

**Report on the Administration of the Meteorological Department of the
Government of India in 1928-29.**

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CHIEF FEATURES OF THE YEAR.

The transfer of the headquarters office from Simla to Poona in batches was completed by the middle of June. The opening ceremony of the new building was performed by His Excellency Sir Leslie Wilson, Governor of Bombay, on the 20th July 1928 in the presence of the Hon'ble Sir Cecil McWatters, then acting Member of the Governor-General's Executive Council, who reviewed the work of the Department from its commencement up to the present day. He emphasised the need for further research on the relation between Upper Air and Surface Meteorology. His Excellency in welcoming the Meteorological Headquarters to Poona referred to the services rendered by meteorology to shipping, aviation and other interests and expressed the hope that the department in its new headquarters would be able to do something in a new branch of research, namely Agricultural Meteorology, besides carrying on other useful work.

2. The first half of the year at Poona was spent in heavy administrative work connected with the transfer of the office from Simla to Poona and the work of re-organisation at the new centre. In spite of the general disorganisation of the headquarters office, considerable attention was paid to researches in both theoretical and practical Meteorology and allied subjects. A number of investigations were taken up by officers and assistants of the department and also by a few science graduates who worked for short periods as voluntary research workers in the Poona office.

3. A spacious hall has been set apart in the new building for use as library where a large number of books and periodicals have already been suitably arranged and adequate facilities have been provided for use of the hall as a study. Fair progress was made in organising a first class observatory and fitting up a laboratory and workshop at the new office.

4. In order to meet the requirements of the London-Karachi Air Mail Service, arrangements were completed towards the end of the year for issuing, through the Karachi civil wireless station, synoptic weather broadcasts on short wave at regular intervals, also for supplying weather reports by wireless to aeroplanes in flight and for receiving synoptic broadcasts from Baghdad.

5. Besides these preparations at Karachi, the activity of the Department was largely directed to the formulation of schemes for meteorological organisation in connection with the future development of air service in India and its neighbourhood. The proposed service will consist of three distinct sections (1) Karachi-Delhi, (2) Delhi-Calcutta and (3) Calcutta-Rangoon with ultimate extension to Victoria Point. The Department will thus eventually be responsible for meteorological services to an air route extending from Basra in the west to Victoria Point in the east and will in this respect occupy a unique position such as very few meteorological organisations in the world have had to undertake. In connection with the Karachi-Delhi and Delhi-Calcutta sections of the air service which are expected to open towards the end of 1929 and 1930 respectively, a scheme for the provision of meteorological facilities was prepared and submitted to Government for sanction. The scheme comprises the location of a forecasting centre at Delhi in charge of a Meteorologist and the fitting up of complete sets of self-recording instruments at six aerodromes along the route besides other details of minor character. In February 1929 Dr. S. C. Roy, Meteorologist, was deputed to inspect the aerodromes along the route from Karachi to Calcutta and report on the possibility of meteorological developments at these places.

6. The International Meteorological Committee, which is the permanent executive body of the International Meteorological Organisation, has decided to form a permanent Secretariat under the direction of the President, which will temporarily be located at either De Bilt or Utrecht in Holland. The Secretariat will be responsible for the organisation of meetings of the Committee and of Commissions and for reports of these meetings; it will also serve as a centre for recording information concerning the meteorological services of the whole world, and will help, as much as possible, the President of the Committee and the Presidents of the Commissions in the performance of their international duties. The annual contributions to be asked from different countries for the upkeep of the Secretariat were fixed at 4,000 gold francs from large, 2,000 from medium sized and 1,000 from small countries. The Government of India was pleased to sanction the payment of 4,000 gold francs annually as India's contribution to the International Meteorological Secretariat.

THE OPENING CEREMONY.

7. As stated in the previous section the opening ceremony of the new headquarters building of the India Meteorological Department at Poona was performed by His Excellency the Governor of Bombay on the 20th July, 1928. A large body of Government officials and other distinguished gentlemen were present at the ceremony. The Hon'ble Sir Cecil McWatters (then Mr. McWatters) on behalf of the Government of India, before requesting His Excellency to declare the building open, said :—

“ May I, in the first place, on behalf of the Government of India, express my thanks to Your Excellency for having so kindly consented to perform this opening ceremony of the new headquarters of the Meteorological Department? I recognize the heavy calls upon Your Excellency's time and attention and it is therefore a matter of great gratification that Your Excellency and Lady Wilson have been able to honour us with your presence to-day. The occasion is a memorable one for the Meteorological Department. Ever since the

foundations of Indian Meteorology were laid by Mr. Henry Blanford 53 years ago, as opposed to the fragmentary studies of weather that had been made before that date in various provincial offices, the Department has had no permanent official home and to-day marks for ever the relinquishment of a series of temporary headquarters which from their unsuitability have undoubtedly retarded progress.

“ The Department is one which suffered a good deal from the inevitable retrenchment after the War, but the last few years have happily been years of expansion and it is certainly true that the practical activities of the Department are now more widely recognized and appreciated than ever before. In their late Simla headquarters, it was possible for the Department to deal with questions of surface meteorology by consideration of ground-level data collected in India and elsewhere, and Mr. Henry Blanford, Sir John Eliot and Sir Gilbert Walker have done invaluable work on these and allied lines. Sir Gilbert Walker indeed in his search for factors which may help to predict the Indian monsoon, was led into studies of world-weather, which form the most complete discussion of the subject available at the present day. Also one very notable experimental enquiry in Simla led Dr. Simpson, now Director of the London Meteorological Office, to publish an explanation of the cause of electricity in thunderstorms in a memoir which has become a classic in meteorological literature.

“ But we are now to add those great fields of fruitful enquiry which depend essentially on accurate physical measurements in the higher winds of the upper air. It is largely upon these features of which at present we have little knowledge, that surface weather is now believed to depend, and India in undertaking this work is in the good company of most civilized nations of the world, with a fair chance of becoming one of the leaders in the van. The pioneer of such upper air work in India was the late Director-General of the Department, Mr. J. H. Field. His earlier efforts were necessarily spasmodic and hampered by the location of the Department's headquarters in Simla. To the layman it is always a surprise that Simla, in spite of its height, is unsuitable as a centre of upper air work. This is so, because balloons carrying instruments land somewhere in the depth of the Himalayas or in Tibet and are never recovered. But it was under Mr. Field's direction that the first serious and continuous effort was made by the institution of the Upper Air Observatory at Agra in 1914.

“ I have emphasised the importance of this new development of upper air research because it is from this point of view that we attach perhaps the greatest importance to the removal of the headquarters of the Department from Simla to an adequate home in Poona in the main path of the monsoon. With our present increased scientific staff and with our improved budget, there is every reason to believe that within the next decade or two great progress will have been made in the understanding of the mechanism of Indian weather, and the Indian Budget may be no longer a “ gamble in rain.”

“ But there are other advantages also which we expect to result from the transfer from Simla to Poona. One duty of headquarters is to warn ports and shipping on the west coast of India about storms or cyclones in the Arabian Sea, and we feel that our proximity to Bombay and the consequent possibility of maintaining close touch with shipping interests cannot but lead to greater efficiency in the storm-warning system. This new building, too, lies between the Colleges of Agriculture and Engineering ; to both of these subjects the Meteorological Department is frequently called upon to apply the results of meteorological knowledge and we look forward to a healthy interplay of ideas between these institutions.

“ The work of the Department covers many other forms of activity, which I can only touch on briefly to-day. The Observatories at Bombay, Calcutta and Madras supply correct time to the shipping at those ports. At Alibag there

is a magnetic observatory of the first order and at Kodaikanal Solar Physics Observatory which maintains a close daily spectroscopic watch of the Sun's variations. From Poona we can keep in closer touch with the activities of both these observatories than we can from Simla. There is also a system of warning for heavy rainfall and the Department has much to do with the supply of weather reports to aircraft, both Civil and Military. In this direction their duties are likely to become vastly more important in the future. The various exhibits which visitors are cordially requested to inspect at the end of the ceremony are intended to illustrate some of these various lines of work for which the Department is responsible.

“I should like to refer to one other matter. It has been the policy of Government for some years past to recruit young Indian scientists for the Weather Department as far as possible. This policy has been consistently followed and we have now only two British officers left, the present Director-General, Dr. Normand, who is worthily carrying on the great traditions of his distinguished predecessors, and Dr. Royds, who is engaged on specialist Solar Physics work at Kodaikanal. The Indian gazetted staff numbers 25, all with excellent scientific qualifications, and forming a band of officers who in academic distinction will compare favourably with any other meteorological service in the world. We look to them with confidence to maintain the traditions of the Department. In meteorological literature we read of the theories and practice of the Norwegian school or the Vienna school of Meteorologists. We look forward to the day when the Indian Service will be regarded throughout the world as having attained by right of research and of practical results the honourable title of the “Indian School of Meteorology.”

“We are celebrating to-day the opening of the Department's new home in a building worthy of its record and of what we hope for its future. To the architects, Messrs. Stevens and Partners, who designed the building and supervised its construction and to the contractors, Messrs. Pallonjee Eduljee, who have co-operated with the greatest good-will, I should like to take this opportunity of expressing our appreciation of their services. I will now ask Your Excellency to be so good as to unveil the two tablets in the Entrance Hall and to wish success to the Department in its new home.”

8. In declaring the building open, His Excellency said :—

“The establishment in Poona of the first permanent headquarters of the Meteorological Department of the Government of India is an event of considerable importance, and I should like to assure you, on behalf of my Government and myself, that we very heartily welcome the Department here and to request you, Mr. McWatters, to convey to the Government of India this expression of our sentiments. We are familiar in India with the value of the work done by this Department in forecasting and recording the progress of the monsoon, and last year we had in this Presidency a striking example of the importance of its weather warnings, in Gujarat and the neighbouring States, which enabled measures to be taken to guard against damage by heavy rains and floods. The reports which I have seen, from local officers in the districts affected, indicate that, although the floods were sudden and widespread, the warnings of the Department made it possible to take, in several places, steps which, although they could not prevent serious damage, mitigated to some extent the disastrous effects of that widespread calamity. The loss of the two passenger ships not far from Bombay last year proved how important it is to obtain early warning of the state of the weather on our coasts, and we may hope that the establishment of this office here will make it possible in the future to give longer notice of the movements of cyclones, which do so much damage in the Arabian Sea. Mariners on the other side of India have, I believe, a weather prophet of their own at Calcutta, and I have no doubt that the work of this office in Poona will give our people on the West Coast a feeling of greater security.

"I think I am right in saying that great strides have been made of recent years in Europe in one branch of your activities, namely, the forecasting of weather in connection with the rapid development of aviation there. The forecasts which appear every day in the Press are not only more detailed, but, so far as my observation goes, a great deal more accurate than they used to be. The needs of India in this connection are not yet so prominent, but every year brings us nearer the flying age in this country too, and I am confident that the demands on this office for accurate data and reliable forecasts will rapidly increase; consequently I do not think that the important step which the Government of India has taken in setting up permanent headquarters for the Department has come a moment too soon.

"The fact that the site which has been chosen for the Meteorological Office is so near our own College of Agriculture is, I trust, a good omen for the future. Other branches of the work done here may interest large sections of the public, but the connection between meteorology and agriculture is one of the deepest interest for all the people of India. Indeed I believe that the Meteorological Department itself had a sort of agriculture origin, for I am told that it was originally started on the recommendation of a Famine Commission, with the object of keeping the administration informed regarding the progress of the monsoon in all parts of India, and, if possible, of forecasting the monsoon rainfall. There is, to my mind, room for very close co-operation between the Meteorological Office and the Agricultural Department. To take a very simple example, it is clear that five inches of rain, well distributed over a whole month, is of much greater value to the crops than five inches all falling on one or two days in the month, and yet they would both appear in the rainfall statistics as five inches. There appears, therefore, to be room for research into the relation of rainfall to crops, the results of which might be of great practical value in an agricultural country such as this.

"I am fully aware of the arduous nature of meteorological research, and it may be that some expansion of the Department would be required to deal with a new branch of research, but it is possible that Dr. Normand may be able to do something in this direction during his term of office, and I can assure him that we shall be very willing for our Agricultural Department, and our Agricultural College, to co-operate with him in any direction in which their assistance may be of value.

"We may well congratulate ourselves on this latest addition to the architectural features of Poona, and upon the fact that the architects, Messrs. Stevens and Partners, and the contractors, Messrs. Pallonjee Eduljee, are both Bombay firms. The foundations of the building were begun in December 1926, and the result that has been so expeditiously achieved reflects the greatest credit on those responsible for designing and executing the work.

"I have had great pleasure in unveiling the tablets in the Entrance Halls and I am sure you will join me in thanking Mr. McWatters for coming from Simla in order to take part in this ceremony, and in wishing all success and prosperity to Dr. Normand and his staff in their new surroundings."

9. Following the opening ceremony there was an exhibition of meteorological instruments, weather maps, charts etc., and work of geophysical and astronomical interest illustrative of the varied activities of this department. The exhibition was thrown open to the public on the following day and proved a great attraction, the number of visitors, at a conservative estimate, exceeding 2,500. As several officers from sub-offices had been present at Headquarters for the opening ceremony, this was made an occasion for convening a conference of departmental officers in which matters of administrative and scientific interest were discussed. It has since been decided that a similar conference of officers shall be held once every year at Headquarters.

STORM WARNING ORGANISATION.

10. *The system of storm warning for ports and shipping.*—The warning of ports and shipping in the Arabian Sea against the approach of cyclonic storms or of bad weather was done from Poona, while Calcutta continued to issue similar warnings for the Bay of Bengal. At present the storm warning list consists of 37 ports on the west coast including three added during the year, and 28 ports on the Bay of Bengal. The station at Elephant Point was closed, while at the instance of the Presidency Port Officer, Madras, Bimlipatam was added to the list of ports under the "general" system. In addition to these regular ports, there are 8 river ports, 14 River Police Stations and 41 District Police Stations which have to be warned by Calcutta in connection with disturbed weather at the head of the Bay of Bengal. At the request of the Government of Bengal three Sub-Divisional Officers in the district of Backerganj were added to the list of River and District Police Stations. Although they do not hoist signals, they now receive warnings on occasions when "warning", "danger" or "great danger" signals are ordered at the river ports and Police Stations. Of the Bay ports 12 are provided with additional information regarding the particular areas in which weather is disturbed by a special system of 'locality signals'. Shipping at sea is also supplied with the latest weather information by means of wireless bulletins broadcast twice daily or more frequently whenever necessary. The radio stations at Bombay, Karachi and Aden serve the Arabian Sea area, whilst those at Calcutta, Rangoon and Madras serve the Bay of Bengal area. The radio station at Matara (Ceylon) serves both areas. The total number of warning messages issued was 8,176.

11. *Warning to ports and shipping in the Bay of Bengal.*—During the year warnings were issued for 32 periods of disturbed weather. Of these 7 developed into storms of slight to moderate intensity two of which are briefly described below.

A shallow depression appeared over the north Bay of Bengal on the morning of the 5th June 1928 in the neighbourhood of Lat. 18° 30' N., Long. 89° E. Moving in a northeasterly direction, the depression intensified gradually and by the evening of the 6th developed into a storm with its centre near Lat. 20° N., Long. 90° 30' E. By 11 hours on the 7th June the storm moved near Cox's Bazar and began to weaken. It caused strong winds with squally weather as far south as the Andamans and was responsible for heavy rain on the north Arakan and Chittagong coasts.

The storm of the third week of October, which crossed the coast near Madras on the 21st evening, although of slight intensity, was remarkable for the heavy rain and floods caused by it in the Vizagapatam and Godavari Districts. The floods resulted in very serious breaches in the railways and roads and a complete breakdown of telegraphic communication and were responsible for considerable damage to property and loss of some lives.

12. Reports on the working of the warning system were received by Meteorologist, Calcutta from 25 Port Officers on his warning list. Most of these officers expressed their satisfaction with the warnings. Among several

appreciative opinions may be mentioned two from the Harbour Master, Calcutta :—

“ Your telegram of the 18th April—‘ Thunder-squalls likely this evening south Bengal ’—was of very great assistance to us in determining the movements of vessels during the late afternoon and evening of that day ”.

“ The warnings in reference to local signals for nor ’westers are of very great advantage to my department.”

13. *Warnings to ports and shipping in the Arabian Sea.*—The west coast ports are warned not only for storms but also for squally weather, especially at the onset of the monsoon. During the year warnings were issued on 32 occasions in connection with depressions, squally weather or winter disturbances. No storm formed in the Arabian Sea during the year. For the Arabian Sea area, reports on the working of the marine warning system were received from 18 officers on the warning lists. The Port Officers at Bombay, Cochin, Calicut, Tellicherry and Mangalore in their reports stated that the warnings were timely and satisfactory in every respect and that no change in the present system was necessary.

14. *Ships’ Observations.*—As usual the department continued to render the utilitarian services of issuing warnings for storms at sea. The chief sources of marine data which are at present available for use by the department are wireless weather messages from ships in Indian waters. The wireless weather messages from ships are meant primarily to supplement the observations from coast stations. In the absence of a large number of observations from sea areas during disturbed weather it is very difficult to draw correct conclusions regarding the formation, position, movement and intensity of storms. This difficulty is even now very keenly felt by the department for lack of an adequate number of ships’ weather messages, especially in connection with the storms in the Arabian Sea, as inferences have, in the circumstances, to be drawn mainly from information from a very open net work of land observatories along the west coast.

The total number of ships’ messages from the Bay and the Arabian Sea this year was 4,342 (from the Bay 2,604 and from the Arabian Sea 1,738) as against 4,835 in 1927-28. This number compares rather unfavourably with the previous year’s. The department, while gratefully acknowledging the valuable assistance rendered by the commanders of ships who took part in this voluntary service of marine observers, feels that further co-operation is possible and takes the opportunity of emphasising the importance of a far greater response to requests from storm warning centres for ships’ messages in the interest of mariners. It would be most helpful if the co-operating captains could try to induce others to take a share in this voluntary work of giving weather information from the sea. It should be constantly kept in mind that no matter how common-place a set of observations may appear by itself, it is of immense value during storm seasons, when it is considered along with the other observations plotted on a weather chart. There is also a great future for synoptic meteorology at sea ; but it will not be possible to make full and early use of this great aid to navigation and safety of life at sea without more extensive co-operation between the sailor and the meteorologist. The need of further co-operation of ships in all parts of the Arabian Sea is therefore

again urged and the Port Officers on the west coast area are especially invited to assist this department in propaganda amongst ships' captains.

Special mention should be made of the following steamers from each of which 40 weather messages or more were received during the year :—

1. Barpeta	244	13. Morvada	55
2. Beme	129	14. Maharaja	52
3. Shahjehan	115	15. Garbeta	52
4. Vita	111	16. Elephanta	51
5. Cocanada	103	17. Bahadur	50
6. Aungban	64	18. Egra	46
7. Juna	64	19. Aronda	42
8. Masimpur	64	20. Bovenkirk	41
9. Singu	63	21. Ethiopia	41
10. Badarpur	62	22. Bankura	40
11. Angora	61	23. Rajula	40
12. Erinpura	57		

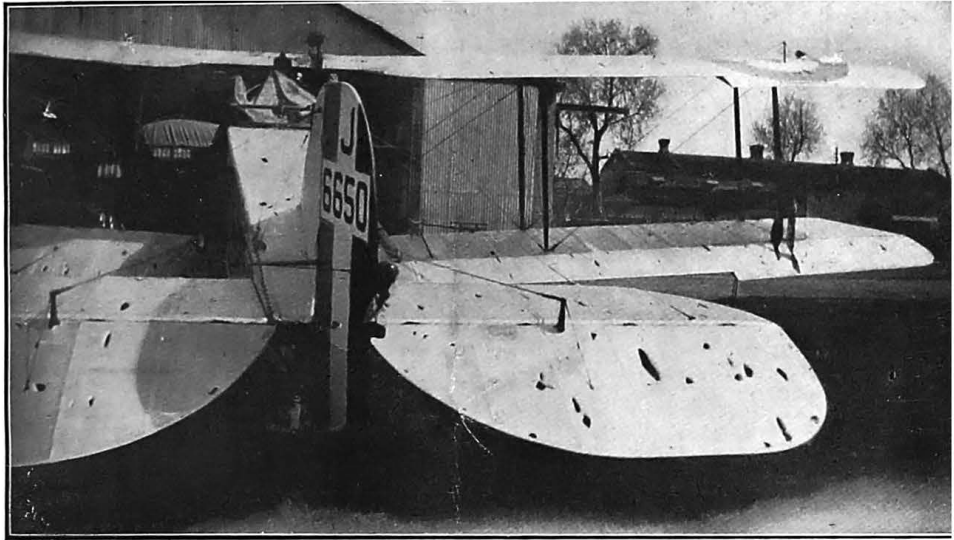
The department heartily congratulates the Commander of the B. I. S. N. Co.'s steamer "Barpeta" which sent the largest number of wireless weather messages for the last two years in succession.

15. An important source of marine data, apart from ships' wireless messages, is the log extracts collected mainly in Calcutta and Bombay. The observers of the Time-Ball and Tidal Observatory of the Rangoon Port Commissioners supplement these data from extracts collected at Rangoon. Occasionally, in special cases, logs of steamers experiencing disturbed weather are collected at Madras; and the Colombo Port authorities also render similar help whenever requested. A total of over 4,000 logs were recorded by the end of the year as against about 3,000 collected during the previous year.

16. The policy of lending meteorological instruments to ships is being pursued slowly but steadily. During the year under review two more ships were added to the list of those supplied with instruments on loan, thus bringing their total number to 14. It is noted with satisfaction that the captains of all these 14 steamers regularly forwarded their weather logs to this department. The department also gratefully acknowledges the co-operation of shipping firms in the matter of collection of weather information from the Indian Seas both during fair and disturbed weather; special mention should, in this connection, be made of the willing help rendered from time to time by Captain E. Trott, Marine Superintendent of the Asiatic Steam Navigation Co., Captain Jas. MacLean, Marine Superintendent of the British India Steam Navigation Co., Captain Whish, Port Officer, Bombay and Commander Norcock, Deputy Conservator of the Port of Calcutta.

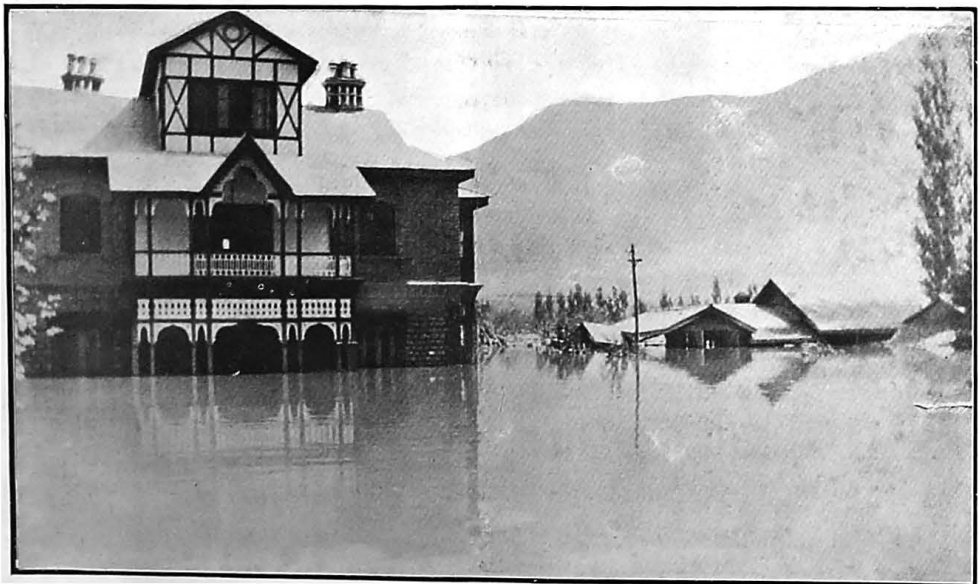
INLAND WEATHER WARNINGS.

17. Inland weather warnings for heavy rain on land were issued during the year by both Poona and Calcutta. Most of the officers on the warning lists are district officers and officers of the irrigation, railway and other departments. The total number at the end of the year was 207, the same as in the previous year. In addition, there were 26 officers of the Telegraph Department who generally required warnings for strong winds.



AEROPLANE DAMAGED BY HAILSTONES.

KASHMIR FLOODS, SEPTEMBER 1928.



STREET UNDER WATER AT SRINAGAR.

18. The number of special inland forecasts and warning messages issued by the Department during the year was 2,942. In addition 852 telegrams of actual heavy rainfall were sent by local meteorological observers direct to various officers.

19. At the end of the year 117 reports on the working of this system were received from recipients of these warnings. Most of them stated that the warnings were satisfactory, while a few offered suggestions or minor criticisms which have received consideration.

On the whole, a comparison of the inland warnings with the actual subsequent rainfall and the tracks of storms across the country shows that most of the warnings issued were timely and proved useful to the recipients.

A special circular letter was issued by the Meteorologist, Calcutta, to officers warned in connection with the storm which affected the Madras coast during the third week of October. The following are some of the opinions expressed by the local officers:—

- | | |
|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Collector of East Godavari District,
Cocanada. | “ I have received intimation from the meteorological authorities on the 21st morning (Sunday) that 48 hours heavy rain was to be expected. The expectations were fulfilled, and there was heavy rain on Sunday and Monday last.” |
| District Traffic Superintendent,
Guntakal. | “ The advice regarding heavy rain on the Coromandel coast was received in this office on 20th October 1928 and necessary precautionary orders were at once issued to stations. There was heavy rain between Nandyal and Bezwada but no damage or loss of life occurred. The advice was timely and useful.” |
| Executive Engineer, G. H. Division,
Dowlaihwaram. | “ No damage has been caused to any works in any jurisdiction. I am of opinion that the warning in question was of considerable use to all concerned.” |

Several letters of appreciation were also received in connection with warnings issued from Poona. The following are a few instances:—

(1) In a letter dated the 17th December 1928, the Political Agent, Banas Kantha, Palanpur, wrote:—

“ The information supplied proved correct in almost all cases during last monsoon ”.

(2) The Chief Engineer in Sind in one of his letters wrote:—

“ I am very pleased to note the care and regularity with which the warnings are issued by the Meteorological Department.”

(3) The following is an extract from the letter, dated the 7th January 1929 from the Executive Engineer, Nasrat Canals Division:—

“ they (warning telegrams) proved to be very useful. The canal officers were thus kept on their guard.”

20. Requests were also received at the headquarters on many occasions from Government officials and private firms for the issue of special weather reports and forecasts and were promptly complied with. A letter of apprecia-

tion from Major H. L. Ovans of the Army Headquarters, India, may be quoted here :—

“ I am directed by the Adjutant General to write and thank you for the very accurate weather forecast for the forenoon on 4th June (Monday), which your staff at Poona telegraphed on Sunday night. Owing to the cloudy weather early on 4th June it was not at all easy to decide whether the rain was likely to hold off during parade hours, but the forecast helped to confirm the justified decision not to cancel the parade.”

21. As mentioned in the last Administration Report the warnings for heavy rain are now included in the Daily Weather Telegram, the text of which is published in most of the important newspapers.

It is suggested that officers and others whose duties require them to keep a close watch on the weather would be better able to do this if they subscribe to the Daily Weather Telegram issued from Poona which only costs Rs. 10 per month.

OFFICES AND OBSERVATORIES.

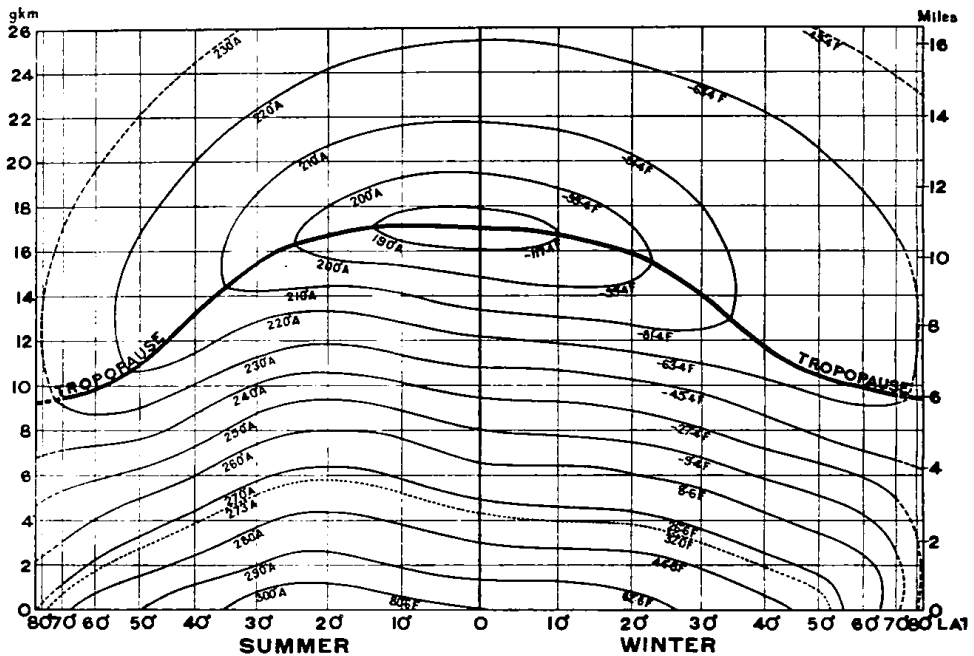
22. *Headquarters Office, Poona.*—The re-organisation of the work at headquarters by dividing the office into seven sections was mentioned in the last year's report. It is desired now to give a brief outline of the activities of the respective sections.

(1) *General Section (Officer-in-Charge—Dr. S. N. Sen).*—This section is responsible for 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 technical work of the Department. During the year pressure of work at headquarters, and in the General Section in particular, was very heavy on account of the additional duties arising out of the construction of the new office buildings at Poona and the transfer of the headquarters office. In fact, so much time was taken up by these abnormal items of work that the serious difficulties could only be overcome through overtime work and the ungrudging co-operation of all the officers and ministerial staff at headquarters and also by the sanction of some extra temporary clerks by Government. This section also had to deal with increased correspondence with foreign Meteorological centres on international matters and had to formulate a number of new schemes, the most important of them being in connection with the preparations for civil aviation in India.

(2) *Weather Section (Officer-in-Charge—Dr. S. C. Roy).*—Details of the work done by this section in connection with the issue of warnings for storms and heavy rain and of special weather forecasts when called for have already been given on pages 6—9. In addition, the weather section is responsible for the issue of a daily telegraphic summary of the general weather situation over the country with a forecast for the next twenty-four hours and the publication of Daily, Weekly and Monthly Weather Reports and the descriptive chapter of the part relating to weather in the Annual Summary.

During the year 71 weather forecasts for aviation purposes were issued. Questions such as revision of weather message codes etc. to suit aviation purposes were also considered by the section.

UPPER AIR TEMPERATURES OVER THE NORTHERN HEMISPHERE.



The above diagram which has been prepared from data collected from all parts of the world shows the distribution of temperature in the atmosphere up to a height of 16 miles over the northern hemisphere in summer and winter. The thick line marked "tropopause" separates the *troposphere* (the region where the air temperature generally falls with height) from the *stratosphere* (the region where the air temperature is either uniform or increases with height). It can be shown from physical principles that convection can take place only within the troposphere.

The following features are noteworthy:—

- (1) At the surface of the earth, the atmosphere is hottest near the equator and coldest near the poles, but up above, this contrast is gradually lost until at a height of 10 miles we actually meet with *colder* air over the equator than over the poles.
- (2) The coldest air over the earth, at a temperature of about -120° F, occurs over the equator at a height of about 11 miles in the form of an anchor ring.
- (3) Over the tropics, the temperature in the stratosphere increases with height.
- (4) The ring of lowest temperature at the tropopause is displaced further northwards in the summer than in the winter.

Results obtained at Agra have been of great help in settling important points in the construction of the above diagram.

The scale for latitude is a sine scale, so that the distance between any two latitudes in the diagram is proportional to the area of the earth's surface enclosed between them.

(3) *Observatories Section (Officer-in-Charge—Dr. K. J. Kabraji).*—This section is responsible for the efficient maintenance of all 3rd to 5th class observatories, except those that are in charge of the Meteorologist, Calcutta or the Meteorologist, Karachi. During the year, 67 observatories were inspected by Officers and Assistants sent out from Headquarters. The number of stations telegraphing visibility in the daily weather telegram increased from 74 to 125. The observatories of great reliability, where no mistake or at most one has been detected, number 24 and the number of stations at which more than 50 mistakes were made was 3. The average number of mistakes during the year at the remaining stations was 10. A brief account of the registration of rainfall carried out under the control of Provincial Authorities is given in a subsequent chapter of the report.

In addition to the duties mentioned above, the periodical supply of meteorological data and reports on meteorological conditions to various Government officers were continued.

(4) *Marine Section (Officer-in-Charge—Mr. S. Basu).*—The object of the section is to undertake special studies in marine meteorology, especially in connection with the formation, growth and subsequent movements of destructive storms and cyclones. The section will eventually be responsible for establishing closer contact and fuller co-operation with the shipping interests in the country than has been possible hitherto.

(5) *Instruments Section (Officer-in-Charge—Mr. J. M. Sil).*—The important routine duties of the section are as follows :—

- (a) All questions relating to meteorological instruments which involve preparation of annual and supplementary indents on the London and Delhi Stores Departments ;
- (b) specification, design, testing, calibration and repair of instruments ;
- (c) maintenance of special instruments throughout India and examination of their records ;
- (d) equipment and maintenance of workshop and laboratory at Poona.

(6) *Upper Air Section (Officer-in-Charge—Dr. K. R. Ramanathan).*—This section is responsible for upper air work at Poona and co-ordination of results of upper air observations throughout India. Sounding balloon work was begun at Poona in August 1928 and the first instrument was sent up on the 6th of that month. With the kind co-operation of the Government of Bombay and the neighbouring Indian States arrangements were made for the recovery of sounding balloon meteorographs through the Mamlatdars. Up to 31st March, 1929, 31 instruments were sent up and 15 were recovered ; of these 7 penetrated into the stratosphere. The first instrument that was recovered had reached a maximum height of about 12 miles ; the base of the stratosphere was seen from the record to be at a height of 10 miles with a temperature of -119° F., or 151° F. below the freezing point. In the stratosphere above the height of 10 miles, the temperature again increased to -87° F. at the top of the ascent.

As a first step towards the co-ordination of upper air observations, the publication, in fourteen parts, of data from 1st January 1928 collected by the department from ascents of pilot balloons, sounding balloons, kites and aeroplanes, was undertaken. The first twelve parts will be published monthly and the last two parts at the end of each year.

(7) *Library and Inquiries Section*.—The library which had gone into disorder during transit from Simla to Poona was re-arranged. Books, periodicals and pamphlets either purchased or received as presentation copies during the year numbered 785. The section is generally responsible for the preparation of monsoon and winter rainfall forecasts, the supply of special meteorological information, replies to scientific inquiries and the editing and distribution of departmental publications.

The routine publications of the department which are shown at length in the Administration Report for 1922-23 serve as the ordinary channels for the supply of information to the public. From time to time, however, special information is also supplied to the Meteorological Departments of England, Australia and Egypt. Special climatological and other meteorological data are also furnished to Government officials as well as to private firms on payment.

The following publications were issued during the year :—

1. *Scientific Notes, Volume I, No. 3*.—“Thunderstorms of Calcutta 1900-1926” by V. V. Sohoni.
2. *Memoirs of the India Meteorological Department, Volume XXV, Part II*.—“Summary of Indian Rainfall for the fifty years, 1875 to 1924”.—Departmental.
3. *Kodaikanal Observatory Bulletin No. LXXXII*.—“A brilliant Day-light Comet observed at Kodaikanal” by P. R. Chidambara Ayyar.

The following were in the press at the end of the year :—

1. *Scientific Notes, Volume I, No. 4*.—“On temperatures of Exposed Rails at Agra” by K. R. Ramanathan.
2. *Scientific Notes, Volume I, No. 5*.—“Frequency of Thunderstorms in India”—Departmental.
3. *Scientific Notes, Volume I, No. 6*.—“Correlations between Pre-monsoon conditions over north-west India and subsequent monsoon rainfall over north-west India and Peninsula” by Mukund V. Unakar.
4. *Memoirs of the Indian Meteorological Department, Volume XXV, Part III*.—“Data of Heavy Rainfall over Short Periods in India”—Departmental.

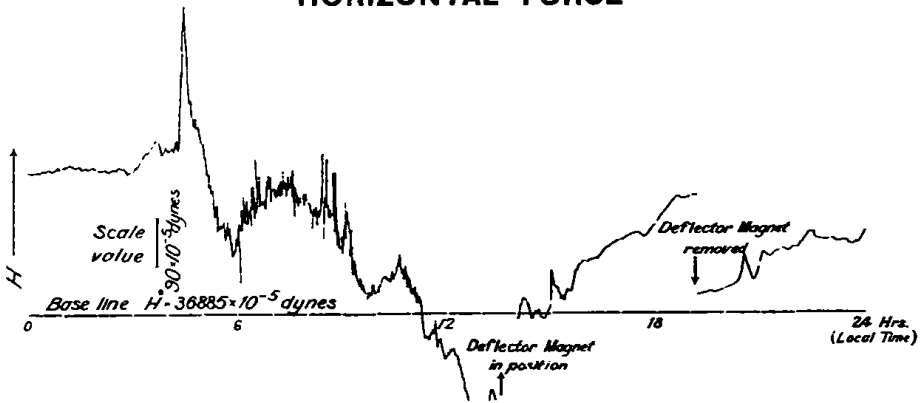
The number of institutions and individuals on the distribution lists of this department was 378 at the end of the year.

23. *Agra (Officer-in-Charge—Mr. G. Chatterji)*.—In accordance with the general upper air extension scheme 11 new pilot balloon stations were established in different parts of India and 3 more were temporarily opened in north-east India to study the nor'westers. The thanks of this department are due to the Mysore and Travancore Governments for their kind co-operation in the collection of upper air data. Preliminary arrangements were made for the starting of upper air work at Seychelles. The opening of all these new stations involved the recruitment and training of the necessary staff and the collection of adequate equipment for the additional upper air observatories. The demand for hydrogen gas for balloon work was very great and Agra observatory had to arrange for an output of the gas nearly three times that of the previous year.

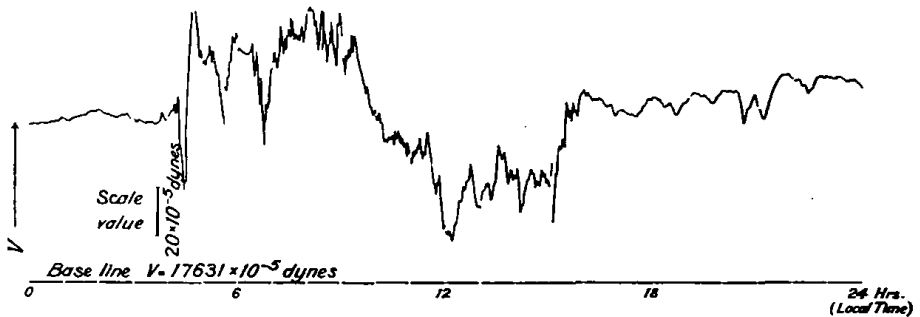
MAGNETIC STORM 8TH. JULY 1928.

(ALIBAG OBSERVATORY)

HORIZONTAL FORCE



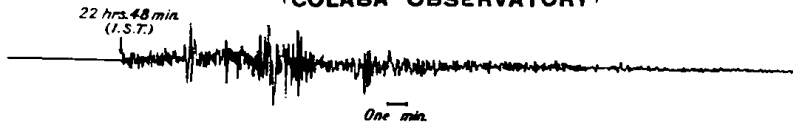
VERTICAL FORCE



SEISMOGRAM OF

AFGHAN EARTHQUAKE 1ST. FEB. 1929.

(COLABA OBSERVATORY)



The first two graphs depict the fluctuations of the horizontal and vertical components of the Earth's magnetic field during a magnetic storm which completely dislocated the telegraph traffic on the 8th. July 1928. This storm also caused brilliant auroral displays and is the severest on record at Alibag since May 1921. It was associated with a special group of sunspots past the sun's central meridian.

The last graph is the record of an earthquake shock which had its origin in Afghanistan. It was felt at Delhi, Lahore and several other places in the Punjab and the North-West Frontier Province and caused considerable damage in Turkisthan.

The daily routine duties, such as eye observation of various meteorological instruments and pilot balloon flights in the morning and the maintenance of a number of self-recording instruments were continued as usual. During the year 97 instruments were let off with balloons and 53 were recovered; the examination of their records led to a general confirmation of the results obtained in previous years. By means of the Chatterji upper air temperature indicator, which consists of a simple and inexpensive arrangement to indicate the level at which any definite air temperature is reached, the levels of given upper air temperatures in different months and at different hours of the day were determined. Balloons with recording instruments which come down automatically after reaching a certain height (christened "clown balloons" by Mr. Field) were used to obtain detailed records of humidity and temperature up to about 2.5 kms. above ground level.

A number of other investigations, both experimental and statistical, were also undertaken at the observatory. The test of airship fabrics received from the Royal Airship Works, Cardington, which was first undertaken at Agra in 1925 was carried on this year also.

An underground hut was built for the installation of a seismograph which was transferred from Simla to Agra on the move of the headquarters office to Poona.

An expedition led by Mr. Chatterji went to Jessore in Eastern Bengal in the middle of March 1929 to collect upper air data in connection with the study of nor' westers.

The pilot-balloon stations at Ambala and Lahore were inspected during the year.

24. *Colaba and Alibag (Officer-in-Charge—Dr. S. K. Banerji)*.—As mentioned in the last year's Administration Report, the Bombay Daily Weather Report was discontinued during the year and instead, a duplicated weather summary was issued from Colaba at noon every day during the period May to November. The summary gives the principal features of weather with forecast for western India and the rainfall amounts registered during the previous 24 hours and also contains half-weekly weather and crop report from the 1st July to the end of November.

The routine operations of the observatories consisted, as before, in securing continuous records of autographic instruments, magnetic, meteorological and seismographic; taking eye observations of auxiliary and recording magnetic instruments five times a day and of the meteorological instruments three times a day. A number of experimental researches which were started at the observatory in recent years were continued and some new investigations were taken in hand. A further study of microseisms appeared to reveal the existence of three distinct types of these vibrations which are readily distinguishable from one another and are associated respectively with (1) southwest monsoon, (2) storms in the Arabian Sea and the Bay of Bengal and (3) local disturbances on the Bombay coast. An ionium collector for the measurement of atmospheric potential gradient was received at Bombay in November 1928 from the Carnegie Institution of Washington, and arrangements were made for obtaining continuous records of the variations of atmospheric potential gradient in the

open space near the sea front. Experiments on earth current measurements were continued and yielded interesting results. Two post-graduate students carried out investigational work in the observatory on thermal conductivity of soil and on atmospheric potential gradient.

Wireless time signals broadcast by Bordeaux were received regularly throughout the year. Whenever Bordeaux was not received, Rugby was heard. The reception of time signals transmitted by Calcutta and Nauen was discontinued from 1st May and 1st August respectively. The observatory rated and issued 51 chronometers and watches to R. I. M. and R. N. ships and collected 1,021 weather logs from ships calling at Bombay. The manuscripts of the Observatory Volume for 1924 were sent to the press and those for 1925 were nearly ready for printing. Considerable progress was also made in the preparation of the volume for 1926.

25. *Calcutta, Alipore (Officer-in-Charge—Mr. V. V. Sohoni).*—The usual work of the first class observatory was carried out satisfactorily. The pilot balloon station which had been located at Diamond Harbour was transferred to Alipore in February last.

The storm and flood warning work of this observatory has been described in earlier sections of this report. Other important duties of the Alipore Observatory are the determination of time by transit observations of stars and the wireless broadcasting of time signals at 14 and 22 hrs. I. S. T., supplying all Indian observatories with instruments and stores, keeping a stock of tested instruments and supervising meteorological observatories in northeast India.

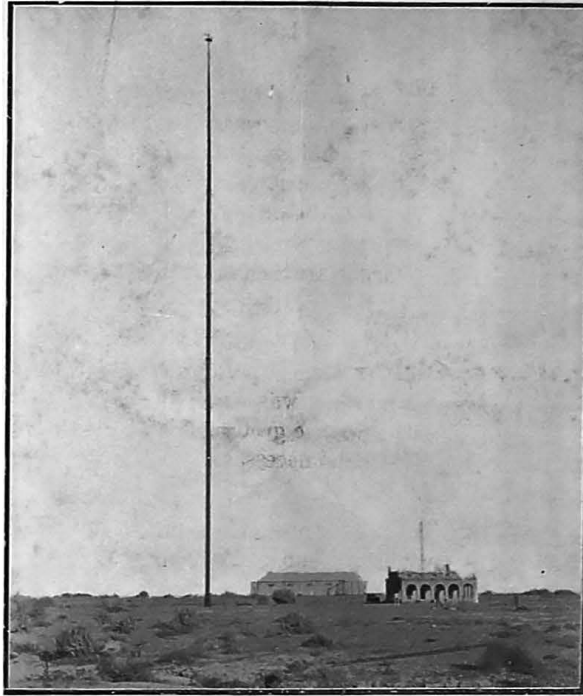
A scheme for the intensive study of weather over northeast India was put into operation from the 1st September 1928. It consisted of three sets of daily observations from 21 of the existing meteorological stations and of non-instrumental observations from 56 auxiliary stations; some of the observatories were equipped with autographic instruments.

The Calcutta office staff inspected 44 observatories in Burma and northeast India.

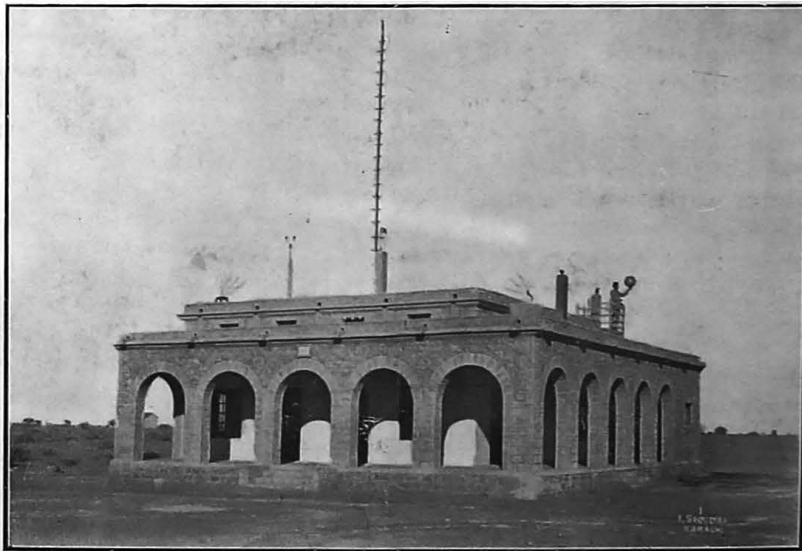
26. *Madras.*—The Madras Daily Weather Report was published throughout the year. One of the most important items of work for which the observatory is responsible is the supply of correct time to local shipping and through the Indian Telegraph system to the whole country, under the supervision of the Director, Kodaikanal and Madras Observatories. Comparisons with wireless time signals broadcast from foreign stations including Bordeaux and Rugby were also made daily as a check on the local time determination. Meteorological observations were made four times a day and the daily mean values obtained by applying corrections for the diurnal variation derived from 20 years' observations. The observatory maintained, as usual, a continuous record of the chief meteorological elements by self-recording instruments and continued the daily pilot balloon observations. Besides the ordinary routine work, the daily values of meteorological normals based on data for the period 1891-1927 were also prepared.

27. *Karachi (Officer-in-Charge—Dr. S. K. Pramanik and then Dr. B. N. Banerji).*—Dr. B. N. Banerji on his return from Europe resumed his duties at Karachi in September, 1928. As the airship intended for the London-Karachi

METEOROLOGICAL OBSERVATORY, DRIGH ROAD, KARACHI.



260-FOOT MAST FOR THE MEASUREMENT OF TEMPERATURE GRADIENT
NEAR THE GROUND.



OBSERVATORY BUILDINGS.

air-route was nearing completion and trial flights expected to commence in 1929, proposals were submitted to Government regarding the action to be taken for the intermediate stage of meteorological preparations for the coming of airships. These contemplate an extension of the present organisation by starting a few more reporting stations in the neighbourhood of Persia, equipping some of the existing observatories along the flying route with self-recording instruments and obtaining synoptic data from larger area than at present.

The observatory building at the Airship Base which was completed at the end of 1927-28 was equipped with self-recording instruments. The recording of ground and upper air observations, including visual observations of the hourly values of cloud and visibility, was started. Instruments for measurement of temperature gradient near the ground were received but could not be fitted up on the 260-foot mast, as the necessary electric power was not available at the aerodrome.

The R. A. F. at Drigh Road continued to extend their valuable co-operation and arranged for the collection of upper air temperature data by aeroplane flights on an average of 12 days per month.

At the forecasting centre, Karachi, a beginning was made with the study of weather conditions based on old data extending upto Italy to the west and Russia to the north.

During the year about 70 route forecasts were supplied by Karachi to aviators of many nationalities flying up to Karachi and across India. Among the noteworthy flights for which forecasts were issued may be mentioned the visit to India of the Under Secretary of State for Air on the flying boat "Iris" and the inauguration of the Dutch Air Mail Service to the Dutch East Indies.

28. *Kodaikanal (Officer-in-Charge—Dr. T. Royds).*—The observatory is mainly engaged on work in solar physics and astronomical researches, and the work during the calendar year 1928 has been summarised in the Annual Report of the Kodaikanal Observatory. During 1928 the solar activity maintained about the same level as during the previous year, although it would seem that the maximum of the spot cycle occurred in 1926. The highest prominence ever recorded at the observatory was photographed on November 19th, 1928 when an eruptive prominence reached a height of 910,000 km. above the solar surface before clouds intervened to prevent its further progress being pursued. Co-operation with other observatories was further increased during the year under the auspices of the International Astronomical Union, at whose request daily character figures for various features of solar activity from the 1st January 1928 were communicated for publication for the use of magneticians and others. The Marseilles observatory has been added to the list of observatories willing to send spectroheliograms regularly to Kodaikanal.

Spectrograms for the determination of the amount of ozone in the upper air were obtained at Kodaikanal on all suitable days from the 12th September 1928 onwards with Dobson's spectrograph which has been loaned to the observatory.

The revived post of Assistant Director was filled by the appointment of Dr. A. L. Narayan, D.Sc., formerly Professor of Physics at the Maharajah's College, Vizianagram, who joined duty on the 18th December 1928.

29. *Quetta and Peshawar.*—(R. A. F. Meteorological Officers—Flight-Lieutenants R. P. Batty and R. G. Veryard respectively).—These observatories which are fitted with a complete set of eye-reading instruments and a number of autographic instruments for recording important meteorological elements carried out the routine duties of a first class observatory. The R. A. F. Meteorologists at the local forecasting centres continued to issue general accounts and forecasts of weather over the Delhi-Peshawar-Quetta-Karachi air routes. They also issued detailed local forecasts and warnings, each for his own immediate neighbourhood. Special route forecasts were issued on about 180 occasions by Quetta and on approximately 250 occasions by Peshawar.

R. A. F. flying machines continued their meteorological observations at Peshawar and Quetta, and also at Kohat and Risalpur, and made the upper air data thus obtained available to this department. There were on the average about 23 ascents per month at Peshawar and 15 at Quetta.

30. *Other Observatories.*—*Departmental.*—There were at the end of the year 215 second to fifth class observatories maintained by the department. Two new third class observatories were opened at Vellore and Gwa. The old observatories at Quetta and Peshawar were closed and reports from the observatories under the R. A. F. meteorologists were substituted for them. The observatory at Lahore continued to function as a combined first class and pilot balloon station.

Non-Departmental.—Besides the above there were 51 non-departmental observatories whose records were scrutinized by this department and in most cases utilised in the Daily Weather Reports and other departmental publications. A new observatory was started at Coonoor and the existing observatories at Dehra Dun and Bahawalpur were equipped as daily reporting stations. The importance of these observatories need hardly be emphasised and the co-operation of the Indian States and public bodies for the furtherance of the study of Indian Meteorology is much appreciated.

RAINFALL REGISTRATION.

31. The registration of rainfall has always been carried out under the control of Provincial Authorities. In 1889 a uniform system was introduced by the Government of India and the Director-General of Observatories was made the consulting Officer in connection with this work. His advice is sought regarding the starting of new rain gauge stations, and he receives annual reports upon the efficiency of the work from the local controlling officers who are in most of the provinces the Directors of Agriculture or of Land Records.

The following table based on reports for 1928-29 shows the number of provincial rain gauges and the rain gauges in the Indian States at the end of

the year and number of inspections of these during the year, with corresponding figures for the preceding year for purposes of comparison :—

No.	Province.	No. of rain-gauges at the end of		No. of inspections.			Remarks.
		1928-29.	1927-28.	1928-29.	1927-28.	Change.	
1	Burma	215	214	204	229	-25	On the whole satisfactory.
2	Assam	126	124	116	108	+8	Equipment good.
3	Bengal	233	232	218	215	+3	Raingauges generally in good condition.
4	Bihar and Orissa ..	298	297	279	274	+5	Registration work satisfactory.
5	United Provinces ..	269	269	224	243	-19	Satisfactory.
6	Punjab	154	151	128	141	-13	These figures do not cover canal stations.
7	North-West Frontier Province.	31	31	28	23	+5	Inspected gauges found in working order.
8	Baluchistan ..	72	72	54	20	+34	All in good condition, defects promptly removed.
9	Bombay	304	304	264	244	+20	Good condition on the whole.
9 (a)	Western India States	27	27	26	26	0	Satisfactory.
9 (b)	Baroda	12	12	7	In good condition.
10	Rajputana ..	329	301	300	282	+18	Efficiently working.
11	Central India ..	198	195	154	155	-1	Generally good.
12	Jammu and Kashmir	33	33	28	24	+4	Generally good.
13	Central Provinces ..	115	115	94	93	+1	Defects removed promptly.
13(a)	Berar	42	42	41	39	+2	Do.
14	Hyderabad ..	14	14	14	14	0	In good condition.
15	Mysore	234	234	197	208	-11	Most of the stations satisfactory.
16	Coorg	9	9	8	7	+1	All in good order.
17	Madras	504	495	483	482	+1	In good condition.
					Net change		+33

32. *Heavy Rainfall Reports.*—Heavy rainfall is often so very local that small unrepresented areas can have as much as 10" without the Daily Weather chart conveying the least suggestion of the local inundations. In order that such useful data might be promptly available for the Daily Weather Report it was arranged in 1921 that reports of 5" or more of rainfall at the Provincial rain gauge stations should be telegraphed to the forecasting centres. The number of such telegrams received during 1928-29 was 256 as compared with 170 in the previous year.

33. *Snowfall Registration.*—Information as to the amount of distribution and time of occurrence of snowfall in the Himalayan and 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.

34. The Meteorological Department owes a large part of its usefulness to the sympathetic assistance it receives from other departments. Civil Surgeons and other officers of Government Departments help the meteorological work as honorary superintendents of observatories and in other capacities. The Posts and Telegraphs Department assist this department in the rapid transmission of meteorological information ; at the same time they allow their employees to act as observers.

Weekly telegrams are received from April to October from the Director, Royal Alfred Observatory, Mauritius and from the departmental observatories at Zanzibar and Seychelles. These telegrams give valuable information of the weather conditions in the Indian Ocean, and the department is indebted to these officers for the punctual transmission of the information. Thanks are also due to the Director of Royal Alfred Observatory for his courtesy in placing the meteorological data of that observatory at our disposal.

The department is greatly indebted for important information on meteorological conditions prevailing before and during the southwest monsoon to the Controller, Physical Department, Cairo ; the Directors of the observatories at Buenos Ayres, Santiago and Batavia ; 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-Salaam ; the Commonwealth Meteorologist, Melbourne, Director Agriculture, Salisbury, Rhodesia ; Chief of the Weather Bureau, Washington, and to the various officers around the Indian frontiers who have collected and supplied valuable snowfall information.

The thanks of the Department are due to the Superintendent of Colombo Observatory for the very useful help he has rendered from time to time in connection with storm warning work. The Department is also grateful to the Director, Koninklijk Magnetisch et Meteorologisch Observatorium, Batavia, Java, who has arranged for daily weather telegrams to be sent from Sabang in Sumatra during the cyclone months April, May and October to December. :

Thanks are also due to the Director General of Commercial Intelligence and Statistics for supplying information in connection with the study of correlation between weather and crops and to Mrs. M. La Frenais, Srinagar, for her permission to reproduce in the present issue of the Administration Report a photograph showing the great flood in Kashmir in September 1928.

POONA ;

T. ROYDS,

The 19th August 1929.

Offg. Director General of Observatories.