the year. A rain-day is taken as one on which 2.54 mm. (0.1 in.) or more of rain falls.

during the season. On the Coromandel coast and on the coast of the Gulf of Mannar the rainfall in December exceeds 275 mm. (11 in.) at Negapatam where it rains on about 1 day in 3. The amount decreases rapidly as the season advances and is less than 50 mm. (2 in.) in January, less than 20 mm. (0.8 in.) in February and less than 10 mm. (0.4 in.) in March. In January, February and March the average number of rain-days per month is less than 3 on all parts of the coast.

*Hot season (April and May).*—In this season the rainfall occurs chiefly in association with local thunderstorms and is as a rule very irregularly distributed, it may be large in amount on the Bengal and Orissa coasts. The intensity of the rainfall in southern Bengal during these storms, which are not of long duration, can be judged from the fact that as much as 178 mm. (7 in.) of rain has fallen in May distributed over less than six days, and at Calcutta as much as 156 mm. (6 in.) has been recorded in 24 hours in May. These thunderstorms accompanied by heavy rain are known on these coasts and at the head of the Bay of Bengal as "Nor'westers"; they occur in April and May and although they usually only last an hour or two they sometimes, though not often, usher in a day or two of continuous rain. Further south on the coast of the Carnatic the heavy showers due to thunderstorms in this season are known locally as the "mango showers" and they give an average of 25 to 50 mm. (1 to 2 in.) of rain in each of the two months and at Madras have been known to give as much as 190 mm. (7.5 in.) in April and 240 mm. (9.5 in.) in May.

*SW. monsoon (June to September).*—This is the rainy season except in the south.

On the Bengal and Orissa coasts and at the head of the Bay of Bengal there is a considerable increase in the rainfall during these months, but to the southward on the south Circars and Coromandel coasts although there is an increase in the amount of rain it is not nearly so large.

The heavy rainfall off the Bengal and Orissa coasts and at the head of the Bay of Bengal is chiefly in the form of torrential showers and the amount that falls on the coast is probably greater than that experienced about 25 to 30 miles out at sea. These showers have been reported to be about 10 miles in extent.

The SW. monsoon rainfall, after the first onset of the monsoon, occurs principally when the monsoon is again increasing in strength after a temporary slackening. Sometimes shallow tropical depressions form ahead of the advancing monsoon air current and cause the rain, but it is not always necessary for a depression to form in order to get rain. In some years one or two rainy days may occur about a fortnight before the arrival of the SW. monsoon proper and these are called the "little rains", but they are by no means a regular phenomenon and are usually the result of the formation of an early tropical depression.

southwards over the Bay of Bengal. The SW. monsoon air current does not usually extend to the northern part of the Bay after September but curves round from the coast of Burma and crosses the Bay, striking the south Circars and Coromandel coasts as an easterly or north-easterly wind. This air has had a fairly long passage over the sea by the time it reaches those coasts hence the heaviest rainfall occurs during this period on the south-eastern coasts of the Indian peninsula where the rainfall during the SW. monsoon proper is slight.

**Annual rainfall.**—Very little information is available with regard to the rainfall over the open sea but according to the most recent estimates the annual rainfall over the Bay of Bengal north of Lat. 10° N. increases from west to east. From the east coast of India to Long. 85° E. the amount is between 1,000 and 1,500 mm. (40 and 60 in.) and between longitudes 85° E. and 90° E. it is between 1,500 and 2,000 mm. (60 and 80 in.). In the equatorial regions it also lies between about 1,500 and 2,000 mm. (60 and 80 in.).

On the east coast of India the highest annual rainfall occurs in the north. At Sagar island at the mouth of the Hooghly river, the amount is as much as 1,762 mm. (69.4 in.) whilst at Calcutta and at Cuttack it is slightly less, namely, 1,589 mm. (62.5 in.) and 1,532 mm. (60.3 in.) respectively. The rainfall decreases southwards along the coast and at Vizagapatam it is only 942 mm. (37.1 in.); it increases again further south to 1,074 mm. (42.3 in.) at Masulipatam and to 1,397 mm. (55 in.) at Negapatam and then decreases again. Pamban in the Gulf of Mannar with only 939 mm. (36.8 in.) has the smallest annual rainfall of any part of the coast.

A chart showing the annual rainfall over the whole area is reproduced in Volume I.

#### Seasonal variation

**Cool season (December to March).**—Over the Bay of Bengal the weather is ordinarily fine in this season. In December in the extreme south of the Bay there may be occasional heavy falls of rain if cyclonic conditions are encountered, and in March in the northern part of the Bay thunderstorms, including "Nor'westers", accompanied by heavy rain occasionally pass into the Bay from the coasts of Bengal and Orissa.

Rain does not occur very often even on the coast in this season except in December and then only on the southern part of the Coromandel coast and in the Gulf of Mannar.

On the Circars and Orissa coasts the total rainfall for the whole season is less than 80 mm. (3.1 in.) falling on about 6 days or less. At Calcutta in January and February there are one or two days a month with rain on the average associated with the passage of western depressions which sometimes affect the area north of Lat. 20° N.; in February the rainfall is usually in the form of thunder-showers. On the Circars coast there is very little rain at any time

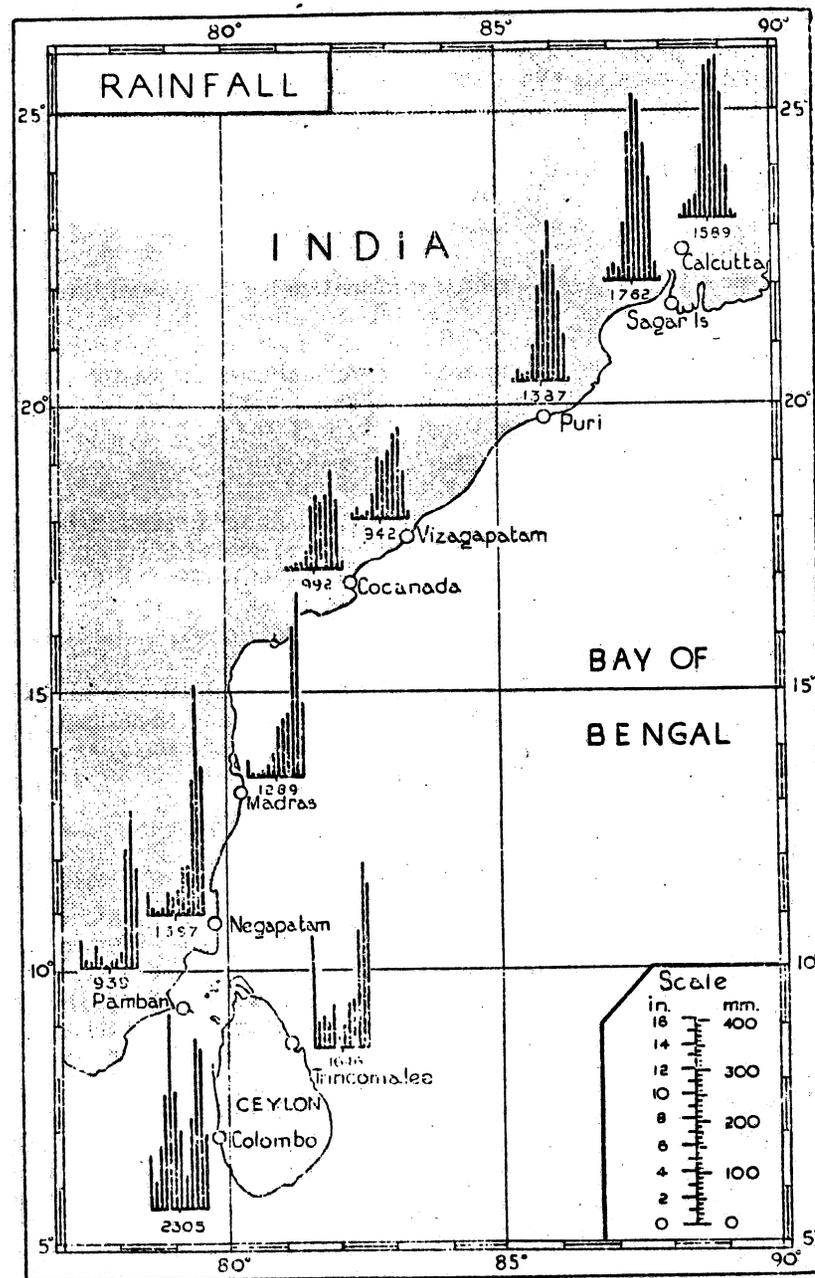


FIG. 29—MONTHLY VARIATION OF RAINFALL

The figures below the step diagrams indicate the total annual amount of rain in millimetres.

In November there is a tendency for greater cloudiness over the sea than over the land, the sky being on the average about half covered over the northern part of the Bay of Bengal. In the southern part of the area south of Lat. 15° N. a certain amount of cloudiness is due to thunderstorms associated with the withdrawal of the SW. monsoon.

The cloud amount has a tendency to increase slightly in the afternoon and in the northern part of the Bay of Bengal the sky is usually about half covered during the afternoons. In November cumulus clouds may develop into cumulonimbus and persist after nightfall.

**Height.**—In order to give an indication of the height of the base of clouds of various types on the east coast of India the following table has been compiled for Calcutta and Madras, it is considered that the heights elsewhere on the coast are probably similar.

The column giving the number of observations shows the relative frequency of the different types of cloud and hence indicates the types most likely to be met with during each season. The column giving the minimum height shows the lowest height to which the base of each type of cloud has been known to descend. The table is obtained from an analysis of the heights at which pilot-balloons were lost in cloud and consequently the figures for the minimum heights do not take account of days with rain and very low cloud when pilot balloon ascents were impracticable. This important limitation should be borne in mind.

APPROXIMATE MINIMUM AND MEAN HEIGHT OF CLOUDS

Calcutta (Diamond harbour). 22° 32' N., 88° 24' E., 33 ft. Period: 1921-9.

Type of cloud	November to February			March to May			June to October		
	No. of obs.	Height		No. of obs.	Height		No. of obs.	Height	
		Min.	Mean		Min.	Mean		Min.	Mean
		<i>feet</i>			<i>feet</i>			<i>feet</i>	
Ci.	20	17,700	20,700	12	19,700	24,300	20	19,400	26,600
Cs.	11	19,700	22,600	6	19,400	20,700	17	20,000	25,300
Ac.	47	8,200	12,100	44	9,200	12,800	84	7,900	12,500
As.	3	7,500	9,800	1	—	14,400	24	6,900	11,800
Sc.	6	5,200	6,900	4	5,200	6,200	7	4,300	6,900
Cu.	22	2,300	4,900	43	1,600	3,000	40	1,600	3,800
Cb.	18	2,000	5,200	68	1,600	3,600	129	1,300	4,300
Nb.	2	2,600	4,900	9	1,300	3,300	121	660	3,000
St.	1	—	3,300	2	4,300	4,900	1	—	3,300

Madras. 13° 04' N., 80° 15' E., 33 ft. Period: 1925-9.

Type of cloud	November to February			March to June			July to October		
	No. of obs.	Height		No. of obs.	Height		No. of obs.	Height	
		Min.	Mean		Min.	Mean		Min.	Mean
		<i>feet</i>			<i>feet</i>			<i>feet</i>	
Ci.	21	24,600	29,900	19	23,300	29,200	22	23,300	28,900
Cs.	—	—	—	—	—	—	1	—	33,100
Ac.	16	9,500	13,100	53	8,500	14,400	47	9,500	13,800
As.	—	—	—	2	13,100	14,800	1	—	18,700
Sc.	4	4,900	7,900	1	—	8,900	2	11,200	11,500
Cu.	2	2,600	3,600	4	2,600	4,300	2	3,900	6,200
Cb.	104	1,600	4,300	55	2,300	4,300	33	2,000	6,900
Nb.	20	1,600	3,000	5	2,000	3,900	3	660	4,600
St.	—	—	—	—	—	—	1	—	3,300

Authority.—Bibliography No. 78.

VI—RAIN AND HAIL

1—RAIN

Step diagrams showing the monthly averages of rainfall and rain-days are reproduced in Figs. 29 and 30 and the corresponding data are given in the general climatological tables on pages 95-102.

The definition of a rain-day adopted in this Part is that used by the India Meteorological Department, namely, a day on which 2.54 mm. (0.1 in.) or more of rain falls.

**General.**—Over the whole region winter is the dry season. At the head of the Bay of Bengal the greater part of the rain falls during the months of the SW. monsoon from June to September, whereas on the coast south of about Lat. 20° N. the greatest amount of rain falls when the monsoon is receding. On the Circars coast the month of greatest rainfall is October; whereas further south on the Coromandel coast and in the Gulf of Mannar it is November. A good deal of the rain on the east coast of India is due to depressions and thunderstorms.

The reason for the heavy rainfall in the northern part of the Bay of Bengal and on the Bengal and Orissa coasts, during the months of the SW. monsoon, is that the air on reaching this region has had a long travel over the open waters of the Bay of Bengal and is consequently full of moisture. Further south on the east coast of the Indian peninsula, on the other hand, the air has passed across the peninsula from the west coast where it has already lost its excessive moisture on the mountains of the western Ghats, it is consequently comparatively dry by the time it reaches the east coast.

The high rainfall in October and November on the south Circars and Coromandel coasts is due to the retreat of the SW. monsoon

**General.**—The average annual amount of cloud over the area under consideration is between 4 and 5-tenths in all parts excepting the extreme south where it is slightly more than 5-tenths and at Pamban, in the Gulf of Mannar, where it is just under 4-tenths. Along the greater part of the coast the period of the year when the cloud amount is greatest is from June to September during the SW. monsoon, and July is the cloudiest month. In the south, however, at Negapatam and Pamban the cloudiest time of the year is in November and December, though on this part of the coast the annual variation is much less conspicuous than it is further north. The increase in cloud amount in the interim period following the SW. monsoon is probably associated with the retreating edge of the monsoon.

#### Seasonal and diurnal variation

**Cool season (December to March).**—The air of the NE. monsoon is cold and dry when it leaves the land in the north but it gradually picks up moisture during its passage over the warm sea so that the amount of cloud gradually increases southwards. Over the central parts of the Bay of Bengal the amount is between 1 and 2-tenths and it increases to 4-tenths in about Lat.  $10^{\circ}$  N. and to between 5 and 6-tenths at the equator.

On the coast north of Lat.  $15^{\circ}$  N. cloud amounts are small during this season, the mean at most places being between 2 and 3-tenths. December or January is the least cloudy month. North of Lat.  $20^{\circ}$  N. the cloudy weather during these months is mostly caused by the passage of western depressions across northern India. There is not very much difference in this season between the average amount of cloud over the sea and over the land.

South of Lat.  $15^{\circ}$  N. the amount of cloud is controlled by the activity of the NE. monsoon. During periods when there is a strong monsoon, skies are generally overcast, and they clear when the NE. monsoon weakens. On the Coromandel coast the average cloud amount in December is between 4 and 5-tenths and in January it is 3 to 4-tenths decreasing to 2 and 3-tenths in February and March.

There is very little diurnal variation of cloud during this season. In December there is a tendency for the amount to increase slightly in the afternoon on the Coromandel coast and in the Gulf of Mannar, and in March there is a slight decrease in the cloud amount in the afternoon on the Coromandel coast but in neither case is the difference more than 1-tenth.

Clouds of the cumulus type may sometimes develop over the land during the afternoons clearing off towards sundown, and in the early mornings, especially over the river valleys, low clouds and mist may be seen which rapidly dissipate after sunrise.

**Hot season (April and May).**—In these months the cloud amount is least in the middle of the Bay of Bengal increasing both northwards and southwards from the Circars coast. Cloudiness increases everywhere as the season advances and in May the average is between

3 and 6-tenths. The cloud is usually of the cumulus type and during a "Norwester" large and vigorous cumulonimbus clouds develop. South of about Lat.  $15^{\circ}$  N. the clouds in May are largely due to the thunderstorms which are associated with the advance of the SW. monsoon. At places where the break of the monsoon occurs in May low cloud is prevalent.

Over the area under consideration there is at most places a slight decrease in the cloud amount in the afternoon below that of the morning. Clouds of the cumulus type, however, have a decided diurnal variation when over the land; the cloud amount increases in the afternoon, and if the clouds persist after sunset they may on occasions develop into cumulonimbus.

**SW. monsoon (June to September).**—Over the Bay of Bengal to the west of Long.  $90^{\circ}$  E., in the Gulf of Mannar and over the sea as far south as the equator, the cloud amount throughout this season is on the average between 6 and 7-tenths. There is an area, however, around Ceylon and to the north-east of that island where the cloud amount is usually less than 6-tenths. To the north of about Lat.  $20^{\circ}$  N. the cloud amount is slightly more than 7-tenths.

The amount of cloud in these months is very large over the whole region. Except in the south the cloudiest month of the year is July when the average is between 7 and 9-tenths. At Pamban in the Gulf of Mannar the amount is between 3 and 4-tenths and at Negapatam about 5-tenths. In September, especially in the north, the cloud amount begins to decrease but it is still mostly between 6 and 7-tenths. The clouds are sometimes very low. The minimum heights to which the bases of the cumulus, cumulonimbus and nimbus clouds at Calcutta and Madras sometimes descend is given in the table on pages 73-4, these are the most frequent type of clouds during these months. Stratocumulus and stratus clouds are not often seen.

There is hardly any diurnal variation in cloud amount during this season.

**Post SW. monsoon period (October and November).**—There is a noticeable decrease in the cloud amount in these months except at Pamban in the Gulf of Mannar and at Negapatam at both of which there is an increase of about 1-tenth between September and October.

The decrease in cloud amount in October is greatest in the north, at Calcutta it is as much as 3-tenths whereas at Madras it is only about 1-tenth. The amount of cloud, although not so large as during the SW. monsoon months, is greater than during the cool season being about 4 or 5-tenths.

In November the sky is usually more cloudy over the south Circars and Coromandel coasts where the average cloud amount is between 4 and 5-tenths than over the north Circars and Orissa-Bengal coasts where the average amount is between 2 and 4-tenths.

MONTHLY AVERAGES OF THE AMOUNT OF CLOUD OF ALL TYPES COMPARED WITH THAT OF LOW CLOUD

Period : 1933-7

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
	<i>tenths</i>												
<b>CALCUTTA</b>													
0800 Total ..	2.0	4.1	2.8	3.8	5.4	8.1	8.7	8.6	7.3	3.7	2.1	1.6	4.8
Low ..	1.0	2.8	1.8	2.3	4.2	6.1	6.7	6.0	4.9	2.4	0.8	0.8	3.3
Diff. ..	1.0	1.3	1.0	1.5	1.2	2.0	2.0	2.6	2.4	1.3	1.3	0.8	1.5
1700 Total ..	2.3	2.9	2.5	3.7	5.3	8.0	8.1	8.5	8.0	4.7	2.4	1.8	4.9
Low ..	0.8	2.0	1.4	2.1	3.6	4.6	5.8	5.5	4.7	3.0	0.7	0.7	2.9
Diff. ..	1.5	0.9	1.1	1.6	1.7	3.4	2.3	3.0	3.3	1.7	1.7	1.1	2.0
<b>SĀGAR IS.</b>													
0800 Total ..	2.9	4.7	4.3	6.2	7.3	8.8	9.3	9.2	8.5	5.3	3.6	2.7	6.1
Low ..	1.6	2.9	3.3	5.1	5.7	6.5	6.9	6.9	6.0	3.4	1.8	1.5	4.3
Diff. ..	1.3	1.8	1.0	1.1	1.6	2.3	2.4	2.3	2.5	1.9	1.8	1.2	1.8
1700 Total ..	3.3	4.1	5.0	5.8	6.9	8.8	8.9	9.1	8.5	5.5	3.9	3.1	6.1
Low ..	2.0	2.1	2.7	4.1	5.3	6.0	6.4	6.6	5.7	3.4	2.1	1.8	4.0
Diff. ..	1.3	2.0	2.3	1.7	1.6	2.8	2.5	2.5	2.8	2.1	1.8	1.3	2.1
<b>PURI</b>													
0800 Total ..	2.7	2.7	2.9	4.6	5.3	7.1	7.9	7.3	6.5	3.8	2.7	1.6	4.6
Low ..	1.2	1.7	1.8	3.4	4.5	4.6	6.0	5.2	5.1	2.3	0.7	0.6	3.1
Diff. ..	1.5	1.0	1.1	1.2	0.8	2.5	1.9	2.1	1.4	1.5	2.0	1.0	1.5
1700 Total ..	2.6	2.3	2.3	4.0	4.5	6.6	7.6	7.1	6.3	4.5	3.0	2.2	4.4
Low ..	0.8	1.5	1.1	2.6	2.5	3.8	5.5	4.9	4.5	2.8	0.9	0.9	2.7
Diff. ..	1.8	0.8	1.2	1.4	2.0	2.8	2.1	2.2	1.8	1.7	2.1	1.3	1.7
<b>VIZAGAPATAM</b>													
0800 Total ..	3.5	3.5	2.2	3.7	5.2	8.0	8.6	7.8	7.4	5.3	4.0	2.9	5.2
Low ..	1.0	1.8	1.1	2.1	2.4	3.5	4.4	3.9	3.8	2.5	1.3	1.0	2.4
Diff. ..	2.5	1.7	1.1	1.6	2.8	4.5	4.2	3.9	3.6	2.8	2.7	1.9	2.8
1700 Total ..	3.4	2.7	2.5	4.8	5.6	8.4	8.6	7.8	8.0	5.9	4.5	3.2	5.5
Low ..	0.8	1.4	0.8	1.9	1.9	3.4	4.3	3.7	3.9	2.4	1.0	0.7	2.2
Diff. ..	2.6	1.3	1.7	2.9	3.7	5.0	4.3	4.1	4.1	3.5	3.5	2.5	3.3
<b>COCANADA</b>													
0800 Total ..	3.9	3.5	3.1	5.4	5.7	7.2	7.6	7.1	6.8	5.2	4.1	2.9	5.2
Low ..	1.6	2.1	1.8	3.3	3.4	3.3	3.6	3.5	3.6	2.9	2.0	1.5	2.7
Diff. ..	2.3	1.4	1.3	2.1	2.3	3.9	4.0	3.6	3.2	2.3	2.1	1.4	2.5
1700 Total ..	3.2	2.6	2.0	3.2	3.6	6.7	7.2	6.5	6.7	5.6	4.2	2.9	4.5
Low ..	1.0	1.6	1.0	1.8	1.9	3.4	3.6	3.4	4.1	3.2	2.1	1.5	2.4
Diff. ..	2.2	1.0	1.0	1.4	1.7	3.3	3.6	3.1	2.6	2.4	2.1	1.4	2.1
<b>MADRAS</b>													
0800 Total ..	5.3	4.4	4.2	5.9	5.8	7.8	8.4	7.6	6.7	6.8	6.5	5.8	6.3
Low ..	3.1	1.7	2.1	2.6	1.5	1.1	1.5	1.8	2.3	3.2	4.1	3.4	2.4
Diff. ..	2.2	2.7	2.1	3.3	4.3	6.7	6.9	5.8	4.4	3.6	2.4	2.4	3.9
1700 Total ..	5.4	3.6	3.1	4.8	5.5	8.4	9.0	7.5	7.3	7.2	6.7	6.0	6.2
Low ..	2.5	0.9	0.7	0.7	0.8	3.9	4.9	3.1	2.2	2.6	3.2	3.0	2.4
Diff. ..	2.9	2.7	2.4	4.1	4.7	4.5	4.1	4.4	5.1	4.6	3.5	3.0	3.8
<b>NEGAPATAM</b>													
0800 Total ..	6.3	5.9	5.8	6.3	6.4	7.1	7.5	7.1	6.5	7.5	7.6	6.7	6.7
Low ..	5.4	5.0	4.8	4.7	4.3	4.2	4.7	4.1	4.2	5.8	6.7	5.8	5.0
Diff. ..	0.9	0.9	1.0	1.6	2.1	2.9	2.8	3.0	2.3	1.7	0.9	0.9	1.7
1700 Total ..	6.1	4.6	4.4	5.1	5.4	7.3	7.9	7.2	6.4	7.4	7.4	6.5	6.3
Low ..	4.9	3.2	3.3	3.1	3.1	4.1	5.1	4.4	4.1	5.3	6.5	5.7	4.4
Diff. ..	1.2	1.4	1.1	2.0	2.3	3.2	2.8	2.8	2.3	2.1	0.9	0.8	1.9
<b>PAMBAN</b>													
0800 Total ..	4.9	4.1	4.0	4.4	4.0	4.3	4.2	4.4	3.9	4.9	5.7	5.2	4.5
Low ..	2.4	1.8	1.9	1.8	1.1	1.3	1.1	1.4	1.2	2.4	3.5	2.5	1.9
Diff. ..	2.5	2.3	2.1	2.6	2.9	3.0	3.1	3.0	2.7	2.5	2.2	2.7	2.6

Authorities.—Bibliography Nos. 114, 116.

Note.—The morning observation is at 0800 local time, the afternoon observation at 1700 Indian Standard Time, Z 5½, which differs from local time by less than half an hour. Monthly averages of the total amount of cloud at 0800 for a longer period are given in the general climatological tables.

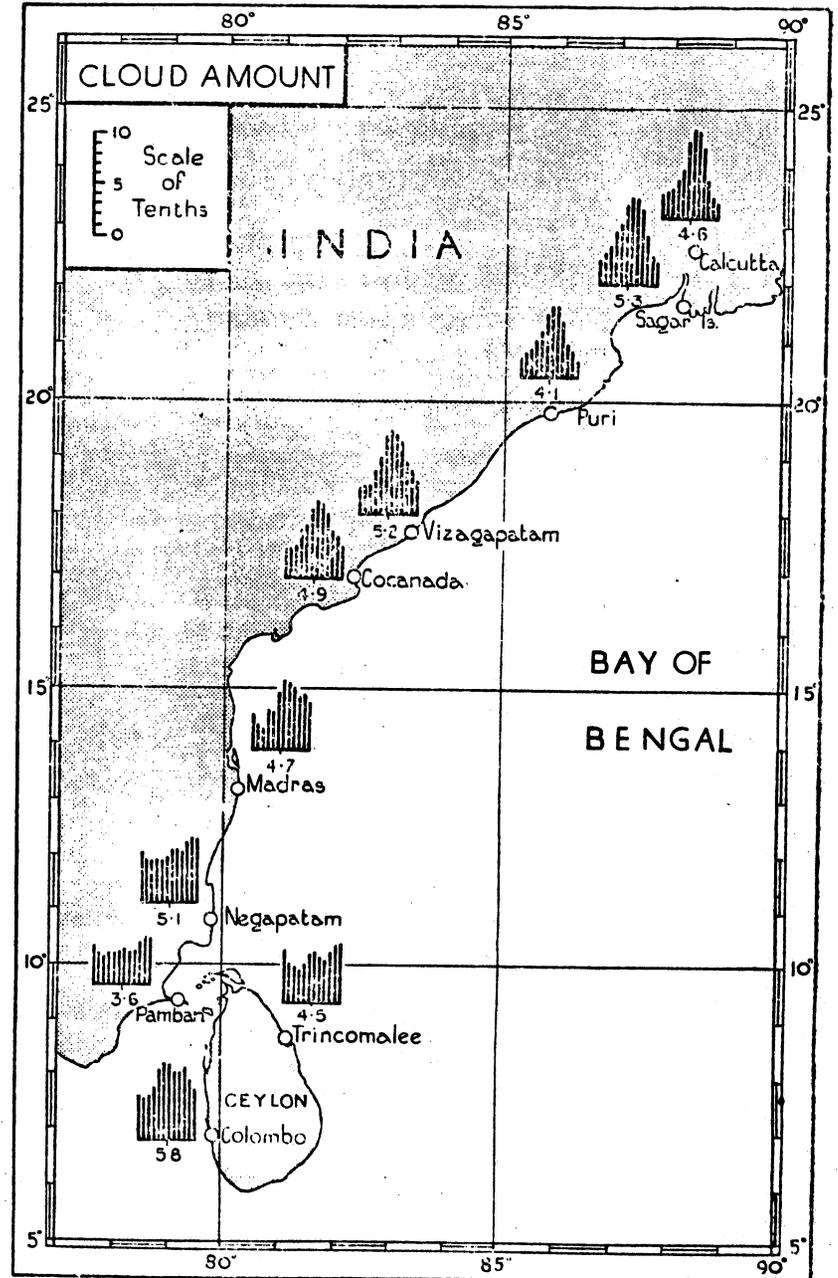


FIG. 28 - MONTHLY VARIATION IN MEAN CLOUD AMOUNT  
The figures below the step diagrams indicate the mean annual cloud amount  
The diagrams are for the morning hour of observation, 0800 local time in India and 0930 (Z-5½) in Ceylon.

are light and variable at all heights below 10,000 feet except when they are affected by tropical storms or depressions. Calms are frequent at the surface especially in the early morning, and at heights up to about 3,300 feet in the north and to greater heights in the south light north-easterly winds become increasingly frequent as the month advances.

As the cool season approaches, the belt of westerly upper winds of middle latitudes strengthens in force and extends further southwards. At Calcutta even as early as October westerly winds prevail at 10,000 feet and strengthen considerably at greater heights sometimes reaching gale force. Vizagapatam being further south lies in the region between the upper westerly and the upper easterly winds, whilst at Madras easterly winds gradually gain predominance above 10,000 feet.

In November NE. monsoon conditions are becoming well established. At Calcutta the calms at the surface give way to light N. or NE. winds at 1,700 feet which back gradually with height becoming NW. or W. at 10,000 feet and strengthening above that level. At Vizagapatam (Waltair) and Madras the winds in the lower layers are much stronger than at Calcutta and blow more persistently from NE., they veer with increasing height above 3,300 feet becoming NE. and E. at greater heights. At Vizagapatam these easterly winds extend up to about 20,000 feet, but there is evidence that the upper westerly winds prevail above that height. At Madras the easterlies extend up to at least 25,000 feet.

#### IV—VISIBILITY

Table VI gives the percentage frequency of visibilities, between different limits, in each month of the year in the morning only at Pamban and in both the morning and afternoon at Negapatam, Madras, Cocanada, Vizagapatam, Purí, Ságar island and Calcutta. The number of days with poor visibility, *i.e.* visibility less than two nautical miles, based on the same data is given in the general climatological tables on pages 95-102.

The visibility over the area under consideration is very good, on the whole, except over the rivers, off the Sundarbans and at Calcutta, where fog and smoke-haze may be experienced from about the middle of November to the end of March. The main cause of this bad visibility at Calcutta in the cool season is the prevailing northerly wind which brings the smoke southwards from the city and from the mills to the north. There is probably a persistent temperature inversion in this region during these months, especially during the night and morning hours. The visibility at Diamond harbour some 40 miles down the Hooghly to the south is much better. Another cause of bad visibility is the large diurnal variation of relative humidity from about the second week in November to the middle or latter part of March when the sky is clear. The high humidity in the evening and at night is sufficient to cause the formation of frequent fogs on the river and the low ground around; these fogs

are liable to come on suddenly. The smoke from the huts in the native parts of the city also condenses the moisture of the air and covers the dwellings with fog.

Along the coast from the Sundarbans southwards to Madras the visibility is generally good except during the heavy rain associated with storms in the Bay of Bengal in the months before and after the SW. monsoon. Over the northern part of the coast the visibility may become poor if there is a strong SW. monsoon, and poor visibility may also be experienced on the southern part of the coast in the vicinity of Madras when there is a strong NE. monsoon. From about the middle of November to the end of March local morning fogs, which may be sufficient to impede navigation, occur over the rivers, but these are usually dissipated an hour or two after sunrise. At False point lighthouse (20° 20' N., 86° 44' E.), near the mouths of the river Mahánadí, in January, February and March the light has occasionally been obscured by land fog.

From Madras southwards to Cape Comorin the visibility is almost always good but on rare occasions there may be fog in the months of March and November. In the Gulf of Mannar the atmosphere often remains hazy in September.

The tops of the hills of the eastern Ghats may be obscured by low clouds both during the SW. monsoon and also in the months immediately before and after that monsoon.

Dust haze is very rarely experienced, but occasionally off the Bengal coast dust haze may precede a "nor'wester" in March and April.

#### V—CLOUD

Step diagrams showing the monthly variation of mean cloud amount at 0800 local time are reproduced in Fig. 28, the corresponding data are given in the general climatological tables on pages 95-102. Table VII shows the monthly frequencies of different amounts of cloud in the morning only for Pamban, and in the morning and afternoon for Negapatam, Madras, Cocanada, Vizagapatam, Purí, Ságar island and Calcutta.

For many practical purposes it is the amount of low cloud, *i.e.* cloud below 8,000 feet, rather than the total amount of cloud that is of importance. Monthly averages of the amount of low cloud are accordingly given in the table on page 69; they refer to the period 1933-7. The corresponding averages of the total cloud amount for the same period are also included for comparison, together with the difference between the two.

Owing to the comparatively large differences in the mean monthly cloud amount from one year to another a period of five years is considered too short to give a very reliable average but the figures give a general indication of the amount of low cloud likely to be expected and its relation to the total amount. The averages of total cloud amount at 0800 given in the general climatological tables and in the step diagrams of Fig. 28 are for a longer period.

The wind speed usually increases fairly rapidly from the surface up to about 1,500 feet after which it decreases until about 6,500 feet is reached, from there at both Calcutta and Madras it increases again up to 10,000 feet but there is no evidence of this increase at Vizagapatam.

*SW. monsoon (June to September).*—With the arrival of the SW. monsoon in June the winds in the lowest layers over the whole region blow from between S. and W. The exact height to which the south-westerly air current extends is not easy to determine owing to the difficulty of getting observations on account of low clouds or strong winds, but when fully developed the current is understood to extend to a height of about 20,000 feet; its thickness varies considerably from day to day owing to variations in the strength of the monsoon.

The upper westerly winds which are so prominent a feature of the circulation of the upper air in the cool season recede northwards in these months beyond the northern limit of the region under consideration here. The equatorial easterly winds on the other hand extend northwards over the whole area and are the prevailing winds above the monsoon current up to very high levels.

In the northern part of the Bay of Bengal the SW. monsoon air current turns northwards and blows as a southerly wind over most of the Bengal coast, continuing north-westwards across northern India to the south of the Himalayas. Calcutta lies in the region where the wind is backing, and where its direction is in consequence more variable and its strength less than in places further south such as Madras.

At Calcutta in the early morning the winds below 1,700 feet are light and chiefly from between E. and SW. with frequent calms. At about 1,700 feet the winds are chiefly from S. or SW. and the wind speed has increased to an average of about 16 knots. Owing to the frequent passage of depressions, winds from all points of the compass are sometimes experienced and winds from directions other than SW. become more common as the season advances. In June SW. winds predominate up to 3,300 feet, they are usually only of moderate strength but occasionally they exceed 27 knots and may reach gale force. The south-westerly air current is still only comparatively shallow in this month and with increasing height the wind veers to W. at 6,500 feet and to NW. at higher levels. There is some evidence that at 20,000 feet light easterly winds predominate with frequent calms, the frequency of easterly winds becoming greater at greater heights. By July the SW. monsoon air current has increased in thickness, SW. winds extend up to about 13,000 feet, the winds becoming easterly above that level. In August and September the SW. monsoon shows signs of weakening and winds become lighter and more variable. Below 10,000 feet they blow mostly from a southerly direction but northerly winds are not unknown; above 10,000 feet the wind blows chiefly from SE. and NE.

At Vizagapatam (Waltair) in the months of the SW. monsoon the winds on the surface are SW. or W. with occasional NW. winds and frequent calms. As the season advances the number of calms increases and the wind becomes W. rather than WSW. In June, July and August the W. and SW. winds show a rapid increase in strength from the surface upwards to 1,800 feet and this increase continues up to 3,300 feet, the speed occasionally reaching gale force; winds from other directions are very rare. With increasing height the SW. winds lose their importance and at 6,500 feet W. and NW. winds prevail, they are frequently strong and may reach gale force. At 10,000 feet in June the winds are much lighter and come from the NW. quadrant. In July and August at this height W. and NW. winds are more persistent than in June and much stronger sometimes blowing with gale force; winds from other directions are rare. The motion of high clouds shows the prevalence of E. or NE. winds at levels of about 30,000 feet in July and August. In September the strength of the wind at all heights is less than in the previous months and the W. and SW. winds although prominent at 1,800 feet become less so at 3,300 feet, at which levels winds are somewhat variable. At 6,500 feet W. and NW. winds predominate but winds from other directions are more frequent than in the previous months. At 10,000 feet the wind is light and usually blows from some northerly direction. E. winds continue to prevail at the level of the high clouds.

At Madras throughout the months of the SW. monsoon the wind at the surface in the early morning is light from SW. or W., its strength increases very rapidly with height and at 1,700 feet the wind blows almost continuously from due W. with occasional winds from NW. and SW. Winds from an easterly direction are very rare. The average speed of the wind is about 22 knots, it exceeds 27 knots on about one day in three, occasionally reaching gale force. Calms and light winds at 1,700 and 3,300 feet are almost unknown. At 3,300 and 6,500 feet NW. winds are more frequent than they are in the lower layers but at all heights up to 18,000 feet the predominant wind direction is W. The average speed of the wind increases with height to 24 knots at 3,300 feet and then decreases slightly to an average of about 18 knots at 10,000 feet. At heights above 20,000 feet as far as can be judged from the observations the wind becomes more variable and above 25,000 feet it is mainly from E.

Conditions show little change throughout June, July and August, except that the westerly winds blow rather more strongly in June and July than in August. By September they become much weaker and the direction of the wind is more variable, the thickness of the SW. monsoon current is less than in the earlier months, and above 10,000 feet easterly winds increase in frequency.

*Post SW. monsoon period (October and November).*—By October the SW. monsoon has withdrawn from most of the northern and central parts of the region under consideration; the winds along the coast

very high levels. There is some evidence that the NE. winds of the lower layers decrease in thickness as the season advances. At Vizagapatam (Waltair) the NE. winds extend upwards over a greater vertical height than they do further north. At 6,500 feet they back slightly to north, though winds from the NE. quadrant still predominate; at 10,000 feet the wind backs still further and westerly winds become frequent increasing in frequency and strength above that height. At Madras the north-easterly winds are stronger than in the north and at 1,700 feet light or moderate winds blow persistently from that direction. In December they continue with little change up to 3,300 feet veering slightly above that level and becoming light and somewhat variable at 10,000 feet. In January they veer at a slightly lower level than in December. The movement of high clouds at Madras indicates that at a height of about 30,000 feet the winds in both December and January are for the most part from the SW. quadrant.

By February the N. and NE. winds have lost their persistence at 1,700 feet. At Calcutta SW. winds begin to make their appearance in February and increase considerably in frequency and strength in March, occasionally exceeding 27 knots. They are comparatively shallow when they first set in and with increasing height the wind changes fairly rapidly becoming W. or NW. at 6,500 feet and continuing from those directions at higher levels as in December and January. The strength of the upper westerlies shows evidence of weakening slightly in March, although even in that month they are comparatively strong and occasionally reach gale force. In February and March after the south-westerlies have set in the wind more frequently veers with height than backs.

At Vizagapatam (Waltair) in February at 1,800 feet light south-westerly winds predominate, at 3,300 feet the winds become more variable and at 6,500 feet they are mainly from the north, backing into the NW. quadrant at 10,000 feet. In March south-westerly winds prevail at 1,800 feet, they decrease in frequency at 3,300 feet and disappear at 6,500 feet at which height the winds are mainly from some northerly direction, veering to between N. and NE. at 10,000 feet. The movement of high clouds indicates that at a height of about 30,000 feet the winds are from W. or SW.

At Madras at 1,700 feet the persistent north-easterly winds of December and January are replaced in February by winds from the SE. quadrant, and in March light southerly winds prevail at that level. At greater heights the wind backs through E. to NE. and N. The winds at 10,000 feet in February are variable but blow chiefly from some northerly direction, but in March they are almost entirely from the NE. quadrant. The winds above Madras are usually only light or moderate in strength although occasionally an E. or NE. wind in the upper levels may exceed 27 knots. The movement of high clouds indicates the prevalence of south-westerly winds at a height of about 30,000 feet in both February and March.

*Hot season (April and May).*—The NE. monsoon winds cease to blow about the end of February or early in March and by the beginning of April winds from a southerly direction have taken their place. These southerly winds are local in character and comparatively shallow and should not be confused with the winds of the SW. monsoon which do not as a rule arrive on the east coast of India until June. At high levels the change from the cool to the hot season is marked by a gradual weakening of the belt of upper westerlies and by its recession northwards to higher latitudes, whereas the equatorial upper easterlies become stronger and more persistent and extend further northwards.

At Calcutta light S. or SW. winds prevail at the surface in place of the calms of the cold season and these SW. winds are felt along the coast at least as far south as Madras. These winds strengthen very rapidly with height in the lower layers and at 1,700 feet they not infrequently exceed 27 knots occasionally reaching gale force. Above that level they decrease in strength and gradually veer to between SW. and NW. at 6,500 feet, and to between W. and NW. at 10,000 feet, they continue to blow from a westerly direction up to at least 25,000 feet. The winds at high levels in this season are much lighter than in the cool season.

At Vizagapatam (Waltair) light SW. or W. winds prevail at the surface with frequent calms. The SW. winds strengthen with height and at 1,800 feet they may occasionally exceed 27 knots especially in May. Above 1,800 feet they decrease slightly in strength and W. winds become more frequent. At 6,500 feet the winds are light and variable with a slight predominance of NW. winds in May. At 10,000 feet N. winds prevail with frequent winds from NW. and NE. The motion of high clouds indicates the predominance of W. winds at about 30,000 feet in April, but in May there is more variability at that level with frequent winds from the east.

At Madras calms continue to be frequent at the surface in the early morning during April and May, but occasionally there may be a light wind from S., SW. or W. In April, light or moderate S. to SW. winds prevail at 1,700 feet and at 3,300 feet, but they fall off rapidly above that height. At 6,500 feet the wind blows almost exclusively from an easterly direction (between NE. and SE.), and NE. winds continue up to 13,000 feet, above which the wind becomes light and variable with a tendency to SW. winds at the level of the high clouds. In May, conditions are very much the same, winds at 1,700 feet are chiefly between S. and W., moderate in strength and sometimes strong. These south-westerly winds are of no great depth. At 3,300 feet the wind becomes lighter and more variable and above that level there is the same rapid change with height as there is in April, with light winds from some northerly direction at 6,500 feet whilst above that level moderate NE. winds prevail. In contrast with conditions in April, in May easterly winds continue to be frequent up to the level of the high clouds.

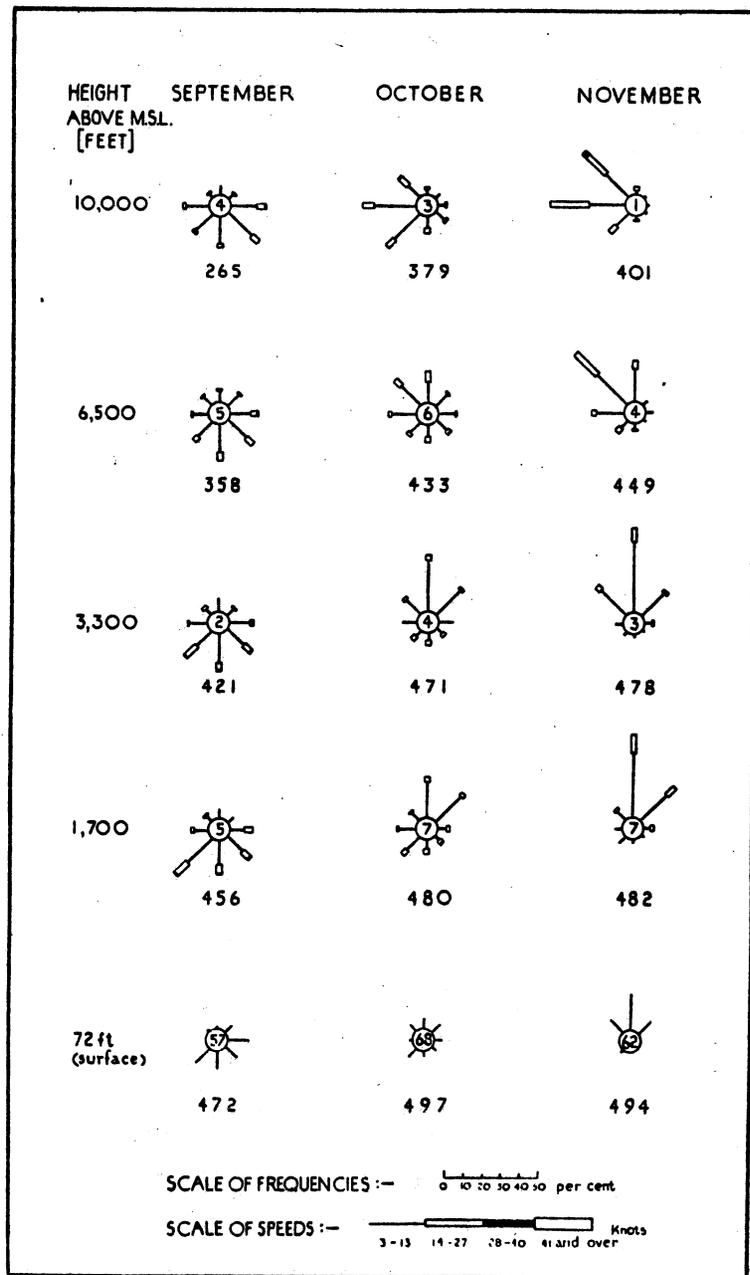


FIG. 27—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

The cloud observations are limited to direction only and give no information about speed. The average height of the low, medium and high clouds may be taken as about 6,500, 16,000 and 33,000 feet respectively.

**General.**—The upper winds of the region under consideration form part of one or other of two main circulations, namely, the westerly circulation of temperate latitudes or the easterly circulation of tropical latitudes. The boundary between these two circulations moves northward and southward during the year. In January the westerly circulation extends furthest south and in that month the surface of separation between the easterlies and westerlies slopes upwards towards the equator; in Long. 78° E. it lies at about 4,500 feet in Lat. 20° N., at 7,000 feet in Lat. 18° N., at 10,000 feet in Lat. 16° N., at 15,000 feet in Lat. 14° N., at 21,000 feet in Lat. 12° N. and above 30,000 feet in Lat. 10° N. Above the surface of separation westerly winds prevail and are likely to increase in frequency and strength with increasing height. In July on the other hand above the surface winds of the SW. monsoon easterly winds extend over the whole region and the westerly circulation has receded northwards to about Lat. 30° N.

**Seasonal variation**

**Cool season (December to March).**—In the north the north-easterly air flow is comparatively shallow and does not extend above 2,000 or 3,000 feet. Above that height the wind gradually backs to west and strengthens, these westerly winds forming part of the general westerly circumpolar circulation of middle latitudes. These westerly winds persist up to great heights and at 30,000 feet there is an almost continuous flow from west or slightly south of west. Observations of the movement of high clouds confirm the existence of this persistent westerly flow.

The NE. winds of the surface layers increase in depth as they penetrate to lower latitudes. In the south the winds gradually veer to E. with increasing height and these easterly winds continue up to great heights. In the extreme south, over Ceylon, the wind remains easterly up to at least 20,000 feet but over Madras the winds become light and variable at 20,000 feet with westerly winds above that level. The westerly winds extend further southwards at high levels than they do on the surface and the boundary between the easterlies and the westerlies slopes upwards with increasing gradient towards the equator; the approximate position of this boundary has already been given in the paragraph under "General" above.

In December and January conditions are typical of the NE. monsoon. In the early morning the wind at the surface is usually calm. At Calcutta the calm gives way to light N. or NE. winds at 1,700 feet which back fairly rapidly with increasing height, becoming NW. or W. at 10,000 feet, and increasing considerably in strength from 6,500 feet upwards; these W. winds persist up to

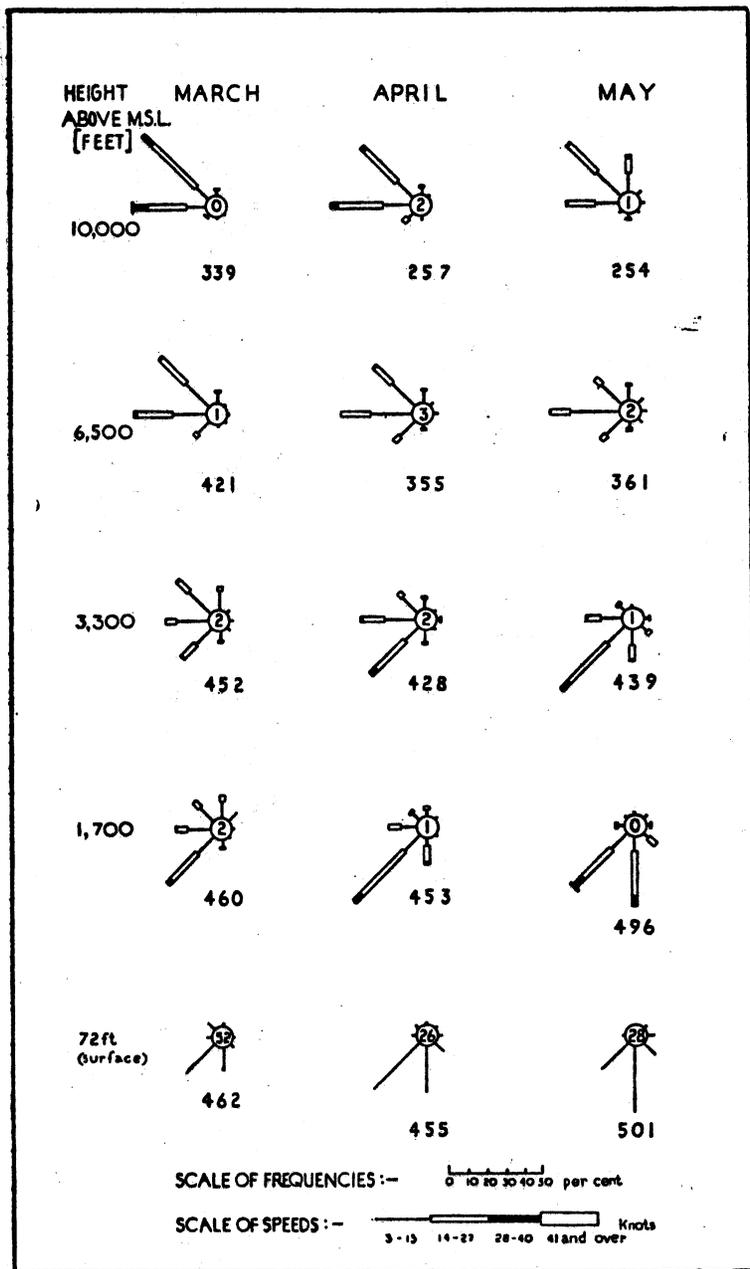


FIG. 25—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

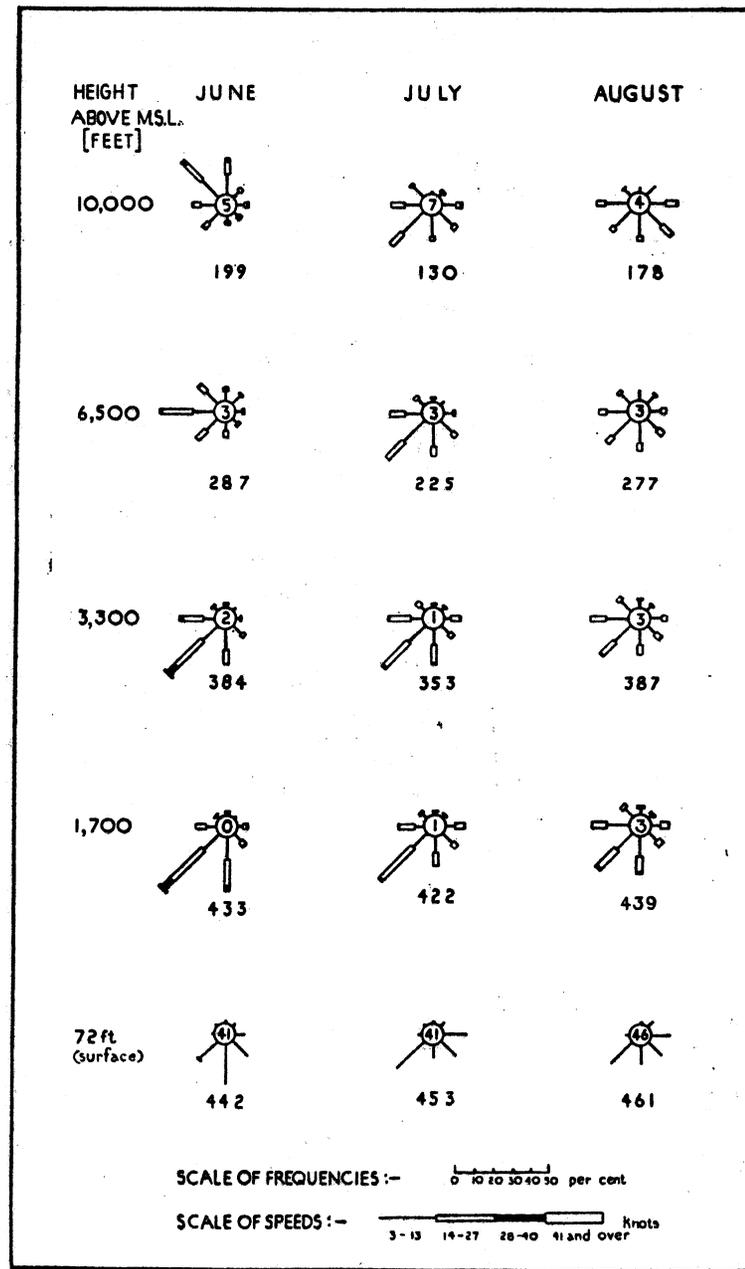


FIG. 26—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.  
The decrease in the number of observations above 6,500 ft. should be noted.

Upper winds  
VIZAGAPATAM  
(Waltair)

6 57

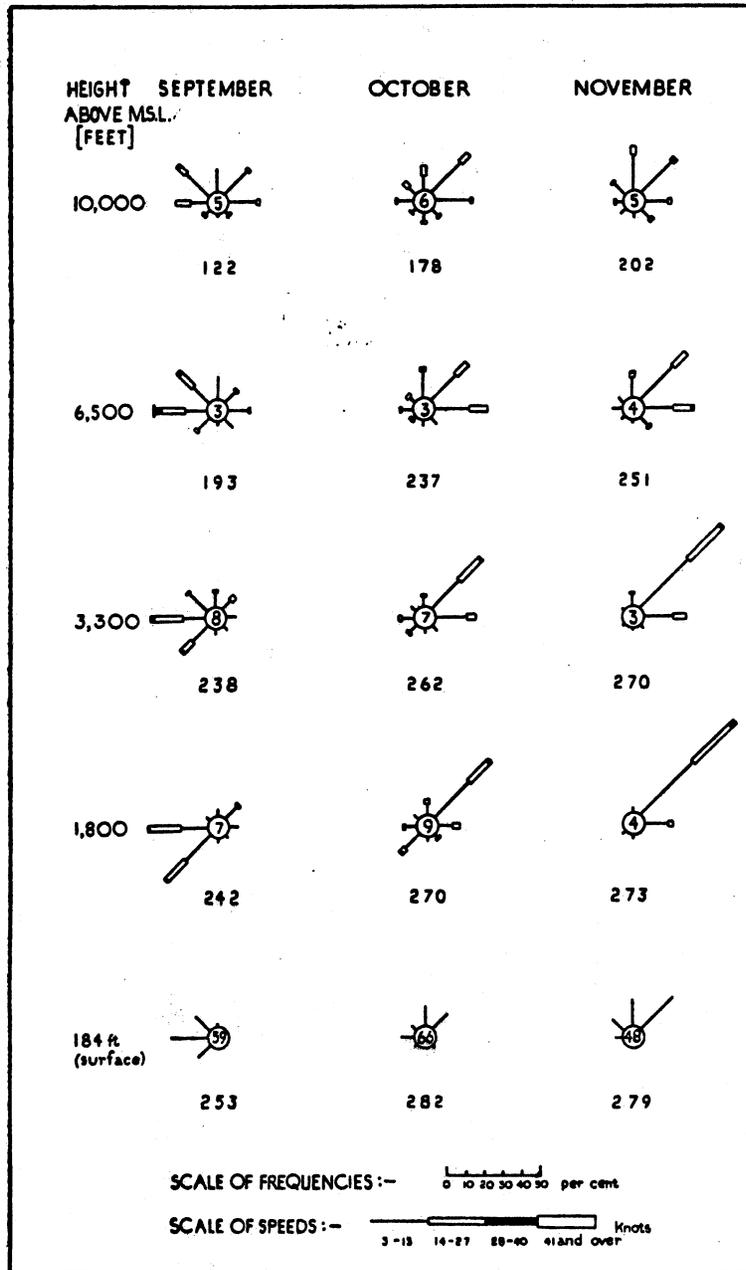


FIG. 23 UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

6 58

East coast of India  
CALCUTTA

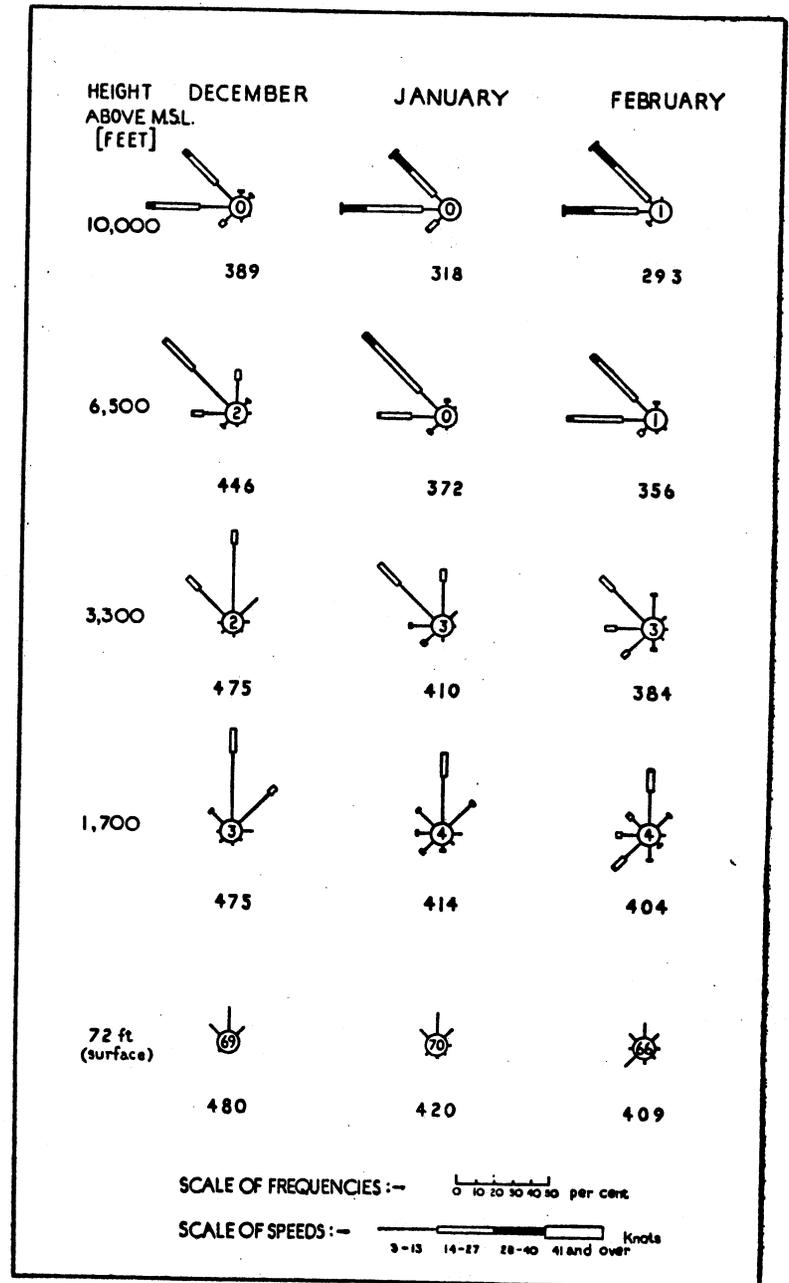


FIG. 24—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

Upper winds  
VIZAGAPATAM  
(Waltair)

6 55

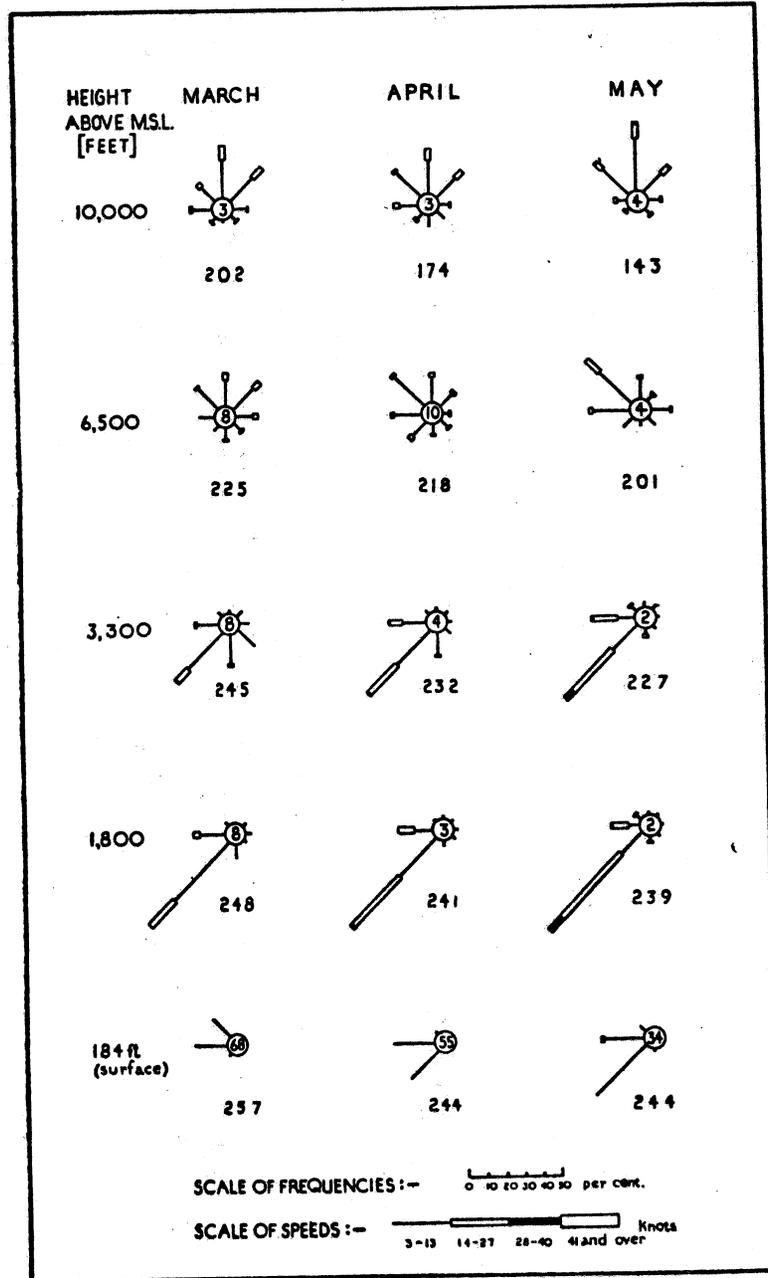


FIG. 21—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

East coast of India  
VIZAGAPATAM  
(Waltair)

6 56

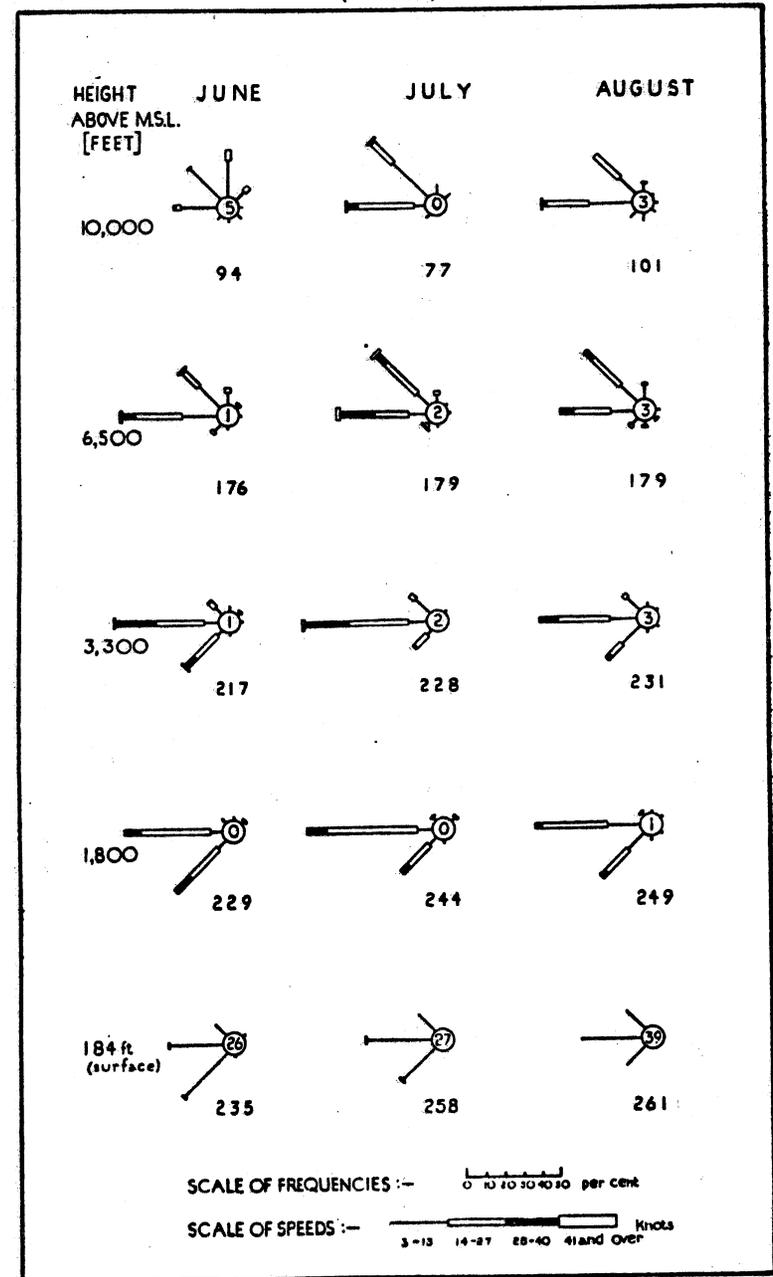


FIG. 22—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.  
The decrease in the number of observations above 6,500 ft. should be noted.

Upper winds  
MADRAS

6 53

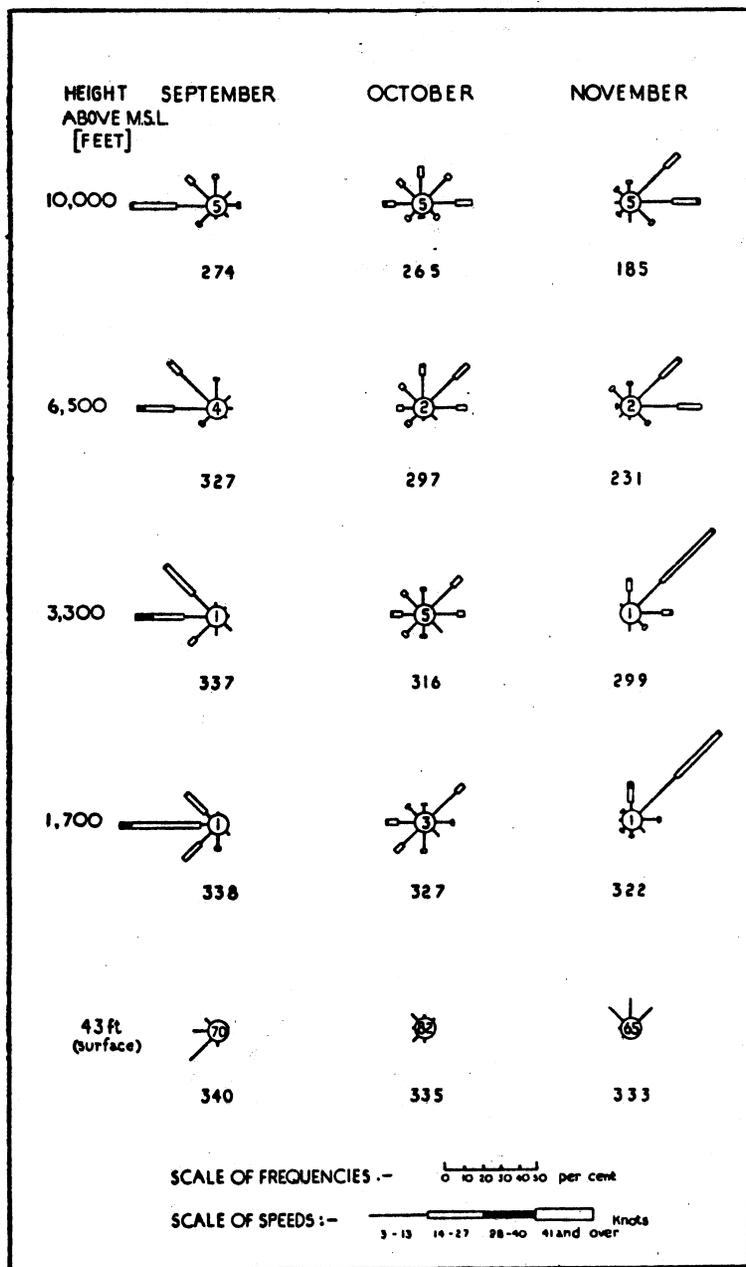


FIG. 19—UPPER WINDS—MONTHLY  
Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

East coast of India  
VIZAGAPATAM  
(Waltair)

6 54

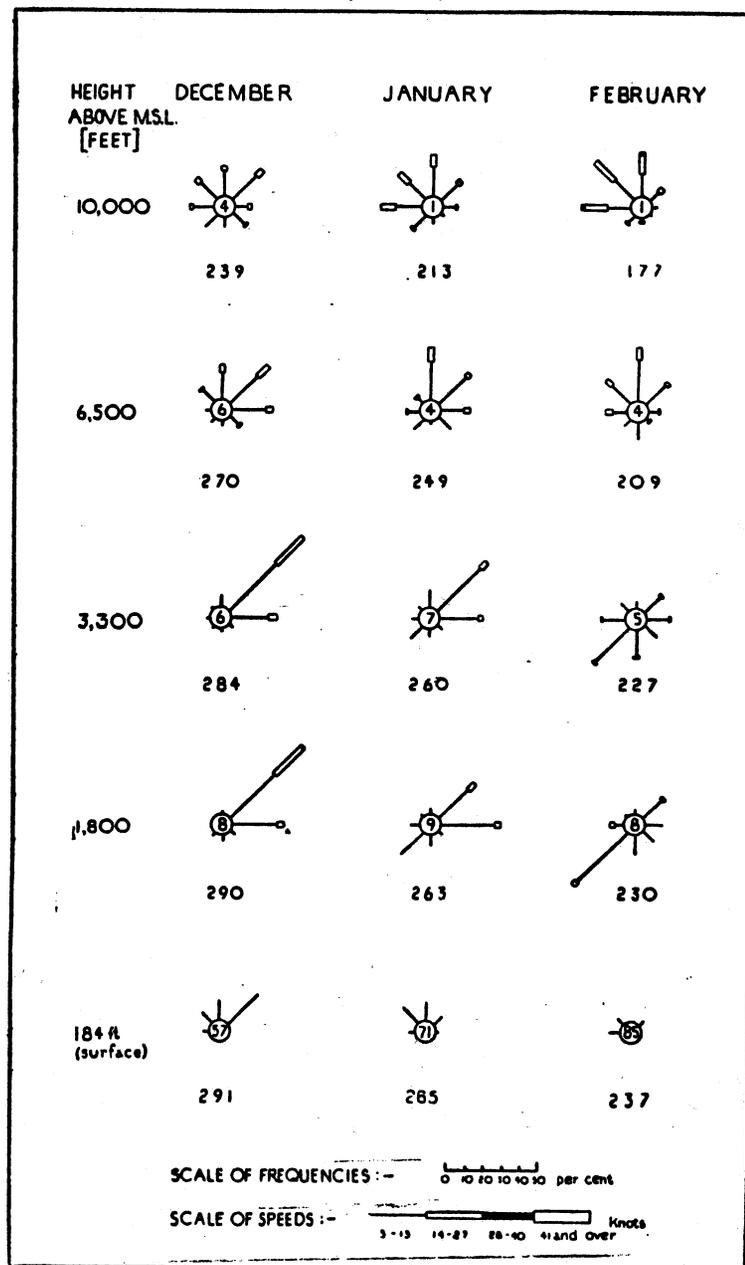


FIG. 20—UPPER WINDS—MONTHLY  
Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

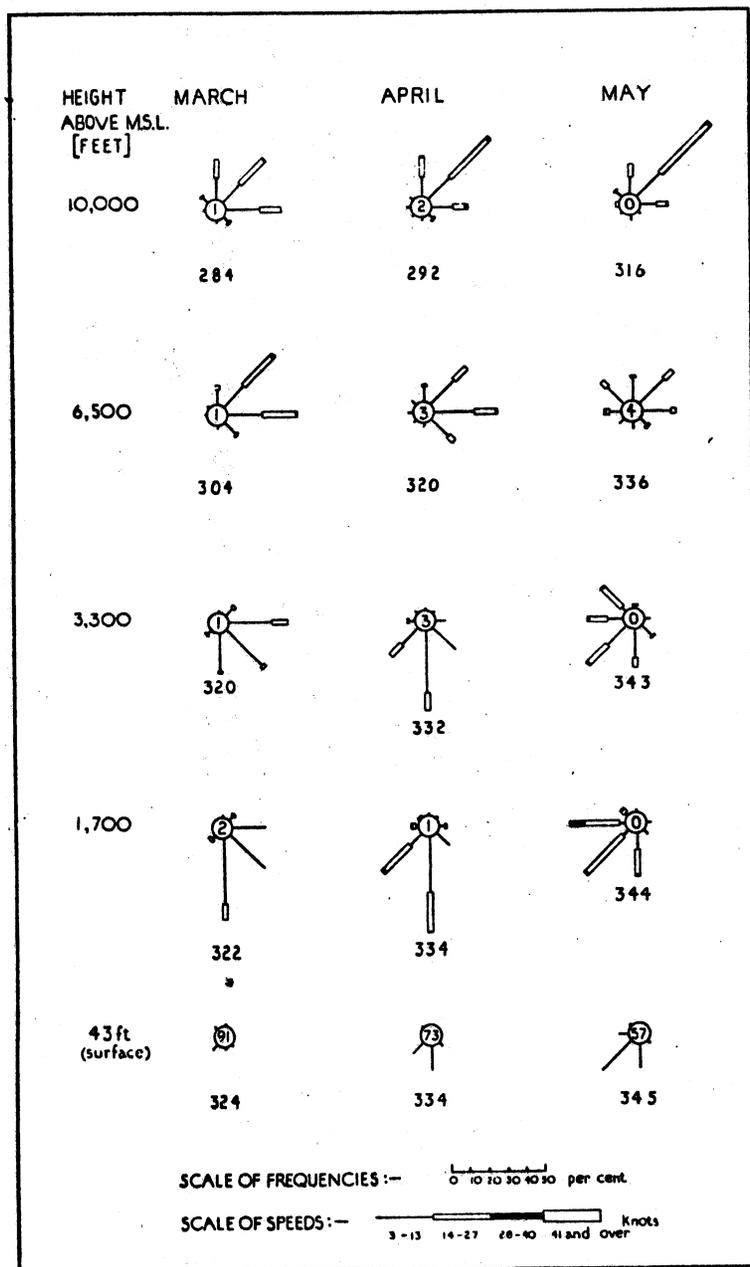


FIG. 17—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

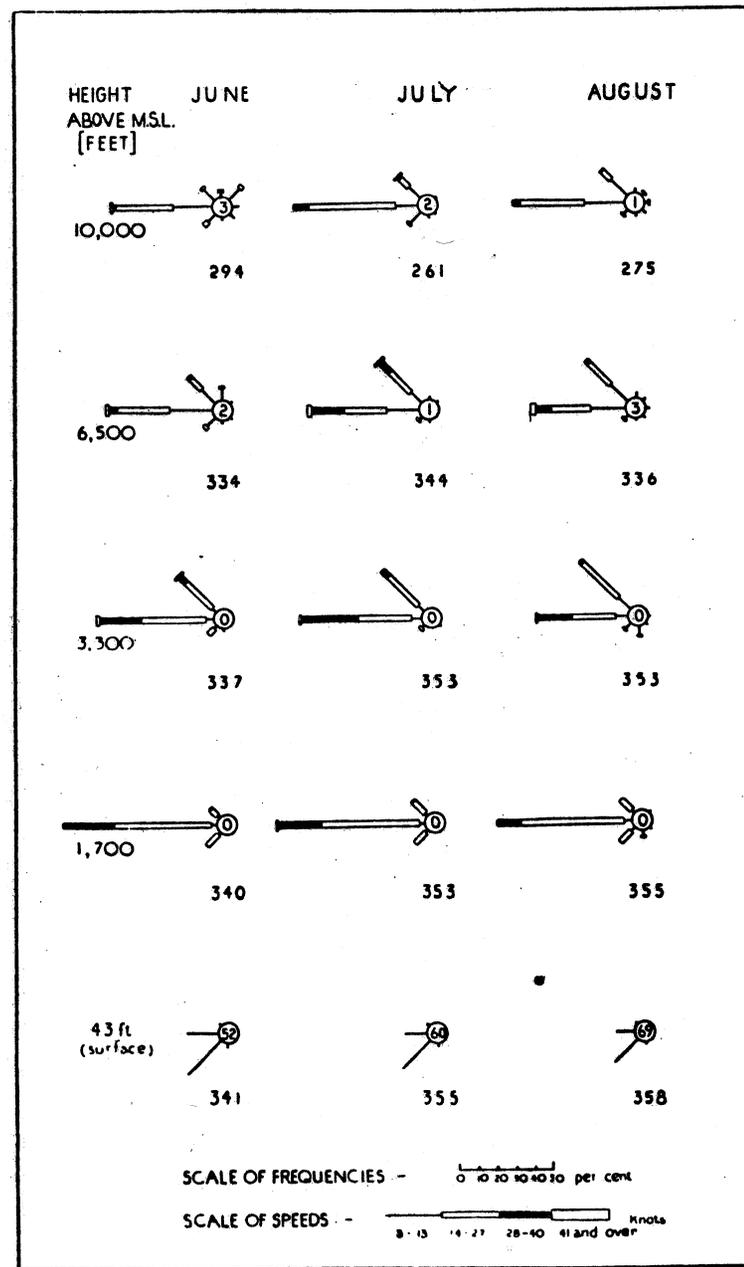


FIG. 18—UPPER WINDS—MONTHLY

Figures inside the circles indicate the percentage frequency of calms.  
Figures below the roses indicate the number of observations.

or two later in the night. By the following morning the sky had cleared and the wind had gone back to SW. by W."

The barograph gave little indication of this "blow," although it showed the pressure for the past few days to have been below the normal for the month.

This next description is of a "Nor'wester" experienced by a ship in the Bay of Bengal; it is included here to show that these storms when encountered at sea are very similar to those that occur over the land; the times quoted are ship's time.

"On April 15th, 1928 the S.S. *Stockwell* encountered a "Nor'wester" in position 17° 34' N., 84° 50' E., about eighty miles off the Circars coast. At 2015 the wind, after having been variable Beaufort force 1, dropped to calm and after an interval of three minutes increased rapidly to gale force from NW. and at 2023 there were violent squalls accompanied by vivid forked lightning. The sky became overcast and rain followed at 2035. A quarter of an hour later the wind moderated, rain ceased and the sky began to clear, and at 2100 the wind backed to SW. and eventually to SE. where the principal wind had come from during the day."

2—UPPER WINDS

Observations of upper winds in the morning over the east coast of India at heights up to 10,000 feet are available for three places namely, Madras, Vizagapatam (Waltair) and Calcutta. Wind-roses for these places are reproduced in Figs. 16-27 and the corresponding data are given in Table V.

The upper winds at Colombo are described in Part 6B on Ceylon and in Figs. 33-40 on pages 144-51 two sets of wind-roses for Colombo are reproduced. One set of observations gives the wind in the morning up to 16,500 feet whilst the other gives the wind in the afternoon up to 6,500 feet. The corresponding data are given in Tables XI and XII.

It should be remembered when using the tables and diagrams that the results are based on observations of pilot balloons and that balloons can seldom be followed to great heights on occasions of cloud, haze or strong wind and never in rain. When the skies are clear the results are probably reliable up to the limits of height shown, but the number of strong winds at the higher levels is likely to be underestimated; on the other hand, when conditions are bad the number of observations falls off rapidly above 3,000 feet and the winds shown above that level cannot be regarded as representative.

In order to supplement the pilot balloon data, observations of the motion of low, medium and high cloud have been included in Table V for Madras, Vizagapatam (Waltair) and Calcutta, but even in these on days when a large amount of low cloud is present observations of medium and high cloud will generally be lacking.

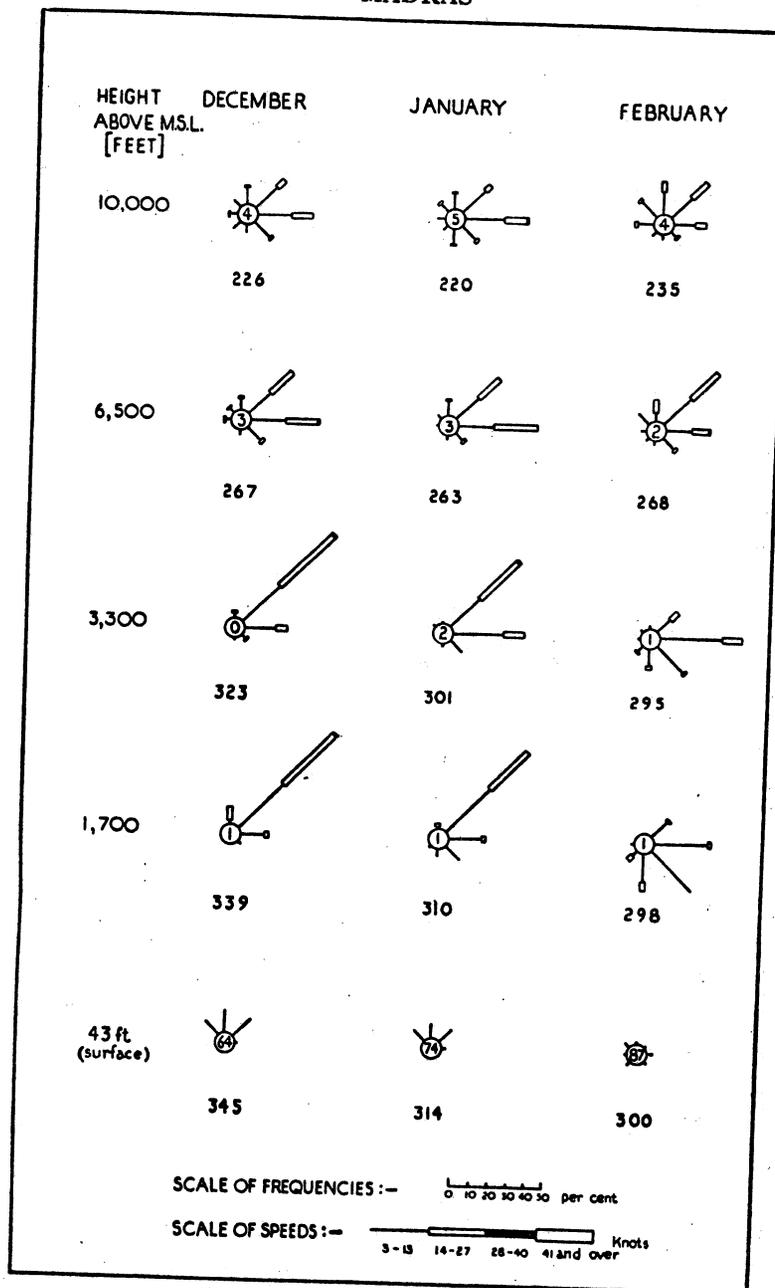


FIG. 16—UPPER WINDS—MONTHLY  
 Figures inside the circles indicate the percentage frequency of calms.  
 Figures below the roses indicate the number of observations.

TABLE I—continued

Negapatam. 10° 46' N., 79° 51' E. 31 ft.

Times of obs. : 0800 (local time) and 1700 (Z-5½)\*\*

Month	Pressure at M.S.L.		Air Temperature								Rain			Thunder heard	Wind										Poor visibility †	Relative humidity %	Cloud amount	Wet bulb temperature °F.	
	Average*	Daily range †	Average †	Mean of		Mean of		Extreme		Average fall	No. of days ‡	Max. fall in 24 hours	Percentage of observations from																
				Daily max.	Daily min.	Highest	Lowest	Highest	Lowest				N.		NE.	E.	SE.	S.	SW.	W.	NW.	Calm							
	mb.	inh.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	mm.	in.	days	Observations at 0800 (local time)**																
January ..	1013	3.8	77	83	71	85	66	89	61	43	1.7	2	130	5.1	0.2	6	5	39	10	<1	0	0	0	39	6	1	79	5.2	72
February ..	1013	4.0	79	85	73	87	67	96	60	16	0.6	0.8	104	4.1	0.2	5	1	20	13	7	5	5	4	36	9	0.2	78	4.4	73
March ..	1011	4.3	83	89	76	94	70	104	62	9	0.3	0.7	71	2.8	0.2	5	1	8	23	10	5	4	5	27	17	0.2	76	4.1	75
April ..	1008	4.4	86	93	79	99	75	107	68	14	0.6	0.9	71	2.8	1	5	1	<1	8	17	13	25	19	8	8	0.2	74	4.3	78
May ..	1006	4.1	89	97	80	104	74	109	69	41	1.6	2	134	5.3	2	5	<1	0	8	5	12	42	39	<1	1	0	69	4.2	79
June ..	1005	3.8	89	98	79	103	75	107	69	33	1.3	2	65	2.6	1	6	0	0	0	0	0	35	64	<1	<1	0	62	4.6	75
July ..	1005	3.9	87	96	79	101	75	107	71	48	1.9	3	113	4.5	0.8	5	0	0	0	0	0	13	87	0	0	0	63	5.2	74
August ..	1006	4.0	86	94	77	99	73	105	69	91	3.6	5	126	4.9	2	4	0	0	<1	0	7	21	70	0	1	0	71	5.3	75
September ..	1007	4.4	85	93	77	97	73	100	69	96	3.8	6	77	3.0	2	4	0	1	<1	1	1	20	71	4	2	0.2	71	5.1	76
October ..	1009	4.3	83	89	76	95	71	99	69	266	10.5	10	269	10.6	3	3	4	6	2	2	3	22	24	25	12	2	81	6.1	76
November ..	1010	4.0	79	85	74	90	70	94	64	450	17.7	13	366	14.4	0.8	5	7	15	3	3	2	2	5	59	4	2	85	6.5	74
December ..	1012	3.8	77	82	72	86	67	93	62	290	11.4	9	206	8.1	0.4	6	5	26	7	0	1	<1	<1	60	0	2	82	6.3	72
Year ..	1009	4.1	83	90	76	104	66	109	60	1397	55.0	54	366	14.4	14	5	2	10	6	4	4	16	32	21	5	8	74	5.1	75

96 9 East coast of India

Authorities.—Bibliography Nos. 49, 114, 116.

Periods.—Pressure (average), 32 years; (daily range), not known.  
Temp., 37-43 years. Rain, 43 years.  
No. of days with thunder, wind (direction), poor visibility, relative humidity and wet bulb temperature, 1933-7.  
Wind (speed), 1870-1920. Cloud amount, 32 years.

Notes.—\*\* Local time is about 11 min. slow on Z-5½.  
\* Corrected to mean of 24 hours.  
† Difference between means at 1000 and 1600 local time.  
‡ (max. + min.).  
‡ Day with 2.54 mm. (0.1 in.) or more of rain.  
‡ Mean of 24 hours.  
‡ No. of days with visibility less than 2 nautical miles.

Month	Observations at 1700 (Z-5½)**										
January ..	6	77	14	3	0	0	0	0	0	0.8	72
February ..	<1	44	37	15	3	0	0	0	0	0	70
March ..	0	21	42	38	3	0	0	1	0	0	76
April ..	0	4	15	46	26	7	1	<1	0	0	71
May ..	0	<1	3	26	28	32	9	1	0	0	66
June ..	0	<1	1	5	24	57	13	0	0	0.2	60
July ..	0	1	<1	5	22	38	33	0	0	0	58
August ..	0	<1	4	28	34	21	12	0	<1	0	68
September ..	0	1	6	30	28	25	9	1	0	0	69
October ..	4	29	8	20	11	15	6	3	4	0.2	75
November ..	11	62	5	6	2	3	1	9	1	3	76
December ..	10	80	6	1	<1	0	<1	2	0	2	73
Year ..	3	27	12	18	15	17	7	1	<1	6	69

See page 69

(1217)

TABLE I—continued

Madras. 13° 04' N., 80° 15' E. 22 ft.

Times of obs. : 0800 (local time) and 1700 (Z-5½)\*\*

Month	Pressure at M.S.L.		Air Temperature						Rain			Thunder heard	Wind										Poor visibility†	Relative humidity %	Cloud amount	Wet bulb temperature °F.			
	Average*	Daily range ††	Average†	Mean of		Mean of		Extreme		Average fall	No. of days‡		Max. fall in 24 hours	Speed in knots	Percentage of observations from														
				Daily max.	Daily min.	Highest	Lowest	Highest	Lowest						N.	NE.	E.	SE.	S.	SW.	W.	NW.					Calm		
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	mm.	in.	days	Observations at 0800 (local time)**																
January ..	1016	3.8	76	85	68	87	62	93	57	35	1.4	2	213	8.4	0.3	4	5	19	15	2	<1	3	13	42	0	3	83	3.4	71
February ..	1014	4.2	78	87	69	91	63	96	59	8	0.3	0.6	48	1.9	0	3	1	2	14	6	8	26	23	20	0	3	85	2.5	73
March ..	1013	4.4	81	90	72	95	67	102	62	5	0.5	0.3	50	2.0	1	4	3	3	5	8	16	34	23	8	0	2	80	2.2	75
April ..	1010	4.4	85	93	77	100	73	109	69	13	0.5	0.7	84	3.3	2	6	0	1	1	9	41	38	9	1	0	0.2	75	4.0	78
May ..	1007	4.1	90	99	81	107	76	113	70	27	1.1	1	133	5.2	7	6	0	1	<1	7	45	30	16	1	0	0	66	3.8	79
June ..	1005	4.0	90	99	81	105	75	110	69	48	1.9	4	54	2.1	7	7	0	0	0	0	7	54	38	<1	0	0	59	5.7	76
July ..	1006	4.0	87	96	79	102	74	106	71	100	3.9	7	116	4.6	7	6	0	0	<1	0	1	54	41	3	0	0.4	69	6.9	76
August ..	1007	4.2	86	94	78	100	73	104	69	118	4.6	8	74	2.9	9	5	1	0	0	1	10	53	33	2	0	0.4	75	6.6	76
September ..	1008	4.3	85	93	77	99	72	102	69	127	5.0	7	99	3.9	10	5	>1	<1	<1	2	8	51	35	1	>1	0.8	73	6.2	76
October ..	1011	4.0	82	89	75	96	70	103	62	298	11.7	10	233	9.2	10	4	4	3	8	2	6	27	24	26	0	2	84	5.2	77
November ..	1013	3.7	79	85	73	90	67	95	59	362	14.3	11	178	7.0	4	5	15	19	9	3	0	3	10	41	0	2	85	5.5	75
December ..	1015	3.7	77	83	70	87	64	95	57	148	5.8	5	262	10.3	0.6	5	16	20	8	<1	<1	0	7	47	<1	2	83	4.7	71
Year ..	1010	4.1	83	91	75	107	62	113	57	1289	50.7	57	262	10.3	58	5	4	6	5	3	12	31	23	16	<1	16	76	4.7	75

Authorities.—Bibliography Nos. 103, 114, 116.

Periods.—Pressure (average), 32 years; (daily range), 20 years.  
 Temp. (average, mean daily max. and min.), 43 years;  
 (mean highest and lowest, extremes), 50 years.  
 Rain (average fall and no. of days), 43 years; (max. fall  
 in 24 hours), and cloud amount, 28 years.  
 No. of days with thunder, 1914-23.  
 Wind (speed), 1901-20.  
 Wind (direction), poor visibility, relative humidity and  
 wet bulb temp., 1933-7.

Notes.—\*\* Local time is 9 min. slow on Z-5½.

\* Observations at 0800 local time.

† Difference between the means at 1000 and 1600.

†† (max. + min.).

‡ Day with 2.54 mm. (0.1 in.) or more of rain.

‡‡ No. of days with visibility less than 2 nautical miles.

Month	Observations at 1700 (Z-5½)**										1600	1700		
	January ..	February ..	March ..	April ..	May ..	June ..	July ..	August ..	September ..	October ..			November ..	December ..
January ..	5	10	51	29	9	<1	0	0	<1	0	0	68	3.3	72
February ..	5	0	12	40	42	6	0	0	0	0	0	67	2.2	74
March ..	6	0	9	28	54	9	0	0	0	0	0	68	1.3	76
April ..	7	0	<1	14	61	23	0	<1	0	0	0.4	73	2.4	79
May ..	6	0	<1	2	64	29	3	<1	0	0	0	69	3.3	81
June ..	6	0	1	4	43	31	9	>1	3	0	0.2	61	6.5	79
July ..	5	0	2	8	44	16	12	15	3	0	0.4	63	7.2	78
August ..	4	<1	3	15	48	21	4	6	2	0	0.2	69	7.1	79
September ..	4	0	3	13	50	14	9	7	4	0	0	68	6.2	79
October ..	4	8	24	24	24	10	3	<1	6	0	0.8	77	5.6	78
November ..	5	34	43	11	7	1	<1	0	3	0	2	76	6.0	74
December ..	5	33	49	16	1	<1	0	0	0	0	0.8	71	5.0	72
Year ..	5	7	17	17	37	14	3	3	2	0	5	69	4.7	77

Table I—General climatological tables

6 97

TABLE I—continued

Cocanada. 16° 57' N., 82° 14' E. 26 ft.

Times of obs. : 0800 (local time) and 1700 (Z-5½)\*\*

98

Month	Pressure at M.S.L.		Air Temperature						Rain			Thunder heard	Wind										Poor visibility†	Relative humidity %	Cloud amount	Wet bulb temperature °F.			
	Average*	Daily range	Average†	Mean of		Mean of		Extreme	Average fall	No. of days‡	Max. fall in 24 hours		Percentage of observations from																
				Daily max.	Daily min.	Highest	Lowest						Highest	Lowest	Speed in knots	N.	NE.	E.	SE.	S.	SW.	W.					NW.	Calm	
													Observations at 0800 (local time)**																
January ..	1015	mb.	74	81	66	87	61	92	59	5	0.2	32	1.3	0	5	23	32	1	1	0	2	<1	5	35	3	77	2.9	67	
February ..	1013		78	86	70	93	65	100	60	8	0.3	45	1.8	0	4	10	15	<1	2	0	0	5	10	57	5	79	3.0	71	
March ..	1011		83	92	74	98	68	108	61	12	0.5	72	2.8	0.8	4	3	7	<1	2	1	12	11	6	57	1	75	3.2	74	
April ..	1008		87	96	79	101	74	109	69	14	0.6	43	1.7	3	4	0	3	<1	5	8	33	8	2	40	0.2	76	4.8	78	
May ..	1005		91	99	82	109	75	115	70	39	1.5	110	4.3	4	5	1	2	2	8	13	37	9	2	26	0.2	73	5.1	81	
June ..	1002		88	96	81	106	75	114	71	122	4.8	154	6.1	4	5	0	2	0	<1	1	40	36	5	15	2	75	6.8	78	
July ..	1002	Data not available	85	91	79	98	74	107	70	148	5.8	107	4.2	1	5	0	<1	0	0	0	39	48	4	8	3	82	7.7	77	
August ..	1003		84	90	78	96	74	100	73	139	5.5	122	4.8	2	4	0	0	0	0	1	33	37	3	26	2	83	7.3	77	
September ..	1005		84	90	78	95	75	99	72	146	5.7	95	3.7	3	4	0	6	0	<1	<1	27	33	6	27	2	82	6.4	78	
October ..	1009		82	88	76	93	71	99	66	199	7.9	163	6.4	2	4	5	35	3	1	1	4	10	11	30	2	80	4.7	76	
November ..	1012		77	83	71	87	65	91	60	138	5.4	236	9.3	0.4	6	7	54	3	0	0	0	0	10	26	0.6	73	4.1	71	
December ..	1015		73	81	66	84	62	90	57	22	0.9	130	5.1	0	6	16	54	<1	0	0	0	0	6	23	0	73	3.2	67	
Year ..	1008		82	89	75	111	60	115	57	992	39.1	54	236	9.3	20	5	5	18	1	2	2	19	16	6	31	21	77	4.9	75

East coast of India

Authorities.—Bibliography Nos. 49, 103, 114, 116.

Periods.—Pressure and cloud amount, 32 years.  
 Temp. (average, mean daily max. and min.), 29 years;  
 (mean highest and lowest, extremes), 37-38 years.  
 Rain, 40-41 years.  
 No. of days with thunder, 1914-23.  
 Wind (speed), 1893-1920.  
 Wind (direction), poor visibility, relative humidity and wet bulb temp., 1933-7.

Notes.—\*\* Local time is about 2 min. slow on Z-5½.  
 \* Corrected to mean of 24 hours.  
 † ‡ (max. + min.).  
 ‡ Day with 2.54 mm. (0.1 in.) or more of rain.  
 †† Mean of 24 hours.  
 ‡ No. of days with visibility less than 2 nautical miles.  
 ‡ Data unavailable.

Month	Observations at 1700 (Z-5½)**										Poor visibility†	Relative humidity %	Cloud amount	Wet bulb temperature °F.
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Speed in knots				
January ..	0	5	37	47	8	2	<1	0	<1	0.2	65	70		
February ..	0	3	9	49	30	8	0	<1	<1	0.2	64	73		
March ..	0	0	2	47	36	14	0	0	<1	0	57	75		
April ..	<1	0	3	25	48	19	<1	1	3	0	62	79		
May ..	1	1	<1	25	48	16	2	3	3	0	60	81		
June ..	1	2	<1	8	13	32	26	6	11	0.6	59	79		
July ..	1	0	<1	1	4	30	40	10	12	1	68	78		
August ..	0	0	1	5	6	29	31	11	17	1	70	78		
September ..	<1	2	3	13	3	25	20	7	26	1	71	78		
October ..	<1	19	23	27	6	10	<1	4	9	1	72	77		
November ..	<1	23	33	28	<1	0	0	0	14	0.8	66	72		
December ..	0	11	45	39	0	<1	0	<1	4	0.2	65	69		
Year ..	<1	6	13	26	17	15	10	4	8	0	65	76		

TABLE I—continued

Vizagapatam (Waltair). 17° 42' N., 83° 18' E. 38 ft.

Times of obs. : 0800 (local time) and 1700 (Z-5½)\*\*

Month	Pressure at M.S.L.		Air Temperature								Rain			Thunder heard	Wind											Poor visibility †	Relative humidity %	Cloud amount	Wet bulb temperature °F.
	Average*	Daily range †	Average ‡	Mean of		Mean of		Extreme		Average fall	No. of days †	Max. fall in 24 hours	Percentage of observations from																
				Daily max.	Daily min.	Highest	Lowest	Highest	Lowest				Speed in knots		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm						
				°F.	°F.	°F.	°F.	°F.	°F.	mm.	in.	days	Observations at 0800 (local time)**																
January ..	1016	4-2	74	81	68	84	63	90	60	12	0.5	0.5	2	2	19	6	3	1	1	0	1	13	32	28	0.2	80	2.7	67	
February ..	1015	4-4	77	84	71	88	66	91	61	22	0.9	0.9	2	2	4	3	3	1	0	1	2	35	10	45	0	81	2.9	70	
March ..	1012	4-3	81	87	75	92	70	97	66	8	0.3	0.5	3	3	3	0	1	1	1	6	46	18	25	0	76	2.9	74		
April ..	1010	4-3	84	90	78	94	73	99	68	18	0.7	2	4	4	1	2	2	1	4	27	46	6	11	0	76	4.3	78		
May ..	1006	4-0	86	92	81	99	74	110	68	50	2.0	3	4	4	1	1	1	1	7	43	32	9	6	0	75	5.7	80		
June ..	1002	3-3	86	91	80	100	73	111	70	123	4.9	7	4	4	0	1	0	1	3	30	49	10	7	0.8	78	7.8	79		
July ..	1002	3-2	84	89	79	96	74	101	71	114	4.5	8	4	4	2	1	1	1	1	14	62	12	7	2	81	8.3	78		
August ..	1003	3-6	83	89	78	95	74	99	70	136	5.4	8	3	3	0	0	0	0	0	18	60	8	14	0.2	82	7.9	78		
September ..	1006	3-8	83	88	78	93	74	98	72	166	6.5	9	2	2	5	3	1	1	0	6	51	17	16	0.2	80	7.1	78		
October ..	1011	3-8	82	88	76	92	72	96	69	180	7.1	7	2	2	29	10	2	2	0	2	25	8	22	0	77	5.1	76		
November ..	1014	3-7	79	84	73	88	67	91	61	95	3.7	4	3	3	29	23	1	0	0	0	20	15	12	0.2	70	4.4	70		
December ..	1016	3-9	74	81	68	84	63	88	60	18	0.7	1	3	3	28	15	1	0	0	0	12	34	10	0	72	3.3	66		
Year ..	1009	3-9	81	87	75	102	62	111	60	942	37.1	51	3	3	10	5	<1	<1	1	12	38	15	17	4	77	5.2	74		

Authorities.—Bibliography Nos. 49, 103, 114, 116.  
 Periods.—Pressure (average) and cloud amount, 32 years.  
 Pressure (daily range), 20 years.  
 Temp. (average, mean daily max. and min.), 25 years;  
 (mean highest and lowest, extremes), 23 years.  
 Rain, 24 years.  
 No. of days with thunder, 1914-23.  
 Wind (speed), 1872-1920.  
 Wind (direction), poor visibility, relative humidity and wet bulb temp., 1933-7.  
 Notes.—\*\* Local time is 3 min. fast on Z-5½.  
 \* Observations at 0800 local time.  
 † Difference between the means at 1000 and 1600.  
 ‡ (max. + min.).  
 † Day with 2.54 mm. (0.1 in.) or more of rain.  
 †† Mean of 24 hours.  
 † No. of days with visibility less than 2 nautical miles.

Month	Observations at 1700 (Z-5½)**											Sec page 69
January ..	0	28	31	14	17	9	1	0	0	0	71	
February ..	<1	0	12	24	32	31	<1	0	0	0.2	74	77
March ..	<1	0	3	11	42	41	2	0	0	0	75	74
April ..	0	0	1	8	24	63	3	<1	<1	0	78	80
May ..	<1	1	<1	3	29	60	5	1	0	0.4	78	81
June ..	<1	2	2	2	14	58	17	3	1	1	75	80
July ..	0	2	3	1	7	45	30	9	3	1	76	79
August ..	0	<1	<1	1	8	57	25	3	5	0.8	76	79
September ..	<1	3	3	8	12	42	19	5	7	1	76	79
October ..	5	30	22	14	12	8	4	1	4	1	74	77
November ..	1	41	34	15	5	3	<1	0	0	0	63	71
December ..	0	24	53	13	6	3	<1	0	0	0	64	69
Year ..	<1	11	14	9	17	35	9	2	2	5	73	76

Table I—General climatological tables

TABLE I—continued

Puri. 19° 48' N., 85° 49' E. 24 ft.

Times of obsn. : 0800 (local time) and 1700 (Z-5½)\*\*

Month	Pressure at M.S.L.		Air Temperature						Rain			Thunder heard	Wind										Poor visibility†	Relative humidity %	Cloud amount	Wet bulb temperature °F.			
	Average*	Daily range	Average†	Mean of		Mean of		Extreme		Average fall	No. of days‡		Max. fall in 24 hours	Percentage of observations from															
				Daily max.	Daily min.	Highest	Lowest	Highest	Lowest					N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm							
January ..	mb. 1015	mb. 72	°F. 89	°F. 63	°F. 84	°F. 57	°F. 89	°F. 51	mm. 8	in. 0.3	0.5	mm. 38	in. 1.5	days 0	††	Observations at 0800 (local time)**										0.6	76	2.0	63
February ..	1013	75	83	69	88	61	93	54	22	0.9	1	108	4.3	1	5	53	30	<1	0	3	4	3	3	3	3	0.6	76	2.0	63
March ..	1010	81	87	75	91	67	102	60	14	0.5	1	58	2.3	1	7	31	21	<1	0	15	17	7	4	4	0.8	80	2.5	70	
April ..	1007	83	88	79	92	72	101	69	17	0.7	1	82	3.2	3	8	13	9	<1	2	21	35	12	3	5	0.4	79	3.7	79	
May ..	1004	85	90	81	94	72	99	62	72	2.8	3	172	6.8	6	10	4	3	<1	3	29	47	12	1	3	0.2	82	3.7	79	
June ..	1000	85	89	81	94	74	100	67	186	7.3	8	200	7.9	7	10	3	1	1	3	36	44	9	1	2	2	85	4.6	81	
July ..	1000	Data not available.	84	88	80	93	75	98	255	10.0	12	301	11.9	6	10	5	2	1	2	23	39	18	3	7	4	84	6.4	80	
August ..	1001	84	88	79	93	75	98	71	313	12.3	13	188	7.4	6	9	9	7	1	<1	13	37	22	2	8	4	85	7.0	80	
September ..	1004	84	89	80	94	75	97	63	224	8.8	11	167	6.6	6	8	9	4	0	<1	23	33	13	6	11	3	85	7.0	79	
October ..	1009	83	89	77	93	71	97	62	174	6.8	7	141	5.6	4	6	6	13	5	3	19	25	12	9	11	0.6	83	5.7	79	
November ..	1013	77	85	69	89	63	93	58	94	3.7	2	243	9.6	0.6	5	5	46	22	2	6	5	3	6	8	0.2	78	3.4	75	
December ..	1015	71	81	62	85	57	91	51	8	0.3	0.4	89	3.5	0	5	64	31	<1	0	<1	1	1	1	<1	0.2	72	2.6	68	
Year ..	1008		80	86	75	97	56	102	1387	54.6	60	301	11.9	41	7	26	14	<1	1	16	24	9	4	5	16	80	4.1	74	

Authorities.—Bibliography Nos. 49, 114, 116.

Periods.—Pressure, rain (average fall and no. of days), and cloud amount, 1889-1920.

Temperature, 30 years.

Rain (max. fall in 24 hours), 28 years.

No. of days with thunder, wind (direction), poor visibility, relative humidity and wet bulb temp., 1933-7.

Wind (speed), 1893-1920.

Notes.—\*\* Local time is 13 min. fast on Z-5½.

\* Corrected to mean of 24 hours.

† (max. + min.).

‡ Day with 2.54 mm. (0.1 in.) or more of rain.

†† Mean of 24 hours.

\* No. of days with visibility less than 2 nautical miles.

Month	Observations at 1700 (Z-5½)**										Poor visibility†	Relative humidity %	Cloud amount	Wet bulb temperature °F.
Month	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm	Thunder heard				
January ..	3	4	23	31	30	9	0	0	0	0.2	66	67		
February ..	0	<1	7	21	48	22	<1	0	<1	0.2	75	73		
March ..	0	0	1	10	53	33	1	1	<1	0	78	77		
April ..	1	0	0	5	51	39	3	<1	0	0	81	79		
May ..	2	<1	1	7	45	39	5	0	<1	1	84	81		
June ..	<1	<1	0	3	39	41	11	<1	4	3	84	81		
July ..	4	<1	6	6	26	37	12	3	5	2	83	80		
August ..	3	2	2	4	33	39	9	3	5	2	82	80		
September ..	3	1	3	10	33	32	10	3	5	0.8	80	79		
October ..	15	11	10	19	25	11	3	1	5	1	70	76		
November ..	15	15	13	20	24	9	0	1	3	0.4	61	70		
December ..	7	9	18	34	26	5	0	0	1	0	61	67		
Year ..	4	4	7	14	36	26	5	1	3	11	75	76		

9 100

East coast of India



TABLE I—continued

Calcutta (Alipore Observatory). 22° 32' N., 88° 24' E. 21 ft.

Times of obs. : 0800 (local time) and 1700 (Z-5½)\*\*

Month	Pressure at M.S.L.		Air Temperature						Rain			Thunder heard	Wind										Poor visibility†	Relative humidity %	Cloud amount	Wet bulb temperature °F.			
	Average*	Daily range‡	Average†	Mean of		Mean of		Extreme	Average fall	No. of days†	Max. fall in 24 hours		Percentage of observations from																
				Daily max.	Daily min.	Highest	Lowest						Highest	Lowest	Speed in knots	N.	NE.	E.	SE.	S.	SW.	W.					NW.	Calm	
	mb.	mb.	°F.	°F.	°F.	°F.	°F.	°F.	mm.	in.	days	Observations at 0800 (local time)**																	
January ..	1017	4.4	67	77	56	83	49	88	44	9	0.3	0.7	42	1.7	0.1	1	17	14	3	4	<1	1	1	17	42	30	84	2.4	57
February ..	1015	4.4	71	82	60	90	51	98	46	28	1.1	2	81	3.2	0.8	2	6	4	5	6	5	14	4	11	45	26	82	2.7	61
March ..	1012	4.5	80	91	69	98	60	103	50	37	1.5	2	70	2.8	3	2	7	3	2	1	5	43	10	9	20	21	81	2.9	70
April ..	1008	4.4	86	95	76	103	68	107	61	48	1.9	3	107	4.2	7	4	1	>1	2	4	15	57	10	3	7	8	79	3.7	77
May ..	1005	3.9	86	95	78	101	70	107	65	146	5.7	7	156	6.1	7	4	>1	1	10	14	28	41	2	1	3	7	79	4.7	79
June ..	1001	3.1	85	91	79	98	73	108	70	302	11.9	13	304	12.0	8	4	>1	3	13	15	25	28	5	2	8	8	84	7.5	80
July ..	1000	3.0	84	89	79	93	75	98	68	318	12.5	18	184	7.2	6	4	0	3	19	22	16	27	3	3	7	10	87	8.6	79
August ..	1002	3.2	83	88	79	92	75	94	74	322	12.7	18	227	8.9	6	3	2	3	15	13	19	31	5	3	9	9	87	8.5	79
September ..	1006	3.7	83	88	78	92	75	95	72	251	9.9	13	369	14.5	9	3	4	4	14	21	14	18	5	7	13	9	87	6.9	79
October ..	1011	3.7	81	87	75	91	68	94	63	106	4.2	6	82	3.2	4	2	16	16	5	5	5	8	5	15	25	22	86	3.7	76
November ..	1015	3.9	73	82	65	87	58	91	51	17	0.7	1	81	3.2	0.2	2	21	11	1	0	0	5	3	21	38	29	82	2.2	65
December ..	1017	4.3	67	77	56	81	50	85	45	5	0.2	0.4	28	1.1	0	1	31	6	2	1	<1	0	>1	14	45	30	80	1.6	57
Year ..	1009	3.8	79	87	71	104	49	108	44	1589	62.6	84	369	14.5	51	3	9	6	7	9	11	23	4	9	22	209	83	4.6	72

Authorities.—Bibliography Nos. 18, 103, 114, 116.

Periods.—Pressure (average), 32 years; (daily range), 23 years.  
Temp. and rain (average fall and no. of days), 43 years.  
Rain (max. fall in 24 hours), 28 years.  
No. of days with thunder, 1914-23.  
Wind (speed), relative humidity, cloud amount and wet bulb temp., 1901-20.  
Wind (direction), poor visibility, 1933-7.

Notes.—\*\* Local time is 24 min. fast on Z-5½.

\* Observations at 0800.

† Difference between the means at 1000 and 1600.

‡ (max. + min.).

§ Day with 2.54 mm. (0.1 in.) or more of rain.

¶ No. of days with visibility less than 2 nautical miles.

Month	Observations at 1700 (Z-5½)**										1600	1700		
January ..	3	18	1	<1	2	3	7	2	29	37	24	52	2.3	62
February ..	4	6	1	<1	6	13	19	13	25	16	6	45	2.4	64
March ..	4	8	1	<1	5	15	25	6	23	16	5	46	2.7	71
April ..	5	2	1	1	4	34	35	6	6	11	5	56	3.2	77
May ..	5	>1	0	6	8	45	32	0	3	5	6	62	4.2	80
June ..	4	>1	1	8	20	40	21	1	3	5	5	75	7.6	81
July ..	4	<1	<1	4	20	32	23	5	1	14	9	80	8.8	81
August ..	3	0	1	6	17	30	30	4	1	11	6	82	8.7	81
September ..	3	3	1	9	17	22	19	3	3	23	10	81	7.9	80
October ..	2	14	4	6	5	9	10	6	15	31	18	72	4.7	76
November ..	2	19	3	0	<1	2	2	3	24	46	26	63	2.8	68
December ..	2	24	<1	1	1	2	2	3	19	47	30	55	1.9	62
Year ..	4	8	1	4	9	21	19	4	13	22	150	64	4.8	74

9 102

East coast of India

(52737)

TABLE II—MONTHLY FREQUENCY OF WIND DIRECTION AND FORCE AT SEA

Number of occasions per 100 on which particular winds may be expected  
 I = Beaufort force 1-3. II = force 4-7. III = force 8-12

20°-25° N., 85°-90° E.

Month	N.			NE.			E.			SE.			S.			SW.			W.			NW.			Calm	Total of			No. of obs.
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III					
January..	16	5	.1	19	6	.2	6	1	0	5	.1	0	6	1	0	10	2	0	6	1	0	5	.7	0	8	73	19	0.3	363
February	13	2	0	8	2	0	7	1	0	4	.7	0	14	1	0	15	6	0	7	.9	0	6	.2	0	10	75	15	0	281
March ..	1	0	0	1	.2	0	2	.8	0	4	2	0	17	13	0	29	16	0	8	1	0	2	.4	0	2	65	33	0	235
April ..	0	.4	0	.5	0	0	.8	.2	0	3	2	0	12	19	0	28	24	0	5	2	.2	.5	.9	.2	2	49	49	0.4	223
May ..	.5	0	0	.9	0	0	1	0	0	4	2	0	16	23	0	13	30	0	3	2	0	2	0	0	4	39	57	0	222
June ..	1	.2	0	2	1	.3	2	.6	.2	4	7	1	11	14	2	15	25	2	3	4	1	.4	1	.3	2	38	53	7	271
July ..	0	.2	0	.4	.2	0	.2	.4	0	1	2	0	10	12	0	12	39	.4	5	11	2	1	.2	.2	2	30	66	2	257
August ..	1	0	0	.2	0	0	2	.5	0	5	4	0	9	19	0	11	33	1	2	7	.7	.5	.3	.2	4	31	63	2	211
September	2	.2	0	2	.8	0	5	3	0	7	7	0	14	16	0	16	11	0	3	2	.4	3	.4	0	6	53	41	0.4	289
October..	9	2	.1	12	6	.6	5	4	0	6	3	.4	7	4	.7	9	4	.2	6	.5	0	8	2	.3	10	63	25	2	382
November	25	7	.2	16	8	.3	4	3	1	3	.6	.6	2	.3	0	3	.3	0	5	0	0	11	1	.1	8	69	21	2	356
December	31	14	0	21	11	0	4	0	0	2	0	0	2	.2	0	1	.2	0	2	0	0	3	.5	0	8	66	26	0	259

Authorities.—Bibliography Nos. 3, 119.

Table II—Wind direction and force at sea

6 103

TABLE II—continued

Number of occasions per 100 on which particular winds may be expected  
 I = Beaufort force 1-3. II = force 4-7. III = force 8-12

15°-20° N., 80°-85° E.

Month	N.			NE.			E.			SE.			S.			SW.			W.			NW.			Calm	Total of			No. of obs.
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III		I	II	III	
January..	4	1	0	20	13	0	23	7	0	9	.8	0	4	0	0	5	0	0	3	.1	0	2	.1	0	9	69	22	0	434
February	4	.6	0	13	4	0	22	5	0	17	1	0	9	1	0	8	1	0	3	.3	0	2	0	0	8	78	14	0	641
March ..	.5	0	0	1	1	0	6	.2	0	12	2	0	23	6	0	26	9	0	3	.5	0	2	0	0	5	74	21	0	525
April ..	.9	.3	0	2	.4	0	5	1	0	13	1	0	21	12	.3	20	19	0	3	.3	0	.5	.2	0	.9	65	34	0.3	434
May ..	.2	0	0	1	0	0	1	0	0	3	.8	0	14	23	0	23	21	0	6	2	0	1	.5	0	3	49	48	0	222
June ..	0	0	0	0	.6	0	0	.9	0	.3	2	0	5	10	0	8	51	0	2	13	0	.6	2	0	5	16	79	0	176
July ..	0	0	0	.6	.8	0	4	2	0	2	.4	0	4	4	1	19	37	3	4	14	2	.6	.6	0	2	34	57	7	231
August ..	.9	0	0	3	1	0	3	0	0	4	1	0	7	7	0	11	43	.3	1	13	1	0	.3	0	2	30	66	2	165
September	3	.7	0	6	.5	0	4	0	0	3	2	0	14	4	0	21	14	0	9	5	.4	5	2	0	6	66	28	0.4	222
October..	5	0	0	18	9	0	13	12	.6	7	2	0	3	2	0	8	2	0	6	.3	0	3	2	0	6	63	30	0.6	159
November	2	4	0	19	22	.7	13	8	1	7	4	0	3	.8	.5	1	.5	.2	2	2	1	2	4	0	2	49	45	4	205
December	.5	4	0	15	64	0	8	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	77	0	103

15°-20° N., 85°-90° E.

January..	13	6	0	29	19	0	10	4	.1	2	.5	0	3	.2	0	3	.3	0	2	0	0	2	.3	0	5	65	30	0.1	1690
February	11	2	0	15	7	0	8	2	0	6	1	0	9	2	0	15	3	0	6	.8	0	5	.2	0	7	74	19	0	1156
March ..	5	.9	0	5	1	0	3	.3	0	5	1	0	13	8	0	23	14	0	10	2	0	4	.5	0	4	69	27	0	945
April ..	1	.3	.2	1	0	.2	1	.2	.2	4	2	.2	14	12	0	25	24	0	8	3	0	1	.2	0	4	54	41	0.8	970
May ..	.7	.2	.1	.6	.2	.3	1	2	0	5	5	.3	11	18	0	18	24	.1	6	4	.1	1	.5	0	1	45	53	0.9	1028
June ..	0	.4	0	.8	.3	0	1	0	0	3	1	0	10	12	.2	11	38	3	2	10	2	.6	1	.1	1	30	64	5	1095
July ..	.5	0	0	.6	.2	0	1	.9	0	3	2	0	7	9	.1	10	47	1	2	11	1	.8	.4	.3	.5	25	71	3	1198
August ..	.4	.2	0	1	.3	0	2	.3	0	3	.8	.1	7	8	.2	9	43	4	2	13	2	.7	1	.1	1	25	67	7	1251
September	2	.3	0	2	.5	0	3	2	0	5	2	0	11	8	0	16	23	2	7	10	1	2	2	.3	3	47	47	3	1422
October..	8	3	0	13	7	0	10	6	0	6	3	0	7	4	0	8	3	0	7	4	0	5	1	0	6	63	31	0	1225
November	15	8	.1	23	25	0	7	6	.2	2	2	.2	1	.7	.1	1	.2	0	.8	.2	0	2	.4	0	3	52	44	0.6	1346
December	15	13	0	24	28	0	6	5	.3	1	.7	0	1	.1	0	1	0	0	.6	.1	0	.9	.2	0	2	51	47	0.3	1435

Authorities.—Bibliography Nos. 3, 119.

6 104

East coast of India

TABLE II—continued

Number of occasions per 100 on which particular winds may be expected.  
 I = Beaufort force 1-3. II = force 4-7. III = force 8-12

10°-15° N., 80°-85° E.

Month	N.			NE.			E.			SE.			S.			SW.			W.			NW.			Calm	Total of			No. of obs.
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III		I	II	III	
January..	5	3	0	26	31	0	16	11	0	3	5	0	2	3	0	7	4	0	0	0	0	3	0	0	1	53	46	0	756
February	4	1	0	27	18	0	20	7	0	9	2	0	6	1	0	1	2	0	5	0	0	1	0	0	3	68	29	0	1004
March ..	2	5	0	16	5	0	21	5	1	16	3	0	18	4	0	4	7	0	5	0	0	1	0	0	3	78	19	0	1056
April ..	1	9	2	6	2	3	13	3	6	21	5	1	21	8	0	8	3	0	7	1	0	5	8	1	3	72	24	1	1095
May ..	0	5	1	1	0	0	7	1	0	10	2	0	17	15	0	13	21	5	3	3	8	5	4	2	3	52	43	2	650
June ..	0	4	0	3	0	0	2	0	0	4	1	0	10	13	1	10	37	2	4	12	7	7	1	2	9	31	65	3	577
July ..	8	2	0	8	8	0	2	2	0	2	1	0	7	10	2	13	37	2	6	13	1	7	1	0	1	32	64	3	520
August ..	1	0	0	0	0	0	2	2	0	3	4	0	11	9	1	16	35	1	7	11	1	7	2	0	1	38	58	3	427
September	6	4	0	4	0	0	2	0	0	2	2	0	10	7	0	17	29	1	10	12	1	3	3	0	2	45	53	0.2	607
October..	8	2	0	7	3	0	9	3	1	9	3	0	9	4	0	9	8	3	8	6	2	5	1	0	6	63	30	0.6	744
November	3	8	9	11	21	6	11	13	1	6	5	0	2	2	3	1	2	2	2	2	4	3	1	8	3	40	54	3	804
December	7	15	4	15	37	1	9	12	0	2	1	0	3	0	0	0	0	0	0	0	0	2	5	1	8	33	66	0.6	481

10°-15° N., 85°-90° E.

January..	5	10	1	21	44	2	6	10	5	1	5	1	2	2	0	4	0	0	2	2	0	4	2	0	7	34	65	0.9	1475
February	9	5	0	25	33	0	8	7	0	2	9	0	2	1	0	9	0	0	4	0	0	2	0	0	4	49	47	0	692
March ..	11	2	0	25	8	0	16	3	0	8	3	2	9	5	6	5	9	1	3	4	0	2	0	0	6	77	16	0.9	621
April ..	6	4	0	11	2	0	10	1	0	12	4	1	11	3	3	11	4	1	5	4	1	3	1	0	10	70	19	0.6	729
May ..	1	4	1	2	7	0	3	1	1	7	3	1	9	10	0	15	26	4	7	5	0	2	1	1	3	48	48	0.8	823
June ..	0	3	0	0	1	2	6	0	0	3	3	1	7	9	3	9	48	2	3	13	2	8	1	6	3	23	72	5	635
July ..	1	2	0	0	1	0	6	6	0	2	3	0	7	10	0	9	51	8	2	13	6	0	1	2	1	21	77	2	788
August ..	2	2	1	2	0	0	5	0	0	3	0	0	4	9	1	11	55	1	2	13	6	6	1	1	5	19	79	2	1014
September	8	0	0	1	0	0	7	5	0	1	4	0	4	8	0	10	43	1	5	20	1	2	1	0	7	24	73	2	1274
October..	4	1	0	5	3	0	7	4	1	5	2	0	7	5	2	13	11	4	9	10	1	6	2	0	4	57	38	0.8	1152
November	8	7	0	16	23	3	8	14	3	4	2	0	2	1	6	2	1	3	2	1	1	2	8	1	3	44	51	2	1009
December	6	9	0	15	37	4	7	15	4	2	3	2	5	6	0	4	6	0	2	1	1	5	1	0	7	32	66	1	1295

Authorities.—Bibliography Nos. 3, 119.

Table II—Wind direction and force at sea

6 105

TABLE II—continued

Number of occasions per 100 on which particular winds may be expected  
 I = Beaufort force 1-3. II = force 4-7. III = force 8-12

5°-10° N., 80°-85° E.

Month	N.			NE.			E.			SE.			S.			SW.			W.			NW.			Calm	Total of			No. of obs.
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III		I	II	III	
January..	9	14	0	18	32	.1	6	6	0	2	.9	0	2	.3	0	2	.2	0	1	.2	0	3	1	.2	2	43	55	0.3	1031
February	8	8	0	19	34	0	7	8	.1	3	.3	0	2	0	0	2	.2	0	2	.3	0	2	.5	0	3	46	51	0.1	1096
March ..	7	2	0	25	13	0	15	5	0	8	.8	0	8	1	0	5	.8	0	3	.4	0	2	.3	0	4	73	23	0	1246
April ..	4	.3	.1	10	1	0	13	2	0	11	2	0	11	2	0	12	6	0	7	5	0	3	.7	0	8	72	20	0.1	1223
May ..	.5	.1	0	3	.6	0	6	.6	0	7	.3	0	12	6	.1	11	29	.2	5	14	.1	2	1	0	4	45	51	0.4	1102
June ..	.1	.3	.1	.6	0	0	.2	0	0	2	.5	0	6	6	0	9	39	.3	7	24	.3	1	3	0	2	25	72	0.7	950
July ..	.5	.1	0	.3	0	0	1	.1	0	3	.5	0	6	4	0	10	39	.6	7	21	.9	2	3	0	1	30	68	1	893
August ..	.5	.1	0	.4	.1	0	1	.3	0	3	.8	0	7	7	0	10	34	.1	9	20	.4	2	3	.1	1	33	65	0.6	1007
September	.9	.1	0	.6	.1	0	2	.2	0	3	.2	0	7	6	0	11	34	.4	7	21	.3	2	1	0	4	33	62	0.7	931
October..	3	.8	0	5	.9	0	6	1	0	5	.6	0	6	3	0	10	15	0	12	17	.1	6	3	0	5	53	42	0.1	1135
November	9	3	0	11	6	0	12	7	0	9	3	0	4	1	0	6	2	0	6	4	.2	7	2	.2	7	63	29	0.4	1178
December	10	10	0	16	15	0	9	7	0	5	2	0	3	1	0	4	1	0	4	.6	0	4	3	.2	4	55	41	0.2	1042

5°-10° N., 85°-90° E.

January ..	7	10	0	16	36	0	7	14	.1	1	1	0	1	.2	0	.4	.5	0	1	1	.1	1	.8	.2	1	35	63	0.4	1606
February	12	10	0	19	34	0	5	10	0	1	1	0	1	.4	0	.6	.2	0	1	.4	0	2	.5	0	2	42	56	0	1163
March ..	14	2	0	26	13	0	15	9	0	5	.8	0	3	.1	0	1	.5	0	.5	1	.4	1	.6	.2	5	67	28	0.6	1082
April ..	6	.7	0	12	1	.1	11	2	.2	12	2	.3	12	3	.2	11	5	.2	6	4	.1	3	.6	0	8	72	19	1	999
May ..	.9	.2	0	.7	.3	0	.8	1	.4	3	.8	.1	7	7	0	15	31	.7	11	13	.5	2	.5	.1	3	40	55	2	824
June ..	.1	.1	0	.2	.2	0	.2	0	.2	.2	.2	.2	3	11	.3	7	51	2	2	21	.2	.4	.8	0	0	13	84	3	489
July ..	0	.3	0	0	0	0	.2	.1	0	.3	.1	0	4	10	0	10	53	.8	4	15	.4	1	.5	.2	0	20	79	1	617
August ..	.2	0	0	0	0	0	0	0	0	.1	.2	0	3	8	0	7	61	.1	.6	19	.1	.2	1	0	.2	11	89	0.2	583
September	.1	.4	0	.1	0	0	.3	0	0	.5	.1	0	6	8	0	9	51	.3	3	19	.2	.7	1	0	.6	20	79	0.5	1118
October..	3	.2	0	4	.2	0	6	1	0	3	.5	0	7	4	0	11	23	.1	11	16	.2	4	2	0	5	49	46	0.3	1274
November	7	2	0	14	7	.1	9	6	0	5	2	0	4	2	0	6	8	.2	6	9	.6	5	1	.1	5	56	38	1	1144
December	7	8	.1	11	22	.2	8	15	.2	3	4	.1	3	1	0	3	2	0	3	2	.2	3	1	0	2	40	57	0.8	1249

Authorities.—Bibliography Nos. 3, 119.

6 106

East coast of India

TABLE II—continued

Number of occasions per 100 on which particular winds may be expected  
 I = Beaufort force 1-3. II = force 4-7. III = force 8-12

0°-5° N., 80°-85° E.

Month	N.			NE.			E.			SE.			S.			SW.			W.			NW.			Calm	Total of			No. of obs.
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III		I	II	III	
January..	15	11	0	15	18	0	7	3	0	4	.7	0	3	.3	0	2	.5	0	2	1	0	5	2	0	8	55	37	0	1117
February	17	8	0	22	18	0	9	4	0	3	.7	0	1	.3	0	.7	.1	0	2	1	0	5	1	0	6	60	34	0	758
March ..	12	3	0	16	7	0	8	2	0	5	1	0	4	.4	.1	5	3	0	8	5	.3	9	4	.1	8	67	25	0.4	874
April ..	6	.6	0	6	.9	0	3	.2	0	3	.3	0	7	1	0	9	12	0	17	15	0	10	3	0	6	60	34	0	782
May ..	.8	.3	0	2	0	0	2	0	0	2	0	0	13	4	0	19	23	0	9	16	.2	3	2	0	3	51	46	0.2	726
June ..	0	0	0	.2	0	0	1	.2	0	1	.6	0	9	9	0	16	26	.2	7	22	.7	.9	5	.2	1	35	63	1	963
July ..	0	.2	.1	0	0	0	0	0	0	.6	0	0	10	4	.1	17	25	.3	9	27	.2	1	6	.5	.4	37	62	1	705
August ..	0	.1	0	0	0	0	.1	0	0	1	.2	0	10	6	0	10	27	.5	7	33	.6	.5	3	.1	.7	28	70	1	861
September	.1	.2	0	0	0	0	.2	.2	0	3	3	0	6	5	0	10	27	.3	6	35	.6	.5	4	0	.8	25	73	0.9	664
October..	.2	0	0	.6	.1	0	.8	.2	0	3	1	0	3	2	0	10	22	.1	11	33	1	3	6	0	3	32	64	1	548
November	7	1	0	4	3	0	3	2	0	5	3	0	6	1	0	11	9	.2	13	15	.2	7	5	0	4	57	38	0.4	889
December	15	6	0	16	7	0	7	2	0	5	.8	0	4	.4	0	4	2	.1	6	6	.1	8	4	.5	5	65	29	0.7	1176

0°-5° N., 85°-90° E.

January..	17	9	0	15	13	0	9	3	.1	4	1	0	4	.5	0	4	.9	0	4	3	0	6	3	.1	5	62	33	0.2	1544
February	19	10	0	15	12	0	6	3	.1	3	1	0	2	.3	0	2	.9	0	6	3	0	8	3	.1	7	60	33	0.2	1161
March ..	14	2	.1	13	2	0	9	2	0	8	1	0	6	1	0	6	2	0	10	3	.1	10	2	0	7	76	17	0.2	1316
April ..	6	.8	0	6	1	0	7	.8	0	7	.9	0	9	2	0	10	6	0	12	11	.1	9	4	0	8	66	26	0.1	916
May ..	1	.6	0	2	.4	0	2	.2	0	4	.4	0	10	2	0	16	20	1	13	16	1	3	2	.7	3	51	43	3	540
June ..	.2	0	0	.2	0	0	.4	0	0	2	1	0	9	7	0	15	34	.7	5	22	.5	1	.9	0	.6	33	65	1	480
July ..	0	0	0	0	0	0	.2	0	0	1	.5	0	10	11	0	9	37	1	2	23	1	.7	.3	0	3	23	72	2	406
August ..	0	0	0	0	0	0	.5	.6	0	3	4	0	15	15	0	9	25	0	1	23	.1	.2	.8	.1	2	29	69	0.2	440
September	.2	.2	0	.2	0	0	.2	.2	0	2	2	0	10	8	0	13	30	.2	7	23	.9	1	2	0	1	33	65	1	863
October..	.6	.2	0	.9	.1	0	1	.1	0	2	2	0	10	6	0	9	20	.5	9	24	1	4	6	.1	2	37	59	2	897
November	6	1	0	5	1	0	4	.7	0	5	1	0	5	2	0	9	15	.4	10	17	.7	8	6	0	2	52	45	1	904
December	7	6	.2	6	4	0	7	2	0	4	.9	0	3	1	0	8	8	.1	13	12	.4	8	7	.2	3	55	41	0.9	984

Authorities.—Bibliography Nos. 3, 119.

Table II—Wind direction and force at sea

6 107

TABLE III—MONTHLY FREQUENCY OF WIND DIRECTION AT COASTAL STATIONS

Number of occasions per 100 on which particular winds may be expected

Period : 1933-7

Month	NELLORE*										MASULIPATAM*																
	0800 (local time)					1700 (Z-5½)					0800 (local time)																
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	C.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	C.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	C.
January ..	5	6	8	1	15	2	4	49	10	0	25	69	6	0	0	0	0	0	47	29	3	3	0	1	0	2	15
February ..	.7	0	3	25	39	6	4	10	12	0	1	80	19	0	0	0	0	0	26	6	3	9	15	3	2	.7	35
March ..	1	2	5	36	41	5	1	6	3	0	0	76	23	.6	0	0	0	0	10	9	7	7	28	1	.6	3	34
April ..	3	2	3	19	57	2	6	4	4	.7	.7	64	31	2	0	.7	1	0	4	2	3	5	62	9	3	1	11
May ..	.6	1	0	10	38	10	30	7	3	0	1	48	32	2	2	11	3	.6	2	.6	1	6	50	15	17	4	4
June ..	0	.7	0	.7	2	14	74	8	1	1	.7	19	18	4	10	42	5	.7	2	0	0	.7	5	6	65	11	10
July ..	0	0	0	0	3	17	75	4	.6	.6	0	8	3	2	22	58	6	.6	0	0	0	0	5	8	77	7	3
August ..	0	0	.6	3	5	8	75	6	2	1	2	17	4	3	5	58	10	0	0	0	.6	.6	9	11	58	14	7
September ..	.7	2	.7	7	8	5	66	10	.7	1	3	34	6	2	4	40	9	.7	5	.7	3	1	6	11	50	14	9
October ..	10	7	5	8	9	3	18	30	10	5	21	52	9	1	0	3	5	4	17	21	8	.6	5	4	13	11	20
November ..	19	8	3	2	.7	2	10	50	5	9	44	39	4	0	0	.7	.7	3	56	30	6	2	0	0	.7	4	1
December ..	7	10	1	3	1	0	5	65	8	.6	38	57	3	0	0	0	1	0	61	30	3	.6	0	0	0	2	3
Year ..	4	3	3	9	18	6	31	21	5	2	11	47	13	1	4	18	3	.8	19	11	3	3	15	6	24	6	13

East coast of India

Authority.—Bibliography No. 114. \* Nellore : 14° 27' N., 79° 59' E., 66 ft. Masulipatam : 16° 11' N., 81° 08' E., 10 ft.

TABLE IV—MONTHLY FREQUENCY OF WINDS OF DIFFERENT FORCES AT COASTAL STATIONS

Number of occasions per 100 on which particular wind forces may be expected.

C = Calm. I = Beaufort force 1-3. II = force 4-7. III = force 8-12

0800 (local time).

Period: 1933-7

Month	PAMBAN				NEGAPATAM				MADRAS				COCANADA				VIZAGAPATAM				PURÍ				SÁGAR IS.				CALCUTTA			
	C	I	II	III	C	I	II	III	C	I	II	III	C	I	II	III	C	I	II	III	C	I	II	III	C	I	II	III	C	I	II	III
January ..	.6	66	33	0	6	61	33	0	0	74	26	0	35	60	5	0	28	72	0	0	3	88	9	0	3	89	8	0	42	58	0	0
February ..	10	86	4	0	9	86	5	0	0	94	6	0	57	40	3	0	45	55	0	0	4	71	25	0	5	89	6	0	45	55	0	0
March ..	14	86	0	0	18	76	6	0	0	95	5	0	57	42	.6	0	25	75	0	0	5	61	34	0	.6	69	30	0	19	81	0	0
April ..	4	80	16	0	8	90	2	0	0	72	28	0	40	59	1	0	11	88	.7	0	3	40	57	0	.7	39	60	0	7	92	.7	0
May ..	3	46	51	0	.6	97	2	0	0	61	39	0	26	73	1	0	7	83	10	0	2	30	68	0	0	23	77	0	3	92	5	0
June ..	.7	45	54	0	.7	99	.7	0	0	45	55	0	15	74	11	0	7	87	6	0	7	35	57	.7	1	42	57	0	8	89	3	0
July ..	3	70	27	0	0	100	0	0	0	63	37	0	8	83	9	0	6	87	7	0	8	47	45	0	2	49	49	0	7	92	.6	0
August ..	5	78	17	0	1	99	0	0	0	80	20	0	26	69	5	0	13	82	5	0	11	48	39	2	4	46	49	.6	9	90	1	0
September ..	1	75	24	0	2	97	.7	0	.7	72	27	0	27	70	3	0	17	80	3	0	11	61	27	.7	4	71	25	0	13	86	1	0
October ..	6	69	25	0	12	84	4	0	0	85	14	.6	30	62	7	.6	22	75	3	0	8	81	10	1	2	88	10	0	25	75	0	0
November ..	.7	56	43	0	4	87	8	.7	0	68	31	.7	27	65	8	0	12	85	3	0	.7	96	3	0	.7	92	7	0	38	62	0	0
December ..	0	44	56	0	0	83	17	0	.6	63	36	.6	23	71	6	0	10	88	2	0	0	97	3	0	1	93	6	0	45	55	0	0

1700 (Z-5½)\*

January ..	Data not available	0	32	68	0	0	46	54	0	.6	87	12	0	0	99	.6	0	1	61	38	0	2	96	2	0	37	63	0	0
February ..		0	60	40	0	0	67	33	0	.7	83	16	0	0	99	.7	0	.7	42	57	0	1	86	13	0	16	84	0	0
March ..		0	58	42	0	0	54	46	0	.6	75	24	0	0	98	.6	1	.6	22	77	0	1	61	38	0	16	83	1	0
April ..		0	50	50	0	0	38	62	0	3	64	33	0	.7	96	3	0	0	16	84	0	0	30	70	0	11	87	2	0
May ..		0	46	54	0	0	36	64	0	3	64	33	0	0	95	5	0	.6	15	84	0	0	22	77	.6	5	90	5	0
June ..		0	61	39	0	0	31	69	0	11	75	14	0	1	90	9	0	4	27	68	.7	0	32	68	0	5	94	1	0
July ..		0	75	25	0	0	55	45	0	12	80	8	0	3	85	12	0	5	34	61	0	0	40	60	0	14	85	.6	0
August ..		.6	70	29	0	0	57	43	0	17	76	7	0	5	82	13	0	5	32	62	.6	0	42	58	0	12	88	0	0
September ..		0	77	23	0	0	59	41	0	26	69	5	0	7	89	4	0	5	45	50	0	1	70	28	.7	23	76	.7	0
October ..		4	79	17	0	0	64	36	0	8	78	13	.6	4	93	3	0	5	78	17	0	5	84	11	0	31	68	.6	0
November ..		1	55	44	0	0	42	58	0	14	73	13	0	0	98	2	0	3	84	13	0	2	95	3	0	46	54	0	0
December ..		0	32	68	0	0	38	61	.6	4	86	10	0	0	97	3	0	1	79	20	0	.7	99	0	0	47	53	0	0

Authority.—Bibliography No. 116.

\* Indian standard time, Z-5½, differs from local time by less than half an hour.

Table IV—Wind force at coastal stations

6 109

TABLE V—MONTHLY FREQUENCY OF WIND DIRECTION AND SPEED IN THE UPPER AIR AND OF CLOUD MOTION

Number of occasions per 100 on which particular winds may be expected  
 I = 3-13 knots (4-15 m.p.h.)    II = 14-27 knots (16-31 m.p.h.)    III = 28-40 knots (32-47 m.p.h.)    IV = over 40 knots (over 47 m.p.h.)    C = less than 3 knots (less than 4 m.p.h.)

Madras. 13° 04' N., 80° 15' E., 43 ft.

Time of obs. : about sunrise.

Period\* : April 1926—December 1937.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>JANUARY</b>																																		
Surface ..	7	0	0	0	9	0	0	0	2	0	0	0	3	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	7	0	0	0	74	314
1,700 ..	6	2	0	0	33	29	0	0	18	2	0	0	10	0	0	0	4	3	0	0	6	0	0	0	0	0	0	0	0	0	0	0	1	310
3,300 ..	7	0	0	0	22	28	7	0	26	11	0	0	8	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	2	301
6,500 ..	8	1	0	0	16	15	4	0	19	23	0	0	5	2	0	0	2	0	0	0	4	0	0	0	1	0	0	0	3	0	4	0	3	263
10,000 ..	8	1	0	0	16	5	0	0	20	13	5	0	10	1	0	0	7	5	0	0	3	0	0	0	4	0	0	0	5	5	0	0	5	220
Low cloud ..		5				54				31				7				2				1				1				0			0	567
Medium cloud ..		3				9				15				28				16				17				9				1			0	67
High cloud ..		0				0				2				13				26				37				16				3			2	158
<b>FEBRUARY</b>																																		
Surface ..	2	0	0	0	1	0	0	0	3	0	0	0	1	0	0	0	3	0	0	0	2	0	0	0	1	0	0	0	3	0	0	0	87	300
1,700 ..	3	3	0	0	11	1	0	0	29	7	0	0	30	0	0	0	15	5	0	0	3	3	0	0	7	0	0	0	0	0	0	0	1	298
3,300 ..	2	0	0	0	9	6	0	0	33	11	0	0	20	1	0	0	9	2	0	0	4	7	0	0	1	0	0	0	7	0	0	0	1	295
6,500 ..	4	7	0	0	19	21	0	0	14	9	7	0	7	2	0	0	2	0	0	0	2	0	0	0	3	0	0	0	7	4	0	0	2	268
10,000 ..	12	6	0	0	15	11	4	0	11	6	4	0	4	9	0	0	3	4	0	0	3	0	0	0	8	2	0	0	12	9	0	0	4	235
Low cloud ..		2				21				40				22				8				4				1				1			0	340
Medium cloud ..		1				3				10				7				10				42				20				6			2	46
High cloud ..		0				0				1				6				22				39				22				4			6	102
<b>MARCH</b>																																		
Surface ..	6	0	0	0	0	0	0	0	3	0	0	0	9	0	0	0	1	0	0	0	4	0	0	0	3	0	0	0	2	0	0	0	91	324
1,700 ..	6	0	0	0	3	6	0	0	19	3	0	0	26	0	0	0	35	9	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	322
3,300 ..	6	0	0	0	5	2	0	0	24	9	0	0	28	2	0	0	21	2	0	0	3	1	0	0	0	3	0	0	0	0	0	0	6	320
6,500 ..	7	3	0	0	16	21	2	0	20	17	1	0	9	7	0	0	2	0	0	0	3	3	0	0	7	0	0	0	7	3	0	0	7	304
10,000 ..	11	11	0	0	14	18	1	0	19	11	4	0	4	1	0	0	1	4	0	0	4	0	0	0	7	0	0	0	4	1	0	0	1	284
Low cloud ..		1				7				18				22				35				16				1				1			0	235
Medium cloud ..		6				0				11				33				14				21				9				7			0	29
High cloud ..		0				0				5				14				25				35				13				3			6	173

Note.—The approximate height of the clouds is as follows : Low cloud, 6,500 ft. ; Medium cloud, 16,000 ft. ; High cloud, 33,000 ft.  
 No information of the rate of motion of clouds is available.

\* Period for cloud motion : 1926-35.

6 110

East coast of India

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected

I = 3-13 knots  
(4-15 m.p.h.)

II = 14-27 knots.  
(16-31 m.p.h.)

III = 28-40 knots  
(32-47 m.p.h.)

IV = over 40 knots  
(over 47 m.p.h.)

C = less than 3 knots  
(less than 4 m.p.h.)

Madras—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>APRIL</b>																																		
Surface ..	0	0	0	0	0	0	0	0	.3	0	0	0	3	0	0	0	14	0	0	0	8	.3	0	0	.3	0	0	0	1	0	0	0	73	334
1,700 ..	.6	0	0	0	.6	0	0	0	3	.6	0	0	9	0	0	0	30	22	0	0	9	19	2	0	1	2	.6	0	.3	.6	0	0	1	334
3,300 ..	1	.3	0	0	1	0	0	0	5	.3	.3	0	17	.3	0	0	34	10	0	0	13	8	.3	0	3	1	0	0	2	.3	0	0	3	332
6,500 ..	8	1	0	0	18	9	.3	0	22	11	.6	0	13	4	0	0	2	.3	0	0	2	0	0	0	3	0	0	0	3	0	0	0	3	320
10,000 ..	10	11	.7	0	16	29	2	0	11	7	2	0	3	.7	0	0	1	0	0	0	.7	0	0	0	2	0	0	0	2	.3	0	0	2	292
Low cloud ..		2				6				9				20				37				23				2				2			1	265
Medium cloud		12				14				7				7				8				20				11				9			0	81
High cloud ..		0				2				2				9				22				38				17				5			5	233
<b>MAY</b>																																		
Surface ..	.3	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	13	0	0	0	22	0	0	0	5	0	0	0	.6	0	0	0	57	345
1,700 ..	.9	0	0	0	.3	0	0	0	2	0	0	0	3	0	0	0	9	14	1	0	4	28	.9	0	3	19	8	0	1	3	1	0	.3	344
3,300 ..	.6	.6	0	0	.3	0	0	0	3	0	0	0	7	.6	0	0	16	5	0	0	15	14	.6	0	8	10	1	0	3	14	.6	0	.3	343
6,500 ..	12	2	0	0	19	6	0	0	15	3	.3	0	5	.6	0	0	4	0	0	0	4	.3	0	0	6	2	.6	0	13	4	0	0	4	336
10,000 ..	9	7	0	0	17	37	2	0	8	6	.6	0	2	0	0	0	3	0	0	0	1	0	0	0	.3	2	0	0	4	1	0	0	.3	316
Low cloud ..		5				9				9				9				28				23				6				10			0	154
Medium cloud		12				24				19				5				9				14				10				5			2	142
High cloud ..		4				7				22				19				11				11				7				6			10	289
<b>JUNE</b>																																		
Surface ..	0	0	0	0	0	0	0	0	0	0	0	0	.3	0	0	0	3	0	0	0	26	0	0	0	17	0	0	0	1	0	0	0	52	341
1,700 ..	.3	0	0	0	0	0	0	0	0	.3	0	0	0	0	0	0	0	.3	0	0	1	9	.3	0	3	52	27	.3	.6	5	.6	0	0	340
3,300 ..	.3	.3	0	0	0	0	0	0	0	.3	0	0	0	0	0	0	.6	0	0	0	2	4	0	0	4	34	23	2	3	20	6	.6	0	337
6,500 ..	6	.6	0	0	2	0	0	0	.3	0	0	0	1	0	0	0	2	0	0	0	6	2	0	.3	23	28	5	2	10	9	2	0	2	334
10,000 ..	3	1	0	0	7	3	0	0	4	0	0	0	3	0	0	0	1	0	0	0	5	3	0	0	21	31	3	.7	7	2	.3	0	3	294
Low cloud ..		3				2				2				2				1				1				12				57			22	212
Medium cloud		7				13				9				2				5				12				35				16			2	198
High cloud ..		2				17				62				7				2				2				3				3			3	235

Note.—The approximate height of the clouds is as follows : Low cloud, 6,500 ft. ; Medium cloud, 16,000 ft. ; High cloud, 33,000 ft.  
No information of the rate of motion of clouds is available.

Table V—Wind direction and speed in the upper air 6 111

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected

I = 3-13 knots  
(4-15 m.p.h.)

II = 14-27 knots  
(16-31 m.p.h.)

III = 28-40 knots  
(32-47 m.p.h.)

IV = over 40 knots  
(over 47 m.p.h.)

C = less than 3 knots  
(less than 4 m.p.h.)

Madras—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>JULY</b>																																		
Surface ..	-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	22	0	0	0	13	-3	0	0	2	0	0	0	60	355
1,700 ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	9	-3	0	3	52	24	1	-6	9	-9	0	0	353
3,300 ..	0	0	0	0	0	0	0	0	0	0	0	0	-6	0	0	0	-3	0	0	0	-9	1	-3	0	5	29	32	1	-4	22	5	0	0	353
6,500 ..	2	-3	0	0	-9	0	0	0	0	0	0	0	-3	0	0	0	1	0	0	0	2	2	0	0	17	23	17	3	7	15	7	2	1	344
10,000 ..	0	0	0	0	-8	0	0	0	-4	0	0	0	-8	0	0	0	2	0	0	0	7	2	0	0	12	47	9	0	8	7	2	8	2	261
Low cloud ..		1				1				1				1				1				5				71				19			0	382
Medium cloud		1				6				8				2				2				10				52				12			4	218
High cloud ..		0				16				76				4				0				1				3				0			0	236
<b>AUGUST</b>																																		
Surface ..	0	0	0	0	0	0	0	0	0	0	0	0	-3	0	0	0	1	0	0	0	18	0	0	0	10	0	0	0	1	0	0	0	69	358
1,700 ..	-3	0	0	0	-6	0	0	0	-3	0	0	0	-6	0	0	0	3	1	0	0	3	8	0	0	4	55	13	0	2	8	0	0	0	355
3,300 ..	-3	0	0	0	0	0	0	0	-6	0	0	0	2	0	0	0	5	-6	0	0	4	1	0	0	6	24	18	1	7	28	3	0	0	353
6,500 ..	3	-3	0	0	2	0	0	0	2	0	0	0	2	0	0	0	1	0	0	0	2	-9	0	0	19	20	9	3	13	16	3	-3	3	336
10,000 ..	3	-4	0	0	1	1	0	0	2	-7	0	0	3	-4	0	0	1	0	0	0	3	1	0	0	22	35	4	-4	12	7	1	0	1	275
Low cloud ..		1				2				3				2				9				15				50				19			0	287
Medium cloud		3				15				18				4				5				9				29				16			0	203
High cloud ..		0				10				73				7				1				1				2				2			0	275
<b>SEPTEMBER</b>																																		
Surface ..	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	16	0	0	0	7	0	0	0	4	0	0	0	70	340
1,700 ..	-9	-3	0	0	0	-3	0	0	-3	0	0	0	3	0	0	0	6	1	0	0	8	12	0	0	4	38	7	0	4	14	-6	0	1	338
3,300 ..	2	0	0	0	1	-3	0	0	1	0	0	0	5	0	0	0	4	0	0	0	10	5	-3	0	11	16	9	0	11	22	-9	0	1	337
6,500 ..	10	1	0	0	4	-3	0	0	3	-3	0	0	2	0	0	0	-3	0	0	0	5	2	0	0	18	16	4	0	23	7	2	0	4	327
10,000 ..	9	2	0	0	5	-4	0	0	5	1	0	0	3	-4	0	0	1	0	0	0	7	2	0	0	16	24	2	0	11	5	0	0	5	274
Low cloud ..		9				3				5				7				3				18				32				22			0	296
Medium cloud		6				8				18				11				4				9				24				17			3	138
High cloud ..		1				9				73				14				0				0				1				1			1	291

Note.—The approximate height of the clouds is as follows:—Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft.  
No information of the rate of motion of clouds is available.

6 112

East coast of India

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected

I = 3-13 knots  
(4-15 m.p.h.)

II = 14-27 knots  
(16-31 m.p.h.)

III = 28-40 knots  
(32-47 m.p.h.)

IV = over 40 knots  
(over 47 m.p.h.)

C = less than 3 knots  
(less than 4 m.p.h.)

Madras—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>OCTOBER</b>																																		
Surface ..	2	0	0	0	2	0	0	0	.3	0	0	0	.3	0	0	0	2	0	0	0	4	0	0	0	1	0	0	0	5	0	0	0	82	335
1,700 ..	4	.9	.3	0	18	6	0	.3	9	.9	0	.3	5	.3	0	0	9	2	0	0	11	6	.3	0	8	7	1	0	6	.9	0	0	3	327
3,300 ..	7	2	.3	0	16	7	0	0	11	4	0	0	7	.3	0	0	5	1	0	0	7	3	0	0	6	5	1	0	9	3	0	0	5	316
6,500 ..	13	4	1	0	17	10	0	0	11	6	0	0	4	.3	0	0	1	0	0	0	5	2	.7	0	5	4	0	0	9	4	0	0	2	297
10,000 ..	9	6	0	0	13	3	0	0	13	9	0	0	4	2	0	0	1	1	0	0	4	2	.4	0	8	6	2	0	8	5	0	0	5	265
Low cloud ..		11				28				24				6				4				7				10				10			0	465
Medium cloud		3				12				35				15				3				11				10				11			2	121
High cloud ..		1				7				50				31				4				3				1				1			2	240
<b>NOVEMBER</b>																																		
Surface ..	11	0	0	0	10	.3	0	0	.3	0	0	0	.3	0	0	0	0	0	0	0	.6	0	0	0	.9	0	0	0	11	.3	0	0	65	333
1,700 ..	4	9	3	0	27	33	.6	0	8	2	0	0	4	0	0	0	3	.6	0	0	2	.9	0	0	.6	0	0	0	1	0	.6	0	.9	322
3,300 ..	6	6	1	.3	18	37	2	0	11	5	.7	0	4	2	0	0	4	.3	0	0	.3	0	0	0	.3	.3	0	0	2	.3	0	0	.7	299
6,500 ..	6	2	.4	0	17	13	.9	0	20	13	.4	0	6	2	0	0	2	.4	0	0	3	0	0	0	1	.9	0	0	7	2	0	0	2	231
10,000 ..	4	2	0	0	22	9	0	0	17	13	.5	0	9	2	0	0	5	0	0	0	3	1	0	0	3	0	0	0	4	1	0	0	5	185
Low cloud ..		12				56				18				5				3				2				2				2			0	624
Medium cloud		9				19				31				15				4				10				4				5			4	87
High cloud ..		2				3				14				32				24				16				4				1			5	223
<b>DECEMBER</b>																																		
Surface ..	12	0	0	0	13	.3	0	0	.6	0	0	0	.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	64	345
1,700 ..	2	7	.3	0	33	38	.9	0	12	3	0	0	2	.3	0	0	0	.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.6	339
3,300 ..	3	1	.3	0	27	40	.6	0	16	7	0	0	3	.6	0	0	.6	0	0	0	0	0	0	0	0	0	0	0	.3	.3	0	0	.3	323
6,500 ..	6	.7	0	0	16	16	.4	0	18	17	.7	0	9	2	0	0	3	.4	0	0	.4	0	0	0	3	.7	.4	0	3	1	0	0	3	267
10,000 ..	9	1	0	0	16	7	0	0	17	12	.4	0	11	2	.4	0	4	.4	0	0	5	0	0	0	4	.9	0	0	5	.4	0	0	4	226
Low cloud ..		7				65				25				3				0				0				0				0			0	594
Medium cloud		14				7				26				12				13				20				3				4			3	70
High cloud ..		0				0				3				16				28				33				15				1			5	195

Authorities.—Bibliography Nos. 72, 115, 116.

Note.—The approximate height of the clouds is as follows: Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft.  
No information of the rate of motion of clouds is available.

Table V—Wind direction and speed in the upper air 6 113

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected  
 I = 3-13 knots (4-15 m.p.h.)    II = 14-27 knots (16-31 m.p.h.)    III = 28-40 knots (32-47 m.p.h.)    IV = over 40 knots (over 47 m.p.h.)    C = less than 3 knots (less than 4 m.p.h.)  
**Vizagapatam (Waltair)** 17° 42' N., 83° 18' E., 184 ft.    Time of obsn : Morning.    Period\* : Sept. 1928-Dec. 1937

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.				
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV						
<b>JANUARY</b>																																						
Surface ..	8	0	0	0	6	0	0	0	8	0	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	11	0	0	0	71	265
1,800 ..	3	0	0	0	21	5	0	0	29	3	0	0	3	0	0	0	6	0	0	0	16	0	0	0	5	0	0	0	5	0	0	0	-8	0	0	0	9	263
3,300 ..	8	-4	0	0	32	5	0	0	20	3	0	0	4	0	0	0	5	-4	0	0	8	0	0	0	4	0	0	0	3	0	0	0	7	260				
6,500 ..	20	8	0	0	20	3	0	0	11	4	0	0	8	0	0	0	2	-4	0	0	7	0	0	0	6	1	0	0	4	2	0	0	4	249				
10,000 ..	15	7	0	0	11	1	-9	0	6	-9	0	0	2	0	0	0	4	0	0	0	8	2	0	0	13	8	0	0	11	8	0	0	-5	213				
Low cloud ..		8				13				22				5				10				20				15				8			0	89				
Medium cloud ..		0				0				5				17				4				30				40				3			0	36				
High cloud ..		0				0				0				0				4				39				55				3			0	85				
<b>FEBRUARY</b>																																						
Surface ..	-4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	-4	0	0	0	-4	0	0	0	6	0	0	0	4	0	0	0	85	237				
1,800 ..	3	0	0	0	13	2	0	0	8	-4	0	0	7	0	0	0	10	-4	0	0	38	3	0	0	5	3	0	0	1	0	0	0	8	230				
3,300 ..	4	0	0	0	11	1	0	0	11	-9	0	0	8	0	0	0	13	-9	0	0	25	1	0	0	11	-9	0	0	6	0	0	0	5	227				
6,500 ..	22	7	0	0	14	2	0	0	5	1	0	0	2	-5	0	0	8	0	0	0	5	0	0	0	7	4	0	0	13	5	0	0	4	209				
10,000 ..	11	11	2	0	6	3	0	0	3	0	0	0	-6	0	0	0	2	-6	0	0	5	1	0	0	11	13	2	0	14	15	0	0	1	177				
Low cloud ..		3				5				7				13				20				38				10				4			0	85				
Medium cloud ..		5				1				0				0				3				25				40				27			0	36				
High cloud ..		0				0				0				0				0				36				63				0			0	39				
<b>MARCH</b>																																						
Surface ..	-4	0	0	0	0	0	0	0	0	0	0	0	-4	0	0	0	0	0	0	0	1	0	0	0	17	0	0	0	13	0	0	0	68	257				
1,800 ..	-4	0	0	0	2	-4	0	0	3	0	0	0	-8	0	0	0	7	0	0	0	43	17	0	0	13	4	0	0	2	0	0	0	8	248				
3,300 ..	2	0	0	0	4	0	0	0	5	-4	0	0	11	0	0	0	15	2	0	0	27	9	-8	-4	11	2	0	0	3	0	0	0	8	245				
6,500 ..	13	4	0	0	15	5	0	0	9	3	0	0	5	-9	0	0	6	-9	0	0	4	-4	0	-4	8	-4	0	0	15	1	0	0	8	225				
10,000 ..	20	8	0	0	17	8	0	0	7	-5	0	0	4	1	0	0	1	0	0	0	3	-5	0	0	10	2	0	0	10	3	0	0	3	202				
Low cloud ..		3				3				0				1				13				68				11				0			0	71				
Medium cloud ..		35				3				0				0				0				8				18				37			0	35				
High cloud ..		0				0				0				0				0				66				34				0			0	42				

Note.—The approximate height of the clouds is as follows : Low cloud, 6,500 ft. ; Medium cloud, 16,000 ft. ; High cloud, 33,000 ft.  
 No information of the rate of motion of clouds is available.    \* Period for cloud motion : 1929-35

6 114

East coast of India

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected  
 I = 3-13 knots (4-15 m.p.h.)    II = 14-27 knots (16-31 m.p.h.)    III = 28-40 knots (32-47 m.p.h.)    IV = over 40 knots (over 47 m.p.h.)    C = less than 3 knots (less than 4 m.p.h.)

Vizagapatam (Waltair)—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>APRIL</b>																																		
Surface ..	-4	0	0	0	-4	0	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	21	0	0	0	2	0	0	0	55	244
1,800 ..	1	0	0	0	1	0	0	0	2	-4	0	0	2	0	0	0	3	0	0	0	29	36	2	0	9	9	0	0	-8	0	0	0	3	241
3,300 ..	2	0	0	0	2	0	0	0	2	-4	0	0	4	-4	0	0	11	1	0	0	25	22	1	0	12	7	-9	0	3	-4	0	0	4	232
6,500 ..	13	2	0	0	8	2	0	0	3	2	0	0	5	-5	0	0	5	-5	0	0	9	2	-5	0	14	1	-5	0	21	2	0	0	10	218
10,000 ..	17	7	0	0	14	5	0	0	5	-6	0	0	5	0	0	0	5	0	0	0	3	2	0	0	9	4	0	0	18	2	0	0	3	174
Low cloud ..		1				3				3				1				6				75				9				3			0	146
Medium cloud ..		8				4				0				0				3				13				26				41			5	91
High cloud ..		1				0				0				0				8				27				53				11			0	79
<b>MAY</b>																																		
Surface ..	0	0	0	0	-4	0	0	0	-4	0	0	0	-4	-4	0	0	-8	0	0	0	37	0	0	0	20	2	0	0	4	-4	0	0	34	244
1,800 ..	-8	0	0	0	1	-4	0	0	1	0	0	0	2	0	0	0	3	-8	0	0	15	46	9	-4	5	8	1	0	3	-8	-4	0	2	239
3,300 ..	3	-4	0	0	3	0	0	0	-9	0	0	0	2	0	0	0	4	-9	0	0	17	32	6	0	8	12	2	0	3	2	0	0	2	227
6,500 ..	10	2	0	0	4	1	0	0	9	-5	0	0	5	0	0	0	3	0	0	0	7	0	0	0	19	2	0	0	24	9	0	0	4	201
10,000 ..	27	8	1	0	13	5	-7	0	6	1	0	0	4	-7	0	0	0	0	0	0	-7	-7	0	0	5	-7	0	0	18	5	-7	0	4	143
Low cloud ..		4				2				2				1				7				65				16				3			0	169
Medium cloud ..		24				27				8				4				1				5				8				23			0	97
High cloud ..		1				9				9				13				8				22				27				12			0	56
<b>JUNE</b>																																		
Surface ..	-4	0	0	0	2	0	0	0	0	0	0	0	-4	0	0	0	-9	0	0	0	33	1	0	0	28	1	0	0	7	0	0	0	26	235
1,800 ..	2	-4	0	0	-9	1	0	0	0	0	0	0	0	0	0	0	-4	-4	0	0	6	21	12	-4	6	37	9	0	3	0	0	0	-4	229
3,300 ..	3	0	0	0	-9	0	-5	0	-5	0	0	0	0	0	0	0	-9	0	0	0	4	16	7	1	7	26	21	1	5	4	-9	0	-9	217
6,500 ..	6	3	0	0	1	-6	0	0	-6	0	0	0	0	0	0	0	-6	0	0	0	5	2	0	0	18	25	7	2	15	11	1	1	-6	176
10,000 ..	19	6	0	0	6	3	0	0	2	0	0	0	3	0	0	0	2	0	0	0	3	0	0	0	19	3	2	0	23	1	0	0	5	94
Low cloud ..		4				8				1				0				5				39				30				14			0	138
Medium cloud ..		12				16				5				3				1				5				24				27			8	115
High cloud ..		5				23				51				14				0				0				0				2			3	91

Note.—The approximate height of the clouds is as follows: Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft. No information of the rate of motion of clouds is available.

Table V—Wind direction and speed in the upper air 6 115

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected  
 I = 3-13 knots (4-15 m.p.h.)    II = 14-27 knots (16-31 m.p.h.)    III = 28-40 knots (32-47 m.p.h.)    IV = over 40 knots (over 47 m.p.h.)    C = less than 3 knots (less than 4 m.p.h.)

Vizagapatam (Waltair)—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>JULY</b>																																		
Surface ..	-4	0	0	0	0	0	0	0	0	0	0	0	-4	0	0	0	-4	0	0	0	24	-8	0	0	34	1	-4	0	12	0	0	0	27	258
1,800 ..	-4	0	0	0	2	-8	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	15	6	0	7	48	11	0	2	-8	0	0	-4	244
3,300 ..	-4	0	0	0	1	-4	0	0	0	0	0	0	-4	0	0	0	0	0	0	0	3	8	2	0	9	33	24	2	10	4	0	0	2	228
6,500 ..	4	2	0	0	1	0	0	0	-6	0	0	0	0	0	0	0	1	0	0	0	-6	1	0	-6	8	17	18	3	9	23	7	2	2	179
10,000 ..	5	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	6	30	6	1	26	16	1	1	0	77
Low cloud ..	1				1				0				0				5				19				61				12				0	194
Medium cloud ..	5				6				5				0				0				1				42				31				8	123
High cloud ..	19				64				13				0				0				0				0				4				0	7
<b>AUGUST</b>																																		
Surface ..	0	0	0	0	0	0	0	0	0	0	0	0	-4	0	0	0	0	0	0	0	14	-4	0	0	32	-4	0	0	14	0	0	0	39	261
1,800 ..	1	-4	0	0	1	0	0	0	-4	0	0	0	1	0	0	0	2	0	0	0	11	18	4	-4	16	36	4	0	1	1	0	0	-8	249
3,300 ..	3	-4	0	0	1	0	0	0	-4	0	0	0	2	0	0	0	2	0	0	0	13	9	3	-4	13	29	10	0	8	3	-4	0	3	231
6,500 ..	7	-6	0	0	0	0	0	0	2	0	0	0	1	-6	0	0	2	-6	0	0	4	2	0	0	11	21	8	0	11	22	5	0	3	179
10,000 ..	4	0	1	0	1	0	0	0	2	0	0	0	2	0	0	0	4	0	0	0	5	0	0	0	23	23	2	1	11	19	0	0	3	101
Low cloud ..	1				2				0				2				2				29				54				11				0	206
Medium cloud ..	16				11				6				1				0				3				41				21				0	89
High cloud ..	0				13				78				6				0				0				3				1				0	54
<b>SEPTEMBER</b>																																		
Surface ..	2	0	0	0	-4	0	0	0	-4	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	19	-4	0	0	10	0	0	0	59	253
1,800 ..	4	0	0	0	8	2	0	0	5	0	0	0	2	0	0	0	2	0	0	0	19	14	1	-4	14	17	1	0	3	0	0	0	7	242
3,300 ..	7	1	0	0	6	3	0	0	5	0	0	0	4	0	0	0	3	0	0	0	12	7	1	0	11	16	3	0	13	1	0	0	8	238
6,500 ..	11	0	0	0	7	2	0	0	10	-5	0	0	6	0	0	0	1	0	0	0	8	2	0	0	11	13	4	-5	12	9	3	0	3	193
10,000 ..	12	0	0	0	16	2	0	0	14	2	0	0	3	-8	0	0	-8	0	0	0	3	2	0	0	9	7	0	0	16	5	2	0	5	122
Low cloud ..	6				6				5				3				7				21				44				7				0	176
Medium cloud ..	8				13				14				11				10				7				19				15				3	68
High cloud ..	0				5				82				11				0				0				2				0				0	78

Note.—The approximate height of the clouds is as follows: Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft. No information of the rate of motion of clouds is available.

6 116

East coast of India

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected

I = 3-13 knots  
(4-15 m.p.h.)

II = 14-27 knots  
(16-31 m.p.h.)

III = 28-40 knots  
(32-47 m.p.h.)

IV = over 40 knots  
(over 47 m.p.h.)

C = less than 3 knots  
(less than 4 m.p.h.)

Vizagapatam (Waltair)—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV						
<b>OCTOBER</b>																																		
Surface ..	10	0	0	0	11	.4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	.7	.4	0	0	7	0	0	0	4	0	0	0	66	282
1,800 ..	6	2	.4	0	26	15	1	0	7	4	0	0	2	.7	0	0	2	.4	0	0	10	3	.7	0	6	1	0	0	4	0	0	0	9	270
3,300 ..	5	2	.4	0	21	16	1	0	16	6	0	0	4	0	0	0	2	0	0	0	5	1	.4	0	6	2	.4	0	4	.4	0	0	7	262
6,500 ..	14	2	0	0	19	9	0	0	18	10	0	0	5	.4	0	0	3	0	0	0	1	2	0	0	6	.8	0	0	4	2	0	0	3	237
10,000 ..	7	6	0	0	22	7	0	0	18	2	0	0	5	.6	0	0	5	1	0	0	3	0	.6	0	8	.6	0	0	5	4	0	0	6	178
Low cloud ..	8				20				28				7				9				15				9				4				0	195
Medium cloud ..	11				16				25				16				4				11				11				4				2	62
High cloud ..	1				14				31				28				8				15				3				1				1	117
<b>NOVEMBER</b>																																		
Surface ..	14	0	0	0	25	.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	9	0	0	0	48	279
1,800 ..	3	.4	.4	0	40	27	4	0	12	3	0	0	.4	0	0	0	2	0	0	0	2	0	0	0	.4	.4	0	0	.4	0	0	0	4	273
3,300 ..	6	.7	.4	0	36	24	2	.4	15	7	.4	0	2	0	0	0	.7	0	0	0	1	0	0	0	0	.4	0	0	1	0	0	0	3	270
6,500 ..	10	3	.8	0	25	10	.4	0	15	10	2	0	6	1	0	0	.8	0	0	0	2	0	0	0	5	0	0	0	4	.4	0	0	4	251
10,000 ..	18	5	0	0	23	2	.5	0	11	3	0	0	6	2	0	0	3	0	0	0	4	0	0	0	4	1	0	0	8	.5	0	0	5	202
Low cloud ..	9				43				27				9				2				3				3				5				0	106
Medium cloud ..	13				5				27				21				9				10				4				3				8	48
High cloud ..	1				0				1				2				28				51				15				1				0	132
<b>DECEMBER</b>																																		
Surface ..	10	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	7	0	0	0	57	291
1,800 ..	1	.3	0	0	33	21	1	0	23	4	0	0	3	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	.3	0	0	0	8	290
3,300 ..	6	.4	0	0	35	20	.4	0	19	5	0	0	3	0	0	0	2	0	0	0	1	0	0	0	.1	0	0	0	.7	0	0	0	6	284
6,500 ..	14	4	0	0	20	9	0	.4	17	4	0	0	6	.7	0	0	3	.4	0	0	3	0	0	0	3	0	0	0	9	.7	0	0	6	270
10,000 ..	13	3	0	0	17	5	0	0	6	2	0	.4	8	.8	0	0	5	0	0	0	8	.4	0	0	10	2	0	0	12	3	.4	0	4	239
Low cloud ..	16				30				21				14				9				3				0				7				0	62
Medium cloud ..	0				4				9				18				13				22				17				17				0	61
High cloud ..	0				0				0				0				11				70				19				0				0	115

Authorities.—Bibliography Nos. 72, 115, 116.

Note.—The approximate height of the clouds is as follows: Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft.  
No information of the rate of motion of clouds is available.

Table V—Wind direction and speed in the upper air 6 117

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected

I = 3-13 knots  
(4-15 m.p.h.)

II = 14-27 knots  
(16-31 m.p.h.)

III = 28-40 knots  
(32-47 m.p.h.)

IV = over 40 knots  
(over 47 m.p.h.)

C = less than 3 knots  
(less than 4 m.p.h.)

Calcutta. 22° 32' N., 88° 20' E. 72 ft.

Time of obs. : about sunrise

Period\* : July 1923-1937

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.	
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV			
<b>JANUARY</b>																																			
Surface ..	12	0	0	0	6	0	0	0	2	0	0	0	1	0	0	0	.7	0	0	0	2	0	0	0	0	0	0	0	6	0	0	0	70	420	
1,700 ..	25	12	0	0	17	2	0	0	5	.2	0	0	3	0	0	0	3	.7	0	0	7	2	.2	0	6	.5	0	0	11	2	0	0	4	414	
3,300 ..	19	6	.2	0	5	0	0	0	1	.2	0	0	.2	0	0	0	3	0	0	0	6	2	.5	0	10	2	0	0	26	15	0	0	3	410	
6,500 ..	2	2	0	0	.5	0	0	0	0	0	0	0	.3	0	0	0	1	0	0	0	5	2	0	0	13	16	2	0	14	34	8	.3	.3	372	
10,000 ..	.3	.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.3	0	0	4	6	.6	0	9	30	12	.9	5	19	11	2	.3	318	
Low cloud ..		8				1				1				0				5				22				37				16				10	100
Medium cloud		0				0				0				0				0				29				58				12				2	28
High cloud ..		1				0				0				0				1				33				55				10				1	108
<b>FEBRUARY</b>																																			
Surface ..	7	0	0	0	5	0	0	0	2	0	0	0	2	0	0	0	3	0	0	0	8	0	0	0	2	0	0	0	5	0	0	0	66	409	
1,700 ..	17	11	.5	0	8	2	0	0	3	.2	0	0	2	.5	0	0	7	.7	0	0	13	7	.7	0	8	4	0	0	6	3	.5	0	4	404	
3,300 ..	12	2	0	0	4	0	0	0	2	0	0	0	2	0	0	0	5	.5	0	0	12	4	.3	0	14	6	.3	0	24	9	0	0	3	384	
6,500 ..	3	1	.3	0	.3	0	0	0	.3	0	0	0	.6	0	0	0	.6	.3	0	0	3	3	.3	.3	12	25	4	0	9	28	5	0	1	356	
10,000 ..	2	0	.3	0	.3	0	0	0	0	0	0	0	0	0	0	0	0	.3	0	0	3	.3	1	.3	6	24	15	1	3	26	15	1	1	293	
Low cloud ..		6				1				3				3				4				22				43				14				3	146
Medium cloud		0				0				0				0				0				44				52				0				4	39
High cloud ..		3				0				0				0				0				35				60				2				0	50
<b>MARCH</b>																																			
Surface ..	2	0	0	0	.2	0	0	0	.9	0	0	0	2	0	0	0	13	0	0	0	23	0	0	0	3	0	0	0	5	0	0	0	52	462	
1,700 ..	9	4	.2	0	6	0	0	0	.7	.2	0	0	.9	.2	0	0	4	1	0	0	13	20	3	0	13	6	.7	0	10	5	0	0	2	460	
3,300 ..	10	3	0	0	2	0	0	0	2	0	0	0	2	0	0	0	5	.9	0	0	13	10	.9	0	18	6	.2	0	17	8	.7	0	2	452	
6,500 ..	6	1	0	0	.7	0	0	0	.7	0	0	0	.7	0	0	0	1	.2	0	0	8	3	.2	0	19	18	2	0	18	18	1	0	1	421	
10,000 ..	3	1	0	0	.3	0	0	0	0	0	0	0	.6	0	0	0	1	.3	0	0	1	1	.3	0	10	21	8	1	9	33	8	0	0	339	
Low cloud ..		1				1				1				1				9				41				33				13				1	152
Medium cloud		0				0				0				0				0				18				55				13				14	36
High cloud ..		3				6				0				0				0				35				45				4				7	57

Note.—The approximate height of the clouds is as follows : Low cloud, 6,500 ft. ; Medium cloud, 16,000 ft. ; High cloud, 33,000 ft.  
No information of the rate of motion of clouds is available. \* Period for cloud motion : 1926-35.

6 118

East coast of India

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected

I = 3-13 knots.  
(4-15 m.p.h.)

II = 14-27 knots.  
(16-31 m.p.h.)

III = 28-40 knots.  
(32-47 m.p.h.)

IV = over 40 knots.  
(over 47 m.p.h.)

C = less than 3 knots  
(less than 4 m.p.h.)

Calcutta—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.				
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV						
<b>APRIL</b>																																						
Surface ..	.7	0	0	0	1	0	0	0	2	0	0	0	6	0	0	0	25	.2	0	0	35	0	0	0	2	0	0	0	2	0	0	0	2	0	0	0	26	455
1,700 ..	4	2	0	0	.9	0	0	0	.4	.2	.2	0	.9	.4	0	0	4	9	2	0	12	33	6	.2	9	7	.4	0	5	2	.2	0	1	453				
3,300 ..	5	2	0	0	.9	0	0	0	1	.5	0	0	1	.2	0	0	6	2	0	0	10	22	4	0	17	11	.7	0	11	4	.2	0	2	428				
6,500 ..	6	.6	0	0	2	0	0	0	3	0	0	0	.3	0	0	0	2	.6	.3	0	11	5	0	0	23	15	.3	0	19	11	.6	0	3	355				
10,000 ..	3	2	0	0	.8	0	0	0	0	0	0	0	.4	0	0	0	2	0	0	0	4	3	0	0	15	24	5	0	12	24	3	0	2	257				
Low cloud ..		1				1				0				1				21				49				16				9			1	290				
Medium cloud ..		0				0				0				1				1				40				48				6			4	43				
High cloud ..		0				2				0				0				0				36				47				11			4	98				
<b>MAY</b>																																						
Surface ..	.2	0	0	0	2	0	0	0	4	0	0	0	8	0	0	0	35	.4	0	0	20	0	0	0	1	0	0	0	.2	0	0	0	28	501				
1,700 ..	1	0	0	0	2	.2	0	0	1	.8	.2	0	3	6	0	0	7	25	5	0	12	22	6	.6	3	2	0	0	1	.2	0	0	0	496				
3,300 ..	.9	.2	0	0	.2	0	0	0	3	.5	.2	0	4	2	0	0	9	8	.5	0	14	29	5	0	12	7	.9	0	4	2	0	0	.7	439				
6,500 ..	7	2	0	0	4	0	0	0	3	.3	0	0	3	.3	0	0	3	2	0	0	12	4	.3	0	26	10	.6	0	15	5	0	0	2	361				
10,000 ..	10	9	2	0	3	.4	0	0	2	0	0	0	.8	0	0	0	3	.8	0	0	2	.4	0	0	13	14	.8	0	19	20	.8	0	1	254				
Low cloud ..		1				2				3				5				39				34				10				5			1	389				
Medium cloud ..		0				0				0				0				0				48				26				18			9	31				
High cloud ..		3				2				1				2				20				27				22				4			17	77				
<b>JUNE</b>																																						
Surface ..	.5	0	0	0	2	0	0	0	5	0	0	0	12	0	0	0	22	.2	0	0	14	.5	0	0	1	0	0	0	1	0	0	0	41	442				
1,700 ..	.7	.7	0	0	.5	.2	0	0	3	2	.7	0	5	3	.5	0	12	14	3	.2	12	23	6	.5	5	6	.2	0	2	.9	0	0	.2	433				
3,300 ..	1	.8	0	0	2	0	0	0	2	1	.3	.3	6	2	.3	0	11	9	0	0	12	19	6	.5	6	11	3	.3	3	1	.3	0	2	384				
6,500 ..	5	2	1	0	6	1	0	0	4	1	0	0	3	2	.3	0	5	4	.3	0	8	7	0	0	12	16	2	.3	9	5	.7	0	3	287				
10,000 ..	11	8	2	0	5	2	0	0	4	2	.5	0	3	.5	.5	0	4	2	.5	0	8	4	.5	0	8	5	.5	0	14	12	4	0	5	199				
Low cloud ..		2				2				8				21				31				23				8				8			1	435				
Medium cloud ..		6				0				13				19				3				13				24				5			18	62				
High cloud ..		13				10				36				7				5				6				15				3			7	83				

Note.—The approximate height of the clouds is as follows: Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft.  
No information of the rate of motion of clouds is available.

Table V—Wind direction and speed in the upper air 6 119

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected.  
 I = 3-13 knots (4-15 m.p.h.)    II = 14-27 knots (16-31 m.p.h.)    III = 28-40 knots (32-47 m.p.h.)    IV = over 40 knots (over 47 m.p.h.)    C = less than 3 knots (less than 4 m.p.h.)

Calcutta—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV		
<b>JULY</b>																																		
Surface ..	-7	0	0	0	3	0	0	0	13	0	0	0	11	0	0	0	7	-2	0	0	21	0	0	0	2	0	0	0	1	0	0	0	41	453
1,700 ..	-9	-9	0	0	1	-7	-2	0	5	6	-7	-2	7	4	0	-2	8	8	0	-2	10	24	2	-2	5	8	-5	0	3	2	-2	0	-9	422
3,300 ..	-9	-9	0	0	2	-6	0	0	4	5	-6	0	6	3	0	0	9	10	-6	0	13	18	2	0	6	12	-9	0	3	3	0	0	1	353
6,500 ..	1	1	0	0	3	-4	0	0	5	2	-4	0	9	4	0	0	13	5	0	0	16	13	0	0	9	8	-4	0	5	2	0	0	3	225
10,000 ..	-8	0	0	0	2	2	0	0	7	3	-8	0	10	3	0	0	11	3	0	0	16	9	0	0	8	8	0	0	8	2	0	0	7	130
Low cloud ..	2				4				19				18				24				19				8				4				2	645
Medium cloud	11				0				11				10				11				17				11				6				23	66
High cloud ..	3				22				47				18				0				0				0				0				10	79
<b>AUGUST</b>																																		
Surface ..	1	0	0	0	4	0	0	0	10	0	0	0	10	0	0	0	10	0	0	0	16	0	0	0	2	0	0	0	-4	0	0	0	46	461
1,700 ..	3	-7	0	0	2	1	-2	0	5	4	-4	0	6	3	-4	0	10	8	-7	0	11	14	1	0	11	8	0	0	6	2	0	0	3	439
3,300 ..	4	-5	0	0	3	1	0	0	6	3	0	0	6	4	-5	0	9	6	-3	0	13	10	-5	0	12	9	0	0	7	3	0	0	3	387
6,500 ..	5	-4	0	0	6	1	0	0	6	3	-4	0	8	5	-4	0	11	5	-4	0	14	5	-4	0	11	5	-4	0	7	2	0	0	3	277
10,000 ..	3	0	0	0	6	0	0	0	8	7	-6	0	11	7	-6	0	12	3	0	0	13	3	0	0	12	5	0	0	5	-6	0	0	4	178
Low cloud ..	2				5				16				23				14				23				12				4				1	535
Medium cloud	3				15				21				2				3				9				11				5				28	72
High cloud ..	1				19				53				10				1				1				3				2				9	143
<b>SEPTEMBER</b>																																		
Surface ..	-6	0	0	0	5	0	0	0	10	0	0	0	7	0	0	0	9	0	0	0	10	0	0	0	-4	0	0	0	1	0	0	0	57	472
1,700 ..	5	0	0	0	4	-4	0	0	7	5	-4	0	10	5	-7	0	12	5	-7	0	17	9	1	0	7	2	0	0	4	1	-2	0	5	456
3,300 ..	7	0	0	0	5	1	0	0	10	2	-5	0	11	5	-7	0	15	4	1	0	10	8	-5	0	9	1	0	0	4	2	-2	0	2	421
6,500 ..	6	-6	0	0	8	-8	0	0	10	3	-8	0	13	5	-3	0	14	4	-3	0	10	3	0	0	7	1	-3	0	6	1	0	0	5	358
10,000 ..	5	0	0	0	4	-8	0	0	13	4	-8	0	16	5	0	0	14	2	-4	0	12	2	0	0	11	2	0	0	3	1	0	0	4	265
Low cloud ..	2				6				17				24				22				17				6				5				1	475
Medium cloud	0				3				24				11				3				3				2				3				48	63
High cloud ..	1				13				52				20				4				4				1				0				6	180

Note.—The approximate height of the clouds is as follows: Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft. No information of the rate of motion of clouds is available.

6 120

East coast of India

TABLE V—continued

Number of occasions per 100 on which particular winds may be expected

I = 3-13 knots  
(4-15 m.p.h.)

II = 14-27 knots  
(16-31 m.p.h.)

III = 28-40 knots  
(32-47 m.p.h.)

IV = over 40 knots  
(over 47 m.p.h.)

C = less than 3 knots  
(less than 4 m.p.h.)

Calcutta—cont.

Height above M.S.L. (feet)	N.				NE.				E.				SE.				S.				SW.				W.				NW.				C.	No. of obs.				
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV										
<b>OCTOBER</b>																																						
Surface ..	5	0	0	0	6	0	0	0	4	0	0	0	3	0	0	0	3	0	0	0	6	0	0	0	6	0	0	0	5	0	0	0	68	497				
1,700 ..	19	3	0	0	19	2	0	0	5	2	2	0	3	2	6	0	5	3	2	0	9	4	2	0	9	6	0	0	6	1	0	0	7	480				
3,300 ..	27	3	0	0	18	1	0	0	7	4	2	0	4	2	4	0	4	3	4	0	4	3	2	0	7	4	2	0	10	2	2	0	4	471				
6,500 ..	10	6	0	0	8	7	0	0	8	7	0	0	7	2	9	0	6	3	0	0	7	2	2	0	7	2	2	0	14	4	0	0	6	433				
10,000 ..	3	5	0	0	3	3	0	0	4	1	0	0	6	2	0	0	6	3	3	0	19	6	3	0	22	6	3	0	8	6	5	0	3	379				
Low cloud ..	12					10					10					11					17					11					5	440						
Medium cloud	1					1					3					1					14					15					27					0	25	63
High cloud ..	4					4					11					13					13					26					13					4	12	112
<b>NOVEMBER</b>																																						
Surface ..	18	0	0	0	8	0	0	0	4	0	0	0	4	0	0	0	4	0	0	0	2	0	0	0	2	0	0	0	4	0	0	0	62	494				
1,700 ..	34	10	0	0	19	6	0	0	4	2	0	0	6	4	0	0	2	2	0	0	5	0	0	0	4	2	0	0	6	1	0	0	7	482				
3,300 ..	37	8	0	0	16	1	0	0	4	6	0	0	8	0	0	0	1	4	0	0	2	2	0	0	4	0	0	0	18	3	0	0	3	478				
6,500 ..	16	5	0	0	3	2	0	0	4	0	0	0	2	0	0	0	3	1	0	0	5	3	2	0	14	3	0	0	22	16	4	0	4	449				
10,000 ..	2	2	2	0	1	2	0	0	7	0	0	0	5	0	0	0	2	5	2	0	9	5	0	0	19	21	0	0	16	15	3	0	1	401				
Low cloud ..	25					19					5					3					7					11					12					18	1	183
Medium cloud	12					1					0					2					6					35					22					7	16	38
High cloud ..	0					0					1					0					5					68					24					1	2	138
<b>DECEMBER</b>																																						
Surface ..	14	0	0	0	6	0	0	0	4	0	0	0	4	0	0	0	2	0	0	0	8	0	0	0	0	0	0	0	8	0	0	0	69	480				
1,700 ..	36	12	0	0	23	4	0	0	5	0	0	0	1	0	0	0	1	0	0	0	3	2	0	0	2	2	0	0	9	6	0	0	3	475				
3,300 ..	36	8	0	0	13	4	0	0	3	0	0	0	1	0	0	0	2	0	0	0	3	2	0	0	3	0	0	0	20	8	0	0	2	475				
6,500 ..	12	5	0	0	3	9	0	0	2	2	0	0	1	0	0	0	1	0	0	0	4	1	0	0	11	6	7	0	27	21	1	0	2	446				
10,000 ..	2	5	3	0	2	5	0	0	3	3	0	0	5	0	0	0	2	0	0	0	6	3	3	0	16	24	5	0	12	21	4	3	3	389				
Low cloud ..	26					10					2					2					1					20					17					21	2	134
Medium cloud	3					0					6					0					4					31					44					3	9	40
High cloud ..	2					0					0					0					0					55					35					3	6	107

Authorities.—Bibliography Nos. 72, 115, 116.

Note.—The approximate height of the clouds is as follows: Low cloud, 6,500 ft.; Medium cloud, 16,000 ft.; High cloud, 33,000 ft. No information of the rate of motion of clouds is available.

Table V—Wind direction and speed in the upper air 6 121

TABLE VI—VISIBILITY AT COASTAL STATIONS

Percentage frequency of different degrees of visibility

0800 (local time).

Period: 1933-7

Limits of visibility Nautical miles	over					over					over									
	0- $\frac{1}{2}$	$\frac{1}{2}$ -2	2-5	5-10	10	0- $\frac{1}{2}$	$\frac{1}{2}$ -2	2-5	5-10	10	0- $\frac{1}{2}$	$\frac{1}{2}$ -2	2-5	5-10	10					
	PAMBAN					NEGAPATAM					MADRAS					COCANADA				
January .. ..	0	0	14	86	0	0	3	20	37	40	.6	8	19	66	6	0	10	79	11	0
February .. ..	0	0	4	96	0	.7	0	13	47	39	.7	10	45	40	4	0	19	71	10	0
March .. ..	0	0	7	93	0	0	.6	13	46	40	0	6	31	44	19	0	5	75	14	6
April .. ..	0	0	13	87	0	.7	0	7	52	40	0	.7	5	29	65	0	.7	78	21	0
May .. ..	0	0	8	92	0	0	0	1	59	40	0	0	0	6	94	0	.6	79	17	3
June .. ..	0	0	9	91	0	0	0	5	55	40	0	0	0	9	91	0	5	81	13	.7
July .. ..	0	0	10	90	0	0	0	22	38	40	0	1	2	10	87	0	8	81	11	0
August .. ..	0	0	13	87	0	0	0	10	50	40	0	1	1	11	87	0	8	74	18	0
September .. ..	0	0	8	92	0	0	.7	12	49	38	0	3	3	7	87	0	7	70	23	0
October .. ..	0	0	23	77	0	0	6	20	49	25	0	5	8	19	68	0	5	68	27	0
November .. ..	0	0	32	68	0	0	7	29	44	20	.7	7	5	36	51	0	2	59	36	3
December .. ..	0	.6	22	77	0	0	6	24	51	19	.6	6	10	57	26	0	0	57	43	0
Year .. ..	0	<.1	14	86	0	.1	2	15	48	35	.2	4	11	28	57	0	6	73	20	1

1700 (z-5 $\frac{1}{2}$ ).\*

January .. ..	Data not available	0	3	8	50	39	0	0	3	28	69	0	.6	23	68	8
February .. ..		0	0	4	56	40	0	0	0	86	14	0	.7	10	74	15
March .. ..		0	0	5	55	40	0	0	4	9	87	Data uncertain				
April .. ..		0	0	5	55	40	0	1	0	3	96	0	0	11	76	13
May .. ..		0	0	3	57	40	0	0	0	3	97	0	0	18	68	14
June .. ..		0	.7	9	51	39	0	.7	1	11	87	0	2	46	47	5
July .. ..		0	0	26	34	40	0	1	3	14	82	0	4	48	45	3
August .. ..		0	0	11	49	40	0	.6	1	8	90	0	3	39	51	7
September .. ..		0	0	11	56	33	0	0	3	9	88	0	3	38	53	6
October .. ..		0	.6	29	50	20	.6	2	8	16	73	0	3	32	59	6
November .. ..		.7	8	33	39	19	.7	6	7	19	67	0	3	20	67	10
December .. ..		0	7	20	55	18	.6	2	3	23	71	0	.6	13	59	27
Year .. ..	<.1	2	14	50	34	.2	1	3	19	77	Data uncertain					

6 122

East coast of India

Percentage frequency of different degrees of visibility

0800 (local time).

Period : 1933-7

Limits of visibility Nautical miles	over					over					over					over				
	0-½	½-2	2-5	5-10	10	0-½	½-2	2-5	5-10	10	0-½	½-2	2-5	5-10	10	0-½	½-2	2-5	5-10	10
	VIZAGAPATAM (WALTAIR)					PURÍ					SÁGAR IS.					CALCUTTA				
January .. ..	0	.6	32	65	2	1	.6	11	87	0	11	78	11	0	0	32	66	2	0	0
February .. ..	0	0	47	50	3	3	0	8	89	0	8	38	33	10	11	31	63	6	0	0
March .. ..	0	0	43	52	5	1	0	8	91	0	.6	46	20	15	18	4	64	32	0	0
April .. ..	0	0	51	48	1	0	.7	14	85	0	0	57	13	20	10	0	28	72	0	0
May .. ..	0	0	50	49	.6	0	8	30	62	0	0	54	17	15	14	0	21	79	0	0
June .. ..	0	3	52	32	13	0	13	36	51	0	3	57	13	9	18	.7	25	74	0	0
July .. ..	0	5	50	45	0	0	14	43	43	0	7	51	16	8	18	0	31	69	0	0
August .. ..	0	.6	34	62	3	0	10	32	58	0	6	51	11	20	12	2	27	71	0	0
September .. ..	0	.7	28	70	1	0	2	29	69	0	2	49	17	11	21	.7	30	51	18	0
October .. ..	0	0	30	69	.6	0	.7	14	85	0	.6	42	36	11	10	1	71	27	1	0
November .. ..	0	.7	23	75	1	.7	0	7	92	0	2	69	25	3	.7	8	89	3	0	0
December .. ..	0	0	28	72	0	0	0	3	97	0	4	62	30	4	0	25	71	4	0	0
Year .. ..	0	1	39	58	2	.5	4	20	76	0	4	54	20	11	11	9	48	41	2	0
<b>1700 (Z-5½)*</b>																				
January .. ..	0	0	41	54	5	0	.6	8	91	0	3	57	26	8	6	0	78	22	0	0
February .. ..	0	.7	37	57	5	0	.7	3	96	0	0	38	30	7	25	0	23	77	0	0
March .. ..	0	0	40	53	7	0	0	8	92	0	0	45	20	12	23	.6	16	83	0	0
April .. ..	0	0	48	48	4	0	0	14	86	0	.7	56	12	15	16	0	15	85	0	0
May .. ..	0	1	48	50	.6	0	3	27	70	0	1	59	11	14	15	0	19	81	0	0
June .. ..	0	5	52	43	0	0	11	30	59	0	3	56	15	9	17	0	17	83	0	0
July .. ..	0	4	53	42	1	0	7	37	56	0	5	48	12	9	26	.6	28	71	0	0
August .. ..	0	3	37	57	3	0	7	32	61	0	4	51	10	16	19	.6	20	79	0	0
September .. ..	0	3	34	62	1	0	3	23	74	0	6	46	16	10	22	0	33	66	1	0
October .. ..	0	5	28	66	1	0	3	34	63	0	2	50	29	10	9	1	56	43	0	0
November .. ..	0	0	29	68	3	0	1	65	34	0	6	71	15	4	4	.7	86	13	0	0
December .. ..	0	0	43	56	.6	0	0	39	61	0	19	40	34	6	.6	0	95	5	0	0
Year .. ..	0	2	41	55	2	0	3	27	70	0	4	52	19	10	15	.3	41	59	<.1	0

Table VI—Visibility at coastal stations 6 123

Authority.—Bibliography No. 116.

\* Indian standard time, Z-5½, differs from local time by less than half an hour.

TABLE VII—MONTHLY FREQUENCIES OF DIFFERENT AMOUNTS OF CLOUD

Number of days per 100 on which particular cloud amounts may be expected  
The figures refer to tenths of sky covered by cloud. 0 = clear sky. 10 = overcast

0800 (local time).						Period: 1933-7														
Cloud amount	0	Tr.-3	4-6	7-9	10	0	Tr.-3	4-6	7-9	10	0	Tr.-3	4-6	7-9	10					
	PAMBAN					NEGAPATAM					MADRAS					COCANADA				
January .. ..	1	16	70	13	0	3	15	26	46	10	12	26	19	23	20	16	34	26	23	.6
February .. ..	4	26	67	3	0	2	17	32	47	2	19	26	22	18	15	19	39	23	19	0
March .. ..	4	28	61	7	0	.6	23	28	47	1	20	30	16	26	8	21	39	26	13	.6
April .. ..	.7	30	59	10	0	1	18	26	50	5	8	19	20	38	15	2	20	42	35	.7
May .. ..	3	29	61	7	0	.6	19	20	57	3	10	19	23	28	20	6	16	31	44	3
June .. ..	.7	29	61	9	0	.7	7	20	65	7	3	12	10	29	46	0	11	24	52	13
July .. ..	3	33	54	10	0	0	8	17	58	17	1	7	8	28	56	0	10	18	48	24
August .. ..	1	27	61	11	0	0	12	20	55	13	2	9	19	26	44	.6	14	17	52	16
September .. ..	1	40	52	7	0	.7	15	27	43	14	5	18	15	28	34	.7	7	33	50	9
October .. ..	1	19	60	20	0	1	7	18	46	28	7	19	10	24	40	10	24	27	32	7
November .. ..	0	5	64	31	0	2	5	16	52	25	7	17	15	26	35	14	33	30	19	4
December .. ..	2	11	64	22	.6	0	18	22	42	18	9	22	19	27	23	23	45	20	11	1
<b>1700 (Z-5½)*</b>																				
January .. ..	Data not available					3	20	26	37	14	10	31	12	26	21	24	41	15	19	1
February .. ..	Data not available					4	43	22	30	.7	30	28	17	16	9	24	50	13	13	0
March .. ..	Data not available					10	36	24	29	1	34	30	11	17	8	33	46	18	3	0
April .. ..	Data not available					9	26	22	38	5	17	30	11	25	17	20	38	27	14	.7
May .. ..	Data not available					12	22	19	41	6	14	25	14	21	26	23	33	19	24	1
June .. ..	Data not available					.7	8	16	64	11	3	8	4	23	62	.7	11	29	50	9
July .. ..	Data not available					0	3	15	65	17	.6	3	6	21	69	0	10	24	48	18
August .. ..	Data not available					.6	10	20	57	12	1	17	10	25	47	0	14	31	45	10
September .. ..	Data not available					1	19	23	46	11	3	21	8	18	50	0	8	39	46	7
October .. ..	Data not available					0	11	20	45	24	5	21	4	19	51	3	24	35	29	9
November .. ..	Data not available					.7	10	17	46	26	6	23	10	17	44	18	25	30	24	3
December .. ..	Data not available					.6	23	19	37	20	6	27	16	25	26	24	43	21	11	1

Authority.—Bibliography No. 116.

\* Indian standard time, Z-5½, differs from local time by less than half an hour.

6 124

East coast of India

TABLE VII—continued

Number of days per 100 on which particular cloud amounts may be expected  
The figures refer to tenths of sky covered by cloud. 0 = clear sky. 10 = overcast

0800 (local time).

Period : 1933-7

Cloud amount	0	Tr.-3	4-6	7-9	10	0	Tr.-3	4-6	7-9	10	0	Tr.-3	4-6	7-9	10	0	Tr.-3	4-6	7-9	10
	VIZAGAPATAM (WALTAIR)					PURI					SĀGAR IS.					CALCUTTA				
January .. ..	23	36	19	16	6	40	26	16	15	3	52	14	14	8	12	60	17	7	11	5
February .. ..	36	24	15	16	9	32	35	18	13	2	29	16	18	21	16	41	14	9	14	22
March .. ..	41	31	18	8	2	35	28	21	14	2	28	15	22	26	9	47	19	14	12	8
April .. ..	21	32	27	13	7	10	36	21	26	7	9	9	28	37	17	29	25	17	20	9
May .. ..	12	21	30	22	15	7	29	21	28	15	1	10	22	43	24	14	16	24	34	12
June .. ..	0	9	19	21	51	0	16	17	44	23	0	0	9	38	53	.7	3	10	60	26
July .. ..	0	3	16	27	54	.6	4	14	58	23	0	0	3	29	68	0	1	5	62	32
August .. ..	0	12	16	26	46	0	6	26	47	21	0	.6	6	24	69	0	2	9	48	41
September .. ..	.7	13	21	25	40	0	17	25	43	15	.7	1	13	35	50	1	10	15	51	23
October .. ..	11	29	18	19	23	24	23	25	20	8	15	19	21	22	23	32	26	12	22	8
November .. ..	21	34	17	17	11	33	33	19	12	3	33	24	19	15	9	53	24	10	8	5
December .. ..	30	37	12	16	5	48	34	12	5	1	49	17	18	10	6	64	16	8	10	2

1700 (z-5½)\*

January .. ..	32	28	18	13	9	36	33	17	12	2	43	21	15	9	12	51	21	10	13	5
February .. ..	33	37	14	11	5	33	42	11	13	1	24	25	22	18	11	33	37	9	12	9
March .. ..	39	32	11	17	1	38	34	17	9	2	39	12	15	21	13	47	25	9	13	6
April .. ..	10	32	22	30	6	19	32	22	24	3	13	13	29	26	19	30	26	16	17	11
May .. ..	9	24	20	33	14	8	36	27	21	8	3	14	24	33	26	16	21	19	25	19
June .. ..	0	7	14	22	57	4	17	22	37	20	.7	1	10	31	57	.7	9	14	35	41
July .. ..	0	5	13	21	61	0	6	20	57	17	0	0	11	35	54	0	3	19	42	36
August .. ..	.6	10	17	26	46	0	9	23	53	15	0	.6	8	23	68	0	3	12	38	47
September .. ..	0	11	14	24	51	3	14	27	49	7	.7	.7	14	34	51	1	3	17	44	35
October .. ..	8	29	15	16	32	12	35	19	26	8	12	19	27	17	25	17	29	17	18	19
November .. ..	21	31	11	17	20	29	32	24	11	4	30	19	25	11	15	43	29	15	8	5
December .. ..	26	39	14	14	7	41	30	19	9	.6	32	29	24	9	6	50	32	9	8	1

Authority.—Bibliography No. 116.

\* Indian standard time, Z-5½, differs from local time by less than half an hour.

Table VII—Cloud amount at coastal stations

6 125

TABLE VIII—MONTHLY FREQUENCIES OF DIFFERENT STATES OF THE SEA

Number of occasions per 100 on which particular states of the sea may be expected.

I = Calm, smooth or slight. II = Moderate. III = Rough. IV = Very rough or high. V = Very high or precipitous. VI = Confused.

0800 (local time).

Period: 1933-7

State of sea	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
	PAMBAN						NEGAPATAM						MADRAS						COCANADA					
January .. ..	76	21	3	0	0	0	83	12	4	.6	0	0	81	17	2	0	0	0	95	5	0	0	0	0
February .. ..	100	0	0	0	0	0	100	0	0	0	0	0	95	5	0	0	0	0	95	5	0	0	0	0
March .. ..	100	0	0	0	0	0	99	1	0	0	0	0	95	4	1	0	0	0	100	0	0	0	0	0
April .. ..	88	11	.7	0	0	0	100	0	0	0	0	0	87	13	0	0	0	0	98	1	0	.7	0	0
May .. ..	57	26	17	0	0	0	100	0	0	0	0	0	85	15	0	0	0	0	98	1	0	.6	0	0
June .. ..	51	32	17	0	0	0	100	0	0	0	0	0	96	4	0	0	0	0	96	3	.7	0	0	0
July .. ..	75	21	4	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0	86	13	.6	0	0	0
August .. ..	88	9	3	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0	95	5	0	0	0	0
September .. ..	81	16	3	0	0	0	100	0	0	0	0	0	99	1	0	0	0	0	97	2	.7	0	0	0
October .. ..	84	13	3	0	0	0	97	3	0	0	0	0	88	10	1	.6	0	0	85	7	6	2	0	0
November .. ..	62	23	15	0	0	0	81	17	1	.7	0	0	69	23	4	3	.7	0	83	11	5	0	.7	0
December .. ..	50	37	12	.6	0	0	85	10	4	.6	0	0	72	19	7	0	2	0	92	7	0	0	1	0
	1700 (z-5½).*																							
January .. ..	Data not available						75	19	5	.6	0	0	63	34	3	0	0	0	84	13	3	0	0	0
February .. ..	Data not available						96	4	0	0	0	0	77	23	0	0	0	0	94	6	0	0	0	0
March .. ..	Data not available						97	3	0	0	0	0	69	30	1	0	0	0	95	5	0	0	0	0
April .. ..	Data not available						99	.7	0	0	0	0	54	45	.7	0	0	0	79	20	1	0	0	0
May .. ..	Data not available						98	2	0	0	0	0	48	52	0	0	0	0	86	13	.6	0	0	0
June .. ..	Data not available						97	3	0	0	0	0	63	37	0	0	0	0	90	9	.7	0	0	0
July .. ..	Data not available						99	1	0	0	0	0	88	12	0	0	0	0	88	11	.6	0	0	0
August .. ..	Data not available						100	0	0	0	0	0	86	14	0	0	0	0	94	4	2	0	0	0
September .. ..	Data not available						99	.7	0	0	0	0	82	17	.7	0	0	0	98	2	0	0	0	0
October .. ..	Data not available						95	4	.6	0	0	0	64	32	3	.6	0	0	67	20	10	3	0	0
November .. ..	Data not available						71	24	3	2	0	0	40	47	9	3	.7	0	72	15	12	0	1	0
December .. ..	Data not available						73	20	6	.6	0	0	53	33	12	0	2	0	76	17	6	.6	.6	0

Authority.—Bibliography No. 116.

\* Indian standard time, Z-5½, differs from local time by less than half an hour.

TABLE VIII—continued

Number of occasions per 100 on which particular states of the sea may be expected.  
 I = Calm, smooth or slight. II = Moderate. III = Rough. IV = Very rough or high. V = Very high or precipitous. VI = Confused.  
 0800 (local time). Period: 1933-7.

State of sea	VIZAGAPATAM						Purí						SÁGAR Is.					
	I	II	III	IV	V	VI	I	II	III	IV	V	VI	I	II	III	IV	V	VI
January .. ..	100	0	0	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0
February .. ..	100	0	0	0	0	0	100	0	0	0	0	0	98	1	.7	0	0	0
March .. ..	100	0	0	0	0	0	97	2	.6	0	0	0	80	16	3	1	0	0
April .. ..	100	0	0	0	0	0	95	3	2	0	0	0	65	18	12	5	0	0
May .. ..	97	3	0	0	0	0	89	8	3	0	0	0	51	23	18	8	0	0
June .. ..	85	15	0	0	0	0	88	6	5	.7	0	0	52	26	15	7	0	0
July .. ..	85	14	.6	0	0	0	95	4	0	1	0	0	67	14	10	9	0	0
August .. ..	90	9	.6	0	0	0	82	4	4	9	.6	0	59	27	9	4	1	0
September .. ..	91	6	3	0	0	0	94	3	2	.7	0	0	75	17	7	1	0	0
October .. ..	90	6	4	0	0	0	97	1	.6	1	0	0	93	5	.6	1	0	0
November .. ..	94	5	1	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0
December .. ..	97	2	1	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0
<b>1700 (Z-5½)*</b>																		
January .. ..	82	14	4	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0
February .. ..	91	8	.7	0	0	0	95	4	1	0	0	0	99	.7	.7	0	0	0
March .. ..	99	.6	0	0	0	0	98	1	.6	0	0	0	85	10	4	.6	0	0
April .. ..	82	17	.7	0	0	0	90	7	3	0	0	0	64	19	9	7	.7	0
May .. ..	69	30	.6	0	0	0	84	13	3	0	0	0	46	31	16	7	0	0
June .. ..	59	39	2	0	0	0	86	11	3	0	0	0	53	30	12	5	0	0
July .. ..	56	39	5	0	0	0	96	1	2	.6	0	0	63	22	9	5	.7	0
August .. ..	52	41	7	0	0	0	88	7	4	.6	0	0	60	25	10	4	.7	0
September .. ..	70	28	2	0	0	0	94	3	3	0	0	0	77	18	4	1	0	0
October .. ..	70	23	7	0	0	0	96	2	2	0	0	0	95	2	2	.6	0	0
November .. ..	85	12	3	0	0	0	100	0	0	0	0	0	99	1	0	0	0	0
December .. ..	88	8	4	0	0	0	100	0	0	0	0	0	100	0	0	0	0	0

Authority.—Bibliography No. 116.

\*Indian standard time, Z-5½, differs from local time by less than half an hour.

Table VIII—State of the sea at coastal stations

6 127