

Report on the Administration of the Meteorological Department of the Government of India in 1930-31.

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CHIEF FEATURES OF THE YEAR.

For some years past the department has been expanding concurrently with the opening of Indian air-routes. In the year under review the schemes connected with aviation reached a stage of completion, at which it was thought they would remain for some time without any further considerable expansion and so enable the department to consolidate its organisation and to settle down to a programme of practical and scientific work, preparatory to further development. Simultaneously however the period of financial stringency that has overtaken India began to be noticeable. Other schemes, unconnected with aviation, but aiming to introduce uniformity and increased efficiency into the departmental organisation had to be shelved, such, for instance, as the projects to raise the remaining observatories in south India to the same status as those throughout northern India and Burma and to give the Headquarters Office at Poona the benefit of the recent developments by arranging for the preparation of an evening weather chart there. Considering that most other countries prepared weather charts three times daily, even before the 1914-18 War, the proposal to arrange for a second daily weather chart at Poona could not be considered extravagant. It is now feared that the stage reached towards the end of the year under review may prove to be not one of merely temporarily arrested development but a climax, beyond which the next stages may perhaps be the retracing of steps recently taken.

2. While the immediate cause of the recent developments was the need to meet the requirements of aviators on the Karachi-Rangoon air-route, who want detailed and up-to-date weather information about upper winds, clouds, visibility, thunderstorms, duststorms, etc., it is not possible to draw any exact line beyond which it may be said that the work done is done solely on behalf of civil aviation and not for other purposes. The general basis of the meteorological organisation, namely, the receipt of weather telegrams at a few forecasting centres from a network of observatories, has been strengthened; and more information is

now available at these centres both about weather near ground level and about the winds aloft; and is of use not only to aviators but also in the preparation of general weather forecasts, storm and heavy rainfall warnings as well as in the investigation of improvements in seasonal forecasting and of the causes of past weather. Part of the development was accomplished in the previous two years and the last stage, except for permanent building schemes, was reached in the early months of 1931, when the arrangements for the Delhi-Calcutta and the Calcutta-Rangoon routes were nearly completed. The gazetted staff for the Delhi Office, which was started last year with the help of one of the reserve meteorologists, and for the new Rangoon Office was recruited. Many observatories were raised from third to second class status, others were newly started, and special stations in the chain of observatories along air-routes were equipped with self-recording instruments. The regional forecasting centres at Calcutta and Rangoon, like those already established at Karachi and Delhi, began to prepare two weather charts a day, one for the usual 8 hrs. observations and the other for the newly introduced 17 hrs. observations, from a net-work of second class observatories in India, excluding the Peninsula. The Rangoon Office was opened in September 1930 and commenced functioning as a forecasting centre a little later. Steps were taken for the acquisition of some buildings and property near the aerodrome at Dum Dum, Calcutta, to locate a subsidiary weather service centre with a Professional Assistant in charge, under the control of the Meteorologist, Calcutta. Provision was also made for a similar centre at Akyab under the control of the Rangoon Office. A few new pilot balloon stations were opened and before the close of the year about 25 stations out of a total of 31 over the country had started to observe regularly an afternoon balloon flight in addition to the usual daily morning flight. This expansion of pilot balloon stations created a largely increased demand for hydrogen and much additional administrative and technical work at Agra Observatory, where special arrangements had to be made to cope with the increase. To complete the meteorological organisation under the sanctioned aviation schemes the main outstanding items are the erection of offices and residential quarters alongside the aerodromes at Karachi, Delhi and Rangoon. These constructions are part of the original plan but have to be deferred until a financially more propitious time arrives, although their value is undoubted, because they would lead to more direct personal touch with aviators and hence to increased efficiency.

With the spread of private flying in India the department has from time to time been called upon to help aviators in a way which is not directly connected with the working of the meteorological organisation. For example, candidates for pilot's licences require to be trained and examined in meteorology as a part of their course, and this department has adopted the policy of providing facilities at forecasting centres for the training and examination by local meteorologists of such candidates.

3. Mention must be made of the deplorable tragedy to the R. 101. The Karachi Meteorological Office had undertaken responsibility for the supply of weather forecasts and warnings to the airship on her incoming and return flights over the Persian Gulf and Mekran section. Special arrangements were made for the discharge of these duties; the forecasting centre was transferred from Karachi to the Airship Base observa-

tory at Drigh Road; a temporary telegraph office was opened there; the meteorological staff was strengthened by the deputation of an extra officer from Poona; a continuous 24 hour weather watch was put into operation a couple of days before the airship left Cardington; and weather charts were prepared twice daily (to be increased to 4 times daily) for the whole area lying between Ismailia and Karachi. All arrangements were running smoothly, and enthusiasm in all ranks was high, only to be suddenly quenched when the lamentable news reached Karachi of the disastrous dive of the airship against a hill near Beauvais in France on the 4th October.

4. An important scheme with which considerable headway was made during the year concerned the opening of a branch of agricultural meteorology. The scheme may be said to owe its origin to the Report of the Royal Commission on Agriculture 1928, and was elaborated by the department in consultation with a few agricultural experts. It proposed the creation of a temporary branch of agricultural meteorology to study the subject statistically and experimentally. About statistical studies it may be observed that if satisfactory correlation between weather conditions and crop yield and crop areas can be established, crop forecasting and the final estimates of production will be improved. Since there is no better deterrent to uncontrolled speculation in agricultural commodities than a good supply of agricultural statistics, and, since the cultivator eventually gains by all improvements in marketing, he stands to benefit in the long run from results of investigations on such subjects. As regards the experimental and biological parts, the proposal was made under two heads—routine and research. Under routine comes the standardisation of the meteorological and physical data collected at experimental farms. Under research the proposal aimed at selecting and standardizing the best methods for the measurement of radiation, evaporation, soil temperature, etc. Soil temperature, ultra-violet radiation and other kinds of radiation, the amount and quality of sunlight, the temperature of the leaves and stems of the plants, the wind forces on the plants are all, as one can readily conceive, phenomena which a research worker may want to know, when correlating the results obtained on experimental farms. In other words the aim is to be able to specify the local weather and climate of each crop, or, as some modern workers now call it, the micro-climate of each crop. The employment of two agricultural meteorologists and subordinate staff is contemplated for a period primarily of 5 years, involving an annual recurring expenditure of about Rs. 40,000. The proposal was placed before the Imperial Council of Agricultural Research, who agreed to give the grant that was required. It is intended that the officers, when appointed, should be in constant touch with agriculturists and meteorologists and be able to give advice in course of time to the agriculturist about meteorology and to the Meteorological Department about types of forecasting that could profitably be undertaken on behalf of agriculture.

5. A much smaller yet interesting scheme that was sanctioned during the year was the grant of two scholarships for post-graduate students to work on meteorological problems. Each scholarship, of Rs. 100 a month, is tenable for one year but renewable for a second year in suitable cases. For the present, the scheme is of a temporary nature and a further report is to be made on its working after two years' experience. In addition to

these regular scholars, it may be mentioned that officers of the department undertake, from time to time, to guide post-graduate students of universities in the study of meteorological problems for university degree theses. A few such workers were under training during the year.

6. On the scientific side of the department's work also there were some noteworthy items of progress. Soundings of the free atmosphere by balloons carrying self-recording instruments were made at Poona and Agra and also at the Nizamiah Observatory at Hyderabad (Dn.) with the co-operation of the Director there. Observations of upper air temperatures and humidities obtained from ascents of the Royal Air Force aeroplanes at Quetta, Peshawar and Karachi were studied. At Agra some innovations were introduced in the design of the Dines meteorographs. The original instrument gives a record which, for short ascents, is too small to be of practical value. A new type of instrument was evolved with more open scale for temperature and pressure and it is possible with its aid to explore in detail the lower layers of the atmosphere, by means of "Clown" balloons which release the instruments at pre-determined heights. A new temperature indicator was designed, which can be used to determine four successively different diminishing temperatures, when let off with hydrogen-filled balloons. Assistance was given as in former years to Professor Mehta for his researches on the transport of the spores of cereals' rust by upper winds. At Bombay, research was carried on on evaporation, on the electric field of overhead thunder clouds, on the electricity of monsoon rain and on the relationships between microseisms and the development and movement of storms over the Indian seas. A variety of subjects were investigated at Poona. The most interesting among them were the studies of the physical structure of individual storms, night radiation, atmospheric electricity, the sea breeze reaching Poona from the Bombay coast, local thunderstorms, the upper air circulation at cirrus level as well as studies regarding the possibility of improving seasonal forecasting formulæ in correlation coefficients. At Karachi, temperature investigations on the airship mooring mast were handicapped to a certain extent on account of defects in the special instrumental equipment, but ordinary thermographs at various heights were kept working and the data thus collected were subjected to a preliminary analysis; while at Kodaikanal, routine and research in solar physics were continued on lines of which a description has already been printed in that Observatory's Annual Report for the year 1930. The collection of data for an intensive study of weather in north-east India, particularly of the origin and mechanism of nor'-westers, was partially suspended during the year, except for the maintenance of self-recording instruments at a few stations, but the preparation of a preliminary report on nor'-westers based on the data accumulated so far was taken in hand. Appendix B shows the papers or notes by departmental officers that were published or were in press.

MARINE METEOROLOGY—STORM WARNINGS.

7. *The system of storm warnings for ports and shipping.*—Warnings for the approach of cyclonic storms or of bad weather were issued as usual from Poona and Calcutta to ports and shipping in the Arabian Sea and the Bay of Bengal respectively. According to the code of storm warning signals prevalent for many years past, the hoisting of a black

ball at the "extended" ports round the Bay of Bengal which exhibit locality signals of disturbed weather indicated "fair weather". This was open to objection inasmuch as its meaning was the reverse of that of a ball in the current international storm signal system, where a ball means "atmospheric disturbance, be alert and look-out for further information". Views of shipping interests and port authorities were taken and the black ball as a signal of fair weather at the Indian ports was abolished. The number of ports in the warning list was 37 on the west coast of India and 28 on the Bay of Bengal. In addition to the sea ports there were 8 river ports, 17 river police stations and 45 district police stations on the Calcutta warning list. The latest weather information was supplied as usual to shipping at sea by means of weather bulletins broadcast twice daily from coastal radio stations. In addition to these regular broadcasts, if the weather situation demanded it, bulletins were issued, as many as six times a day. The total number of weather bulletins and warning messages issued during the year was 9,712.

8. *Services to ports around the Bay of Bengal.*—Warnings were issued for 49 periods of disturbed or suspicious weather. On eight occasions the disturbances developed into storms, one of which was very severe. This occurred in November 1930, preceded by a period of unsettled weather, to the east of Ceylon. A depression formed in the south of the Bay on the 27th which intensified rapidly into a severe storm. On the morning of the 28th, its centre lay near latitude $10\frac{1}{2}^{\circ}$ N., longitude $82\frac{1}{2}^{\circ}$ E. Taking a northwesterly course, the storm crossed the Coromandel coast on the 29th morning between Cuddalore and Madras. It weakened during its passage westward across the Peninsula but caused some unsettled weather in the south-east Arabian Sea, off Malabar after the 30th. During its approach and passage very strong winds caused considerable damage to telegraph lines near the south Coromandel coast. There was also very heavy local rain in south Madras ranging from 5 to 12 inches in a day. This heavy rain caused breaches in the railway lines and much damage to crops and property in south-east Madras. The usual circular letters were issued to 28 Port Officers asking for opinions regarding the warnings issued to them during the year. All those who replied expressed satisfaction with the warnings received by them and had no suggestions or criticisms to offer.

9. *Services to Arabian Sea-ports.*—Warnings for disturbed or squally weather were issued on 15 occasions. The most important of these was during a storm which formed off the Coromandel coast in October. The storm originated in the Bay but moving westward crossed the coast near Negapatam on the 24th and passed into the Arabian Sea during the next two days as a depression. Once in the Arabian Sea it again gathered strength and became a storm on the 27th with centre near latitude $14\frac{1}{2}^{\circ}$ N., longitude 71° E. The storm took a northerly course and ultimately passed inland just north of Surat at about 10 P.M., on the 29th. During its northward passage in the Arabian Sea, gales and squalls were experienced on and off the west coast right up to Surat. Some very very heavy falls of rain occurred in south India, the most outstanding ones being 16 inches at Negapatam on the 22nd and 13 inches at Trichinopoly on the 23rd. This heavy rain in south Madras, especially in the Nilgiris, caused severe flooding in many places leading to dislocation of

railway traffic, loss of property, damage to standing crops and also some loss of life. Seventeen Port Officers sent their annual returns about the warnings sent to them; all of them said that the warnings were timely and satisfactory and that no change in the present system is necessary.

10. *Exchange of information with ships at sea.*—The chief sources of marine data are wireless weather messages from ships at sea and extracts from weather logs of ships calling at the principal ports on the Indian seaboard. The object of the system of radio messages from ships is to attain greater efficiency in cyclone-warning work. It was started in 1914, suspended during the War and resumed in 1921. Since that year there has been a steady increase in the use of this system by ships in Indian waters. The number of ships' messages from the Bay and the Arabian Sea during the year totalled 5,869 (from the Bay 4,491 and from the Arabian Sea 1,378) in comparison with 4,635 in the previous year, 4,342 in 1928-29, 3,689 in 1925-26 and 956 in 1921-22. It is not possible to name here every steamship that rendered help in this direction, but given below is a list of those ships which sent more than 40 weather messages during the year along with the numbers of messages sent by each:—

Angora	94	Ethiopia	103
Arankola	130	Garbeta	60
Arona	72	Havildar	46
Aungban	209	Hosang	59
Badarpur	169	Jalapalaka	72
Barpeta	120	Jalavira	55
Baymay	122	Maharaja	87
Binfield	53	Masimpur	44
Chakrata	61	Meerkerk	59
Chantala	102	Nawab	77
Chilka	112	Pasha	56
Cocanada	59	Rajula	133
Dara	70	Rohna	43
Egra	136	Schiekerk	60
Ekma	75	Singu	134
Elephanta	41	Tairea	65
Erinpura	59	Varsava	44

This is certainly a most gratifying increase indicating as it does growing willingness on the part of the ships' officers to co-operate with weather services ashore; but even so forecasting officers occasionally lack, at critical times, ships' observations from the vicinity of the centre of a disturbance at sea and find themselves compelled to draw their inferences from and base their broadcast messages to ships on coastal observations alone. Such situations are more particularly experienced in regard to the Arabian Sea, which, not being land-locked like the Bay of Bengal, makes the forecaster wish for more observations from steamers there. It may be that sometimes it happens that storm centres develop in ocean areas far from the normal shipping routes, that is, in areas where there are few, if any, ships to send reports. Possibly also commanders of ships with the aid of the wireless weather reports are now better able to avoid storm areas. Despite these facts it is felt that improvement in the system is still possible, and it would be most helpful if co-operating captains could induce others to take a share in this organisation of

supplying information from sea. A message, which may appear to be colourless by itself, is frequently of great use, when considered along with other observations plotted on a chart. There is a great future for synoptic meteorology at sea; but still more extensive co-operation between the sailor and the meteorologist is needed to make full use of the great aid of wireless weather reports to navigation and safety of life at sea.

11. The second important source of data for later study is the log extracts collected by the marine clerks in Calcutta and Bombay and other agencies mentioned below. The old log form was replaced by two new forms—one for use during ordinary weather and the other during disturbed weather. These forms were designed to secure the collection of fuller marine data on a more elaborate scale, and the British India Steam Navigation Company, the Scindia Steam Navigation Company and the Asiatic Steam Navigation Company continued the arrangements with their ships' captains to copy and despatch such logs to this department direct. The Port authorities at Rangoon also continued to render help by allowing the observers of the Time Ball and Tidal Observatory of the Port Commissioners to collect ships' data. Occasionally in special cases logs of steamers with experience of disturbed weather were collected at Madras; and the Colombo Port authorities also helped this department similarly whenever requested. A total of over 4,600 logs was recorded at the end of the year. The policy of lending meteorological instruments to ships was pursued slowly but steadily. During the year under review three more ships were added to the list of those supplied with meteorological instruments, thus bringing their number to 19. The weather logs from the captains of these 19 steamers were received regularly.

INLAND WEATHER WARNINGS AND FORECASTS.

12. *Heavy rainfall warnings.*—The majority of the officers to whom warnings of heavy rain on land are issued from Poona and Calcutta were district officers and officers of the Irrigation, Railway and other departments. The number of officers on the warning list was 239 officers including 28 officers of the Telegraph Department who generally required warnings for strong winds. This is a slight decrease, compared with the previous year for which the corresponding figures were 263 and 31. This decrease is attributable to the fact that a number of former recipients of warnings have enrolled themselves as subscribers to the Daily Weather Telegraphic Summary, which contains heavy rainfall forecasts, and have removed their names from the list of special warnings. The system worked satisfactorily throughout the year; the forecast and warning messages issued from forecasting centres number 5,746, while 1,118 telegrams of heavy rainfall reports were sent direct to various officers by local meteorological observers. Reports on the working of the warning system were received from 107 officers who have expressed satisfaction with the warnings issued; the few suggestions or criticisms that were received were all on minor points. The following extracts from reports of officers may be of some interest.

From the Executive Engineer, Karnal Division:—

“Warnings received from the Meteorological Department, Poona, during 1930 monsoon proved distinctly satisfactory. There were no floods in the river of any magnitude with the exception of one (on 27th July 1930) the warnings of which had already been received and the forecast amply fulfilled.”

From the Superintending Engineer, Northern Circle, Bombay:—

“Warnings for floods and storms sent by telegram during the last year were promptly received by the Executive Engineers in the circle and were considered very useful.”

The Executive Engineer, Nellore Division:—

“There were severe floods due to heavy rain in Nellore District and the staff in the mofussil were warned in advance to be on the alert.”

The Engineer-in-Chief, Calcutta-Chord Railway, to the Meteorologist, Calcutta, dated 4th July 1930:—

“Your kind help has contributed to the success of the operations (on the Bally bridge) to a large extent and I am most grateful to you and your staff for the assistance you have given me.”

13. *Aviation forecasts.*—With the extension of the State Air Mail services from Karachi to Delhi and later on with the inauguration of the French and Dutch Air-Mail Services, the forecasting centres at Karachi, Delhi, Calcutta and Rangoon supplied an increasing amount of information to fliers. In addition to the regular air mail services there was an appreciable number of forecasts issued to private fliers. The total number of aviation forecasts issued was about 1,750 out of which Karachi was responsible for about 800, Delhi for 400 and Calcutta for over 100, Quetta and Peshawar for over 300.

OFFICES AND OBSERVATORIES.

14. A list of the staff of the India Meteorological Department as it stood on the last day of the year under review is given in Appendix A. The second and revised edition of the note on “Functions and Organisation of the India Meteorological Department” was published by the Department of Industries and Labour in February 1931. This contains a general description of the organisation and duties of each office. In July (1930), which is the anniversary month of the opening of the department’s headquarters at Poona, was held the third annual conference of departmental officers. It considered and made recommendations upon questions such as the training of air pilots in meteorology, aviation forecasting arrangements, broadcasting observations from shore stations for the benefit of ships at sea, remodelling of codes in order to fall in line as closely as possible with international practices and other administrative matters.

15. *Headquarters Office, Poona.*—The main lines of scientific work have already been mentioned amongst the chief features at the beginning of this report. A helpful means of maintaining interest on the scientific side is the colloquium, of which 21 meetings were held, the discussion at each meeting being opened by a member of the staff who took as his subject either his own original work or a recent important paper published in a foreign journal. The Director-General (Dr. Normand) was the President of the Physics Section of the Indian Science Congress held in January 1931 at Nagpur, in which six other officers of the department took part personally and to which several more contributed papers. On the administrative side, the attention of the office as a whole was directed mainly to the consolidation of schemes for giving

meteorological facilities to aviators and making fresh proposals for improving the position of meteorology in general and in creating a new section of agricultural meteorology under the auspices of the Imperial Council of Agricultural Research. The general work of the office is best described by reviewing briefly the activities of the different sections separately.

(a) *General Section.*—This section is responsible for the administration of headquarters and sub-offices and deals with budget and accounts, establishments, general registry, all technical questions involving change of policy or fresh expenditure and the co-ordination of the technical work of the department. During the year it had to cope with the administrative work involved in the opening of the new forecasting centre at Rangoon and also in connection with the proposed new branch of agricultural meteorology, sanction for which was obtained during the year. This scheme has already been outlined under the “Chief Features” of the year at the beginning of this report. Government sanctioned two research scholarships to be awarded to suitable candidates; the first awards of scholarships were made during the year and the scholars started work. The section also had to prepare proposals for additional staff at Headquarters necessitated by the increase in normal routine and to deal with the effects of the withdrawal by the Telegraph Department of the long standing concession of sending express weather telegrams at ordinary rates. This has resulted in the department having to provide about Rs. 2 lakhs more for telegrams annually.

(b) *Weather Section.*—The functions of this section have been partly outlined in previous pages dealing with storm and heavy rain warnings. The section is responsible for the issue of daily weather telegrams, the daily, weekly and monthly weather reports and for the preparation of portions in the Annual Summary of the India Weather Review relating to weather. It has been the feeling for many years that one chart a day is not really sufficient for a proper study of weather changes. All other countries with meteorological services recognise this and generally make three charts a day. All the interests that make use of our weather reports and warnings including the newspaper reading public would be profited both directly and indirectly on account of the anticipated improvement in forecasts and warnings. A proposal to inaugurate a second afternoon chart was therefore made but had unfortunately to be held up owing to the unfavourable financial situation. The 1929 Weather Message Code was revised and brought into line with the new International Code (Copenhagen Code). This new code is called the Weather Message Code 1931. Karachi Meteorological Office broadcasts observations from a number of stations and the code that it used to employ was replaced from the 1st March 1931 by a new “Indian Broadcast Code” prepared by this section. This new code is almost the same as the second form of the Copenhagen Code. A fresh code was devised to give surface landing conditions to pilots of aeroplanes.

(c) *Observatories Section.*—This section administers and arranges for the regular inspection of all the departmental observatories that are not under the charge of sub-offices. During the year, with the opening of the sub-office at Rangoon, the administrative control of the Burma observatories was transferred to that office. The administrative control of a few stations in Sind and west Rajputana was handed over to

the Karachi office. Five second class observatories, seven third class observatories and one first class observatory were started during the year. The new Weather Message Code was introduced at most of the observatories in India, Burma and Ceylon. A new hand-book of Instructions to Observers at second and third class observatories was published and distributed.

(d) *Instruments Section*.—As usual, the section remained responsible for the test, standardisation, repair and issue to observatories of special and self-recording meteorological instruments. During the year 51 self-recording and 117 other instruments were issued, 29 self-recording and 45 other instruments tested and 141 instruments repaired. A beginning was made towards equipping all first class observatories with a standard set of up-to-date autographic instruments. The section provided instrumental equipment for an experimental marine expedition in the Bay of Bengal and for a temporary research observatory at Khandala in charge of one of the research scholars. The work of remodelling dial pattern anemometers proceeded apace and it was decided to replace gradually the existing anemometers by the I. M. D. cyclometer type. With a view to standardise instrumental equipment employed in the department, specifications, drawings and instructions for the care of each type of instruments were prepared. An improved pattern of windvane with splayed tail and ball bearings was developed and provisional specification drawn up. A study of the atmospheric potential gradient with special reference to the study of fine weather changes in the electrical field near the ground was undertaken.

(e) *Marine Section*.—In addition to carrying out its usual duties of co-ordinating the work of collection, examination and study of ships' weather logs and of maintaining contact with shipping interests, the section organised towards the end of the year a small marine tour in the Bay of Bengal on the routes from Calcutta to Rangoon and Rangoon to Madras in order to find out the best methods of organising marine expeditions in the future. At the instance of the Captain-Superintendent of the I. M. M. T. S. Dufferin, the papers on meteorology written by the cadets during the course of their examinations were judged and a prize from this department given to the best pupil. It is hoped to be able to render similar service in future years. At the instance of the marine departments of the Governments of Bombay and Bengal a brochure on "Winds, Weather and Currents on the Coasts of India and the Laws of Storms" was compiled for the benefit of mariners in Indian waters, and was sent to press.

(f) *Upper Air Section*.—Sounding balloon work was carried on at Poona from April to June and from November to March. During the monsoon similar work was done at Hyderabad with the co-operation of the Director of the Nizamiah Observatory. The number of meteorographs let off altogether was 145 out of which 78 were recovered. Observations of upper air temperatures and humidities collected by R. A. F. aeroplanes at Peshawar, Quetta and Karachi were tabulated. The upper air data of 1928 in 14 parts were published. A revised pilot balloon code was prepared in collaboration with the Agra Observatory. Some research investigations were completed and others were in progress.

(g) *Library Section*.—In addition to the care of the library, this section, as usual, prepared the various seasonal forecasts and carried

on studies relating to them. The seasonal forecasting formulæ discovered by Sir Gilbert Walker were brought up-to-date. The various formulæ as well as individual correlation co-efficients were examined by Fisher's method for testing their significance. The number of books, pamphlets and periodicals either purchased, received as presentation copies or exchange copies was 466. The number of institutions and individuals on the free distribution list of this department was 343 at the end of the year. The routine and research publications of the department as well as those of individual members of the staff are listed in Appendix B.

(h) *Climatology Section*.—The routine activities of this department have been described in the last year's administration report. During the year the section also prepared a number of climatic tables for Indian stations required partly for a new work on the climatology of the world, for which Sir Gilbert Walker and the Director-General of Observatories (Dr. Normand) are the joint editors of the portion relating to India.

16. *Upper Air Observatory, Agra*.—This observatory administers all the pilot balloon stations of the department except those at Karachi, Delhi, Calcutta, Rangoon and Poona, where the staffs are under the charge of the local officers. As mentioned above under Chief Features, the work has grown with the opening of new pilot balloon stations and the extension of others, and the staff had to be increased by one Assistant Meteorologist's post and about a dozen technical subordinate posts. A new pilot balloon station was opened at Sambalpur and the two stations in Bengal which were running on a temporary basis under the Nor'-wester scheme were closed down. Preliminary arrangements involving recruitment and training of staff for four new stations, to be opened under the Calcutta-Rangoon Aviation scheme, were made. With the advent of two flights a day at a number of pilot balloon stations along the air routes the demand for hydrogen rose greatly this year and was the highest yet recorded, the output being approximately ~~one~~ ^{one} and a half million cubic feet. The construction of additional hydrogen plant, though sanctioned, had unfortunately, but unavoidably, to be postponed to the subsequent year. In all 257 sounding balloons were released, including about two dozen from Allahabad during the monsoon. Out of these 124 were retrieved and it was found that a number of them had penetrated the stratosphere as high as 20 to 25 geodynamic kilometres. Some further improvements were introduced in the Dines' type of meteorograph (see Chief Features) as well as in the Chatterjee Indicator designed for determining different levels of temperature in the free air. Soundings with the latter class of instruments were carried on regularly at Agra, Calcutta and Bombay.

To meet the growing needs of the activities at Agra a new building for supplies and stores, another for a godown for carpenters, an additional building for office accommodation and a new transformer house were constructed.

17. *Colaba and Alibag Observatories*.—A weather summary containing the principal features of weather over western India and the chief rainfall amounts has taken the place of the Bombay Daily Weather Report since the commencement of the issue of the Indian Daily Weather Report from Poona. The material for this is telephoned from Poona

to Colaba. The issue is limited to the period 1st May to 30th November and includes from 1st July onwards a bi-weekly weather and crop report for districts.

The routine meteorological, seismological, magnetic and time work at Colaba and Alibag Observatories was carried on as in previous years. A few special instruments such as a microbarograph and a Milne-Shaw seismograph were installed during the year and the old Omori seismograph was put out of action. Wireless time-signals from Bordeaux and Rugby were received in connection with the time-service of the observatory which is responsible for dropping the time-balls in the port of Bombay and maintaining the tower clocks at Ballard Pier and the Prince's Dock. During the year 72 chronometers and watches were received in custody, 38 were issued to R. I. M. ships, 7 to R. N. ships and 33 returned to England for repairs. The Observatory Volume for 1926 was published during the year, those for 1927 and 1928 were sent to press, and considerable progress was also made with the manuscripts of the volume for 1929.

Four research students from the Royal Institute of Science and the Wilson College were engaged in work on meteorological and physical problems under the direction of the Meteorologist. The Meteorologist himself carried on further investigations on the electrical field of overhead thunder-clouds described in last year's administration report. Another piece of research by him was on the electricity of monsoon rains. A paper on the subject contributed to the Indian Science Congress discusses the drop of the potential gradient produced by monsoon rainfall and its relationship with wind, amount of rainfall and charges of raindrops. The results appear to support the breaking drop theory of the origin of electricity in non-thunderstorm rain. The Meteorologist also undertook the analysis of microseisms associated with storms in the Bay of Bengal as recorded by the Calcutta and Bombay Milne-Shaw seismographs, with the object of studying their relationship with the direction of movement of storms.

18. *Alipore Observatory and Meteorological Office, Calcutta.*—Additional staff including a third Assistant Meteorologist was sanctioned and appointed during the year, and the office began preparing a daily afternoon chart from the 1st October, in addition to the regular morning chart. The immediate cause of these additions was the need to supply improved information to aviators, which formed a new addition to the functions of the Alipore Office, which include storm and heavy rain warnings for the Bay of Bengal and the surrounding areas. A special temporary duty was the issue of weather reports and forecasts to the Kanchenjunga Expedition in the summer of 1930, the members of which expressed appreciation of the forecasts. The Alipore Observatory also remains responsible for the test and standardisation and issue to observatories of ordinary meteorological instruments. Its duties include the determination of time by transit observations of stars and the wireless broadcasting of time signals twice a day and dropping the time-balls in the city of Calcutta. During the year, the Port Commissioners decided to discontinue the time-balls belonging to them, namely that on the Port Commissioners' Office and at the Kidderpore Docks. As a result of the increased responsibilities and the two sets of observations a day it was necessary to give up the previous arrangement

of using some of the members of the staff of the office as signallers; and arrangements were made under which the Telegraph Department opened a telegraph office in the Meteorological Office towards the end of the year. Submissions of proposals for a third nor'-wester season of intensive study of weather were postponed mainly on account of the impossibility of Agra observatory being able to make the necessary arrangements for upper work during the nor'-wester season in 1931. A new Milne-Shaw seismograph was installed. The Meteorologist carried on a detailed investigation of nor'-westers in Bengal.

19. *Madras Observatory*.—The Madras Daily Weather Report was published throughout the year. In addition to the usual tables and a summary of the weather situation in the Madras Presidency, a 24 hours' forecast was given during the year as a new feature. The supply of correct time to local shipping and through the inland telegraph system to the whole country continued to be one of the important items of work. With the accurate reception of wireless rhythmic time signals from Bordeaux and Rugby, time determination by transit observations was considered superfluous and with effect from December 1930 the clock correction was deduced from the wireless time signals.

20. *Meteorological Office, Karachi*.—The most important event that affected this office was the projected flight to India of the ill-fated airship R-101, which has already been referred to at some length in the "Chief Features". The Karachi Office had undertaken full responsibility for the supply of weather reports, forecasts and warnings to the Airship on her incoming and return flights over the section east of longitude 48° E. A detailed programme for the supply of weather reports and forecasts, based upon the division of the period of the airship's stay in the region into different epochs, was worked out and exchanged with the programmes of the London and Ismailia services. A temporary telegraph office was opened at the Airship Base Observatory at Drigh Road and the forecasting section at Karachi, temporarily increased by the addition of a forecasting officer from Poona, was shifted there and housed temporarily in hired tents. When all was ready came the news of the tragedy and all the special arrangements were immediately cancelled.

The supply of aviation forecasts to the Imperial Airways mails, the Indian State Air Mail Service, the Dutch and French Air Mail Services which started regular operation in September 1930 and January 1931 respectively, the Royal Air Force, the Flying Boat Squadron of Basra and other fliers, trans-continental as well as local, constitutes the principal work of the Karachi Meteorological Office. For its daily charts the office receives synoptic broadcasts containing 0200, 0600 and 1200 G. M. T. observations from Iraq stations. The reception of Abu Zabal synoptics was temporarily stopped in May but was restarted in September. The synoptic broadcasts from the Air Ministry station at Ismailia were also received and proved useful.

To meet the needs of aviation services a few more stations were added to the list of reporting observatories. Late in November 1930 it was learnt that the Indo-European Telegraph Department would close down in the interior of Persia from the 1st March 1931 and that their Persian Gulf Section would be taken over by the Imperial and International

Communication Company. The question of the continuance of such observatories in the Persian Gulf and in Persia as are being worked by the telegraph personnel came up for serious consideration. The co-operation of the Consulate authorities in the interior of Persian stations was enlisted and with the help of the Director of the Indo-European Telegraph Department, Karachi, it has been arranged that the Imperial and International Communication Company will take over the observational work at the observatories in the Persian Gulf on the existing conditions. Wing Commander Howe of the Flying Boat Squadron of the Persian Gulf came from Basra to discuss with the Meteorologist the possibility of the supply of regular meteorological information for the Basra-Bahrein-Muscat-Gwadar-Karachi route.

The Meteorologist prepared a brochure on "The Meteorology of the Persian Gulf and Mekran" giving an account of the present state of knowledge regarding weather over the region in question. As mentioned above under Chief Features, some work was also done in connection with the observations and analysis of temperatures at four different heights on the 264 ft. mast at the Airship Base Observatory. The electrical resistance thermometers were functioning at the four heights for a few months but were put out of use because of contact trouble in the Thread Recorder; and the bulk of the observational material therefore consists of the records of four ordinary thermographs.

21. *Kodaikanal Observatory.*—The solar and astronomical researches during the calendar year 1930 have been summarised in the Annual Report of the Kodaikanal Observatory. An addition to the routine work has been made by the inclusion of the measurement and tabulation of prominences photographed in hydrogen light from January 1st, 1929. Another addition to the routine was a tabulation of areas of $H\alpha$ absorption markings uncorrected for the curvature of the Sun's surface. The daily character figures for solar activity according to $H\alpha$ disc spectroheliograms were communicated quarterly to the Observatoire Fédéral, Zurich, for publication. Occasional staff meetings were held for the discussion of different scientific topics or papers.

One or two schemes regarding the amenities necessary for Kodaikanal Observatory were under consideration. The first is the scheme for municipal water supply. This was during the year in its rudimentary stage and included direct pumping of water into the reservoir near the observatory which will also supply other tax-payers in the vicinity. The Sanitary Engineer suggested that the Government of India should be asked to contribute to the capital cost. Another necessity for the Kodaikanal Observatory is a building to accommodate library, photographic records and office rooms. The existing accommodation is being found insufficient, because the library has been growing and the stock of photographic records has been accumulating at a rapid rate. Plans were prepared for the new building, but nothing further could be done on account of the adverse financial position.

22. *Meteorological Office, New Delhi.*—This forecasting centre continued its work in the hired building at 19, Prithviraj Road. Two weather charts, (8 hrs. and 17 hrs.), were prepared daily. Issuing weather reports and forecasts to aviators for the region between Jodhpur and Gaya remained the chief function of this office.

23. *Meteorological Office, Rangoon.*—As a part of the extension of the provision of meteorological facilities for aviation on the air-route from Calcutta to Rangoon and Victoria Point, this office was opened in September 1930. The office commenced functioning as a forecasting centre by the middle of December, its responsibility being limited on one side by Akyab and on the other by Victoria Point. It prepares two sets of weather charts daily and has the administrative control of some 20 observatories in Burma, of which it also will prepare the climatological data.

24. *Meteorological Offices at Quetta and Peshawar.*—As mentioned in the previous year's Administration Report, a Meteorologist from the India Meteorological Department held charge of the centre at Peshawar until the return of the R. A. F. Officer. Immediately after this, the R. A. F. Meteorological Officer at Quetta left and the officer of the Indian Meteorological Service was posted to Quetta. These officers issued detailed local forecasts and warnings each for his neighbourhood, as well as general forecasts for the Delhi-Peshawar and Quetta-Karachi air-routes. The work of the first class observatories at Quetta and Peshawar was carried out as usual.

25. *Other Observatories.*—The position as regards number of observatories of various classes is shown in the table below, which also gives the corresponding figures at the end of the year 1929-30. For a classification of these observatories, the reader is referred to Appendix C:—

	on 31st March 1931.	on 31st March 1930.
I Class	14	13
II Class	153	148
III Class	85	78
IV Class	23	23
V Class	19	19
Non-departmental .	54	52

The records of the non-departmental observatories were scrutinised by this department and in most cases utilised in the daily weather reports and other departmental publications. The importance of these observatories need hardly be emphasised and the co-operation of the Indian States and other public bodies who maintained such observatories for the furtherance of the study of Indian meteorology is much appreciated.

RAINFALL REGISTRATION.

26. The system of provincial rainfall registration, for which the Director-General of Observatories is the consulting authority, continued its usual widespread work satisfactorily. The following table based

on reports for 1930-31 shows the number of raingauges in each province and in the Indian States at the end of the year and the number of inspections of these during the year with corresponding figures for the preceding year for comparison:—

No.	Province;	Number of Raingauges at the end of			Number of Inspections.			Remarks.
		1930-31	1929-30	Change	1930-31	1929-30	Change	
1	Burma . . .	214	214	0	216	211	+5	Satisfactory.
2	Assam . . .	129	129	0	113	118	-5	Do.
3	Bengal . . .	236	234	+2	206	210	-4	Generally good.
4	Bihar and Orissa	298	297	+1	260	275	-15	Generally satisfactory.
5	United Provinces	269	269	0	228	239	-11	Satisfactory.
6	Punjab . . .	154	154	0	120	121	-1	Generally good.
7	North-West Frontier Province.	33	33	0	26	28	-2	Do.
8	Baluchistan . .	76	77	-1	53	64	-11	Good .
9	Bombay . . .	303	304	-1	262	266	-4	Satisfactory.
9(a)	Western India States.	27	27	0	27	27	0	Do.
9(b)	Baroda . . .	13	13	0	10	7	+3	Do.
10	Rajputana . . .	332	342	-10	305	322	-17	Generally good
11	Central India . .	197	197	0	142	158	-16	Satisfactory.
12	Jammu and Kashmir	34	34	0	28	16	+12	Generally good.
13	Central Provinces	115	115	0	96	96	0	} Generally good (excluding 76 raingauges under Irrigation Department.)
13(a)	Berar . . .	42	42	0	42	39	+3	
14	Hyderabad . . .	54	19	+35	2	19	-17	Steps being taken to improve the conditions of all the new raingauges.
15	Mysore . . .	239	239	0	225	205	+20	Generally good.
16	Coorg . . .	9	9	0	6	5	+1	Good.
17	Madras . . .	510	510	0	488	483	+2	Do.
		Net change +26			Net change -57			

Heavy Rainfall Reports.—Heavy rainfall is often so very local that small unrepresented areas can have as much as 10 inches without the weather chart with 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 10 years ago that observers at the provincial raingauge stations should telegraph to forecasting centres falls of 5 inches or more. The number of such telegrams received during 1929-30 was 233 as compared with 248 in the previous year.

Snowfall Registration.—Information about the distribution and the 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.

CONCLUDING REMARKS.

27. 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 Posts and Telegraphs Departments assist 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 these observatories 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 Controller, Physical Department, Cairo; the Directors of the Observatories at Buenos Ayres, Santiago, the Astronomer Royal, Cape Town; Director L'Observatoire Physique Central, Leningrad; the Secretary, Friends' Industrial Mission, Banani Pemba, Zanzibar; the Principal Medical Officer, Tanganyika Territory, Dar-es-Salam; the Commonwealth Meteorologist, Melbourne; Director of Agriculture, Salisbury, Rhodesia; Chief of the Weather Bureau, Washington. Thanks are due to the Director, Koninklijk Magnetisch und Meteorologisch Observatorium, Batavia, for similar information and also for the daily weather telegrams from Sabang in Sumatra during the cyclone months April, May and October to December.

Thanks are due to the Marine Superintendents of the British India Steam Navigation Company, the Scindia Steam Navigation Company and the Asiatic Steam Navigation Company, for continuing the arrangement under which many captains of their fleets send weather logs to this department; and to Mackinnon Mackenzie and Company for affording facilities for the experimental tour on their mail steamer in the Bay of Bengal, to study possibilities of marine meteorological expeditions. Captain Whish, Principal Officer, Mercantile Marine Department, Bombay, Commander A. G. Kinch, Deputy Conservator of Port, Bombay, and Commander Norcock, Deputy Conservator of the Port of Calcutta, have been willing helpers of this department, for which it is grateful to them.

The department is indebted to the Government of His Exalted Highness the Nizam of Hyderabad for the help rendered in carrying on

sounding and pilot balloon work at the Nizamiah Observatory, and to the Governments of Mysore and Travancore for their co-operation by regular collection of pilot balloon data at Bangalore and Trivandrum respectively.

Thanks are due to the Eastern Telegraph Company for charging this Department half the usual rates for the transmission of South American weather telegrams. Thanks are also due to the various pilots of the Imperial Airways Limited for the supply of weather logs to this Department; to the various ships' officers, who send their marine weather logs direct to this Department; to the Superintendent of the Colombo Observatory for the useful help he has rendered from time to time in connection with storm warning work.

C. W. B. NORMAND,

Director-General of Observatories.

POONA;

The 11th September 1931.

APPENDIX A.

THE STAFF OF THE INDIA METEOROLOGICAL DEPARTMENT AS IT STOOD ON
31ST MARCH 1931.

METEOROLOGICAL OFFICE, POONA.

Director-General of Observatories:

C. W. B. Normand, M.A., D.Sc. (Edin.).

General Section.

Meteorologist	V. V. Sohoni, B.A. (Hons.), B.Sc. Bombay.
Assistant Meteorologist	C. P. Venkataramier, M.A. (Madras) (Temporary).
Superintendent	Shamsul Haq, Khan Saheb.
Assistants	6.
Stenographers	2.
Cashier	1.
Clerks and typists	13.

Weather Section.

Meteorologist	S. Basu, M.Sc. (Allahabad).
Assistant Meteorologist	B. N. Desai, M.Sc. (Bombay), Ph.D. (Edin.), B.A., LL.B. (Bombay).
Assistants	2.
Clerks and tabulators	12.
Draftsmen	5.

Observatories Section.

Meteorologist	K. J. Kabraji, B.A. (Hons.), B.Sc. (Bombay), M.Sc., Ph.D. (London).
Assistant	1.
Inspector of Observatories	1.
Clerks	3.

Marine Section.

Meteorologist	S. Mal, M.Sc., Ph.D., D.I.C. (London) (on probation).
Assistant	1.
Clerk	1.
Draftsman	1.

Instruments Section.

Meteorologist	J. M. Sil, B.A. (Calcutta), B.Sc. (Engg.) (Boston Tech.).
Assistants	2.
Clerks	2.
Draftsman	1.
Senior and Junior Observers (temporary)	2.
Store-keeper (temporary)	1.
Mechanics (temporary)	2.
Skilled Mistri (temporary)	1.
Overseer (clerk of works, temporary) (abolished from 1st April 1931)	1.

Upper Air Section.

Meteorologist	K. R. Ramanathan, M.A., D.Sc. (Madras) (on leave).
	L. A. Ramdas, M.A., Ph.D. (Calcutta), Meteorologist (officiating).
Assistant Meteorologist	Barkat Ali, B.A., M.Sc. (Punjab).
	S. P. Venkateshwaran, B.A. (Hons.) (Madras) (temporary).
Assistant	1.
Clerks	2.
Senior and Junior Observers	5 (including 3 Senior Observers of the establishment of Agra, temporarily transferred).
Draftsman	1.
Clerk (temporary)	1.
Observer (temporary)	1.

Library Section.

Meteorologist	S. R. Savur, M.A. (Madras), Ph.D. (London).
Assistant Meteorologist	M. V. Unakar, Rao Saheb, B.A. (Bom- bay).
	S. L. Malurkar, B.Sc. (Mysore), M.Sc. (Cantab.) (temporary).
Assistants	2.
Librarian	1.
Clerks	5.
Draftsman	1.

Climatology Section.

Meteorologist	S. R. Savur, M.A. (Madras), Ph.D. (London).
Assistant Meteorologist	V. Doraiswamy Iyer, B.A. (Madras).
Assistant	1.
Clerks	10.

UPPER AIR OBSERVATORY, AGRA.

Meteorologist-in-Charge	G. Chatterjee, M.Sc. (Calcutta).
Meteorologist	N. K. Sur, D.Sc. (Allahabad).
Assistant Meteorologists	B. N. Sreenivasiah, M.Sc. (Calcutta).
	D. M. Patel, B.Sc. (London), A.R.C.S. (on probation).
	S. K. Das, M.Sc. (London), D.I.C. (offg.).
Superintendent	Babu Ram Samnol (on probation).
Mechanical Assistant	Chainsukh.
Chief Observer	1.
Chief Computer	1.
Foreman	1.
Clerks or Observers	42 (at Agra).
Clerks or Observers	71 (out-station staff).
Mechanics (temporary)	10.
Clerks and Observers (temporary with out time limit sanctioned by Govern- ment)	9.
Clerks and Observers (temporary with time limit sanctioned by D. G. O. and Government)	5.
Enginemen (permanent)	2.

COLABA AND ALIBAG OBSERVATORIES, BOMBAY.

Meteorologist S. K. Banerji, M.Sc., D.Sc. (Calcutta).

At Colaba.

Head Clerk P. A. Salvi, B.A., LL.B. (Bombay) (on probation).

First Assistant 1.

Observers 6.

Cashier 1.

Marine Clerk 1.

Typist and Stenographer 1.

At Alibag.

Observers 2.

ALIPORE OBSERVATORY AND METEOROLOGICAL OFFICE, CALCUTTA.

Meteorologist S. N. Sen, M.Sc. (Calcutta and London), Ph.D. (London).

Assistant Meteorologists M. G. Subrahmanyam, Rao Bahadur, B.A. (Madras), LL.B. (Bombay).

A. K. Das, M.Sc. (Calcutta), D.Sc. (Paris) (on probation).

C. Ramaswamy, M.A. (Hons.) (Madras) (offg.).

Superintendent K. P. Banerji, M.A.

Professional Assistant N. P. Chatterji, M.Sc. (Calcutta) (on probation).

Chief Observer G. N. Mukherji.

Clerks (upper division) 5.

Clerks (lower division) 25.

Stenographer 1.

Draftsmen 3.

Observers 4.

Inspector of Observatories 1.

METEOROLOGICAL OFFICE, NEW DELHI.

Meteorologist S. C. Roy, M.Sc. (Calcutta), D.Sc. (London).

Assistant Meteorologist B. K. Roy, M.Sc. (Calcutta) (on probation).

Professional Assistant V. V. Subbu, M.A., B.L. (Madras) (on probation).

Inspector of Observatories 1.

Head Clerk 1.

Cashier and Typist 1.

Clerks 6.

Observers (upper air) 3.

Observers (surface) (under training) 2.

METEOROLOGICAL OFFICE, KARACHI.

Meteorologist B. N. Banerji, M.Sc. (Allahabad), Ph.D. (Cantab).

Assistant Meteorologists P. R. Krishna Rao, B.Sc. (Mysore).
K. Das, M.Sc. (Punjab), Ph.D. (London) (on probation).

Chief Observer 1.

Head Clerk 1.

Inspector of Observatories 1.

Steno-typist 1.

Clerks or Observers 11.

Clerks or Observers (temporary) 5.

SOLAR PHYSICS OBSERVATORY, KODAIKANAL.

Director	T. Royds, D.Sc. (London).
Assistant Director	A. L. Narayan, M.A., D.Sc. (Madras), F.I.P.
Assistants	3.
Recorders	4.
Mechanic	1.
Book-binders	2.

METEOROLOGICAL OFFICE AND OBSERVATORY, MADRAS.

Assistant Meteorologist	A. A. Narayana Aiyar, B.A. (Madras).
Time Assistant	1.
Weather Assistant	1.
Clerks	4.
Observers	3.
Printer	1.

METEOROLOGICAL OFFICE, RANGOON.

Meteorologist	S. K. Pramanik, M.Sc. (Lucknow), Ph.D. (London), D.I.C. (London).
Assistant Meteorologist	S. S. Lal, M.Sc. (Lucknow), D.I.C. (London), M.Sc. (London) (temporary).
Professional Assistants	H. R. Puri, M.Sc. (Punjab). U. N. Ghosh, M.Sc. (Calcutta) (on proba- tion).
Inspector of Observatories	1.
Clerks	10.
Observers	4.

METEOROLOGICAL OFFICE, No. 3 (INDIAN) WING, R. A. F., QUETTA.

Meteorologist	A. K. Roy, B.Sc. (Calcutta), B.A. (Oson.) (on probation).
Senior Clerk	1.
Junior Clerks	3.

METEOROLOGICAL OFFICE, No. 1 (INDIAN) GROUP HEADQUARTERS, R. A. F., PESHAWAR.

Meteorological Officer (R. A. F.)	R. G. Vervard, Ft./Lt.
Senior Clerk	1.
Junior Clerks and Observers	3.

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. Delhi Daily Weather Report (to date).
- iv. Karachi Daily Weather Report (to date).
- v. Madras Daily Weather Report (to date).

2. Weekly Weather Report (to date).

3. Monthly Weather Report (to date).

4. India Weather Review, Annual Summary for 1929, in seven parts:

- i. Introduction.
- ii. Part A.—Summary of Weather and Rainfall.
- iii. Part B.—Snowfall.
- iv. Part C.—Storms and Depressions.
- v. Part D.—Annual Tables.
- vi. Part E.—Seismic Records.
- vii. Part F.—Errata to Monthly Weather Reports.

5. Daily Rainfall of India for 1927.

6. Monthly Rainfall of India for 1927.

7. Upper Air Data, 1929, in 14 parts:

- i. Parts 1—12.—Winds in January to December.
- ii. Part 13.—Monthly Means of Pilot Balloon Data and Monthly Frequencies of Clouds.
- iii. Part 14.—Sounding Balloon Data.

8. Seasonal Memoranda:

- i. Memorandum on the Probable character of the weather in North-West India in January, February and March 1931.
 - ii. Statement of the Rainfall and Snowfall of North-West India in January, February and March 1930 and a comparison of the Seasonal Forecast with the actual Precipitation.
 - iii. Memorandum regarding the probable amount of Monsoon Rainfall in 1930.
 - iv. Memorandum on the Rainfall of June and July and the probable amount during August and September 1930.
 - v. Statement of actual Rainfall in the monsoon season, June to September 1930, and a comparison of the Forecasts with the actual Rainfall.
9. Magnetic, Meteorological and Seismographic Observations made at the Government Observatories, Bombay and Alibag, in the year 1926.
10. Report on the Administration of the Meteorological Department of the Government of India in 1929-30.
11. Annual Report of the Kodaikanal Observatory.

II.—*Occasional.*

1. Memoirs of the India Meteorological Department:

Vol. XXV, Part VII.—An Analysis of the Base Line values of Autographic Instruments, by Sudhansu Kumar Banerji, D.Sc.

2. Scientific Notes :

Vol. II—

- No. 16.—Winds in the first 3 Km. over Port Blair, by K. P. Ramakrishnan, B.A.
 No. 17.—Parts A—D.—Tables of Monthly Average Frequencies of Surface and Upper Winds up to 3 Km. in India.

Vol. III—

- No. 18.—The Structure of the Madras Storm of January 1929, by K. R. Ramanathan, M.A., D.Sc., and A. A. Narayana Iyer, B.A.
 No. 19.—Distribution of Air Density at M. S. L. over India, by U. N. Ghosh, M.Sc.
 No. 20.—Correlation between Rainfall in North-West India and Height of Indus River at Bukkur, by Rao Saheb Mukand V. Unakar, B.A.
 No. 21.—Upper Air Circulation over India and its neighbourhood up to the Cirrus Level during the Winter and the Monsoon, by H. C. Banerji, M.Sc., and K. R. Ramanathan, M.A., D.Sc.
 No. 22.—The Structure and Movement of a storm in the Bay of Bengal during the period 13th—19th November 1928, by K. R. Ramanathan, M.A., D.Sc.
 No. 23.—Historical Note on the Catch of Raingauges, by H. R. Puri, M.Sc.
 No. 24.—On the utility of the observations of Barometric characteristics and tendencies for forecasting Weather in North-West India, by Ft.-Lieut. R. P. Batty, B.A.
 No. 25.—Heights of clouds in India as determined from Pilot Balloon Ascents, by the late M. V. Narayanan, B.A., and M. P. Manna.
 No. 26.—Some statistical Relations between Temperature and Pressure in the upper atmosphere over Agra and Batavia, by S. Gopal Rao, B.A.
3. Kodaikanal Observatory Bulletins :
- No. LXXXVII.—Summary of Prominence Observations for the first half of the year 1929.
 No. LXXXVIII.—Summary of Prominence Observations for the second half of the year 1929.
 No. LXXXIX.—The Rotation of Hydrogen Absorption Markings and their Height above the Surface of the Sun.
4. Meteorology of the Persian Gulf and Mekran, by B. N. Banerji, M.Sc., Ph.D., F. R. Met. Soc.
 5. Five-Day Normals of Maximum and Minimum Temperature and Accumulated Rainfall.
 6. Winds, Weather and Currents on the Coasts of India and the Laws of Storms.
 7. Instructions to Observers at the Second and Third Class Observatories, 1930.
 8. Weather Code, 1931.
 9. Pilot Balloon Code, 1931.
 10. Handbook of Codes, 1931.

The following meteorological and other papers or notes were contributed by members of the staff to extra-departmental journals:—

Normand, C. W. B.—

“The Upper Atmosphere.”—Presidential address at the Section of Mathematics and Physics of the Indian Science Congress, January 1931—Proceedings, Asiatic Society of Bengal.

Banerji, S. K.—

- Microseisms associated with disturbed weather in the Indian seas—Philosophical Transactions of the Royal Society. Series A, Vol. 229, pp. 287—328.
- The Electric Field of Overhead Thunder-clouds—Quarterly Journal of the Royal Meteorological Society, Vol. 56, No. 236, July 1930, pp. 305—334.
- Effect of Indian Mountain Ranges on Air Motion—Indian Journal of Physics, Vol. V, Part 7, February 1931, pp. 699—745.

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APPENDIX C.

CLASSIFICATION OF OBSERVATORIES, ETC.

Weather observatories.—The functions of a weather observatory are the recording of weather elements through the agency of an observer with the help of instruments near the ground (as distinct from upper air observations obtained by means of balloons, etc.). Observatories where the staff is provided and paid for by other agencies, for instance Indian States, are called non-departmental, although instruments are supplied by the Meteorological Department. These surface observatories are classified thus:—

First Class.—Such observatories are furnished with autographic instruments for continuously recording pressure, temperature, humidity, wind direction and velocity and rainfall, in addition to instruments read by eye. They can undertake special observations (e.g., on atmospheric electricity, terrestrial magnetism, seismology), some of the first-class observatories also determine time. The staff required varies from two part-time observers to about four full-time observers according to the amount of special work and of computation and tabulation of data.

Second Class.—At second class observatories observations are taken two or three times daily and telegraphed to one or more forecast centres. The existing standard times of observation in India are 8 hrs. (local time) and 17 hrs. I. S. T., the observations being made by a part-time observer on Rs. 25 per mensem generally.

Third Class.—The observatories belonging to this class are those where (a) readings are taken daily at 8 hrs. (local time) and sent by telegram to one or more forecast centres or (b) readings are recorded twice daily at 10 hrs. and 16 hrs. (local time) but not telegraphed. At each (a) type observatory there is one part-time observer on Rs. 15 a month. Practically all (b) type observatories are non-departmental.

Fourth Class.—At such observatories either observations of temperature, wind and rainfall only or of temperature and rainfall only are recorded. The staff at a fourth class observatory consists of a part-time observer on an allowance not exceeding Rs. 12 a month.

Fifth Class.—At these observatories part-time observers on an allowance of Rs. 5 a month record and telegraph rainfall only.

Pilot Balloon Observatories.—At these observatories pilot balloons (i.e., balloons without attached instruments) are released and observed through special theodolites for the determination of wind directions and velocities at various heights in the free atmosphere. The minimum staff is two full-time observers for one balloon flight per day and three full-time observers and a balloon maker for two balloon flights per day.

Upper Air Observatory.—At such an observatory in addition to the pilot balloon work observations of upper air temperatures, humidities and pressures up to heights of about 15 miles by means of sounding balloons (i.e., with instruments attached), are undertaken.

Solar Physics Observatory.—The department has such an observatory at Kodai-kanal equipped with photoheliograph, spectroheliograph, etc., where special work on solar physics is done.

Forecast Centres.—These centres are located at different meteorological offices such as Calcutta, Karachi, Delhi, etc., where weather observations are collected by telegram from a number of observatories and plotted on weather charts, which form the basis of weather reports and forecasts. Of these centres there are two types, the first being the main centres serving a large area for general purposes such as the headquarters office at Poona and the second the regional centres serving more limited areas for special purposes, for instance air routes.