



**Report on the Administration of
the Meteorological Department
of the Government of India
in 1938-39.**



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Report on the Administration of the Meteorological Department of the Government of India in 1938-39.

I.—CHIEF FEATURES OF THE YEAR.

1. The year 1938-39 saw the completion of an important stage of development in the organisation of the department which was planned to be achieved without any increase in the budget grant. The scheme involved reduction of expenditure in certain directions and increase in others and was designed to give the following additional facilities:— (1) Provision of an afternoon weather chart for the Headquarters Office at Poona, (2) re-establishment of the forecasting centre at Delhi, (3) establishment of a wireless station at Poona, (4) reorganisation of the superior staff, (5) transfer of the upper air office from Agra to Delhi and (6) provision for a small increase in staff in the R. A. F. Meteorological Offices and the establishment of a few additional observatories in north-west India. The afternoon weather chart at Poona which had been sanctioned on a temporary basis for two years with effect from 1st April 1937, was sanctioned as a permanent measure with effect from 1st April 1939. The construction of the wireless station at Poona was completed by the Posts and Telegraphs Department in March and the station commenced working with effect from 1st April 1939. The reorganisation of the gazetted staff was sanctioned with effect from 1st October 1938. Sanction was also accorded towards the end of the year to the re-establishment of the forecasting centre at Delhi with effect from 1st September 1939. The transfer of the Upper Air Office from Agra to Delhi was approved, a suitable site at Delhi was reserved and necessary provision to enable construction work to be commenced in 1939-40 was included in the budget. A few minor items such as the appointment of a Meteorological Assistant for the Meteorological office at Peshawar and the establishment of a few additional observatories in north-west India were also sanctioned by Government.

2. Reorganisation of the superior staff of the department.—The very considerable increase in recent years in the demand for meteorological service by civil aviation, the Royal Air Force, the Navy, the mercantile shipping and the public in general made certain reorganisation of the superior staff essential. There were no intermediate administrative posts between that of the Director General of Observatories and the executive grade of officers, namely, the Meteorologists and in the past, every addition to the activities of the department meant direct addition to the administrative work of the Director-General of Observatories to the detriment of the technical and professional side of his duties. To remedy the position, Government sanctioned during the year the conversion of three posts of Meteorologists into three posts of Superintending Meteorologists, two of these officers being posted in the Headquarters Office at Poona and the third in charge of the Upper Air Office at Agra, which is the central

office controlling the extensive upper air organisation over the country. One post of Meteorologist was converted into two posts of Assistant Meteorologists and an aviation section was started at Poona and another at Agra; the aviation section at Agra is to be transferred later to Delhi when the Agra Upper Air Office moves to that station. One of the Superintending Meteorologists at the Headquarters will deal with administrative and the other with technical matters. The establishment of an aviation section at Delhi will enable the department to maintain closer liaison with the departments of civil aviation and the Royal Air Force. It is hoped that the reorganisation of the superior staff will enable the department to deal more efficiently with the many technical and administrative questions which the development of civil aviation involving both day and night flying is giving rise to.

3. Transfer of the Upper Air Office from Agra to Delhi and the establishment of a Forecasting Centre at Delhi.—The Aerological Observatory at Agra was established in 1914 purely as a research centre. Its location was dictated mainly by a consideration of two facts, firstly, that balloons let off from the station with recording instruments drop generally in the thickly populated area of the Gangetic plain and the chance of recovery is therefore great and, secondly, that Agra is near the boundry of the two main monsoon currents and gets air sometimes from the one and sometimes from the other. The general object was to study the seasonal and day-to-day changes in the conditions of the upper air. It was realised that the data collected would prove valuable when aviation came along, but at that time there was no other utilitarian object in view. Now the application of upper wind data to aviation has grown, and in such a way as to surround the original functions of the Agra Observatory with an evergrowing mass of other duties, particularly of organising and running a large number of pilot balloon observatories over the extensive area from Bahrein to Chittagong and Peshawar to Trichinopoly. The office work now dominates the research activities. The functions now are mainly utilitarian and are largely concerned with the administration and supervision of meteorological work at the aerodromes. The site at Agra is good for an observatory but for service to aviation is a backwater. It has, therefore, become important that the Upper Air Office should be transferred to a station where it can come into close touch with aviation interests and can have also access to upper wind charts as used in day to day forecasting work. At the same time the associated observatory should not be very far from the convenient position it now occupies for sounding balloon work in northern India. The Government of India therefore accepted the proposal to transfer the Upper Air Office from Agra to Delhi. They had under consideration the necessary allocation of funds for the construction of buildings for the office on a site measuring about 20 acres south of Lodhi Road and adjoining the Aliganj Nursery.

The Government of India also accorded sanction to the re-establishment with effect from 1st September 1939, of the forecasting

office at Delhi, which was retrenched in 1932 owing to acute financial stringency which prevailed in that year. Owing to the increased frequency of flying, both civil and military, along the trans-India route and along the feeder routes passing through Delhi, the need for re-establishing the forecasting office there has been increasingly felt in recent years. The forecasting office is proposed to be housed in the Willingdon Air Port as soon as the necessary accommodation becomes available.

4. Short wave wireless station at Poona.—The construction of the wireless station at Poona, which was taken in hand by the Posts and Telegraphs Department last year, was completed and the station commenced trial broadcasts and reception towards the end of the year. The programme for "regional" and "collective" broadcasts of meteorological data to be brought into operation in April 1939 for the benefit of the departmental forecasting offices and the neighbouring meteorological services was worked out. Poona wireless station will enable the department to reciprocate a service which Malaya, Siam, Indo-China and other neighbouring meteorological services have been rendering for some years now.

5. Government economy orders.—Very stringent economy had to be observed throughout the year on all items of expenditure of a contingent nature owing to a cut of 10 per cent. imposed by Government in the grant under contingencies. Inspection tours had to be curtailed on account of a similar cut under travelling allowance. The ban on the recruitment of outsiders involved additional work on the staff as a whole, and even with extra attendance it was found difficult to keep the work clear of arrears.

6. Transfer of Forecasting Office from Karachi Town to Karachi Air Port.—The Meteorological Office at Karachi was shifted to the newly constructed administrative building at the Karachi Air Port. The new location will enable pilots at Drigh Road, before they take off, to pass through the Forecasting Office and to have the weather situation explained to them by the meteorological staff with reference to the synoptic charts. It is expected that the improved liaison between meteorological, wireless and flying personnel made possible by this shift will result in better service to aviation. The shift made consultation with the Meteorologist by the Flying Boat Captains, who take off from the West Wharf, Keamari, at a distance of about 15 miles from the Air Port, difficult, and a scheme for making available to these captains copies of weather charts was under consideration.

7. Conference for deciding on further improvements and plans for future.—A conference of departmental officers was held towards the end of July 1938 for discussing further improvements in the services rendered to the general public, the seamen and the airmen. The conference considered questions of evolution of clouds, marine observations, synoptic broadcasts, upper air climatology, preparation of air-mass statistics, duties of staff at pilot balloon and current weather stations, estimation of vertical visibility and such other subjects. The Directors of the Burma Meteorological Department and the Nizamiah

Observatory, Hyderabad and the Meteorological Reporter to the Government of Mysore also attended the conference by invitation and took part in the discussions. This conference immediately followed a Symposium on "Weather Prediction" held in the Library Hall of the Headquarters Office, Poona under the auspices of the National Institute of Sciences of India to which the officers of the department contributed largely.

8. Transfer of the work of storm warnings in Burman waters to the Burma Meteorological Department.—The Burma Meteorological Service having decided to take over from the India Meteorological Department the work of storm warning to shipping in Burman waters and to Burman ports, the transfer of that work was made from 1st April 1939.

9. Services to Aviation.—Further improvements were effected in the meteorological arrangements for aviation. The most important of these were the shifts of pilot balloon and current weather observatories from Gwadur to Jiwani, Allahabad to Bamrauli and Alipore (Calcutta) to Dum Dum, the starting of double flight pilot balloon stations at Rajsamand and Madhosagar, the addition of afternoon flights at Bhuj, Malegaon, Hyderabad (Begumpet) and Bangalore and of early morning ascents at Ahmedabad.

The international codes have been adopted in full with effect from 1st January 1939, for all current weather reports, including reports of dangerous phenomena and improvements thereof, issued from stations on the air routes. These codes provide for more detailed information relating to clouds and for the issue of special reports in respect of thunderstorms and duststorms at a distance, deterioration of visibility and lowering of cloud base. New editions of the pamphlet on meteorological organisation for airmen and of the aviation weather codes (Pocket Card) were issued.

On the trans-India route, the routine arrangements for the issue of forecasts, upper wind and current weather reports by W/T to all the main aerodromes and to aircraft in flight were continued. On other routes, schedules of supply of weather reports were prepared by the meteorological offices to suit the time table and needs of the air services. Arrangements have, however, been made for routine distribution of pilot balloon and current weather reports along Karachi-Colombo route.

Arrangements were also made during the year for the supply of weather reports and forecasts to the Air Services of India, Ltd., for their Bombay-Porbander Service, and to Indian National Airways for their Lahore-Delhi Service.

10. Broadcasts to shipping.—At the request of the Royal Indian Navy, evening synoptic broadcasts in addition to the morning ones began to be issued through the Navy Wireless Station at Bombay from 1st June.

11. International Meteorology.—Necessary action was taken on the resolutions adopted at the meetings of the Commission for the Synoptic

Weather Information held at Salzburg in September 1937. The internationally approved form for the "station model" was adopted for the weather charts, and certain changes were introduced in codes. Proposals for consideration at the next meeting of the various international commissions to be held in Berlin in June 1939, were submitted to the International Meteorological Secretariat or the Presidents of the different Commissions. Proposals for the next meeting of the Regional Commission II in January 1940 were under examination. Government decided to depute the Director General of Observatories to attend the Berlin meetings of the International Meteorological Committee.

12. **Routine activities and special investigations.**—The department carried on as usual all its normal activities, including its marine and inland warning work at the headquarters office as well as in the various sub-offices. Sounding balloon ascents were made at Agra, Poona, Madras, Ahmedabad, Sambalpur and Bangalore. Daily sounding balloon ascents were made at Trivandrum for about three weeks in July to study the properties of the monsoon current as it enters the south of the Peninsula; arrangements were also made for simultaneous ascents at Madras and Ahmedabad for comparative study. More than 375 sounding balloons were let off during the year of which 144 were retrieved.

Of the important items of investigational work at the headquarters office may be mentioned the development of an electrical windvane to indicate directions at a distance by visible signal and an application of saturation and saturation-potential temperatures for the recognition of air masses. Some of the formulae for the seasonal forecasts were revised as a result of statistical investigations. Analysis of rain water was made at Bombay for determining its chloride, nitrate and nitrite contents. Measurements of ozone in the upper atmosphere were also made by using Dobson's spectrograph.

At Agra, investigation was undertaken to develop cheap and efficient dry cells for use in connection with night balloon ascents and with radio-meteorographs and preliminary work was started for the local manufacture of Harvard type radio-meteorographs. At the Colaba Observatory, a study of the severe magnetic storms recorded at Alibag during the sunspot cycle 1928-38, and an examination of the records of the Chilean earthquake of 25th January 1939 were undertaken. The officers of the civil meteorological office at Karachi were engaged in an investigation into the variation of the lapse rate of temperature in the atmosphere near the ground at the Karachi Air Port, while the R. A. F. Meteorologist there was engaged, amongst other things, in the study of aeroplane ascents made at different times of the day and of the inversions over Karachi and Quetta. At Kodaikanal, besides the construction of a monochromator for use with the 18 feet prism spectrograph and a 20 feet grating spectrograph in Eagle mounting, attention was also given to a photometric study of the changes of the Magnesium b and other strong Fraunhofer lines from the centre of the sun's disc to the polar limb and the equatorial limb, and to measuring the intensity of cosmic radiation and studying its diurnal variation.

13. **Agricultural Meteorology.**—The Agricultural Meteorology Section at Poona continued to make steady progress in the study and investigation of problems affecting agriculture. An instrument was made for measuring the percentage proportions of rain or irrigation water, lost by evaporation and by percolation, and, of that retained in the soil layers with which plants are concerned. The movement of moisture and salts through soil layers was studied. The secular variation in the frequency of frosts in Gujarat was analysed; an analysis was also made of rainfall in the Bijapur and Amraoti districts. The study of the exchange of heat and moisture between the surface layers of the soil and of the atmosphere was continued.

14. **Publications.**—Three Memoirs and four Scientific Notes were sent to the press and three other papers were received and were being considered for publication. In addition, several officers and members of the staff contributed papers or notes to extra-departmental journals, Indian as well as foreign. The quarterly "Seismological Bulletin" began to be issued during the year. This summarises in a convenient form all the available seismic data obtained from departmental and other seismological observatories in India and Ceylon.

15. **Warning messages.**—The number of weather forecasts issued to aircraft from the different forecasting centres totalled 8,976. Besides these, about 14,000 upper wind reports and more than 23,000 reports of current weather, including warnings of adverse weather and intimations of improvement thereof, were supplied to pilots from different stations along the air route. Nearly 7,300 warning messages were issued to ports and 3,100 messages to shipping at sea including those in connection with disturbed weather over the seas; warning messages of heavy rain, untimely rain, high winds and frosts numbered about 7,000.

II.—MARINE METEOROLOGY.

Storm Warning.—Storm warnings for the Bay of Bengal and the ports around it continued to be issued from the Meteorological Office at Calcutta and those for the Arabian Sea area from the Headquarters Office at Poona. The latest information about weather was supplied as usual to shipping at sea by means of wireless weather bulletins issued from coastal radio stations twice daily on ordinary undisturbed days and more frequently on disturbed days.

During the year three meetings with ships' officers and ships' and shore W/T officers in Bombay and two with ships' officers in Calcutta were arranged, at which experiences and views were exchanged on the Department's service to ships.

The question of starting pilot balloon observatories in some of the islands in the Indian Seas received consideration during the year. Government sanctioned the establishment of a pilot balloon station at Car Nicobar from 1st April 1939. An officer was deputed to visit Laccadive Islands to report on the possibilities of starting pilot balloon observatories in the Amini Divi islands and at Minicoy.

The total number of broadcast messages issued during the year by the Calcutta Office to shipping in the Bay of Bengal was 2,047 as against 2,045 in the previous year. The Poona Office issued 1248 messages to shipping in the Arabian Sea as against 1,445 in the previous year.

Services to ports around the Bay of Bengal.—No change was introduced in the system of storm warnings for ports around the Bay of Bengal during the year. The Calcutta Office continued to be responsible for warning all the 24 ports, including those in Burma. Of the 16 periods of disturbed or suspicious weather in the Bay for which warnings were issued, 8 developed into depressions 6 of which intensified further and became cyclonic storms. The cyclonic storm which prevailed over the Bay of Bengal from 5th to 12th October 1938 was of very severe intensity. Weather became disturbed from the Arakan to the Orissa-Ganjam coast in the Bay of Bengal on the 5th morning and a depression formed near Lat. $17\frac{1}{2}^{\circ}$ N. Long. 90° E. by that evening. The depression moved very slowly in a north-westerly direction and intensified into a cyclone which was of severe intensity by the morning of the 9th and centred about 60 miles southeast of Puri. Some of the ships in the field of the cyclone reported very strong winds, high seas and squally weather; E. S. Chilka encountered westnorthwesterly wind of 'storm force' and confused sea and swell off Gopalpur on the 9th evening. With the approach of the cyclone centre near the coast, the barometer fell rapidly at Puri and Gopalpur, the latter station recording a pressure deficiency of as much as 1.25 inches at 4 hrs. on the 10th morning. Crossing the coast slightly to the north of Gopalpur by 8 hrs. of that morning, the cyclone weakened and moving northwestwards, filled up over the west Central Provinces on the 12th. There was widespread and locally heavy rain in and around the path of the cyclone; Mohana in Ganjam district had 12 inches of rain and Itchhapur in Vizagapatam district 11 inches, on the 10th.

The cyclone caused considerable damage in the Ganjam district. According to newspaper reports the tidal waves which rose to great heights inundated the coastal areas sweeping away many houses as well as heads of cattle and filling tanks and wells with brackish water. Breaches were caused in the railway communication between Madras and Calcutta, telegraph and telephone lines were cut off and electric supply was dislocated. Many trees were uprooted and many houses demolished and blown off by the strong winds which blew for hours with very high velocity, resulting in the loss of a few lives and considerable damage to livestock and property.

The usual circular letter was issued to port authorities asking for their opinions and suggestions regarding the warnings issued to them during the year. Nearly all of them expressed satisfaction with the warnings issued and the system in use. The total number of warnings issued to ports by Calcutta Office was 3,105 as against 4,094 in the previous year.

Services to Arabian Sea ports.—Warnings for the Arabian Sea ports continued to be issued by the Poona Office. The system of storm warnings remained unchanged during the year. There were 41 ports on the warning list. Of the 37 disturbed or suspicious weather conditions for which warnings were issued, 5 developed into depressions, 2 of which further intensified into cyclonic storms. Of the two storms, the more severe one originated in the Bay of Bengal near Lat. 15°N. Long. 90°E. at the beginning of the last week of September and moving in a westerly direction, crossed the north Madras coast near Masulipatam by the 30th morning. The storm weakened during its passage across the Peninsula, and passing out into the Arabian Sea, lay as a depression off the north Konkan coast on the morning of the 2nd October. The depression intensified again into a cyclonic storm by the 5th morning when upper winds over Bombay blew with gale force. Curving northeastwards, the cyclone crossed coast to the north of Bombay near Damao during the 5th-6th night, weakened and became unimportant by the 7th morning.

The cyclone caused widespread and locally heavy rain over the north and west of the Peninsula. According to newspaper reports, extensive damages to crops, cattle and building occurred at places adjoining the Kanara and the Konkan coasts, and railway services and telegraphic and telephonic communications were dislocated in the Konkan.

24 port officers sent their Annual Returns regarding the warnings issued to them. All of them stated that the warnings were timely and satisfactory in every respect and that no change in the present system was necessary. The number of warning messages issued to ports by the Poona Office was 4,242 as against 7,355 in the previous year.

Exchange of information with ships at sea.—The chief sources of marine data are wireless messages from ships at sea and extracts from weather logs of ships calling at the principal ports. In the year under review 13,600 radio messages were received from ships in the Bay of Bengal and Arabian Sea as against 13,145 received in the previous year. The slight increase is due to the introduction of the practice of recording and transmitting of a second set of routine observations daily at 12 G.M.T. by all ships in Indian waters from 1st January 1939. It is not possible to name here every steamship that sent messages, but those that sent 75 messages or more during the year are listed below along with the number of messages received from each.

Name of Ship.	No. of messages.	Name of ship.	No. of messages.
1. Akbar	79	13. Ethiopia	140
2. Alvi	175	14. Gairsoppa	98
3. Badarpur	122	15. Garbeta	111
4. Baloeeran	132	16. Garmula	75
5. British Architect	81	17. Gogra	95
6. British Emperor	123	18. Golconda	98
7. British Justice	144	19. Gurra	80
8. Chilka	82	20. Jalabala	91
9. Cranfield	87	21. Jaladuta	106
10. Ekma	89	22. Jalaganga	105
11. Elmadina	85	23. Jalakrishna	81
12. Erinpura	136	24. Jalamani	121

Name of Ship.	No. of messages.	Name of Ship.	No. of messages.
25. Jalamohan	149	42. Masimpur	166
26. Jalapatma	125	43. Nawab	91
27. Jalapalaka	115	44. Orna	75
28. Jalaputra	104	45. Pundit	87
29. Jalarajan	139	46. Pasha	76
30. Jalarashmi	110	47. Rahmani	75
31. Jalaratna	118	48. Ranee	100
32. Jalatarang	118	49. Rohna	108
33. Jalave ra	100	50. Singu	127
34. Jalavihar	110	51. Sirsa	76
35. Jalavijaya	111	52. Shwedagon	170
36. Jalajyoti	139	53. Sonavati	96
37. Karagola	76	54. Surada	104
38. Khandalla	88	55. Tanfield	86
39. Kbosrou	139	56. Varsova	102
40. Kohinur	116	57. Yenang Yaung	143
41. Maharaja	85		

A few pilot balloon messages were received by wireless from some H. M. ships.

The meteorological observations made on board the ships copies of which are sent regularly to this department by the Captains of several ships, mainly plying in Indian waters, and those extracted by the Department's marine clerks in Calcutta and Bombay harbours from as many other ships' logs as possible constitute the second principal source of marine data. The Department's thanks are particularly due in this respect to the British India, the Peninsular and Oriental, the Scindia, the Asiatic, the Bombay and Persia and the Bombay Steam Navigation and the Burma Oil, the Anglo-Iranian Oil and the Indo-Burma Petroleum Companies for the standing arrangements on a number of their ships to copy out and despatch extracts from weather logs on forms supplied by this Department. About 5,500 logs were so collected during the year.

Synoptic data for ships' use.—The issue by the Navy Wireless Station at Bombay of synoptic broadcasts containing data of selected stations and ships at about noon every day for the benefit of shipping in Indian waters was continued as in the previous year. On 1st June the issue of evening synoptic broadcasts in addition to the above, through the Navy Wireless Station at Bombay, was also commenced. From 1st October the morning and evening synoptics were issued in three parts, A for the Arabian Sea, B for the Bay of Bengal and C for the neighbourhood of Ceylon. From 16th October the upper air data of some coastal stations were added to both morning and evening synoptics. From 1st January a revised list of stations, more suited to the purposes of these broadcasts, was brought into force and the number of ships' reports in them was raised to a maximum of 12 in each.

III.—AVIATION METEOROLOGY.

Improvement in Organisation.—Further improvements were effected in the meteorological arrangements for the air routes. New pilot balloon observatories making two ascents daily were established at Rajsamand and Madhosagar to meet the requirements of the Flying

Boat Service; the installation of searchlights and visibility instruments at these stations was taken up. On the Karachi-Colombo route, the observatories at Bhuj, Malegaon and Hyderabad (Begumpet) began taking daily afternoon pilot balloon observations in addition to the observations in the morning. Arrangements were also made for a third pilot balloon ascent at Ahmedabad in the early morning. The observatory at Bangalore commenced taking daily an additional pilot balloon observation in the afternoon. With the transfer of the Imperial Airways seaplane base from Gwadur to Jiwani, about 80 miles west of Gwadur, the pilot balloon and current weather observatory at the former station was transferred to the latter. The pilot balloon and current weather observatories at Allahabad and Alipore (Calcutta) were shifted to the Aerodromes at Bamrauli and Dum Dum respectively. A temporary observer was posted at the seaplane base at Bally for about 3 months for the issue of special reports, mainly of visibility, for the benefit of the Flying Boat Service.

Arrangements were made for the supply of SPEMET reports from Cawnpore on requisition by airmen, and for the daily transmission of all MET reports issued from Allahabad and New Delhi to the Cawnpore Aerodrome, for exhibition on the Weather Notice Board there and supply to local enquiries. Arrangements were also made for telegraphing, as a routine measure, the morning and afternoon PILOT reports of Madhosagar to Delhi W/T for their transmission by wireless to Jodhpur and Allahabad, and their exhibition (instead of the Agra PILOT reports) on the Weather Notice Boards at Jodhpur, Delhi and Allahabad. Current weather (MET) reports of Bhuj were supplied to Karachi and Ahmedabad on days of southbound and northbound Tata Services respectively.

An Aviation Section has been started at the Upper Air Office, Agra, which with that office will later be transferred to Delhi. This Section will function mainly as an executive section in respect of observational arrangements on the air routes, and, when transferred to Delhi, will maintain a liaison with the Civil Aviation Department and the Royal Air Force.

Introduction of new international codes.—The international codes have been adopted with effect from 1st January, 1939, for all current weather reports, including the reports of dangerous phenomena and improvements of thereof issued from stations on the air routes. These codes provide for more detailed information relating to clouds and also for the issue of special reports in respect of thunderstorms and dust-storms at a distance, deterioration of visibility and low cloud. New editions of the pamphlet on Meteorological Organisation for Airmen and of the Aviation Weather Codes (Pocket Card) were issued.

Arrangements for the supply of weather reports and forecasts.—The Meteorological Offices at Karachi and Calcutta continued to share responsibility for the supply of weather reports and forecasts on the main trans-India route and the other routes over northern India, while the Poona Office issued forecasts for airmen in southern India.

The R. A. F. Meteorological Offices at Peshawar and Karachi supplied weather reports and forecasts for the R. A. F. flights in northwest India. On the trans-India air route, the routine arrangements for the issue of forecasts and upper wind and current weather reports by W/T to all main aerodromes and to aircraft in flight were continued. On other routes, schedules showing the manner in which weather reports and forecasts are to be supplied were prepared by the Meteorological Offices to suit the time-tables and needs of the air services, as in previous years. On the Karachi-Colombo route, arrangements were made for the routine distribution of pilot balloon and current weather reports. Arrangements were also made for the supply of weather reports and forecasts to the Air Services of India, Ltd., for their Bombay-Porbandar Service and to the Indian National Airways for their Lahore-Delhi Service.

Weather reports and forecasts were also supplied, on requisition, to various individual fliers, the Flying Clubs and to R. A. F. planes and squadrons. The following were some of the special flights for which weather reports and forecasts were supplied:—The flights of (1) the Under-Secretary of State for India, (2) His Excellency the Viceroy from Calcutta to Jamshedpur, (3) His Excellency the Governor of Bombay from Bombay to Calcutta and back, (4) His Excellency the Governor of Sind from Ambala to Karachi, (5) the Chatfield Committee, (6) the R. A. F. long distance flight from Ismailia to Australia and (7) the German plane "Condor".

Statistics of aviation forecasts and current weather reports.—The total number of aviation forecasts, as distinct from aviation weather reports, issued during the year was 8,976, of which Karachi office was responsible for 4,476, Calcutta for 1,576, Poona for 2,337, Peshawar for 346 and the R. A. F. Meteorological Office, Karachi for 241. Altogether about 15,000 routine current weather reports and about 14,000 upper wind reports were issued from stations on the various air routes, most of them being distributed by wireless. In addition, nearly 7,000 special current weather reports in answer to requisitions by aircraft and about 1,000 warnings of adverse weather and improvement thereof were issued by the chain of current weather stations along the air-routes.

General.—Arrangements were made for hourly—and in case of bad visibility half-hourly—observations of visibility at the principal aerodromes in India at which meteorological staff is posted.

Pilots of some of the regular air services continued to send in their weather logs and occasionally AERMET messages from the air. The AERMET messages help considerably in forming a clear idea of the weather conditions which prevailed during the flights and of their possible developments.

24 candidates for the pilot's "B" licence were trained and examined in Elementary Meteorology.

In connection with the incidence of fog over the Hooghly river near the Bally Bridge and a possible alternative spot for alighting of sea-planes, an examination of the occurrence of fog, mist and haze phenomena at stations round about Calcutta, in south Bengal and Orissa was made for the months of December, January and February during the years 1935-38.

IV.—SQUALL, HEAVY RAINFALL AND FROST WARNINGS.

Inland weather warnings and forecasts.—The majority of officers to whom warnings of heavy or untimely rain and strong winds on land were issued were district officers and officers of the Irrigation, Railways, Police, Telegraph and other departments. In addition to these, officers of agricultural departments, a number of district officers and some private agriculturists were warned of conditions favourable for the occurrence of frost. The total number of addresses on the Poona warning list was 232 and on the Karachi list 15. In the case of Calcutta, the inland warning list consists not only of the officers and interests mentioned above but also of river ports, river boat stations and police stations which receive special warnings for storms and occasionally for nor'wester squalls. The Calcutta warning list had on its roll 74 Irrigation, Railway, Telegraph and other officers, 58 Police Stations, 13 River Boat Stations and 8 River ports. In addition, 415 district and police officers in Bengal received great danger warnings in respect of cyclones likely to affect their areas. Apart from these specific warnings to individual officers, the Daily Telegraphic Weather Summaries contained heavy rainfall and cold wave forecasts and all subscribers thereto and others to whom the information became accessible thus received these warnings. In addition to warnings sent to those on the standing lists referred to above, warnings were also issued in response to special requisitions.

The experimental scheme for the supply of heavy rainfall, untimely rainfall and low temperature warnings to Collectors of the Bombay Presidency introduced at the instance of the Government of Bombay continued to be in operation during the year. The provincial Agricultural Officers as well as 27 officers of the United Provinces Agricultural Department also received warnings, as in the previous year.

The Meteorological Office at Calcutta issued 4,463 inland warnings, including special weather bulletins for rivercraft, warnings of probability of thundersqualls in Bengal and great danger warnings to the District and Police Officers. The Poona Office issued 2,303 inland warnings including those of low temperature and occasional special messages and the Karachi Office issued 244 warnings. 742 heavy rainfall telegrams were sent direct to various officers by departmental meteorological observatories.

41 officers on the Poona warning list and 124 officers on the Calcutta list sent reports on the inland warning system. Nearly all of them expressed satisfaction with the warnings received by them. As in the last year, a number of Collectors of the Bombay Presidency reported

that although the warnings issued were correct, full advantage of them could not be taken due to difficulties in dissemination of the information to the villages in time, and suggested that warnings should be sent direct to Mamlatdars of Talukas. A note on the subject was sent to the Bombay Government.

The suggestions or criticisms received from officers throughout India were examined and suitable action taken. The following are extracts from some of the reports:—

The Executive Engineer, Cossye Division, Midnapore reported—

“No warning telegrams were found defective. All were timely, useful and satisfactory in every respect.”

The Officer-in-charge, Fulchari P. S. wrote—

“These were received timely and were very useful and satisfactory. For receiving these telegrams timely nothing untoward happened to any boat or steamer during the year 1938.”

The Chief Officer, Ahmedabad Municipality wrote—

“.....all the warnings except three were more or less followed by the actual occurrence of the event as forecasted.”

The Superintending Engineer, Public Works Department, Trichinopoly reported—

“These warnings are generally timely and useful except in a few cases where no such intimations were received.”

The Superintending Engineer, III Circle, Irrigation Works, U. P. stated—

“.....There is not the slightest doubt that the warnings serve a very useful purpose.”

V.—OFFICES AND OBSERVATORIES.

A list of the staff of the India Meteorological Department as it stood on the 31st March, 1939 is given in Appendix A.

Headquarters Office, Poona.—Dr. S. K. Banerji and Dr. K. R. Ramanathan were appointed Superintending Meteorologists in the Headquarters Office, the former being placed in charge of administrative matters and the latter of technical matters. Dr. C. W. B. Normand, Director General of Observatories, proceeded on leave *ex-India* for 6 months and 7 days with effect from the 18th March 1939, and Dr. S. K. Banerji was appointed to officiate as Director General of Observatories. Mr. V. V. Soboni was transferred from Karachi to Poona to officiate as Superintending Meteorologist. The important items of scientific work done in this office have been given in the section on Chief Features, but it may be added that 11 scientific colloquia were held, the discussions being opened by a member of the staff or sometimes by an outside scientific worker either on a special

subject of interest or his own scientific work. A conference of departmental officers was held in July, 1938 and its recommendations were considered and, as far as possible, acted upon. Two officers were deputed to attend the Lahore Session of the Indian Science Congress, one of them being Dr. K. R. Ramanathan, the President of the Physics and Mathematics Section of the Congress. The subject of Dr. Ramanathan's address was "Earth's Magnetism and the Upper Atmosphere."

The Director General of Observatories was nominated India's representative on the Meteorological Sub-Commission of the International Commission for Air Navigation.

384 requests for scientific data and information were replied to.

His Excellency the Governor of Bombay and Lady Lumley paid a visit to the office in July.

Mr. M. P. van Rooy, Meteorologist, the Union of South Africa Meteorological Office, Pretoria, who arrived in December on a five months' deputation, was given all facilities and help in seeing and studying the methods and organisation work of this Department.

The activities of the different Sections of the Headquarters Office are briefly described below:—

General Section.—The section dealt as usual with matters relating to the administration of headquarters and sub-offices including such items as budget, accounts, establishment, works, stationery, forms, printing, publications, general registry and matters involving fresh expenditure, as well as arrangements for the co-ordination of work. As a result of the reorganisation sanctioned during the year, an Aviation Branch was created in the section to deal with questions relating to meteorological work for aviation and to attend to and carry out international recommendations.

Considerable time was given to finding out ways and means to give effect to the economy orders issued by Government. On certain grave difficulties being brought to the notice of Government in giving effect to the orders prohibiting appointments of outsiders, Government sanctioned certain relaxations with regard to the recruitment of outsiders in vacancies at the surface, current weather and pilot balloon observatories.

The local audit of the accounts for the years 1936-37 and 1937-38 took place in April and action was taken on the audit report.

A revised, 1939 edition of the "Functions and Organisation of the India Meteorological Department" pamphlet was published.

A scheme for the regional synoptic broadcasts from Calcutta, Karachi and Poona, and collective broadcasts from Poona was drawn up.

Weather Section.—The normal duties of this section, viz., the issue of warnings to shipping and ports in the Arabian Sea and to individual interests in respect of heavy rainfall and low temperatures for the whole country excepting northeast India and Sind, of weather reports to all aircraft in the Peninsula, of Daily Weather Telegrams and of the Daily, Weekly and Monthly Weather Reports and the preparation of portions of the Annual Summary for the India Weather Review were carried on as usual.

The Government of India sanctioned on a permanent basis from 1st April 1939, the preparation of the afternoon chart at Poona.

Synoptic broadcasts from Hanoi, Cavite, Baghdad, Abu Zabaal, Singapore, Ismailia, Bandoeng and Beyrout were received as an experimental measure towards the end of the year and their data were plotted on weather charts with a view to examine their utility in day to day forecasting for Indian areas. The examination revealed that these observations from the surrounding areas considerably help in understanding the day to day changes in weather in India. With the starting of the Poona W/T station from the middle of April 1939, as mentioned earlier, it will be possible to receive regularly throughout the year the above and some other meteorological broadcasts of neighbouring countries.

- Owing to an increase in the frequency of the Tata Air Services to five per week and the opening of new air services, the aviation work of this Section increased considerably, the total number of aviation forecasts issued during the year being about double of that in the previous year.

Special forecasts of weather for the Nanga Parbat area were supplied to the Meteorological Reporter, Srinagar in connection with the German Himalayan Expedition.

The resolutions passed by the Commission for Synoptic Weather Information at its meeting held at Salzburg in September 1937 were considered and suitable action was taken where necessary. The methods of preparing the most important weather charts were brought in line with international practice. An examination of the gustiness factor in day to day forecasting was taken in hand and some additions and alterations were introduced in the different codes in use in the department.

The working of the experimental scheme for the supply of heavy rainfall and low temperature warnings to Collectors of the Bombay Presidency was reviewed, and a short note on the subject sent to the Government of Bombay.

The revised Brief Weather Code 1938 was introduced from 1st July 1938.

The publication in the Indian Daily Weather Report of the data of Burman stations (excepting a few selected ones) was discontinued and the space thus saved was utilised to publish the data of a few Iranian stations from 1st September.

Four candidates for pilot's "B" licence were trained and examined in Elementary Meteorology.

Observatories Section.—As usual this section continued to administer and arrange for the inspection of departmental observatories in central and southern India and to supervise generally the administration of surface observatories immediately controlled by sub-offices. In connection with the daily afternoon weather chart at Poona, seven observatories in the Peninsula were raised to the second class. The observatories at Karwar, Hyderabad (Deccan), Ichalkaranji, Madras (Flying Club) and Gnatong were closed and Coonoor was reduced from class II to Class III. The administrative and technical control of Aden Observatory was transferred to the Colonial Office. Government sanctioned the starting of second class observatories at Rajsamand and Madhosagar.

Revised instructions for tabulating hourly values of the velocity, direction and gustiness of wind from Pressure Tube Anemograms were prepared and brought into use at anemograph stations from 1st January.

In connection with problems incident to aerodrome planning, the Director of Civil Aviation in India proposed that steps be taken to obtain detailed wind data at all principal civil aerodromes. Accordingly, arrangements were made at certain observatories of the department for wind direction and velocity to be recorded five times daily.

42 observatories were inspected during the year.

With a view to find out the difference in the synoptic charts prepared according to (a) absolute time and (b) local mean time, certain observatories were instructed to record observations at 8 hours I.S.T. besides the usual 8 hrs. local time observations during the periods 4th to 10th July 1938 and 10th to 16th January 1939, and the data so recorded were examined.

Instruments Section.—The section continued to be responsible for the purchase, test, standardisation and repairs of meteorological instruments and for the issue of such instruments and the supply of forms and stationery to all surface observatories.

The work of gradually replacing the old instruments at observatories with up-to-date ones of I. M. D. specifications started in 1932, was nearly completed, and good progress was made in the introduction of Kew pattern barometers at the plain stations. Preliminary action was taken to supply the coastal observatories with wind instruments coated with a special paint which was found to resist better the effect of the salt laden atmosphere at sea-coast observatories. About 1,800 instruments were purchased and about 1,500 instruments were issued to departmental observatories. The purchases and issues of instruments and stores had to be curtailed owing to the large cut in the financial allotments.

A searchlight and an alidade were temporarily installed at the Juhu Aerodrome observatory for cloud-height observations at night, and the erection of a Dines P. T. Anemograph at that observatory was also being arranged. Electrical wind instruments were supplied for installation at Karachi.

At the request of the Director, Burma Meteorological Department a few wind instruments and copies of certain I. M. D. specifications were supplied. One thermograph was loaned to the Archæological Department. The total number of instruments loaned to outside organisations was 23. About 60 enquiries relating to meteorological instruments, etc., were dealt with. About 900 instruments were tested, 250 repaired and 65 wind instruments made or remodelled. An apparatus was assembled to compare the opacities of the plates in Bennet-Casella visibility meters. Some alterations were made and improvement effected in the recording unit of the Milne-Shaw seismograph at Colaba. For pilots' notice boards at Aerodrome observatories, 530 arrows and 44 cylinders were made in the workshop and detailed instructions and drawings were prepared for the pictorial or visual representation of "upper winds" and "current weather" reports on the boards. One raingauge for recording the intensity of rainfall and an electrical windvane for indicating at a distance the direction of wind by visible signals were developed. A large number of accessories such as housings, stands, etc., for the searchlight equipments was also made.

A few new exhibits were added to Poona Meteorological Museum and a complete inventory of the exhibits was prepared. About 1,300 visitors on 98 different occasions were shown round the observatory.

Marine Section.—The normal duties of the section, *viz.*, the co-ordination of the work of collection, examination and study of ships' weather logs and of issuing instructions for observations at sea and maintaining contact with shipping interests were carried on as usual.

The improvements made in the system of synoptic broadcasts through the Navy Wireless Station, Bombay have already been referred to in the section on Marine Meteorology.

Statistics of ships' W/T messages received and broadcast during 1938 were supplied to the President of the Sub-Commission for the Radiometeorological Organisation of the Oceans. Dry and wet bulb readings recorded at different heights above water on H.M.I.S. Investigator from October 1937 to April 1938 were being studied. Climatological data and other information were supplied to the London Meteorological Office for the Navy Meteorological Handbook for the East Indies.

The circulars issued by the Sub-Commission on Swell of the International Commission of Maritime Meteorology were studied and necessary action was taken. Suitable action was also taken on the resolutions adopted by the International Maritime Commission at their July 1938 meeting at De Bilt.

A circular letter was issued to all ships in Indian waters inviting them to make and transmit daily a second set of routine observations, at 12 GMT from 1st January and other observations according to the new schedule of times. A new edition of Part 2 of the Weather Code for Ships (1936)—weather broadcasts to ships—was prepared.

The essays in Meteorology by cadets of the Indian Mercantile Marine Training Ship Dufferin were judged, and a suitably inscribed aneroid was sent to the Captain Superintendent, Dufferin, for presentation to the winning cadet.

Upper Air Section.—As in the previous year, sounding balloon work was carried on at Madras or Bangalore (with the co-operation of the Government of Mysore) according to season. To study the properties of the monsoon current, sounding balloon ascents were made daily at Trivandrum, with the co-operation of the Meteorologist to the Government of Travancore, for about three weeks in July; ascents at Ahmedabad and Madras were also arranged on these days to obtain comparative data. Altogether 94 instruments were let off during the year and 46 were recovered.

The data from aeroplane ascents at Peshawar and Karachi were reduced and prepared for publication. Measurements of the heights of bases of low clouds were made every night at Poona during the monsoon by search-light.

A paper summarising the results of sounding balloon ascents at Madras was completed and is in course of publication; another on the results of sounding balloon ascents made at Poona and Madras during the Polar Year was nearly completed. Studies on the (1) application of saturation and saturation-potential temperatures to the recognition of air masses in storms, (2) the special sounding balloon ascents made at various stations during a monsoon depression in 1937 and (3) upper winds at high levels over Poona, were in progress.

Three accelerometer films exposed by the pilots of Messrs. Tata Sons, Ltd. (Aviation Department) while flying over the Western Ghats were analysed to study the vertical currents experienced by aeroplanes in bumpy air.

Statistical Section and Library.—The duties of this section include statistical work connected with the issue of seasonal forecasts and with climatology; the care of the library, the editing and distribution of departmental publications, and supply of miscellaneous information—in reply to inquiries are also included in the work of the section.

Statistical investigations to improve the existing formulæ for the seasonal forecasts were continued as in the previous years, and some of the formulæ were revised after omitting such factors as were recently found on examination to be statistically non-significant.

As new tables for the calculation of relative humidity based on recent values of saturation pressures of water-vapour have been used in the Department since 1938, revised tables for the calculation of vapour pressures also from the same values of saturation pressures, were prepared.

The usual monsoon rainfall forecasts were issued in June and August; as the indications were conflicting as to what the winter precipitation would be, no forecast of winter rains was issued.

Requests numbering 287 for climatological, meteorological and astronomical information were received and replied to.

The publications sent to press are shown in Appendix B. Abstracts of meteorological papers published in India in 1937 were sent to the Office National Meteorologique, Paris, and of papers relating to meteorology, geo-physics and solar physics to the National Institute of Sciences of India; the titles of these papers, with reprints as far as available, were also sent to the Meteorological Office, London.

The routine activities of the Climatology Branch and the usual advisory functions of the Director General of Observatories with regard to the registration of rainfall, inspection of raingauges and preparation of provincial rainfall tables were carried on as usual. A circular was issued to the various officers in charge of rainfall registration in the different provinces and the Indian States to arrange for the observations being taken uniformly at 8 hrs. L.M.T. instead of at 8 hours. I.S.T.

The International Meteorological Committee at its Locarno meeting of 1931, entrusted the publication of a "Gazetteer of Meteorological Stations of the World" to the International Meteorological Secretariat, De Bilt. At their request a gazetteer of meteorological stations under this Department was prepared and forwarded to the Secretariat.

As it was found necessary to have 17 hrs. (I.S.T.) pressure normals in connection with the analysis of afternoon charts, a suitable method was adopted to derive these values from the available normals for 8 hrs. L.M.T., and the work of preparation was taken in hand.

Agricultural Meteorology Section.—Proposals for making the Agricultural Meteorology Section permanent were under consideration of the Government of India. In the meantime, the Imperial Council of Agricultural Research continued to finance the Section as in previous years.

The grounds and instrumental equipment of the Central Agricultural Meteorological Observatory were extended, and a 35 ft. tower was constructed to study the exchanges of heat and moisture between the surface layers of the soil and of the atmosphere. A new instrument was designed for measuring the proportion of rain or irrigation water lost by evaporation and percolation respectively and the fraction actually retained in the soil layers with which plants are concerned. One of these instruments was made and was under test. Experiments on the movement of moisture and salts through soil layers resting on a water table were made. Similar experiments were made with samples of "normal" and "kallar" or alkali soil samples received from the Punjab Agricultural Department. Measurements of (1) solar and sky radiation, (2) radiation minimum temperatures under different conditions of exposure, (3) the effect of surface covers on soil temperature, (4) evaporation from soil and water surfaces, (5) the effect of

size of Stevenson screen on temperature records, (6) transpiration from plants, (7) the climates of different crops, (8) the exchange of moisture between plant materials and the atmosphere, (9) the seasonal variation of the nitrogen content of the surface layers of the soil, etc. were continued.

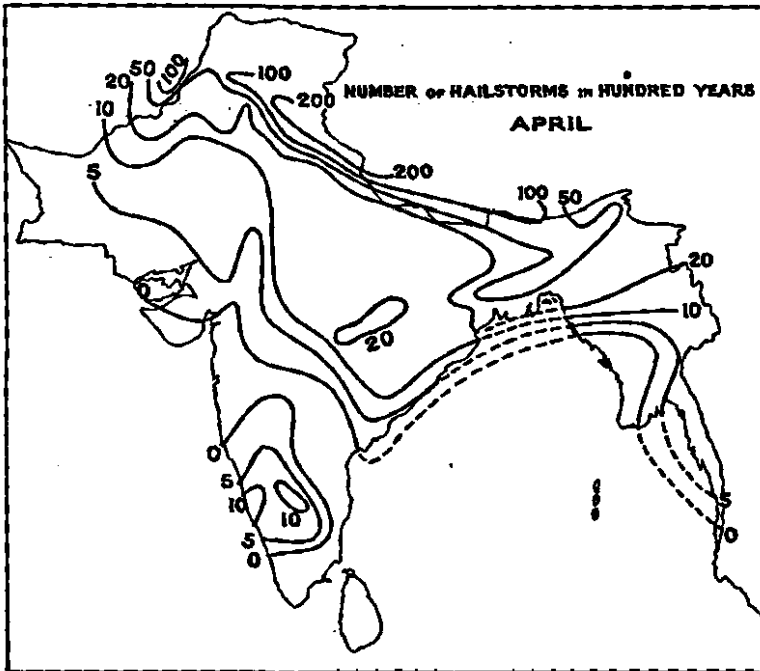
Precision crop-weather observations at Poona and Karjat were continued and some experience was gained in applying the sampling methods to the estimation of the yields of crops. Much of this work was done with the co-operation of agricultural officers. Besides working out the results of the above experiments and the data collected at the observatory, the statistical branch also made progress with other investigations, *e.g.*, (1) the date and type of onset of the southwest monsoon along the west coast of peninsular India, (2) the secular variation in the frequency of frosts in Gujarat, (3) the seasonal distribution of rainfall in the Bijapur district, (4) the analysis of rainfall in Amraoti district, etc. Items (2) and (3) above were taken up at the instance of the Bombay Government, the former to see if cold waves are becoming more frequent in Gujarat and the latter to indicate the permanent measures that may be taken to minimise the effects of famines in that district.

The Section continued to act as a liaison between meteorology and agriculture by helping agricultural workers in setting up farm observatories, by training their assistants deputed to Poona for the purpose and by calibrating or repairing their meteorological instruments when sent to Poona. Special attention was also given to the officers in charge of the Locust, Dry Farming, Sugarcane, and Cereal Rust Research Schemes of the Imperial Council of Agricultural Research. Another aspect of the liaison was to discover the types of weather forecasts and warnings that would be most useful to the farmer generally and to arrange for the issue by the All-India Weather Forecasting Section at Poona of these warnings and forecasts. The experimental scheme for issuing warnings to district officers of cold-waves and heavy rainfall in the Bombay Presidency having run for two years, was reviewed and a note on the subject was sent to the Government of Bombay. The issue of cold-wave warnings to the provinces and Indian States liable to them was continued.

The Agricultural Meteorologist attended the meetings of the Standing Committee on Field Experiments of the Imperial Council of Agricultural Research in November 1938. The Science Congress meetings at Lahore gave him further opportunities to come in contact with the leading agricultural research workers in the country.

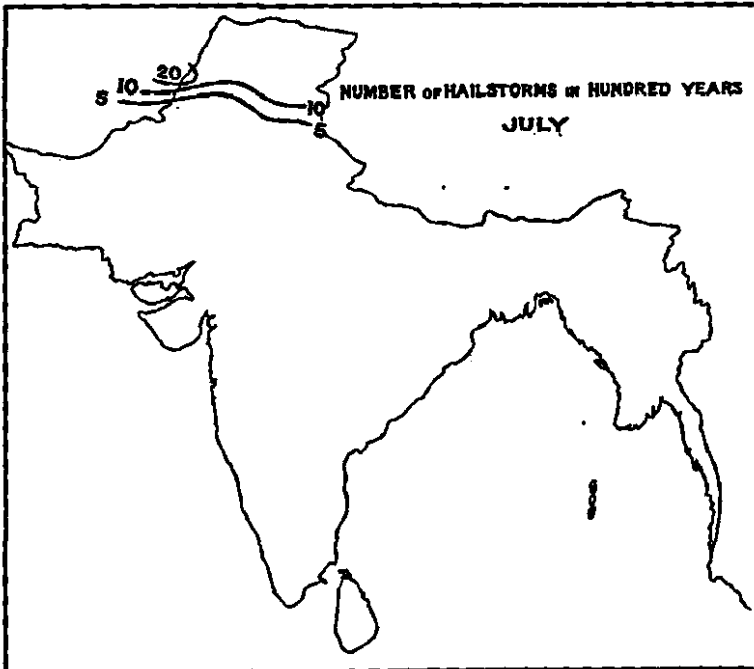
A number of original papers and notes were prepared or published.

The staff of the Agricultural College, Poona continued to extend their valuable co-operation as in previous years. Particular mention must be made of the co-operation of the Agricultural Chemist, who gave considerable help in the work on the seasonal variation of soil nitrogen, and of the Crop Botanist, who continued to give his help in the precision-studies on paddy



HAILSTORMS: WHERE THEY OCCUR MOST FREQUENTLY.

Hailstorms are generally most frequent in April, their number being relatively the largest in the hills of North India. In the Himalayas 100-200 hailstorms occurred at each station during the last 100 years.



HAILSTORMS: WHERE THEY OCCUR.

Hailstorms in July are generally confined to extreme north where their number during the last 100 years varied from 20 to 5 as shown. Elsewhere their number has been 3 or less during the same period.

Upper Air Observatory, Agra.—This observatory continued to control the work of the pilot balloon stations of the department and maintain supplies of hydrogen, balloons and other stores to all the stations.

With the reorganisation mentioned among the Chief Features, the post of the Meteorologist-in-charge was converted into that of Superintending Meteorologist and an additional post of Assistant Meteorologist was sanctioned. A new aviation section was formed and was placed in charge of an Assistant Meteorologist. The full administrative and technical control of the auxiliary centres at Jodhpur, New Delhi and Bamrauli and the combined pilot balloon and current weather observatories along the trans-India air route was transferred to this office from 15th November.

Two new pilot balloon observatories were started at Madhosagar (Gwalior) and Rajsamand (Udaipur) seaplane bases on the trans-India seaplane route in May. The total number of pilot balloon stations in the department at the end of the year was 84. The pilot balloon stations at Allahabad and Gwadur were shifted to Bamrauli and Jiwani respectively. 11 pilot balloon observatories were inspected during the year. Towards the end of the year the Inspector of Observatories was sent to Car Nicobar to investigate the possibilities of starting a pilot balloon station there. The pilot balloon observatories at Bangalore, Begumpet and Bhuj started afternoon flights from the 20th May, 20th June and 19th July respectively, in connection with the development and organisation of air routes in India.

The observatory continued to supply hydrogen gas to the Burma Meteorological Department in lieu of payment. A few instruments were also supplied on loan.

As before, the technical data received from the pilot balloon observatories were scrutinised, sounding balloon records were regularly worked out, manuscripts of upper air data were prepared for publication and seismic data were tabulated. The duties of a first class observatory were also carried out as in previous years. Copies of monthly wind frequency tables for three coastal stations for three years and for ten coastal stations for two years were prepared for supplying to the London Meteorological Office in connection with the preparation of a handbook of local weather for the use of Naval officers.

The office manufactured 3,66,400 cubic feet of hydrogen during the year including that supplied to the Burma Meteorological Department.

Upper air instruments such as the sounding balloon meteorograph were manufactured as usual.

153 sounding balloon ascents were made at Agra, 88 at Ahmedabad and 47 at Sambalpur. 63 instruments let off at Agra (12 of these being those sent prior to 1st April 1938), 24 at Ahmedabad and 9 at Sambalpur were retrieved.

34 requests for scientific information and data were replied to.

In connection with a study of atmospheric turbulence over the aerial route from France to Indo-China by an Air France survey

plane, detailed instructions on cloud and special balloon observations were issued to Drigh Road, Jodhpur, Allahabad, Gaya, Dum Dum and Chittagong. Instructions for special surface observations were also issued to Gaya and Chittagong.

Arrangements were made for the supply of special pilot balloon data to Imperial Airways pilots for the extra services during Christmas.

Facilities were given, as before, to Dr. K. C. Mehta of the Agra College in his investigations on the transport of spores of cereal rust.

Candidates numbering 19 for the pilot's B-licence were trained and examined in Elementary Meteorology.

The equipment for carrying on regular aerometeorograph ascents at the R. A. F. Meteorological Offices was developed. Further work was done on the development of an apparatus for calibrating a number of meteorographs at a time. Some work was done on the design of a cheap photo-thermograph to replace the present aeroplane strut psychrometer for observations of wet and dry bulb temperature in aeroplanes. The production of cheap but efficient dry cells for night pilot balloon and radio-meteorograph ascents was attempted. Preliminary work on the local manufacture of Harvard type radio-meteorographs was started. The new type of French H. I. C. Hydrogen generators (portable) were tried at Agra and one was sent to Port Blair.

The title of Rai Bahadur was conferred on Mr. G. Chatterjee, Superintending Meteorologist, in the New Year Honours.

The Hon'ble Member in charge of the Department of Communications and Mr. S. A. Rafique, Information Officer, Government of India, Home Department, visited the observatory.

Colaba and Allbag Observatories.—These observatories form the Departmental centre for geophysical studies and carried on as usual meteorological, seismological, magnetic and atmospheric electricity work. The Colaba Observatory also received regularly the rhythmic time signals from Bordeaux or Rugby for rating the standard clocks and maintained a time service for the port of Bombay; the time ball at the Princes Dock Tower was dropped regularly at 8-30 A.M. I.S.T. It continued to stock the Royal Indian Navy's chronometers and watches for maintenance and rating, the average number of instruments for daily rating being 67. The collection of weather logs from ships calling at the Bombay port and the standardisation of their barometers were carried on as in previous years. Pilot balloon work was carried on at the Juhu Aerodrome Observatory; 11 "Meteor" reports were supplied by this observatory to the Officer Commanding, 14th Heavy Battery, R.A., Colaba. The Bombay Daily Weather Report was issued as usual during the period 1st May to 30th November.

A few photostat copies of Colaba seismograms were sent on request to foreign seismological and geophysical institutes. The work of scrutinising and collating seismological observations made at the departmental seismic stations was continued as in previous years.

The total number of shocks recorded with origin in India and neighbourhood was 39. The publication of a quarterly Seismological Bulletin was commenced.

Continuity of registrations and of absolute determinations of the various magnetic elements was maintained at Alibag. Data regarding the magnetic character of days and the daily ranges of variation of magnetic elements were supplied regularly to the Royal Meteorological Institute, De Bilt, the Solar Physics Observatory, Kodaikanal and the Physics Department, Allahabad University. In accordance with the request of the International Commission for Terrestrial Magnetism, the Colaba magnetic data for the years 1872 to 1882 were classified for their magnetic character according to Greenwich days and sent to the Chief Director, Royal Netherlands Meteorological Institute, De Bilt, Holland. The year was noteworthy for unusual magnetic activity, 19 magnetic storms of moderate intensity and 10 of great intensity being recorded by the magnetograph at Alibag. The Telegraph Department, Bombay, continued to be intimated of these storms immediately it was known that one was in progress.

Copies of the observatory volume for 1936 were distributed and the proofs of the volume for 1937 were returned to press.

The W/T operators on four ships of the Bombay Steam Navigation Company were trained in meteorological work.

248 enquiries regarding meteorological, seismic, magnetic and astronomical information were answered. About a thousand persons were shown round the observatory.

His Excellency the Governor of Bombay and Lady Lumley paid a visit to the Alibag Observatory in December 1938.

Investigational work in various subjects was pursued. A study of the land and sea breezes, of the variation of rainfall between different places in Bombay and of the differences between the dry bulb and maximum temperatures in the Kew type shed and in a Stevenson screen at Colaba was commenced. Papers on the climatology of Bombay and changes of atmospheric potential gradient associated with monsoon rains in Bombay were prepared. Studies of the Hindu-Kush earthquake of the 14th November 1937 and the Khandwa (C. P.) earthquake of the 14th March 1938 were in progress and an examination of the records of the Chilean earthquake of the 25th January 1939 was undertaken. A study was commenced of the severe magnetic storms recorded at Alibag during the sunspot cycle 1928-38. A study of the electrical characterisation of days at Colaba was also commenced.

Alipore Observatory and Meteorological Office, Calcutta.—The principal functions, *viz.*, (1) storm warning for the Bay of Bengal, (2) heavy rainfall warnings for northeast India and the adjoining areas, (3) squall warnings for Bengal, (4) the issue of weather reports and forecasts to the aviators for air routes in northeast India and the east United Provinces including the trans-India air route between Allahabad

and Akyab, (5) determination and supply of correct time for the public, the seamen and the Telegraph Offices in India, (6) publication of the Calcutta Daily Weather Report, (7) the issue of a daily weather bulletin briefly summarising the weather conditions at the head of the Bay and over Deltaic Bengal to the All-India Radio for broadcasting and (8) the meteorological and seismological observations, were carried on as usual. Storm warnings were issued to shipping in Burman waters and to Burman Ports as before; this work has however been taken over by the Burma Meteorological Service from 1st April 1939.

In addition to the first class observatory at Alipore, the Auxiliary Centre at Dum Dum and the current weather station at Asansol, the Calcutta Office had under its control 77 surface observatories including the voluntarily co-operating observatories at Jamshedpur, Dhanbad, Lumding and Cooch Behar. Inspection was made of 36 departmental and 1 non-departmental observatories.

Meteorological instruments belonging to the Mathematical Instruments Office, Calcutta, the Chemical Examiner to the Government of Bengal, the Indian Association for the Cultivation of Science, the Divisional Forest Officer, Palamau and ships' Captains were tested. Some part-time observers of the department and a teacher deputed by the Education Officer of the Tata Iron and Steel Co., Jamshedpur, were trained in meteorological work. About 325 teachers of High Schools in Bengal and Assam undergoing training in Science and Geography at the Calcutta University were given facilities to see the working of the various instruments at the Alipore Observatory.

217 requests for scientific information and data were replied to.

The pilot balloon work and a part of the current weather work of the Alipore Observatory was transferred to the Dum Dum Aerodrome on 30th April.

The Hon'ble Mr. S. N. Roy, C.S.I., C.I.E., I.C.S., Secretary to the Government of India, Department of Communications visited the Calcutta Office in December 1938.

Meteorological Office, Karachi.—On completion of the Administrative Buildings and residential quarters at the Karachi Air Port, Drigh Road, the office was shifted from its rented premises in the city of Karachi to the Air Port on the afternoon of the 30th December 1938.

The Office supplied weather reports and forecasts for the Sharjah/Jask-Allahabad section of the main air route (both for the land and sea planes) and for the feeder routes between Karachi and Delhi via Lahore, between Karachi and Ahmedabad on the Karachi-Colombo route and between Bhopal and Delhi on the Bombay-Delhi route, and for other routes within its area of responsibility. Current weather and upper wind reports (including warnings of adverse weather) commenced to be supplied by W/T to the Imperial Airways flying boats operating between Karachi and Allahabad.

With the increase in the frequency of services run jointly by the Imperial Airways and the Indian Trans-Continental Airways to 5 per week and the corresponding increase of the Indian National Airways

and Tata Services, the schedules of supply of meteorological data to pilots were suitably revised. Logs of the pilots of the Indian Trans-Continental Airways, the Indian National Airways and the Tata Services were received regularly. The pilots of almost all services continued to visit the office frequently to discuss weather conditions personally with the officers.

The R.A.F. Meteorological Officers at Peshawar, Hinaidi and Helio-polis continued to be supplied with observational data as usual. In addition to the R.A.F. long distance flight from Ismailia to Australia mentioned earlier, forecasts were issued for a large number of R.A.F. planes and squadrons. Weather reports and forecasts numbering 153 were issued to the R.A.F.; 3,222 sets of routine data were also supplied from the Drigh Road observatory. The number of sets of observations received from the R.A.F. was 1,656. The office continued to receive observations of temperature and humidity made in R.A.F. aeroplane ascents.

During the year 31 observatories were inspected. Progress was made in regard to the starting of second class observatories at Cawnpore Aerodrome and at Phalodi. The auxiliary centre at Jodhpur began to function as a first class observatory with all the surface observatory instruments except the Dines P. T. Anemograph from 1st April.

The reception and issue of regional broadcasts were continued as in the previous year.

The observatory at Drigh Road continued its usual work as pilot balloon and first class surface observatory; it also took the current weather observations during its open hours and passed them on to the main office for further disposal. The observatory continued to train some of the observers proceeding to the Persian Gulf sections in observational work.

521 requests for meteorological information were answered. Co-operation was extended to Mr. Subrahmanyam, Aerodrome Officer, Karachi Air Port, in carrying out experiments in the sending up of balloons such as would be of use to fliers in locating aerodromes from above during fog.

One pilot was examined in Elementary Meteorology for the B-licence and two trained.

The office took part in an exhibition arranged in connection with the opening ceremony of the Air Port Buildings. A large number of visitors including His Excellency the Governor of Sind and many other distinguished persons were shown round the exhibition.

Kodaikanal Observatory.—The routine work of the observatory was carried on as in previous years, and co-operation extended to the other observatories under the auspices of the International Astronomical Union. Calcium flocculi spectroheliograms numbering 318 were sent to the Solar Physics Observatory, Cambridge and reports on prominence statistics and the general work of the observatory for the year 1938

to the Royal Astronomical Society, London. The usual statements of character figures of solar activity, of bright eruptions and of spectrohelioscope observations were supplied to scientists and institutions interested in them.

The Annual Report of the observatory for the calendar year 1938 gives a summary of the solar and astronomical researches carried on during that year. A line-shifter for use with $H\alpha$ -spectroheliograph was designed and mounted. A 12" siderostat was built up from the parts received from the Takthasingji Observatory, Poona and mounted; the siderostat has been temporarily fitted with a 7" mirror. A monochrometer for use with the 13' prism spectrograph was constructed and mounted; a few experimental plates were also taken with it. In order to obtain high dispersion spectrograms of the sun at the centre and the limb, a 20' grating spectrograph in Eagle mounting was constructed. Some photographs were obtained for making a photometric study of the changes of the Magnesium b lines and other strong Fraunhofer lines from the centre of the sun's disc to the polar limb and to the equatorial limb. A study of the spark spectrum of Bromine from 2200 to 6500 Å was undertaken. A statistical study of prominence areas to determine the possible influence of the earth on solar prominences was also taken up. Some measurements of the intensity of cosmic radiation were made to study its diurnal variation with reference to sidereal and mean times.

38 requests for scientific information and data were replied to.

His Excellency the Governor of Madras and Lady Erskine visited the observatory in October 1938.

The Director was elected a member of the International Solar Commission in August 1938.

Meteorological Office, Quetta, temporarily located at Karachi.—This office remained under the charge of an officer deputed from the India Meteorological Department and paid for by the Royal Air Force. It continued to be housed in the premises of the civil meteorological office in Karachi up to the 30th December after which it was shifted to the new administrative building at the Karachi Air Port, Drigh Road along with the latter office.

Regional weather forecast for Sind and Baluchistan together with local forecast for Karachi was supplied by telephone daily to the Aircraft Depot, to the Western Command, Karachi till its abolition and to 31 A. C. Squadron, R.A.F., Drigh Road till its shift to Lahore. A copy of the regional forecast only was supplied by R.A.F. W/T to the R.A.F. station, Fort Sandeman. Since the 25th February 1939, an extract from the regional forecast is also being supplied through army signals to the Western (Indpt.) District, Quetta. After the shift of the office to the Air Port, the routine forecast is being issued daily in the morning (about 8 hrs.) except on Sundays and R.A.F. holidays instead of every night (except on Saturdays) as prior to the shift. Four new forms were brought into use for exhibition of forecasts and observational data at the Aircraft Depot on a separate meteorological notice board.

In addition to the routine forecasts mentioned above, 215 route forecasts and 12 local forecasts including 5 for night flying, 22 'Meteor' reports for artillery practice were also issued on request. Requests from the R.A.F. and army authorities for supply of meteorological information and data were complied with. Special detailed forecasts for Srinagar-Nanga Parbat route and the adjoining areas numbering 30 were issued to the German Nanga Parbat expedition. The pilot Herr Thoenes of the expedition communicated through the R.A.F. Liaison Officer that the weather reports from Karachi were very good and accurate.

One of the R.A.F. personnel was given facilities for studying meteorology for the second class air navigator's licence examination.

The Headquarters, Air Forces in India, sanctioned an annual 'liaison' visit of the R.A.F. Meteorological Officers to the Units in their area. They also sanctioned a daily aeroplane ascent at Karachi and three ascents a week at Fort Sandeman for recording upper air temperature and humidity. Such ascents made at Karachi totalled 109 and at Fort Sandeman 5. The data obtained were telegraphed to Poona as soon after the flights as possible and published in the Indian Daily Weather Report. Co-operation of the Drigh Road R.A.F. personnel made possible a number of experimental aeroplane soundings with Bosch-Cannegieter aerometeorographs.

The Meteorologist was also engaged in the study of a number of meteorological problems affecting aviation such as a study of the inversions over Karachi, and the structure of the atmosphere over Karachi and Quetta and analysis of vertical visibility observations.

The office contributed a number of exhibits mainly concerning the investigation of the upper air by aeroplanes to the exhibition in connection with the opening ceremony of the new Karachi Air Fort building.

Meteorological Office, Peshawar.—This office remained in charge of an R.A.F. Meteorological Officer under the technical control of the Director General of Observatories and functioned as during previous years as a forecast office for the R.A.F., a first class observatory and a pilot balloon observatory.

The data for weather maps at this office were considerably increased during the year by the addition of telegrams of observations of some Indian stations and of Iraq stations received in a composite telegram from the civil meteorological office at Karachi and by the reception of the Karachi morning synoptic broadcast through the R.A.F. W/T. An inference and forecast for the next 24 hours for the area Waziristan, the North-West Frontier Province and the Punjab were issued through the R.A.F. W/T at about 8 hrs. to all R.A.F. units stationed in this area and a detailed report and forecast for the Peshawar area was circulated to No. 1 (Indian) Group, R.A.F., No. 20 A.C. Squadron, R.A.F., Assistant Director of Medical Services, Brigade Headquarters, Government House and the British Military Hospital, Peshawar, as a routine daily except on Sundays.

In addition to the routine forecasts mentioned above, 258 route forecasts for cross country flights and 32 forecasts for night flying to the R.A.F. Pilots, 73 forecasts to Military Units along the Frontier upon operations and manœuvres and 10 'Meteor' reports for artillery practice were also issued. By arrangement with Headquarters, Air Forces India, forecasts for west Kashmir, the north Punjab and the route between Srinagar and Nanga Parbat were supplied to the Junkers Aircraft co-operating with and the German party climbing Nanga Parbat. Some meteorological data were supplied on request to several enquirers including most of the Medical Military Units in Peshawar, All-India Radio, Military Grass Farms, the Extra Assistant Director of Agriculture, North-West Frontier Province, 'Electricity', Peshawar, the Burma Shell Co., and the Associated Press.

The R.A.F. Units at Peshawar, Kohat and Risalpur made 313 observations of upper air temperatures and humidity by aeroplane ascents and the data so obtained were telegraphed to Poona and published in the Indian Daily Weather Report. 15 aeroplane ascents were also made at Ambala in June 1938.

The annual conference of the R.A.F. Meteorologists was held at Peshawar in April. The Meteorological Officer inspected some observatories in the North-West Frontier Province. He delivered lectures on subjects of meteorological interest at Kohat and Lahore R.A.F. stations, and attended the Officers' Conference at Poona in July 1938.

An analysis of ionisation measurements at the Kew Observatory was prepared for publication, and cloud photography to illustrate the advance of western disturbances across the northwest frontier and a comparison of upper winds as measured by pilot balloons and by observation of smoke clouds liberated by aircraft at various heights were carried out.

Other Observatories.—The numbers of observatories of the various classes are given below with the corresponding figures at the end of the previous year.

Class.	On 31st March 1939.	On 31st March 1938.
I	14	14
II	196	192
III	39	47
IV	18	18
V	23	24
Non-instrumental	16	16
Non-departmental	59	61
Total under the Department's technical control	306	311

As before, the records of the non-departmental observatories were scrutinised and in most cases utilised in the daily weather reports and other departmental publications. Their importance need hardly be emphasised, and the co-operation of the Indian States and other

public bodies who maintained them for the study of their own climatology and the furtherance of Indian Meteorology is greatly appreciated. Among them may be mentioned Nepal, Kashmir, Hyderabad, Mysore, Baroda, Bhopal, Travancore, Bahawalpur, Bikaner, Jodhpur, Jaipur, Udaipur, Cooch Behar, Jhalawar, Nawanagar, Kotah, Ichalkaranji and Miraj, the Municipalities of Ahmedabad, Ootacamund, Coonoor, Murree and Mussooree and the Agricultural Departments of Bombay, Sind and the Punjab.

VI.—RAINFALL REGISTRATION.

The rainfall data collected by the provincial rainfall organisations, for which the Director General of Observatories is the consulting authority, are published in the provincial rainfall tables. They are collected and issued in a single volume for the whole of India by this Department. The number of stations included in the organisation in the different provinces and the number inspected during the year, together with corresponding figures for the previous year, are given in the following table. On the whole the work of rainfall registration was carried out satisfactorily throughout India.

Rainfall Registration during 1938-39.

Province.	No. of raingauges at the end of			No. of raingauges inspected.		
	1938-39.	1937-38.	Change.	1938-39.	1937-38.	Change.
Assam	128	127	+1	106	109	-3
Bengal	233	232	+1	164	188	-24
Orissa	75	74	+1	59	60	-1
Bihar	236	239	-1	199	207	-8
U. P.	273	273	0	248	261	-13
Punjab	196	196	0	171	175	-4
Jammu and Kashmir	31	30	+1	18	11	+7
N. W. F. Province	31	31	0	30	29	+1
Baluchistan	78	78	0	76	75	+1
Sind	67	67	0	63	50	+13
Rajputana	188	188	0	164	163	+1
Bombay	203	200	+3	177	174	+3
States in Bombay Area	80	79	+1	49	47	+2
Central India	127	125	+2	107	107	0
Central Provinces	161	162	+1	152	160	-8
Berar	42	42	0	38	42	-4
Eastern States	75	61	+14	71	60	+11
Hyderabad	61	60	+1	58	60	-2
Mysore	76	76	0	76	76	0
Coorg.	21	21	0	17	21	-4
Madras	492	492	0	461	447	+14

Heavy Rainfall Reports.—Heavy rain is sometimes so very local that small unrepresented areas can have as much as 10 inches without the present net-work of daily reporting stations conveying the least suggestion of the local deluge. To obtain reports of such local heavy

rain promptly for the daily weather report, it was arranged 18 years ago that observers at all rain-gauge stations at district headquarters in British India as well as in the Indian States should telegraph to forecasting centres falls of 5 inches or more. Nearly 800 such telegrams were received at Poona during 1938-39.

Snowfall Registration.—Information on the distribution and time of occurrence of snowfall in the Himalayas and the Afghan mountain areas was, on the whole, tolerably complete, and the thanks of the department are due to the various officers who collected and forwarded the reports.

VII.—CONCLUDING REMARKS.

The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from other Departments. Officers of various Government departments help the meteorological work as honorary superintendents of observatories or in other capacities. The Department's thanks are due to them and also to those who rendered assistance in the systematic collection of hail reports from the rain-gauge stations under them. The Burma Meteorological Department gave valuable co-operation in all matters, especially in maintaining uniformity of practice between Burma and India in aviation and other questions. The India Meteorological Department is greatly indebted to the Imperial Council of Agricultural Research for inaugurating work in Agricultural Meteorology. The department is also very grateful to the Principal of the Agricultural College, Poona, for the facilities given for experimental work at the College Farm. The Posts and Telegraphs Department assists this department in the rapid transmission of meteorological information particularly in connection with the warning services.

Weekly telegrams are received from April to October from the Director, Royal Alfred Observatory, Mauritius. These telegrams give valuable information of the weather conditions in the Indian Ocean, and the Department is indebted to this observatory for the punctual transmission of the information.

The Department is greatly indebted for important information on meteorological conditions prevailing before and during the south-west monsoon to the Director General, Physical Department, Cairo; the Astronomer Royal, Cape Town; the Director, British East African Meteorological Service, Nairobi; the Port Officer, Seychelles; the Commonwealth Meteorologist, Melbourne; Chief Meteorologist, Salisbury, Southern Rhodesia; the Director, Koninklijk Magnetisch und Meteorologisch Observatorium, Batavia, who also arranges for the daily weather telegrams from Sabang in Sumatra; the Chief of the Weather Bureau, Washington and the Directors of the Observatories at Buenos Ayres and Santiago.

Thanks are due to the various ships which wirelessed or posted weather messages (including pilot balloon observations) and to the Marine Superintendents of the British India, Peninsular and Oriental,

Scindia, Asiatic, Bombay-Fersia and Bombay Steam Navigation Companies and the Burma Oil, the Anglo-Iranian Oil and Indo-Burma Petroleum Companies for continuing the arrangement under which many captains of their fleets send weather logs to this Department; to the various ships' officers who sent their marineweather logs direct to this department, and to the Principal Officer, Mercantile Marine Department for arranging meetings at his office between an officer of this department and ships' captains.

Thanks are also due to the Superintendent of the Colombo Observatory for the most useful help he has rendered from time to time in connection with storm warning work and for the useful data of Ceylon stations supplied to this department.

S. K. BANERJI,

Offg. Director General of Observatories.

POONA;

The 23rd May 1939.

APPENDIX A.

THE STAFF OF THE INDIA METEOROLOGICAL DEPARTMENT AS IT STOOD ON 31ST MARCH 1939.

METEOROLOGICAL OFFICE, POONA.

Director-General of Observatories.

C. W. B. Normand, C.I.E., M.A., D.Sc. (Edin.) (On leave ex-India).

S. K. Banerji, M.Sc., D.Sc. (Cal.) (offg.).

Superintending Meteorologist K. R. Ramanathan, M.A., D.Sc. (Mad.)
(offg.).Superintending Meteorologist V. V. Sohoni, B.A. (Hons.), M.Sc. (Bom.)
(offg.).*General Section.*Meteorologist K. J. Kabraji, B.A. (Hons.), B.Sc.
(Bom.), M.Sc., Ph.D. (Lond.).Assistant Meteorologists B. N. Desai, B.A. (Hons.), LL.B., M.Sc.
(Bom.), Ph.D., D.Sc. (Edin.), F.R.S.E.

. P. K. Sen-Gupta, D.Sc. (Alld.) (offg.).

Superintendent C. P. Venkataramier, M.A. (Mad.).

Assistants B. P. Mukherji, B.A. (Cal.).

. A. Das, M.Sc. (Cal.).

. T. N. Bose, B.Sc. (Cal.).

. G. T. Athavale, B.Sc. (Bom.), Dr. Ing.
(Aach.), A.I.R.O.

. A. Narayanan, M.A. (Mad.).

Stenographers Munir Bakht.

. Shive Ram.

Steno-typists 3 (including 1 for W. S.).

Cashier 1.

Senior Clerks or Observers 2.

Clerks and typists 12.

*Weather Section.*Meteorologist S. N. Sen, M.Sc. (Cal. & Lond.), Ph.D.
(Lond.) (On leave).

. Barkat Ali, B.A., M.Sc. (Punj.) (offg.).

Assistant Meteorologists S. P. Venkiteshwaran, B.A. (Hons.)
(Mad.).

. H. R. Puri, M.Sc. (Punj.) (offg.).

Weather Section—contd.

Assistants	S. N. Naqvi, M.Sc. (Alig.). R. L. Dixit, B.Sc. (Alld.). K. L. Sinha, M.Sc. (Dacca). (Tempy.).
Clerks and tabulators	15.
Draftsmen	9.

Observatories Section.

Assistant Meteorologist	Barkat Ali, B.A., M.Sc. (Punj.) (offg. as Meteorologist).
Assistants	V. Ganesan, B.A. (Mad.). S. Gupta, M.Sc. (Cal.).
Inspector of Observatories	T. Ramananda Rao, B.Sc. (Mysore).
Clerks	2.
Current Weather Observers	7 (at outstations).

Marine Section.

Assistant Meteorologist	V. Doraiswamy Iyer, B.A. (Mad.) (On leave). C. P. Menezes, B.A., B.Sc. (Bom.) (offg.).
Assistant	Md. Khalil Khan, M.Sc. (Alig.).
Clerks	2.

Instruments Section.

Meteorologist	J. M. Sil, B.A. (Cal.), B.Sc. (Engg.) (Boston Tech.).
Assistant Meteorologist	C. Ramaswamy, M.A. (Hons.) (Mad.).
Assistants	K. S. Agarwala, M.Sc., LL.B. (Luck.). S. C. Chatterji, B.Sc. (Cal.) (offg.)
Clerks	5.
Draftsman	1.
Senior Observers	3.
Junior Observer	1.
Senior Store keeper	1.
Junior Store-Keeper	1.
Chief Mechanic	1.
Mechanics	3.
Carpenter	1.

Upper Air Section.

Meteorologist	N. K. Sur, D.Sc. (Alld.).
Assistant Meteorologist	K. Nagabhushana Rao, M.Sc. (Mysore) (Tempy.). [†]
Assistant	K. P. Ramakrishnan, B.A. (Mad.).
Clerks	2.
Senior Observer	1.
Junior Observers	4.

Statistical Section and Library.

Meteorologist	A. K. Roy, B.Sc. (Cal.), B.A. (Oxon.).
Assistant Meteorologist	C. G. Pendse, M.A., Ph. D. (Camb.) (Tempy.).
Assistants	D. Sankaranarayanan, B.A., L.T. (Mad.) (on leave).
	S. Sen-Gupta, M.Sc. (Dacca), Ph.D. (Berlin) (Offg.).
	S. Venkataraman, B.A. (Mad.) (offg.).
	S. Sansarchand (offg.).
Librarian	1.
Clerks [®]	15.
Draftsmen	3.

Agricultural Meteorology Section.

Agricultural Meteorologist	L. A. Ramdas, M.A., Ph.D. (Cal.) (Tempy.).
Assistant Meteorologist	A. K. Mallik, M.Sc., B.Sc. (Ag.) (Alld.) Assoc. I. A. R. I. (Tempy.).
Meteorological Assistant	P. K. Raman, B.A., M.Sc. (Mad.).
Senior Observers	2.
Junior Observers	3.
Typist	1.

Upper Air Observatory, Agra.

Superintending Meteorologist	Rai Bahadur G. Chatterjee, M.Sc. (Cal.)
Meteorologist	S. Basu, M.Sc. (Alld.).
Assistant Meteorologists	K. Das, M.Sc. (Punj.), Ph.D. (Lond.).
	N. P. Chatterjee, M. Sc. (Cal.) (Tempy.).
	L. S. Mathur, M.Sc., D.Phil. (offg.).
	Mohamad Aslam, M.Sc. (Alig.) (Tempy.).
Superintendent	Babu Ram Samnol.
Mechanical Assistant	Chain Sukh, A.M.I.E.E.
Chief Observer	M. P. Manna.
Meteorological Assistant at Allahabad	M. D. Mathur, M.Sc. (Punj.).
Meteorological Assistant at New Delhi	Krishna Chandra, M.Sc. (Alld.), M.Sc. (Lond.) (offg.).

Upper Air Observatory, Agra—contd.

Meteorological Assistant at Jodhpur	S. C. Chakravarty, M.Sc. (Dacca).
Chief Computer	J. B. L. Mathur, B.Sc. (Alld.).
Foreman	M. L. Dutta, A.M.M.E.
Inspector of Observatories	P. M. Neogi, B.Sc. (Cal.).
Stores and Supply Assistant	M. M. Bugai, B.A. (Engg.) (Stan- U. S. A.), M.Sc. (Mass. U. S. A.) A.M.Am.I.E.E. (Tempy.).
Clerks or Observers	42 (at Agra).
Clerks or Observers	94 (at outstations including the staff at R. A. F. offices at Peshawar and Quetta—temporarily shifted to Karachi).
Mechanics	11.
Enginemen	3.

Colaba and Alibag Observatories, Bombay.

Meteorologist	S. R. Savur, M.A. (Mad.), Ph.D. (Lond.).
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At Colaba.

Head Clerk	D. L. Chaudhuri, M.Sc. (Cal.).
First Assistant	S. M. Mukherji, M.Sc. (Dacca).
Observers	0.
Cashier	1.
Marine Clerk	1.
Typist and Stenographer	1.

At Alibag.

Observers	2.
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Pilot Balloon Observatory, Juhu.

Professional Assistant	S. D. Bose, B.Sc. (Cal.) (offg.).
Senior Observer	1.
Junior Observers	2.
Current Weather Observer	1.

Alipore Observatory and Meteorological Office, Calcutta.

Meteorologist	S. K. Pramanik, M.Sc. (Luck.), Ph.D. (Lond.), D.I.C.
Assistant Meteorologists	B. K. Roy, M.Sc. (Cal.). S. Mal, M. Sc. (Benares), Ph.D. (Lond.), D.I.C., F.R.Met. Soc. R. Ananthakrishnan, M.A., D.Sc. (Mad.) (offg.).
Superintendent	T. N. Mitra, B.A., B.L. (Cal.).
Chief Observer	R. Baksi, M.Sc. (Cal.) (offg.).
Inspector of Observatories	1 (Temporarily vacant).
Clerks (Upper Division)	6.
Stenographer	1.

Alipore Observatory and Meteorological Office, Calcutta—contd.

Senior Observer	1.
Clerks (Lower Division)	25 (including 1 post vacant due to retirement).
Clerks and Typists (Routine Division)	5 (including two posts of teletypists).
Current Weather Observer	1 (at outstation).
Printer (Press staff)	1.

Dum Dum Branch.

Professional Assistant	B. B. Roy, M.Sc. (Cal.) (offg.).
Senior Observer	1.
Junior Observers	3.

Meteorological Office, Karachi.

Meteorologist	B. N. Sreenivasaiah, M.Sc. (Cal.) (offg.).
Assistant Meteorologist	S. L. Malurkar, B.Sc. Mysore), M.Sc. (Camb.).
	S. N. Roy Chowdhury, M.Sc. (Cal.) (offg.).
Professional Assistant	1. (Temporarily vacant).
Chief Observer	S. P. Sirkar, M.Sc. (Cal.) (On leave).
	S. S. Ramakrishnan, M.A. (Mad.) (offg.).
Head Clerk	R. C. Chatterji, B.A. (Cal.).
Inspector of Observatories	1. (Temporarily vacant).
Steno-typist	1.
Senior Clerks or Observers	6.
Clerks or Observers	16.
Junior Clerks or Observers	2.
Observer	1 (at outstation).
Clerk (temporary)	1.

Solar Physics Observatory, Kodaikanal.

Director	A. L. Narayan, M.A., D.Sc. (Mad.), F.I.P.
Assistant Director	A. K. Das, M.Sc. (Cal.), D.Sc. (Paris), F.R.A.S.
Assistants	P. R. Chidambara Aiyer, B.A., (Mad.), F.R.A.S. (On leave).
	Md. Salaruddin, B.A. (Andhra).
	B. G. Narayan, B.Sc. (Mysore).
	C. K. Ananthasubrahmaniam, B.A. (Mad.) (offg.).
Recorders	4.
Mechanic	1.
Book-binder	1.

Meteorological Office, Quetta, temporarily posted to Aircraft Depot, Drigh Road Karachi (Sind).

Meteorologist	P. R. Krishna Rao, B.Sc. (Mysore) (Tempy.).
Senior Clerk	1.
Junior Clerk	1.

Meteorological Office, No. 1 (Indian) Group Headquarters, R. A. F., Peshawar.

Meteorological Officer (R. A. F.)	Fl.-Lt. L. H. Starr.
Senior Clerk or Observer	1.
Junior Clerks and Observers	4.

Lahore Observatory.

Chief Observer	D. N. Chopra, B.Sc. (Punj.).
Clerks or Observers	3.

Madras Observatory.

Assistant-in-charge	A. Narayanamurti, B.A. (Mad.).
Senior Observer	1.
Junior Observers	2.

Officers on leave.

- C. W. B. Normand, C.I.E., M.A., D.Sc. (Edin.) (on leave *ex-India*).
 T. Royds, D.Sc. (Lond.), F.R.A.S. (Leave on average pay for four months and eighteen days combined with leave on half average pay for 20 months and 12 days, preparatory to retirement from 12th March 1937).
 S. N. Sen, M.Sc. (Cal. and Lond.), Ph.D. (Lond.).
 V. Doraiswamy Iyer, B.A. (Mad.).

Officers on Foreign Service in Burma.

- S. C. Roy, M.Sc. (Cal.), D.Sc. (Lond.), Meteorologist.
 S. S. Lal, M.Sc. (Luck. & Lond.), D.I.C. (Lond.), A.Inst.P., F.R.Met. Soc., Assistant Meteorologist.
 S. K. Das, M.Sc. (Dacca & Lond.), D.I.C. (Lond.), F.R.Met. Soc., Assistant Meteorologist.
 U. N. Ghosh, (Cal.), Professional Assistant.

APPENDIX B.

PUBLICATIONS.

The following departmental publications were issued or sent to press during the year:—

I.—*Periodical.*

1. Daily Weather Reports:—
 - (i) Indian Daily Weather Report (to date).
 - (ii) Calcutta Daily Weather Report (to date).
 - (iii) Karachi Daily Weather Report (to date).
2. Weekly Weather Report (to date).
3. India Weather Review, Monthly Weather Report (to date).
4. Supplement to the India Weather Review—Monthly Frequency Tables for the 12 months in 1937.
5. India Weather, Annual Summary, 1937, in five parts:—
 - (i) Introduction.
 - (ii) Part A.—Summary of Weather with Tables.
 - (iii) Part B.—Snowfall.
 - (iv) Part C.—Storms and Depressions.
 - (v) Part D.—Seismic Records.
6. Daily Rainfall of India, 1936.
7. Monthly Rainfall of India, 1936.
8. Upper Air Data, 1937, in 2 parts:—
 - (i) Part A.—Monthly Means of Pilot Balloon Data.
 - (ii) Part B.—Sounding Balloon and Aeroplane Data.
9. Seasonal Memoranda:—
 - (i) Memorandum on the probable character of the weather in north-west India in January, February and March 1939.
 - (ii) Statement of the rainfall and snowfall of northwest India in January, February and March 1939.
 - (iii) Memorandum regarding the probable amount of monsoon rainfall in 1938.
 - (iv) Memorandum on the rainfall of June and July and the probable amount during August and September 1938.
 - (v) Statement of actual rainfall in the monsoon season, June to September 1938.
10. Magnetic, Meteorological and Seismographic observations made at the Government Observatories, Bombay and Alibag, in the year 1936.
11. Report of the Administration of the Meteorological Department of the Government of India in 1937-38.
12. Report of the Kodaikanal Observatory for the year 1938.

II.—*Occasional.*

1. Memoirs of the India Meteorological Department:—
Vol. XXVI—

Part X—The General Circulation of the Atmosphere over India and its neighbourhood, by K. R. RAMANATHAN and K. P. RAMAKRISHNAN.

Vol. XXVII—

Part I—A study of dust-storms at Agra, by B. N. SRINIVASAIAN and N. K. SUR.

Part II—Discussion of the results of sounding balloon ascents at Madras, by N. K. SUR and K. P. RAMAKRISHNAN.

2. Scientific Notes:—

Vol. VII—

No. 79—Atmospheric electric potential gradient, conductivity and air-earth current on electrically 'quiet' days at Colaba, by S. M. MUKHERJEE.

No. 80—Normal monthly percentage frequencies of surface and upper winds (afternoon) up to 3 km. in India, Burma and Persian Gulf.

No. 81—Vertical currents in the first few kilometers over Poona and their possible effect on the measures of upper winds made by pilot balloons assumed to rise at a known constant rate, by K. P. RAMAKRISHNAN.

No. 82—An analysis of Indian rainfalls using the median as a statistic, by L. S. MAHALINGAM.

3. Kodaikanal Observatory Bulletin:—

Summary of prominence observations for the first half of the year 1937.

The following were contributed to extra-departmental publications:—

BANERJI, S. K.

Does thunderstorm rain play any part in the replenishment of earth's negative charge? 1938 *Q. J. Roy. Met. Soc.*, 64, 293—299.

Potential gradient inside thunderclouds. 1938 *Q. J. Roy. Met. Soc.*, 64, 221—222.

Earthquake problems of India. 1938 *Sci. and Cult.*, 3, 637—642.

On the interchange of electricity between solids, liquids and gases in mechanical actions. 1938 *Indian J. Phys.*, 12, 409—436.

Our knowledge of frictional electricity. (Pres. Address, Fifth Annual Meeting, Lahore, Jan. 1939.) 1938 *Annual Report and Proc. Indian Phys. Soc.*, 5, 1—12.

DAS, A. K.

Progress of meteorology in India during the last 25 years. *Progress of Science in India*, 732—741. 1938 Indian Sci. Congr. Ass.

DESAI, B. N.

— (S. MAL and)

The mechanism of thundery conditions at Karachi. 1938 *Q. J. Roy. Met. Soc.*, 64, 525—537.

— (S. MAL and)

Thundersqualls of Bengal. 1938 *Gerl. Beitr. Geophys.*, 53, 288—304.

— (P. M. BARVE, Y. S. PARANJPE and)

Importance of dialysis in the study of colloids. V—Colloidal gold. 1938-39 *Proc. Roy. Soc. Edin.*, 59, 22—29.

— (P. M. BARVE, Y. S. PARANJPE and)

Importance of dialysis in the study of colloids. VI—Colloidal vanadium pentoxide. 1938-39 *Proc. Roy. Soc. Edin.*, 59, 30—37.

IYER, V. D.

An attempt at foreshadowing monsoon rainfall in Mysore. 1938 *Curr Sci.*, 6, 510—511.

KRISHNA RAO, P. R. — (K. L. BHATIA and)

Distribution of temperature and humidity in the upper air over Karachi. 1939 *Curr. Sci.*, 8, 71—73.

PURI, H. R.

Airman's weather worries. 1938 *Aviation Gazette and Annual*, 7—10.

RAMANATHAN, K. R.

Climatology of Bombay. 1938 *J. Univ. Bombay*, 7, 1—8.

The earth's magnetism and the upper atmosphere. 1939 Pres. Address. Sec. Math. Phys., twenty-sixth Indian Sci. Congr., Lahore. 25 pages.

RAMDAS, L. A.

Report on simple methods of measurement in agricultural meteorology. 1937 *Kommission für landwirtschaftliche Meteorologie, Protokolle der Tagung in Salzburg*, 53—57.

— (A. K. MALLIK and)

The exchange of moisture between air layers near the ground and substances like soils, plant leaves, seeds etc., exposed to the atmosphere. 1938 *Curr. Sci.*, 6, 452—453.

— (V. SATAKOPAN, S. GOPAL RAO and)

Frequency of days with hailstorms in India. 1938 *Indian J. Agri. Sci.*, 8, 787—805.

SAVUR, S. R.

The fundamental idea underlying statistical tests of significance. 1938 *Curr. Sci.*, 7, 106—107.

A problem in coin-tosses. 1938 *Proc. Phys. Soc. Lond.*, 50, 947—960.

SIL, J. M.

Some atmospheric-electric observations at Poona. 1938 *Terr. Mag. and Atmos. Elec.*, 43, 139—142.

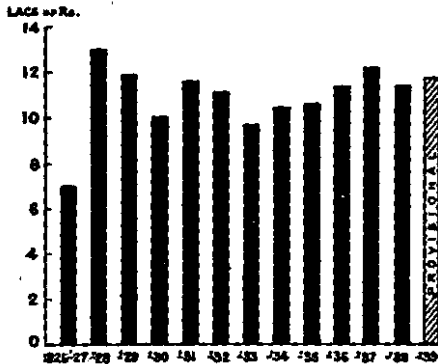


FIG. 1. EXPENDITURE.

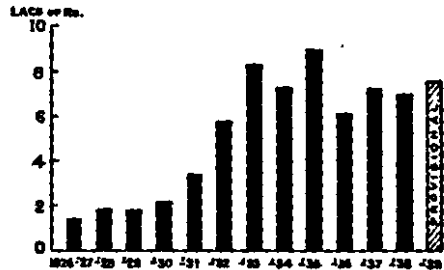


FIG. 2. EXPENDITURE ON TELEGRAMS.

(EXCLUDING EXPENDITURE ON TELEGRAMS AND ENGLISH CHARGES)

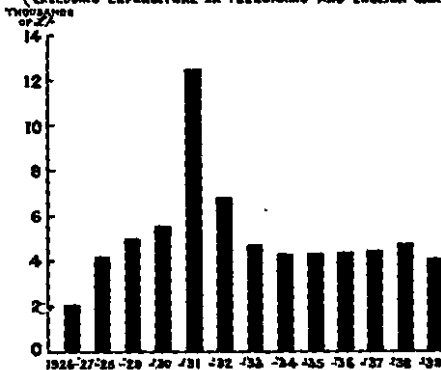


FIG. 3. GRANT FOR PURCHASES BY INDIA STORE DEPT., LONDON, (i.e. ENGLISH CHARGES).

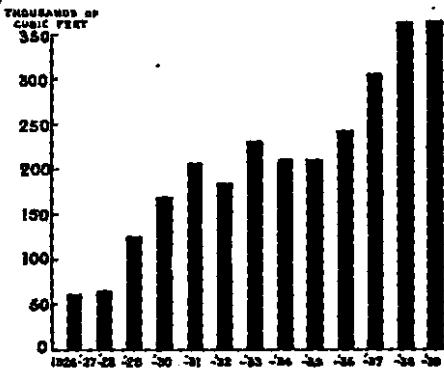


FIG. 4. PRODUCTION OF HYDROGEN FOR BALLOONS.

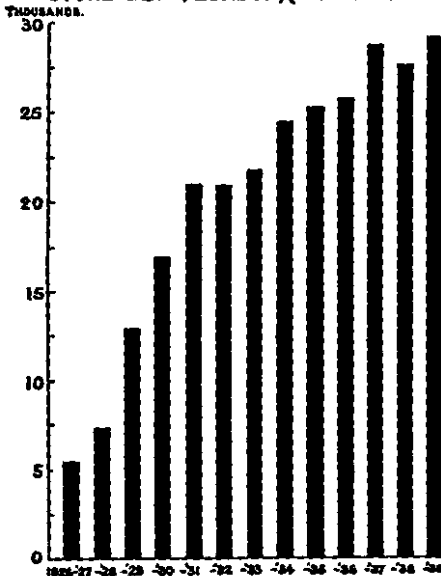


FIG. 5. NUMBER OF PILOT BALLOON ASCENTS.

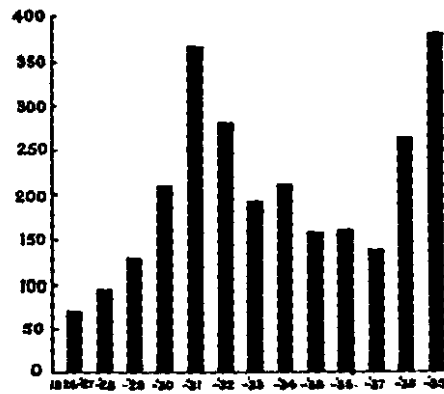


FIG. 6. NUMBER OF SOUNDING BALLOON ASCENTS.

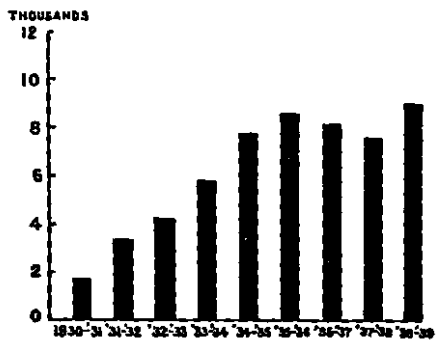


FIG.7. WEATHER FORECASTS FOR AVIATION.

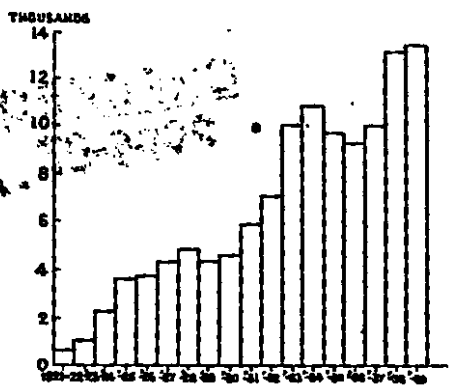


FIG.8. WIRELESS WEATHER MESSAGES FROM SHIPS.

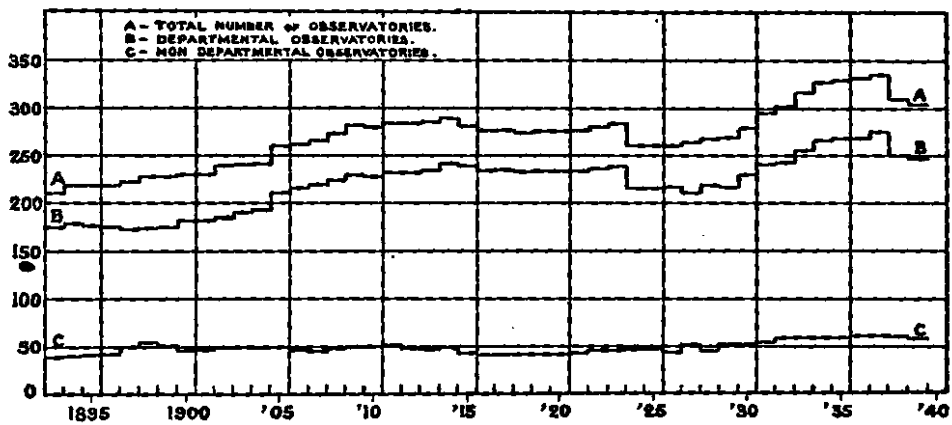


FIG.9. SURFACE METEOROLOGICAL OBSERVATORIES.

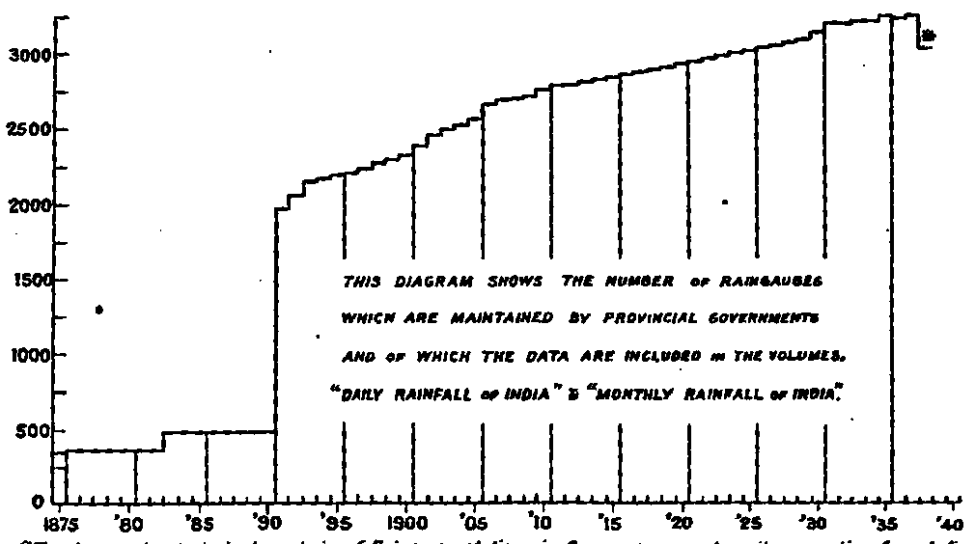


FIG.10. DEVELOPMENT OF PROVINCIAL RAINFALL ORGANISATION IN INDIA.