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REPORT

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE.

UPSALA, 1894.

Published by Authority of the Meteorological Council.

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REPORT

OF

THE FIRST MEETING

OF THE

INTERNATIONAL METEOROLOGICAL COMMITTEE OF THE CONFERENCE AT MUNICH,

At UPSALA, in AUGUST 1894.

First Meeting, Monday, August 20th.

THE MEETING was opened at 1h. p.m. in the Hall of the Faculty of Philosophy of the University,

Present: Professor Fries, Rector of the University, Messrs. von Bezold, Billwiller, Hann, Hepites, Hildebrandsson, Mascart, Mohn, Paulsen, Scott, and Tacchini.

Professor FRIES opened the proceedings with the following words:—

"Gentlemen,—Before you commence your deliberations on subjects of the highest importance from meteorology, I take the liberty of claiming your attention for a few minutes.

"You will permit me in the first case to express our satisfaction at seeing you, and our recognition of the fact that you have chosen Upsala for your place of meeting.

"Our town is, as you will doubtless have already noticed, simple in its character and modest in its size; and it seems to us somewhat difficult to see why you have selected it in preference to many other towns its superior in all respects.

"However, many scientific men know that thorough and useful work may be done with very moderate resources. We have abundant examples of this taken from the records of our own University.

"If you turn your eyes to the walls of the building in which we are assembled you will see the names of ancient Professors

of our University who have at least made their marks in different branches of science.

"Among them you will find one which is doubtless not unfamiliar to you, that of the inventor of the centigrade thermometer, the simplest, and the most generally used, of all meteorological instruments. In more modern times the University has had on its books the name of the late Mr. Theorell, the ingenious deviser of various forms of apparatus which are assuredly well known to all meteorologists.

"It is the memory of such work as this, and of other researches in the domain of meteorology which have been carried on here, attracted you to Upsala for your meeting, and we, members of the University, cannot but feel flattered and proud of the choice you have made.

"Let me express to you our sincere good wishes, and our lively hopes for the success of your meeting. May the deliberations you are about to commence be of value to your science, if so, they cannot fail to be of use to the human race.

"Gentlemen, with these sentiments, and these hopes, I have the honour to bid you, *welcome to Upsala.*"

Mr. SCOTT, as Secretary, replied as follows:—

"Mr. Rector and Gentlemen,—In the unexpected and lamented absence, through indisposition, of our President, Professor Wild, the duty devolves upon me, as Secretary, to express to you, on the part of the International Committee, our sincere thanks for the kindly words of welcome which we have just heard.

"In accepting the invitation of your and our eminent colleague, Professor Hildebrandsson, to meet under the auspices of your ancient and renowned University, now in the fifth century of its existence, the University not only of Celsius and Theorell but also of Linnæus; we felt sure that nowhere could we meet with a more cordial reception than in Upsala, and that nowhere would be shown a warmer interest in the progress of our science.

"The special inducement to the Committee to visit Sweden has been the extent to which the study of the clouds has been carried on at your meteorological observatory, mainly through the unsparing self-devotion of your observing staff.

"It is in Sweden and Finland that the greatest examples of untiring diligence in meteorological observations have been shown. The eye readings maintained prior to the establishment of automatic instruments at 20 minutes intervals, from March 1st, 1848 to December 31st, 1856, at Helsingfors, were made and recorded by close neighbours of yours, and the measurements of the higher clouds carried on at Upsala are a lasting glory to Swedish meteorological science.

"In conclusion I would only express the hope that the outcome of our deliberations may prove to be of lasting value to our science, and therefore worthy of the great university in

which we meet, and of the warmth of reception with which we have been greeted."

Professor FRIES withdrew.

The Committee constituted itself for the first Meeting.

The SECRETARY read:

(1.) A telegram from Professor Wild from Berlin, dated August 15th, announcing that owing to indisposition he was unable to come to Upsala.

(2.) A letter from Rear-Admiral de Brito-Capello expressing his sincere regret at being unable to attend the Meeting.

In the absence of the President, owing to indisposition, Mr. SCOTT, as sole representative of the Bureau, proposed that the Committee should request Monsieur Mascart to accept the Presidency for the Upsala Meeting.

This proposal was unanimously adopted.

M. MASCART thanked the Committee for the proof of confidence which had just been placed on record, and proposed that the secretary should despatch a telegram to Professor Wild to express the regret of the Committee at his non-appearance, and more particularly at the cause to which his absence was due.

The Committee decided—

1. That the Minutes should be kept in French.
2. That the Meeting should not be open to guests, with the sole exception of that devoted to the discussion of the cloud question. The members of the cloud committee, appointed at Munich, would be invited to take part in that discussion, and other meteorologists present at Upsala would also be admitted on that occasion.

The Meeting terminated at 11.30 a.m.

(Signed) E. MASCART.

Second Meeting, Tuesday, August 21st, 9h. 45m. a.m.

Present: Messrs. von Bezold, Billwiller, Hann, Hepites, Hildebrandsson, Mascart, Mohn, Paulsen, Scott, Snellen, and Tacchini.

The Minutes of the First Meeting were read and confirmed.

The SECRETARY reported that the telegram had been despatched to M. Wild as arranged at last meeting.

On the invitation of the President, Mr. Scott, the Secretary, read the Report. (Appendix I.)

On the conclusion of the report the President expressed the wish that the Minutes should contain an expression of the profound regret with which the Committee had received the news of the decease of M. Lang. All who were present at Munich had recognised the ability with which M. Lang had discharged the functions of President of the Conference, while the charm of his character had gained for him the unanimous sympathy of those brought in contact with him.

The Committee adopted the report of the Secretary as provisional Programme.

The discussion was opened on Question 2—

The International Bureau.

M. HILDEBRANDSSON communicated to the meeting the principal arguments which he had developed in a pamphlet, and which had been already distributed to the members.

He added, moreover, that M. Wild, who had proposed the question at Munich, was disposed to recognise that there were serious difficulties to be experienced in its realisation.

Several members expressed their views on the question, and, after discussion, the following resolutions were adopted :—

1. "The Committee thanks M. Hildebrandsson for his pamphlet, and decides that it should be printed (Appendix II.). It is convinced that the idea of the constitution of an International Bureau does not appear to be realisable."

2. "The International Meteorological Committee appears to be the proper body to establish and maintain relations between the different institutions, and to arrange for the carrying out of investigations of general utility."

M. HANN referred to the proposal made by M. Mohn at Munich, for the preparation of Climatological Tables, and proposed the following resolution :—

"The International Committee requests the directors of the different Meteorological Institutions to prepare monthly means, for definite decades, as was proposed and adopted at Vienna in 1873 (for instance, 1871–80, 1881–90, &c.), for the principal meteorological elements (pressure, temperature, humidity, rain, &c.) for a certain number of their stations.

The results to be published and communicated to the International Committee.

The resolution was adopted.

M. SNELLEN proposed to add the following words: "the Committee considers that it would be easy to obtain assistance towards the cost of publication, by subscriptions or by other means."

This addition was approved.

The discussion was opened on Question 6—

The Acceleration of Telegrams.

M. SNELLEN read the proposal which he had made, jointly with Neumayer, and of which copies had been distributed to the members. (Appendix III.)

Several members stated their opinions that numerous attempts had already been made to ensure more rapid transmission of the telegrams, and that it would be very difficult to obtain from the telegraphic administrations any real improvement in the way of the desired acceleration of the service.

M. TACCHINI was of opinion that in preference to making a definite proposition it would be better to approach the directors of the telegraphic services. If they, by chance, found that the circular system was acceptable, the details of the scheme might be discussed. With that reserve we considered that the Committee might adopt, in principle, the proposal made by Messrs. Neumayer and Snellen.

M. BILLWILLER proposed that the Committee should address an application to the International Telegraphic Bureau, which is located in Switzerland, to have this question considered at their next Conference.

After discussion, the proposal was adopted by the following resolution :—

"The Committee is of opinion that it would be useful to secure that the International Meteorological Conference should deal with the question of the possibility of simplifying and accelerating the service of transmission of International Meteorological Telegrams, and should inquire if the introduction of a circular service between the Meteorological Offices would render it possible to attain the object in view."

The Committee requested Mr. Scott, the Secretary, to conduct the necessary correspondence in conjunction with M. Billwiller.

(Signed) E. MASCART.

Third Meeting, Wednesday, August 22nd, 9h. 55m. a.m.

Present: Messrs. von Bezold, Billwiller, Davis, Hann, Hepites, Hildebrandsson, Mascart, Mohn, Paulsen, Scott, Snellen, and Tacchini.

The PRESIDENT welcomed Mr. Davis who had arrived at Upsala, from Cordova, since the previous meeting.

The Minutes of the Second Meeting were read and confirmed.

The discussion was opened on the second portion of Question 8—

Telemeteorography.

The proposal made by Dr. van Bebber was read. (Appendix IV.)

M. SNELLEN exhibited to the meeting specimens of the curves furnished by the telemeteorographic instruments of M. Olland, at Utrecht, which work between the Cathedral and the Meteorological Office of that city. He stated that the apparatus had also been in action between Utrecht and the sea-coast, at Flushing.

M. SNELLEN was requested to draw up a detailed report on the subject, which might be appended to the Report of the present meeting. (Appendix V.)

After discussion the following resolution was adopted:—

"The Committee considers that the establishment of a system of telemeteorography would be of great importance. The forms of the apparatus which have been hitherto employed, with the condition of using a single wire, have not been tried for a sufficiently lengthened period. It is extremely desirable that new investigations should be carried on on the subject."

Mr. DAVIS requested permission to add to the Programme the consideration of the subject of Evaporation.

Mr. DAVIS exhibited samples of the results he had already published on the subject of Evaporation, and which have appeared, in the Spanish language, in the Report of the Central Meteorological Office of the Argentine Republic.

He remarked in addition,—"In view of the great difference in the quality of water evaporated from the different systems of evaporators in general use, would it not be advisable to recommend the adoption of one form of instrument, and exposed under the same conditions? Thus a relative measure of the evaporating influences would be obtained, and direct comparisons could be made of these influences from the observations of different parts of the globe, which at the present time is quite impossible."

Several of the Members expressed their opinions on this difficult question, and the Committee decided, finally, to abide by the resolution on the subject of Evaporation which had been adopted at the Congress of Rome(*a*).

The discussion was opened on Question 7—

The Scintillation of the Stars. (Appendix VII.)

The Committee considered that it was not possible to frame a resolution on this question, as it ought to be made the subject of special instructions to be issued by different central institutions.

M. MOHN submitted a communication from M. Ventosa, of Madrid, on observations of differences in the definition of the images of stars as indications of weather.

NOTE (*a*).—Resolution 21, p. 13:—

"The Congress points out that atmometers generally should fulfil certain conditions of comparability, and expresses the opinion that there is need of fresh researches being undertaken, for the determination of the form and exposure of the instruments to be employed."

M. TACCHINI was requested to be so good as to read this communication, and to inform the Committee, at a subsequent meeting, if he found that the views of M. Ventosa were well founded.

On the subject of Question 8—

Maritime Meteorology.

M. SCOTT, the Secretary, distributed to the Committee copies of a pamphlet by Rear-Admiral Makaroff (*a*) which had arrived at Upsala from St. Petersburg.

The discussion was opened on Question 3—

Agricultural Meteorology.

The different members of the Committee were requested to forward to the Secretary, for insertion in the Appendices to the Report, notices on the measures which had been adopted in their countries in order to communicate to agriculturists information which might be of use to them in their operations. (Appendix XI.)

The discussion was opened on Question 9—

Psychrometrical Observations below 32°.

M. MOHN commenced by mentioning the investigations carried out at Spitzbergen by M. Ekholm in the way of comparing the psychrometer with natural ventilation with the condensing hygrometer.

From this inquiry he had deduced the rule that 0°·81 F. (0°·45 C.) should be substituted from the reading of the thermometer covered with ice, and that then Jelinek's tables should be used.

The physical cause of the elevation of the wet bulb reading was to be found in the difference between the maximum tension of aqueous vapour in presence of water and in presence of ice.

In the opinion of several of his colleagues it would be important to adopt the rule proposed by M. Ekholm, in order to obtain more accurate means of vapour tension and humidity than we have at present.

M. von Bezold said that M. Ekholm's paper had excited great interest at Berlin, and that an investigation of the question would be undertaken.

The Committee decided that it was desirable to calculate new tables for the wet bulb thermometer when the bulb was coated with ice, based on the figures for the tension of vapour in presence of ice.

NOTE (*a*).—Respecting the necessity of an international agreement with regard to the publication of material contained in Naval Meteorological Journals.

Until these tables are ready the rule proposed by M. Ekholm, should be employed for the calculation of mean results for vapour tension and for the humidity of the air.

The discussion was opened on Question 10—

The coming Conference.

The Committee was of opinion that the International Conference which is proposed to be held in Paris in 1896 should have a character similar to that of Munich in 1891, and that it should meet about the middle of the month of September. The President and Secretary were requested to make the arrangements necessary for carrying out the proposal.

The PRESIDENT announced that the next Meeting would be held on Thursday at 6 p.m., to discuss the Report of the Sub-committee appointed at Munich for the question of cloud observations. (Questions 4 and 5 of the Programme.)

(Signed) E. MASCART.

Fourth Meeting, Thursday, August 23rd, at 6h. 25m. p.m.

Present:—Messrs. von Bezold, Billwiller, Davis, Hann, Hepites, Hildebrandsson, Mascart, Mohn, Paulten, Scott, Snellen, and Tacchini.

In addition the following members of the Cloud Committee were present by invitation.

MM. Broounof (Kieff), Fineman (Upsala), Riggenbach (Basle), Rotch (Boston, U.S.A.), Sprung (Potsdam), Teisserenc de Bort (Paris).

The Minutes of the Third Meeting were read and confirmed.

On the limitation of the President, the Secretary read a letter which had just been received from Lieut.-General Wauwermans, President of the Congress of the Sciences of the Atmosphere at Antwerp. (Appendix VII.)

The PRESIDENT reminded the Committee that Questions 1 and 3 contained in the letter from M. Wauwermans had already been dealt with by the Committee.

As to Question 2, M. Hepites proposed the following resolution which was adopted:—

"The International Meteorological Committee has a high appreciation of the value of the investigations carried out by systematic balloon ascents, and hopes that the endeavours made at various institutions may be continued and increased in number."

The Committee requested the Secretary to thank M. Wauwermans for his communication, and to enclose to him a copy of the resolution they have adopted.

M. TACCHINI communicated to the Committee a verbal report on the paper by M. Ventosa (Third Meeting).

The Committee, having heard the explanations kindly supplied by M. Tacchini, was disposed to consider the inquiry on which M. Ventosa is engaged to be of a very interesting character, but it did not feel itself in a position to express a definite opinion thereon until the inquiry was completed. This epoch would not long be delayed, according to the statements made by M. Ventosa. In the opinion of the Committee it would above all be necessary to carry on observations of this nature with very simple instruments, which are the only ones to be placed in the hands of a few meteorological observers at Stations of the First Order.

M. HILDEBRANDSSON submitted to the Committee the Report of the Sub-committee for the Study of Clouds (Appendix VIII.).

The Committee discussed the Definitions which formed part of that report, and, with some modifications, these were adopted.

The Committee passed to the examination of the Instructions which were proposed, and these were adopted.

M. HILDEBRANDSSON proposed that the International Committee should, through its Secretary, address the different institutions in order to ascertain if they were disposed to organise arrangements for observing the upper clouds on a uniform plan, as had been proposed at Munich in 1891. He submitted a list (Appendix IX.) of the institutions which had already announced their readiness to undertake these researches.

(Signed) E. MASCART.

Fifth Meeting, Friday, August 24th, 9h. 25m. a.m.

Present: Messrs. von Bezold, Billwiller, Davis, Hann, Hepites Hildebrandsson, Mascart, Mohn, Paulsen, Scott, Snellen, and Tacchini.

Messrs. Broounof, Fineman, Riggenbach, Rotch, Sprung, and Teisserenc de Bort were present by invitation.

The Minutes of the Fourth Meeting were read and confirmed.

M. HILDEBRANDSSON resumed his remarks on the subject of the measurement of the height of the clouds, and stated that the methods to be recommended for these observations would be found set out in a paper which he had published conjointly with M. Hagström (des principales méthodes employées pour observer et mesurer les nuages).

The Committee was satisfied that experience had shown that the altitude of clouds might be determined with a very close

approach to accuracy, and was of opinion that such observations should be carried out in different countries, by preference by photographic methods.

The direct observations of the velocity of motion of clouds should be made at as many points as possible, while the determinations of their altitudes need only be carried out at a limited number of stations, conveniently situated. The interest of these observations would be greatly enhanced if they were made at the same epoch. With that object the Committee proposes that the first series of observations should be undertaken for one year, from May 1, 1896 to May 1, 1897.

M. SPRUNG submitted to the Committee a proposal he had made for the simplification of cloud observations. This paper was ordered to be printed. (Appendix X.)

This exhausted the Programme.

The PRESIDENT, before closing the Meeting, said that he considered it an agreeable duty to act as the mouthpiece of the Committee in expressing to M. Hildebrandsson its very best thanks for the special care with which he had arranged the present meeting, and had prepared for his colleagues such a cordial reception. M. Hildebrandsson has, moreover, made a most important contribution to our proceedings by his profound investigations into the classification of clouds, and their apparent movements, and on the introduction of practical methods suitable for determining their altitudes. If, as we hope, our Meeting at Upsala makes a progress in science, the greater part of the credit is due to the enlightened co-operation of M. Hildebrandsson.

The PRESIDENT proceeded to thank his colleagues for the courtesy and kindly feeling evinced to himself, and which had rendered the discharge of his provisory functions an easy task. He could not omit to remind them that he had derived great assistance from the habitual zeal and punctuality of the Secretary, Mr. Scott.

He was happy to say that all the discussions had been conducted with the most perfect cordiality, and that the recollections of Upsala could not fail to cement even more closely together the ties of friendship between the scientific men devoted to this branch of science.

M. HILDEBRANDSSON replied:—

"Gentlemen, I thank you for the kindly and flattering words which our President has been pleased to address to me. I pray you to convey to him the expression of our recognition of the admirable manner in which he has discharged his important functions, of his patience, his perspicacity, and finally of the

great interest which he has been able to infuse into all his remarks. If our Meeting has been in any way profitable to science, our success is to be attributed to our illustrious colleague, and to the prudence with which he has guided our proceeding."

The Minutes of this Meeting were read and confirmed.

The Meeting was closed.

(Signed) E. MASCART.

APPENDIX I.

Report of the Secretary.

The Report now submitted has been prepared without the concurrence of our President, who has been prevented by his indisposition from attending the present meeting. He has however taken the initiative of communicating to you all that has passed since our Conference at Munich by means of the circulars he has from time to time issued. My duty, as Secretary, is simply to supply some small *lacunæ* in the provisional programme which I have the honour to submit for your favourable consideration.

Among the newly elected members of the Committee, Messrs. Eliot and Ellery have not been able to find time to come to Upsala, and I have been charged by them with the duty of representing them at the present meeting. Dr. Paulsen, of Copenhagen, has arrived; Mr. W. G. Davis has taken the trouble of making the long journey from Argentina in order to take his seat on the Committee and we bid him a very hearty welcome. We cannot commence our proceedings without the expression of the sincere grief with which we have received the news of the lamented decease of our colleague, Dr. C. Lang, the President of the Munich Conference.

It only remains for me to enumerate to you the communications which have reached the office, and finally to propose for your adoption the programme of the questions which we have to discuss.

1. The Report of the Munich Conference has appeared in the three languages and is in your hands.

2. *The International Bureau.*—M. Hildebrandsson has recently printed and distributed to you a paper on this subject.

3. *Agricultural Meteorology.*—Mr. Harrington has not found it possible to prepare a report on this important subject. I venture therefore to propose that communications should be made to the office, with a view to their insertion in the appendices to our Report, as to the measures at present adopted in different countries to distribute to agriculturists weather forecasts, and also the results of climatological discussions carried out in relation to agricultural investigations.

4. *The Establishment of Stations for the observation of Upper Clouds.*—M. Hildebrandsson has not issued detailed instructions as were proposed at Munich, but with the assistance of Messrs. Hagström and Åkerblom he has prepared a very careful account of the principal methods employed for these researches. You will probably have already received this pamphlet, which is full of the most indispensable information bearing on this line of investigation. We have not received replies from all the establishments which have been invited to take part in these researches—all the answers not having come in as yet.

5. *The Cloud Atlas.*—The Committee appointed at Munich has increased itself by the co-option of other members, and we look forward to the result of its deliberations on this question from the scientific as well as from the artistic point of view.

6. *The more rapid transmission of Meteorological Telegrams.*—M. Snellen has communicated a report on his proposal, and Rear-Admiral de Brito Capello, who is, unfortunately, prevented from coming to Upsala, recalls to the attention of his colleagues the remarks he made on this subject at the meeting of the Committee in Paris.

A proposal from M. van Bebber has been sent to the office, which is in a more or less intimate relation to this question, and deals with the importance of making some experiments in telemeteorography.

7. *The Scintillation of Stars.*—M. Charles Dufour wishes to bring under the notice of the Committee, a communication which he has published on this subject in the Bibliothéque Universelle for June 1893. The matter has already been dealt with by M. Montigny of Brussels in numerous papers.

8. *Maritime Meteorology.*—Rear-Admiral Makaroff has forwarded for the members of the Committee several copies of his pamphlet on the necessity of an international convention on the subject of the discussion of the elements contained in the meteorological logs of ships.

The communication appears to have a private character, and the office is unable to form an opinion as to whether it should be submitted for discussion.

9. *Psychometrical Reductions below 32° F.*—MM. Hildebrandsson and Mohn propose to raise a discussion on this point.

10. *The Coming Congress.*—The question of the next congress should be discussed. No communication on the subject has reached the office.

Upsala, August 20.

Robert H. Scott,
Secretary.

APPENDIX II.

On the Proposed International Meteorological Bureau. Remarks by H. Hildebrand Hildebrandsson.

The author commences this communication by noticing the action taken on the question at Leipzig in 1872, at the Congress of Rome, and at the Conference of Munich, and continues as follows:—

The discussion of this question implies the consideration of three points.
(1.) *Why should an International Bureau be erected?*
(2.) *The necessary Staff*, and
(3.) *The probable Expense.*
We shall try to treat these three points separately.

(1.) *Why should an International Meteorological Bureau be erected.*

First, it must be remarked that *such a Bureau, if established, should in no way rule or interfere with the work done at the institutes or observatories in the different countries.* No meteorological council or director in any country would place himself and his service neither directly or indirectly under such a control. If so, it is evident that a *Central Institute* leading or ruling in any way the meteorological services in all countries is out of question.

On the other hand a *Bureau for administrative purposes only*, as proposed at the Conference at Munich in 1891, is, perhaps, not of so great importance that it would generally be considered necessary to create such a Bureau for such purposes *only*.

For my part I think that it would be very good if *a Bureau could be erected* (1) *for the administrative purposes mentioned at Munich, and* (2) *for the solution of such scientific problems as should be considered as indispensable for special or general researches of meteorologists in every country. The Bureau should be under the order and the control of the Permanent International Committee.*

Thus, the Bureau should be of use for meteorologists almost in the same way as the Metrical Bureau at Breteuil has been for students of physics.

At Breteuil nobody pretends that the Bureau should in any way interfere with or direct the work to be done in the different physical institutes; it only provides all physicists in the world with the constants and the verified instruments indispensable for almost all physical researches. What is thus done at Breteuil is also of great importance for meteorology, and it therefore seems unnecessary that the Meteorological Bureau, if erected, should deal with the testing of instruments. This is of great importance for the reduction of expense.

As to questions of general interest, and serving as bases of, or indispensable for, meteorological researches in all countries, it is not difficult to find a great number of these. We have only to remember in the first place the above-named questions recommended by the Congress at Rome. Fifteen years are

gone since that time, and the questions are still waiting their solutions, though many of them have been partially treated by eminent men of science. Take the isobars for the 12 months and for the year. It is evident that if, for instance, anybody should wish to study the variations of pressure from month to month in different parts of the globe — a research of the utmost interest — such a research would only be possible as far as the mean barometrical pressures in the different countries are known for each month.

One can easily find many other researches of the greatest importance which are in the same condition, viz., are impossible to deal with, if the monthly isobars are not known; and I think we must confess that at the present time they are not known with the precision possibly attainable if we had a staff who could do this tedious and difficult work—bring together what is already done in the different countries and complete it as far as can be done at present. It is quite true that nobody can do such a work *for a given country* better than the meteorologists of that country itself. For instance, it is not likely that one could in another country have traced the isobars for the North Atlantic as well at Captain *Rung* has done in his magnificent Atlas *Répartition de la pression atmosphérique sur l'océan Atlantique septentrional*. But on the other hand it is evident that it is very difficult for a private person or for a single institute to construct such maps for the whole earth in a satisfactory way, and moreover to publish from time to time new editions. This task seems to be best committed to a special Bureau. As to the special and fundamental works for the different countries, they would not in this case by any means be rendered unnecessary. On the contrary, it is probable that the general work done by the Bureau should be an encouragement for the meteorologists of the different countries to give their contributions to the common work.

What has been said on the isobaric charts could of course be repeated on all other researches of general interest or of a fundamental nature. It must be the object of further consideration to determine the researches that ought to be carried out in the first place. I have only endeavoured to prove *that there exist a great number of scientific problems which must be considered indispensable for all, or a great number of, researches in meteorology, and which might in the most practical way be treated by a special Bureau*. If not, a great number of researches are practically impossible to deal with, and it will totally depend on the interest, time, and money at the disposal of the different meteorologists when they can be treated.

(2.) *The necessary Staff.*

Firstly, a *director* of the whole service is indispensable, who should be in communication, and in continous correspondence with, the different meteorological institutes and with meteorologists in general, should prepare the questions to be treated at the Bureau, and receive the orders of the Permanent Committee. He might also perhaps be the secretary or assistant secretary at the meetings of the Committee.

Besides, two assistants seem to be necessary as permanent aids to the director.

The director should be named by the Committee for a period of three or five years, and the assistant meteorologists also, on the proposal of the director, for the time found in each case to be convenient.

Extra assistants and calculators should be engaged by the director when (and for the time) found necessary.

(3.) *The probable Expense.*

It is not easy to calculate the probable expense, and of course we are only able to do this approximately. First we have to deal with the salaries of the staff. In the Metrical Bureau they are as follows:—

1.—Director - - - - - -	Frcs.	15,000
2.—Two assistants (at 6,000 fr.) - - - - -	„	12,000
	Frcs.	27,000

Perhaps the same sum might be adopted here.

If, as we have said above, instrumental work does not enter into the functions of the Bureau, expenses for instruments are, in general, not necessary.

As to a library, it is evident that every meteorological establishment and probably every author, will consider it as a duty to give copies of all new publications to the Bureau, and, as far as copies of older publications are preserved, all official institutes or observatories will undoubtedly be willing to send whatever the Bureau wants in this way. Of course, expenses for books and instruments should not be considered as special charges; as, probably, they will not exceed a few hundred francs every year, and they may well be included among the general expenses.

How much money is wanted for general expenses, for extra assistants and calculators, and for publications, depends entirely on the quantity of work expected to be done. On the other hand the work which can be done is limited by the means at the disposal of the Bureau. For my part I think that a safe proportion is adopted if we insert a sum nearly equal to the fixed salaries, say 23,000 francs. Then the total annual expense for the Bureau should be 50,000 francs.

I suppose that the Permanent Committee cannot now enter into the details —what proportion of this sum should be employed for each part of the service. This must be different in different years, and the Committee must from time to time discuss and fix the budget on receipt of the director's report. But with the above-named sum a good deal of useful and, I dare say, *indispensable* work can certainly be done.

If a Government or private persons in any way would give to the Bureau a proper locality, the rent of rooms might be spared. Besides, it must be remarked that the localities required are only good apartments for office work, as no laboratory is wanted.

We cannot tell if the different Governments are willing to supply funds for the Bureau, and at present it is not our duty to consider this point. We are only charged to consider the question from a scientific point of view, and propose what would be useful and practical *if* money could be had. It is always good to have a definite scheme settled. If the Committee unanimously accepts such a scheme it will probably sooner or later be realised. The sum required is not so great.

A private donation of 1 to 2 million francs would be sufficient, and greater donations have often been given for scientific purposes.

APPENDIX III.

HAMBURG and UTRECHT.—12th July 1894.

PROPOSAL.

The Deutsche Seewarte and the Royal Meteorological Institute of the Netherlands have the honour to lay before the International Meteorological Committee the following report relating to Question 52 of the Munich Conference (the more rapid transmission of meteorological telegrams).

The present question has been already several times discussed, among others, in a detailed way in the year 1886, in a Treatise on Practical Meteorology,* from which we reproduce verbally the following passages, which agree with the views of both institutions:—

"In endeavouring to effect this reorganisation of the meteorological telegraphic service it is not so much a question of an increase or improvement of the telegrams as of a fixed organisation and an acceleration in the exchange of telegrams. This new system should be in its principal features similar to that adopted in America, as the telegraphic connections should be arranged in such a manner that all the inland telegrams should arrive at the central office about an hour and a quarter after the observations have been taken, and be entered and discussed ready for transmission for the purposes of international exchange. This exchange might be effected in the same way as

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* *See* van Bebber, Handbuch der ausübenden Witterungskunde. II. Theil (gegenwärtiger Zustand der Wetterprognose), p. 17 and following pages.

in America, according to a system of 'circuits,' by which means the central offices would be placed in direct telegraphic communication, and the exchange of telegrams be carried out in a pre-arranged order. If this exchange could begin about an hour and a half after the time of observation, the central offices would be in full possession of the complete data contained in the European telegrams about two and a quarter hours after that time. In order that the system should be carried out in that way it is absolutely necessary to give up local time in taking observations and to adopt simultaneous time.

"Considering the present difficulties, it appears to be necessary that the different Governments should, without exception, grant their meteorological institutes the funds for carrying on meteorological telegraphy, and all possible privileges with respect to the use of the telegraph, both at home and abroad, so that meteorological telegraphy may be freely developed in each separate country.

"In this way each country would be able to choose its materials according to its own judgment, and to put them to practical use, and so to pursue with zeal and success its own interests in the satisfactory development of its meteorological service.

"From the experience which has been gained hitherto, an arrangement between the different institutions for facilitating a more practical and fruitful exchange of reports does not appear to present insurmountable difficulties."

Agreeing with these views, the above-mentioned institutions beg to recommend the following proposals to the International Committee:—

1. The directors of the central offices of the different countries concerned with this subject should make application to their Governments, or telegraphic administrations, to transmit the meteorological telegrams from the different observing stations as rapidly as possible to the central telegraph offices, by granting them precedence over other telegrams, so that at a fixed time, at the latest an hour and a half after the time of observations, those offices may be connected with the other central offices in an international "circuit-system." Care must be taken to carry out the exchange in the circuit completely and without interruption, so that all the central offices may, without delay, be in possession of the complete materials, and be able to communicate them immediately to the meteorological institutes.

The directors of the different countries, should, of course, themselves decide whether, in the proposed system, the central office should act as the principal station for the international transmission of the telegrams, or whether the nearest telegraph office should be used for that purpose.

The method of utilising the telegrams should also be left to the judgment of the different directors, who should likewise decide as to the way in which the telegrams should be transmitted from the different observing stations to the central offices, *e.g.*, whether by establishing an inland "circuit-system" or in any other way.

We may again repeat expressly that there is no question of increasing the amount of information contained in the telegrams, but only an acceleration of their transmission. The amount of information might rather be reduced, both by decreasing the number of stations, or by a little suitable abbreviation of the telegrams. But this subject should be left to future conferences. In any case, a greater uniformity in the distribution of the telegraphic reporting stations, both as regards their situation and their importance, seems to be very desirable.

2. If the telegraphic administrations of Europe shall decide to place the necessary telegraphic lines at the disposal of meteorological telegraphy during certain times of the day, the change to simultaneous observations would seem to be absolutely necessary from the point of view of meteorological telegraphy. The importance of the theoretical reasons for or against simultaneous observations is nearly equal on both sides, but practical considerations, which, with the advance of weather telegraphy, continually gain in importance, settle the matter; as without the introduction of absolute time of observation a decided acceleration of the telegrams cannot be obtained. The question of time here plays the most important part, and, although all requirements cannot be equally satisfied, it is plain that an agreement between different countries is urgent on account of the importance of the question. Take, for instance, 7h. a.m. Greenwich

time: then the simultaneous time of observation would be, for Hamburg, 7h. 40m.; Berlin, 7h. 54m.; Vienna, 8h. 6m.; St. Petersburg, 9h. 2m.; and Moscow, 9h. 20m.; local time. The equidistant periods of 1h. p.m. and 7h. p.m. might be recommended for other times of observation, so far as meteorological telegraphy is concerned. But an arrangement between the directors should definitely settle these epochs.

(Signed) NEUMAYER,
Deutsche Seewarte.
MAURITS SNELLEN,
Royal Meteorological Institute
of the Netherlands.

APPENDIX IV.

To the INTERNATIONAL METEOROLOGICAL COMMITTEE

Since the deaths of Buys Ballot and van Rysselberghe, the interest taken in telemeteorography has considerably decreased, although the advantage of such a system for weather prediction, and especially for storm warnings, cannot be denied. By the aid of telemeteorography, anyone would be able at any moment, either by day or night, to follow continuously the weather changes, and especially the tendency to change, and could make much use of this knowledge. A system of telemeteorography could be easily carried on without any considerable trouble to the telegraphists, if only such lines were used as were temporarily free (*e.g.*, more especially at night time).

The principal question would be the establishment of simple, cheap, but trustworthy self-registering instruments; the question of cost would be trifling, compared with the practical importance of the arrangement. If such a system of telemeteorography were established in certain countries, a further step might be taken by having some of the international telegraph lines, of which there are several between neighbouring countries, placed in connexion with the registering instruments of the central offices for a longer or shorter time, when they are not occupied by the telegraphic service.

The undersigned begs to propose that:—

"The International Meteorological Committee should declare it desirable in the interest of the furtherance of weather predictions and storm warnings, that trials of telemeteorography should be made in certain countries, in order that proposals with respect to it may be made to the International Telegraph Congress, which is to be held in the year 1896."

(Signed) Professor DR. VAN BEBBER.

Hamburg, 18th June 1894.

APPENDIX V.

TELEMETEOROGRAPHY.

In order to obtain an idea of the development of any meteorological phenomenon at a certain place, it is absolutely necessary to know the atmospheric conditions of the surrounding localities. We must, therefore, have at the central office observations of temperature, atmospheric pressure, direction and force of wind, &c. of the various stations round this centre. The final aim of telemeteorography is to furnish these indications automatically, by means of electric wires connecting the central office with surrounding stations.

When developed to the highest degree of perfection, telemeteorography would consist of a telegraphic network all over Europe, connecting the wires of several stations in each country to the central offices, and these would be themselves connected with each other by a second system of wires. At regular intervals, say, hourly, each central office would receive the reports of the various stations, not only from its own country, but also from all the other

European stations. This is the scheme that Professor van Rysselberghe proposed to the Permanent Committee at the meeting at Copenhagen in 1882. In his manner we should be able to dispense entirely with ordinary meteorological telegraphy, with its defects. Meteorologists would be warned in a much better manner than at present of every change which occurred in the condition of the atmosphere, for they would receive information about the weather, not only three times a day, but would have for each hour a complete representation of the distribution of the meteorological conditions over the whole of Europe, and would thus be able to form an exact idea of their propagation. M. van Rysselberghe's telemeteorographic system would also offer another great advantage; the meteorological telegrams would be received at the central stations at the actual time of observation, and not five hours afterwards, as is the case at present. The introduction of this system would be an enormous step in advance for weather forecasts and storm warnings.

But we may also be less exacting, and be content with having a limited number of stations connected with a central office. This was Professor Buys Ballot's idea, when, in 1868, in his memoir *De invoering en verklaring van den Aeroclinoskoop* he expressed the wish of being able to follow at a glance, at Utrecht, the simultaneous variations of the condition of the atmosphere at the various meteorological stations of the Netherlands. In connexion with the ordinary telegraphic transmission of meteorological reports, such a curtailed system would still render great service to practical meteorology. Once in possession of the European meteorological telegrams, we should have the means of forming an opinion upon the changes which have taken place in meteorological conditions since the last observation, by taking note of the indications of the telemeteorograph of our own country. The changes in the readings of the barometers at surrounding stations would give, for instance, an indication which cannot be neglected as to the direction of the track of a barometric depression in the neighbourhood.

The question is therefore reduced to the construction of an apparatus composed of two parts, an *indicator* and a *receiver*, connected by a telegraphic wire.

The indicator has to transform the indications of the various meteorological instruments in such a way that they may be transmitted telegraphically by simple contacts, and form these contacts at equal intervals, say, of one hour.

The receiver has to collect the reports of the indicator and to translate them into intelligible symbols, either by a telegraphic code, or directly in figures, or by giving a graphical representation of the changes of the meteorological elements.

The last method, although by no means the easiest, seems to have the greatest attraction for the creative genius of instrument makers.

These views, expressed by M. Buys Ballot, inspired M. Olland, a skilful instrument maker at Utrecht, to realize the desire of that well-known meteorologist. In January 1875 he addressed a letter to the Minister of the Interior requesting permission to explain these ideas and to construct a specimen instrument. He intended at first to adapt it to the registration of the variations of level of water, &c., but he asserted at the same time that his system could be applied just as easily to the registration of the indications of meteorological instruments. The Amsterdam Academy of Sciences reported favourably on the proposal, and M. Olland was directed to construct an apparatus which would record, in the room of the director of the Royal Meteorological Institute at Utrecht, the indications of a barometer and an anemometer placed on the top of the cathedral tower. The condition was further stipulated that these two stations should be connected by only one single telegraphic wire.

This was the state of things when Professor van Baumhauer, who had just been elected President of the Commission of the Netherlands at the exhibition of Philadelphia in 1876, put himself in communication with M. Olland and ordered him to make a specimen of this apparatus, according to the plan laid down in his memoir, *Sur un météorographe universel destiné aux observations solitaires*; even if the instrument could only work with a double wire. The apparatus was made and sent to Philadelphia, where it gained a medal.

Later on, M Olland succeeded in constructing an apparatus fulfilling the condition of having only a single telegraphic wire between the two stations. This apparatus was completed in July 1877 and remained in operation for eight

years, and it worked in such a satisfactory manner that M. Buys Ballot proposed to the Government in 1879 that similar instruments should be erected at four distant stations, suitably chosen at the extremities of the country, and connected by wires to the central station. This project was abandoned owing to the cost of the requisite telegraph lines.

On the other hand, M. Olland had the satisfaction of seeing a telemareograph erected at the Hook of Holland in the same year, 1877, and indicated the variations in the level of the sea at a distance of 2,500 metres, by means of a cable constructed expressly for that object. The instrument is still in action, and works to the perfect satisfaction of the engineers.

In 1873, Professor van Rysselberghe published in the bulletin of the Royal Academy of Belgium, a notice—*Sur un système météorographique universel*, in which he described a self-recording instrument that could be converted into a telemeteorograph by placing the two parts of the apparatus at a great distance from each other, but connected by two telegraphic wires (p. 24 of the Excerpt from the above-mentioned Bulletins).

On the 11th of May 1875, he submitted to the Academy of Science at Brussels his universal meteorograph which he proposed to erect in that city, to reproduce the curves of a mercurial barometer, a psychrometer, a hair hygrometer, an anemometer—velocity and direction, a rain-gauge, and finally, a tide-gauge, situated at a distance from the registering apparatus.

In 1878, he obtained from the Belgian Government a grant for the installation of the instruments he had invented.

During the Congress of Electricians in Paris, in 1881, the Rysselberghe telemeteorograph was in action for a certain time between that city and Brussels, and a little later a telemeteorograph was erected at the observatory at Brussels to register observations from Ostend. This worked regularly for two years, but the experiment was given up owing to the cost of maintenance of the telegraph line.

A telemareograph erected, in 1888, at Antwerp was more fortunate. It registers on one cylinder the variations of level of the Scheldt and of its affluents at 15 different points, and it is in action at the present day.

In 1882, Dr. P. Schreiber published a description of a telemeteorograph in Carl's *Repertorium für Experimental Physik*, vol. xviii. It appears to me that the construction of the apparatus and the distribution of the electric current are much more complicated than in Olland's or van Rysselberghe's instruments, and as far as I am aware, Dr. Schreiber's apparatus has never been constructed.

I do not know of any other descriptions of telemeteorographic systems beyond those already mentioned, with the exception of some vague statements at times met with in catalogues of instruments not expressly constructed for registering at a distance, in which the authors assert that their apparatus might be easily adapted to that object. Without wishing to decide how far these assertions are correct, we must however admit that experience of their working is wanting, and this is precisely where the difficulty commences.

I may, therefore, confine myself to giving an idea of the principle of the two instruments by Olland and Rysselberghe only; and beginning with the first I will give a recapitulation of the description which I published in 1879, in vol. xiv. of the *Archives Néerlandaises* entitled *Le télémétéorographe d'Olland*.

M. Olland's method of registration can be applied to all kinds of meteorological, and to many other, instruments; it only requires that the apparatus should indicate by means of a hand moving over a dial; but as every instrument may be changed to a dial instrument, its adaptation to the telemeteorograph is always possible.

Let us take, as an example, a barometer whose readings we wish to know at the central station every quarter of an hour. M. Olland employs a balance barometer, but one with a float or an aneroid would do as well. The tongue of the beam, under the influence of the atmospheric oscillations, turns an index to the right or left upon a graduated dial. The divisions of this graduation are raised and therefore project in the form of teeth. In order to transmit the position of the hand on the dial to the other station, a second axis in the prolongation of the axis of the dial carries a metallic arm (the observing arm) with a light platinum spring fitted at its end. Every quarter of an hour a toothed wheel makes this arm accomplish a revolution, which lasts about a minute, and

during that time the little platinum spring touches successively each of the raised graduations on the dial, and also the index of the barometer which lies somewherte beween two of these graduations, or exactly over one of them. If, now, the dial and its index are isolated from the observing arm, but each connected with one of the electrodes of a galvanic pile, the current will pass each time that the platinum spring touches either a division of the dial or the index. The current is then transmitted by the telegraphic wire to the central station, where it traverses the coil of an electro-magnet whose armature carries a tracing style. Opposite this style there is a cylinder which turns exactly once on its axis while the observing arm makes one revolution, so that at each closing of the current, a small and very distinct line is traced on the paper covering the cylinder.

During the isochronous movement of the observing arm and of the recording cylinder, a series of small lines corresponding to the divisions of the barometric scale are drawn on the latter at regular intervals; but between these lines there will be one due to the contact of the observing arm with the needle of the barometer, and which therefore faithfully reproduces the position of the latter between the divisions of the barometer scale. One of the advantages of Olland's apparatus is, that it not only gives the reading of the instrument, but also the whole scale.

What has been said of the barometer applies equally to the other instruments. Their indices traverse the same dial, but in order that they may never interfere with each other a definite arc is assigned to each of them, within which each must remain. The observing arm coming, therefore, into contact with each index successively, and with its special scale, transmits the reading of each of the instruments to the cylinder of the central station.

It is seen therefore that the apparatus must necessarily consist of the following parts, in addition to the meteorological instruments:—

At the central station there must be—(1.) A regulating clock, which closes at equal intervals a current putting the other parts in motion. (2.) A system of wheels to turn the cylinder.

At the second station there is another set of wheels which put the observing arm in motion.

To obtain a uniform movement of these two sets of apparatus, M. Olland has adopted a conical pendulum, which controls the movement of the toothed wheels. As soon as the above-mentioned current passes, the two conical pendulums begin to turn, but the cylinder and the observing arm remain at rest, each held by a second stop, which is not released until after several revolutions of the pendulums, when these have acquired their maximum deviations and consequently a very uniform motion. To attain this object, the cylinder and the observing arm are retained on their axes by a slight friction.

Having arrived at this phase the observing arm will soon touch the first graduation of the dial, and the style begins to trace its marks upon the cylinder.

The current therefore has to perform these very distinct functions at the two stations, viz., at the first, to release the toothed wheels of the conical pendulum, and release the cylinder and mark the traces, while, at the second station, the two last duties are replaced by those of making the observing arm turn, and to pass as soon as the platinum spring touches one of the graduations of the dial or one of the indexes.

For that purpose the galvanic current finds at each station three directions to follow, of which, however, only one is open at once, according to the position taken by a wheel (the distributing wheel) fixed on one of two corresponding axes of the wheel-work of the conical pendulums. The distributing wheel only completes one revolution during the time of one observation, so that at the end it is in the same condition as at the commencement.

In the condition of rest, the distributing wheel of the central station does not enter into consideration, as then the regulating clock closes the circuit. But at the secondary station, it takes such a position during the time of rest, that the circuit of the first direction is closed, by means of a small piece of ebonite which presses on a contact spring. At both stations the electro-magnets, which held the wheel-work in check, lift their stops immediately that the regulating clock closes the circuit, and the apparatus commences to work

After a very short time the two contacts are broken, and the distributing wheels take a second position, in which another pair of contacts is closed, so that the current may pass in the second direction at both stations. The electro-magnets, which keep back the cylinder and the observing arm, are now traversed by the current, and these two parts of the apparatus commence their revolution.

The contacts are soon broken again by the continuous rotation of the distributing wheel; at the central station a rim resting on the remaining part of the circumference of this wheel, presses a third contact-spring, giving a passage to the current to traverse the bobbins of the electro-magnet of the tracing style, and as soon as the observing arm at the secondary station touches one of the graduations of the dial, the style traces its first mark on the cylinder.

After an entire revolution of the cylinder and of the observing arm they are arrested; the conical pendulums are also soon brought to rest, and the distributing wheels having made an exact revolution, the current can pass, as soon as, after a quarter of an hour, the regulating clock closes the circuit afresh to make a second observation, and so on.

Of course, the electro-magnet of the tracing style is slightly lowered, about half a millimetre, during an entire revolution of the cylinder, so that the second series of lines is traced at that distance below the first. The cylinder and the observing arm being released at the same moment, and going isochronously, the first traces should fall exactly under each other in a vertical line, and as they are equidistant, the same occurs with the second, third, &c. On the contrary, the lines which indicate the varying positions of the index of the instrument during each successive observation are put backwards and forwards. The complete representation drawn on the paper which covers the cylinder consists then, when it is finished, of a series of vertically equidistant lines for each meteorological element, formed of small horizontal traces, interlaced by a curve formed in the same way. We have, therefore, a most complete graphic representation, as the vertical lines denote the scale of the instrument, by which we read at once the indication for each moment, without having to measure anything.

The above description should be sufficient to give an idea of the construction and manner of working of the Olland telemeteorograph, although it is very incomplete; but I have purposely avoided entering into details, so as not to be tedious. For this reason I have omitted the manner by which M. Olland overcame various difficulties, for instance, that of the hands of the instruments not being sufficiently rigid to prevent them from being carried away by the spring of the observing arm, and not being kept in the same plane as the dial. And I might have indicated the way in which the conical pendulums acquire their maximum deviation after a less number of revolutions than would be the case if this work were left entirely to the motive weight of the clockwork, and other appendages which, although almost indispensable, do not help to elucidate the principle adopted by the inventor for transmitting the indications of the instruments to a distance.

In the case of instruments with counters which sum up a number of movements, like the wind-wheel of a Robinson's anemometer, and the rain-gauge, M. Olland employs a different kind of registration from that of the other apparatus. The indices of these instruments are held on their axes by slight friction, so that they are carried on by the observing arm when it touches them; from this moment the tracing style is pushed against the paper of the cylinder, and does not leave it before the index is brought back to the zero of its scale. The result of this arrangement is that the indication of the instrument is not represented by a line between those of the graduation, but by a continuous trace whose length depends on the arc traversed by the index during the interval of rest of the instrument.

M. van Rysselberghe's apparatus has much in common with that of M. Olland; but still the difference between them is sufficiently great to allow of a choice between them.

The description which I have found of the apparatus in its definite form is in *Elektrotechnische Bibliothek*, Bd. xxxvi., p. 174; it appears to be taken from the following articles:—Schreiber (Hoffman's Bericht, p. 548); von Bezold, in the *Rapport officiel de l'Exposition d'Electricité à Munich*, p. 182;

Engineering, 1884, v. 37, p. 399; LEVY, *Zeitschrift für Instrumentenkunde*, 1882, p. 233; DUMONCEL, *La Lumière électrique*, VI. 1882, p. 241.

The construction corresponds in a great measure to that of the instrument above mentioned, and was described in 1873 in the bulletins of the Royal Academy of Belgium. M. van Rysselberghe applies two systems of registration, viz., metallic dipping-rods or plungers and projecting studs. To give an idea of the first method, M. van Rysselberghe writes:—

"Suppose we have to register the variations of the level of a mercurial column (a siphon barometer, an open stem thermometer, and a psychrometer) In front of a cylinder (with horizontal axis) covered with a sheet of paper would be a little Morse telegraph mounted on a small carriage.

"A platinum dipping-rod, connected to the carriage by a metallic wire (passing over two pulleys), is suspended vertically above the level of the mercury. Further, one pole of a battery would be connected with the dip and the other with the mercurial column, after passing through the bobbins of the telegraph. Lastly, at equal intervals (say, every hour), clockwork moves the carriage to and fro in front of the cylinder. At noon, for instance, the carriage would be put in motion, and while it advanced, the dip would descend towards the mercury, then at the instant of contact, the telegraphic circuit being closed, a trace would commence upon the cylinder and would be prolonged until the moment when the carriage, having arrived at the end of its course, would be brought back to its initial position, and remain at rest for a whole hour. Between noon and 1 o'clock the clockwork would turn the cylinder a little, and at 1 o'clock it would cause the carriage to make a second movement to and fro. Now, if between noon and 1 o'clock the level of the mercury had fallen a millimetre, at 1 o'clock the dip would have to descend a millimetre lower before touching the mercury, and thus closing the telegraphic circuit; then the trace engraved at 1 o'clock would be a millimetre shorter, and so on at 2 o'clock, &c. In a word, the successive traces engraved from hour to hour would exactly reproduce, by the variations of their length, the variations of the mercurial level which had to be registered.

"The principle of this method is due to Wheatstone, and it is remarkable for its precision, for the force necessary to make the style move is obtained independently of the indicating instrument, which is left freely to itself. And although it is true that it does not furnish a continuous curve, but a broken one, on the other hand it has the advantage of giving diagrams with graduated time-scales.

"But there is nothing to prevent the excursions of the carriage in front of the cylinder from succeeding each other at very short intervals, every five minutes, if desired."

The method of projecting studs is adapted especially for instruments with hands (or indices), and it has been described as follows:—

"Suppose it is a question of observing, not the height of the mercury, but that of the index of the counter of a Robinson's anemometer at the end of a given time. This index would not be rigidly fixed on its axis, and the toothed wheels of the counter would be calculated so that even in the strongest winds known this index, which would always be displaced by quantities proportional to the spaces traversed by the wind, could never make a complete turn in the interval of two consecutive excursions of the carriage.

"Then the index would be put in communication with one of the poles of the battery, while, concentrically with the axis of the index, a little pulley would be arranged, carrying a small stud, in communication with the other pole. Lastly, over the groove of the pulley a metallic wire, attached to the carriage, would be passed. At each of the excursions of the latter the stud would touch the index and move it back to zero, and would each time cause at the moment of contact the closing of the telegraphic circuit, and consequently the beginning of a trace whose length would be proportional to the displacement of the index since the last marking, and therefore proportional to the velocity of the wind during the same period."

After giving these details about some portions of his instrument, and other particulars which would be too long to repeat here, M. van Rysselberghe continues the description, of which the following is a résumé:—

A clockwork movement causes a vertical registering cylinder to make an entire turn at regular intervals (for instance, every 10 minutes). At the side

of the cylinder there is a screw, the axis of which is parallel to the axis of the former, and which carries an electro-magnet, the armature of which is furnished with a style that travels over the paper covering the cylinder as soon as an electric current passes through the coils of the electro-magnet. At its lower part the axis of the cylinder carries a toothed sector, which forms the connexion between the recording cylinder and the indicating instruments.

The latter are arranged all round the cylinder, and to each of them corresponds a toothed pulley, and a plunger if the instrument is mercurial, or a toothed wheel with a stud if it is an instrument with an index, in accordance with the system above explained. Then all the plungers and all the studs are in communication with the positive pole of the battery, while all the indices and indicating surfaces are connected with the negative pole. But while the cylinder is at rest the studs do not touch their indices, and the plungers are at a distance from the corresponding mercurial surfaces, so that at that time the telegraphic circuit is not complete anywhere. But suppose that the movement of the clockwork causes the cylinder and the toothed sector to make an entire revolution, the latter coming into contact successively with each of the toothed wheels corresponding to the various instruments, then the plungers and studs will come into contact one after the other with their respective surfaces and indices. And at each contact the current will pass, traversing the coils of the electro-magnet, and causing in each instance a trace to commence on the cylinder.

When the sector leaves the wheel of each instrument, the current is broken mechanically, and the plungers as well as the pulleys attached to the studs are drawn back, so that the same process may be successively repeated with all the instruments. After each revolution of the cylinder, the electro-magnet with its style descends a little, parallel to the generatrices of the cylinder.

With regard to registration at a distance, M. van Rysselberghe says in his memoir presented to the Academy: "Let us leave the meteorological instru-" ments on the table . . . and the sector, with clockwork which tends " to turn it, but let it be momentarily stopped, or rather held in check. On " the other hand, let us place, on another table, the receiving cylinder with " its graving style, electro-magnet, and clockwork identical with the former " apparatus, for causing the cylinder to turn, but held in check by an escape-" ment controlled by a clock; then suppose the two tables to be at a great " distance from each other but connected by two telegraph wires. If, at the " instant at which the clock sets free the motor at the cylinder, we can give " an isochronous movement to the sector, the problem will be solved," &c.

In the definitive construction of his telemeteorograph, M. van Rysselberghe has adopted a governor acting under centrifugal force, but differing from Watt's in the placing of the balls, and by which, according to the author of the article in the *Elektrotechnische Bibliothek*, the clockwork is regulated so accurately that it would not be difficult to construct two recording cylinders to go perfectly together, and that it would be possible, by mounting two pieces of clockwork going at absolutely the same rate, to copy the indications with all the precision desired from one of the recording cylinders on to the other, whatever be the distance they are apart. This is indispensable when the results of an apparatus are to be observed at the same time at a distant place.

For the same reasons which have led me to omit a number of details in the description of Olland's telemeteorograph, I have not drawn attention to the way in which M. van Rysselberghe changes his method of stud contacts when he wishes to record the indications of dial instruments, which are not of the nature of counters, as, for instance, the aneroid, the metallic thermometer, &c., nor to the device which he applies to the dipping-rod recorders to avoid the oxidation of the mercury, the great defect in this kind of instruments before his time.

I have endeavoured in the preceding pages to give as complete a summary as possible of what has been done in the way of telemeteorography; I only regret not having had the opportunity of taking cognizance of all the articles quoted, which treat of the question.

On the other hand, I have obtained information from M. Lancaster in Brussels on some of the details I have mentioned, and I am sincerely grateful to him.

Up to the present time there is no country in which the principle of registration at a distance of the indications of meteorological instruments has been introduced. On the other hand, it has been introduced on an extensive scale both in Holland and Belgium for tide-gauges. This shows us that the solution of the problem depends in great measure on the interests involved. In Belgium it has been abandoned on the ground of the cost of maintenance. in Holland, for the same reason, it has not been introduced. The success of its application to tide-gauges shows that the difficulty can be surmounted when we have to deal with cables or aerial lines specially devoted to the service. On the other hand, the employment of the ordinary telegraph lines appears to raise grave difficulties.

To make a fresh experiment, I obtained, in 1891, from his Excellency the Minister of Public Works, the permission to have a contract drawn up, by which M. Olland should undertake the removal of the instrument from the tower of the cathedral, clean it, make certain improvements in it, change a few of the details, to make it answer better for recording at a great distance, and, lastly, to put it in operation between Flushing and Utrecht during the night, by employing the telegraph line between the two towns.

During the same year the apparatus was ready, and performed satisfactorily in the workshop of the maker, with the insertion between the two portions of a resistance, in metallic wire, corresponding nearly to that of the telegraphic wire between the two towns. The indicator was taken to Flushing and erected there; the receiver was mounted at Utrecht, and it was hoped that telemeteorographic communication would soon be an accomplished fact, but no record of the instruments at Flushing have, up to the present time, been received at Utrecht.

To remove the difficulty, a relay with a local battery was added to send a stronger current through the bobbins of the style; the electro-magnets of the various ratchets were changed for cores of soft iron magnetised by induction by means of a permanent magnet, and which would be demagnetised by the current. The object of these and other alterations was to render the instrument more sensitive, and it was hoped by this means to obviate the loss of the current over the line; but another difficulty was met with, viz., the electro-magnets were too sensitive in the receiver and not sufficiently so in the indicator. The battery was placed in the central office near the receiver; this instrument, therefore, received the whole current without any of its intensity being lost, while it arrived at Flushing having lost in a great measure its original force. At Utrecht the current was so strong that the permanent magnet lost its magnetism, while at the distant station the armature did not move.

When, at last, the starting of the wheel-work of the conical pendulum and the observing arm at Flushing was successful, a new disappointment presented itself, for as soon as the distributing wheel at Utrecht central station had taken its last position, at which it gives access to the current closed by the observing arm, the tracing style was pressed hard against the cylinder, before even the observing arm made its contacts, and it remained in this position during the entire revolution of the cylinder. The result of this was a continuous line without any interruption. When examined *à posteriori* this was very easily explained. The contact having been made by the distributing wheel, the current began to pass, not through the observing arm, which had not yet made contact, but by leakages. This explanation was confirmed in a very striking way by placing a telephone in the circuit; although the style remained motionless, sticking to the cylinder, one could hear very distinctly the contacts of the graduations and of the index of the barometer as well as those of the anemometer, by the sudden variations of the intensity of the current when the observing arm successively touched one of the projecting parts.

The difficulties experienced by M. Olland clearly show that there is only one single remedy for these defects, viz., to set in motion the conical pendulum and the cylinder at the receiving station in a purely mechanical manner, and only to employ the electric current to accomplish these operations at the same moment with the corresponding apparatus (conical pendulum and observing arm) of the indicating station. In this way there will only be a single electro-magnet at a time in the circuit, so that the battery could be regulated entirely

according to this special need. As this battery has no other use than to actuate the two electro-magnets of the stops, it must be removed from the principal line and given such a position that it shall not be closed except in the two first positions of the distributing wheel.

A second battery should be erected at the second station (the indicating station) in the circuit of the observing arm; at each moment, when this touches one of the graduations of the dial or one of the indicating hands, a current is sent along the line, and, although it will lose much by leakage, it will, however, reach the bobbins of the electro-magnet of the style, and a trace will be marked on the paper of the recorder, provided the battery is powerful enough for this part of the current to attract the armature. But, on the contrary, these bobbins will never be traversed by a current which is not desired, as in the original arrangement.

On the 4th August last, I recommended M. Olland to make this new arrangement, but up to the present time he has not completed it; he seems to have met with fresh serious obstacles. Let us hope, however, that he will soon succeed.

(Signed) MAURITS SNELLEN.

Utrecht, 7th November, 1894.

APPENDIX VI.

NOTE relative to the SCINTILLATION of the STARS, by M. C. DUFOUR, PROFESSOR of ASTRONOMY at the UNIVERSITY of LAUSANNE, translated from a paper in the "Annales Hydographiques," 1894.

Of late years the scintillation of the stars has been studied by many observers with the help of more or less delicate optical instruments, and amongst others by M. Montigny, of Brussels.

I have also tried a telescopic scintillometer, and finally, have decided in favour of observation by the naked eye, and this is the only kind of observation possible at sea. I found that with some little experience it became fairly easy to estimate the intensity of the scintillation. I used the figures 0 to 10 to describe the different degrees of intensity, 0 representing an absence of luminous movement, a condition which is rarely met with, at least, in Switzerland, and then only in stars near the zenith; and 10 describing a very marked scintillation, when the star appears to jump and changes colour, this is seldom seen, and then only in stars near the horizon.

If, at first, observers should find difficulty in estimating these values, they would soon learn to distinguish these scintillations as "very strong" "strong," "moderate," "feeble," or "very feeble." It is by these, and especially by the latter, that coming bad weather is indicated in Switzerland.

But it is not certain that this rule can be applied to other countries or under different meteorological conditions, for a similar wind does not always bring unsettled weather in all countries, and the hygrometric conditions of the atmosphere are very different. For instance, the vicinity of glaciers and of perpetual snow, such as we have in Switzerland, dries the atmosphere much in the same way as a lake of sulphuric acid would, for, as the experiences of my friend, Professor Forel, and my own on the Rhône Glacier in 1870 and 1871 have already shown, vapour is deposited on the ice and snow in the same way as it is on a glass of fresh water in summer, or on the windows of our houses in winter. Therefore, in the vicinity of glaciers, the air is more or less dry. At Morges, I have even succeeded in rendering the air of a certain space drier by placing in it some ice upon which the vapour became condensed.

But this condensation is more or less intense, and the dryness of the air also varies according to the hygrometric conditions of the atmosphere and the direction of the wind in the upper regions. It is not impossible that this may be one of the elements which influence the intensity of scintillation. These conditions do not exist in other countries, and especially not at sea, except perhaps in the Polar regions.

Therefore, I dare not affirm that the results obtained in Switzerland would be the same over the whole globe, but they show at least that the question is worthy of investigation.

With regard to the manner of observation, I am convinced that the best system is observation by the naked eye, at least when carried out by observers with good eyesight. Naval officers might employ themselves in this way during their watches.

Here a difficulty presents itself. At first sight we recognise that the scintillation varies according to the apparent height of the star, in the sense that as the star approaches the zenith the scintillation becomes more feeble. I have compiled a table from my numerous observations which gives the average variation in scintillating power as these bodies rise above the horizon.

I found that for the various elevations the scintillation was proportionate to the following figures:—

From 0 to 10 from the zenith	0·30.
15	0·41.
20	0·45.
25	0·54.
30	0·60.
35	0·80.
40	1·12.
45	1·36.
50	2·03.
55	2·83.
60	3·71.
65	5·09.
70	7·02.
75	7·89.

These calculations may be considered as trustworthy, as they have been frequently utilised in making reductions by Professor Montigny of Brussels, who has also studied scintillation, but who commenced his observations at a later period than I did, and he considers them satisfactory.

At first sight, it might be imagined that the intensity of the scintillation is proportionate to the thickness of the atmospheric layer traversed by the luminous ray. It is easy to see that this is not the case, but rather that, except near the horizon, this intensity *is proportional to the product obtained by multiplying the thickness of the atmospheric layer which the luminous ray traverses by the refraction at the elevation under consideration.*

This may be demonstrated by drawing two curves having the zenithal distances as their abscissæ. In one of them the ordinates should be proportional to the intensity of the scintillation, in the other they should be proportional to the above-mentioned product; in this way we obtain two curves absolutely alike.

But we cannot compare observations taken near the horizon with those obtained at a greater elevation, because near the horizon the luminous rays have to penetrate a much less transparent atmospheric layer, by which they are partly absorbed, and they therefore reach our eyes under modified conditions.

Also preference must be given to observations made at an elevation higher than 10° rather than to those obtained at a lower elevation.

The diminution of scintillation as a star approaches the zenith is a difficulty for observers. If the elevation of a star is known it is easy by means of the above table to reduce the scintillation observed to that at its normal elevation, for instance, at 30°. I experienced no difficulty in this, as the greater number of my observations were made at Morges, in latitude 46° 30′ N. Besides, I had made a table giving, for each half-hour of sidereal time, the elevation above the horizon of every star of which I had observed the scintillation, and I had drawn curves of the elevations by which I was enabled at a glance to compare the relative heights of these stars.

This is possible at a fixed point, but it cannot be done at sea by reason of the constant change in the latitude of the vessel. However, if, as I believe, the observation of scintillation should become more general and should yield results valuable to navigators, it would be worth while to draw up a table of this kind for every five degrees of latitude for all stars of the first magnitude which could be observed by vessels.

If such a table is not within reach, or if the observer is not in the habit of describing the scintillations by figures, but by words, such as "very feeble," "feeble," "moderate," &c., there could be no question of reducing them to a normal elevation. But strictly speaking this is not necessary, and the normal elevation can be dispensed with. In studying the scintillations of the whole group of stars of the first magnitude, an experienced observer would readily estimate whether the general appearance could be described as "strong," "moderate," "feeble," or "very feeble," and also what connexion it might have with the meteorological conditions of the succeeding days.

It is well, however, to bear in mind that the proximity of clouds gives an appearance of greater scintillation to the stars. If, therefore, the scintillations appear to the observer to be "strong" they must be described as "moderate," and if apparently "moderate" they should be described as "weak."

In conclusion, should anyone desire further scientific information on the subject of scintillation, it is to be found in the interesting notice contributed by Arago to the "Annuaire du Bureau des longitudes," for 1852; and at the same time they will realise the dearth of continuous and systematic observation of this phenomenon which then existed. This it was which first gave me the idea of commencing my researches in order to supply, if possible, this deficiency.

APPENDIX VII.

Congress of Atmospheric Science, Antwerp, 1894. Secretary's Office, 16, Rue du petit Chien, Antwerp.

Antwerp, August 20th, 1894.

To the President of the International Meteorological Committee.

SIR,

THE Congress of Atmospheric Science, which has met at Antwerp and has just completed its operations, has expressed certain wishes, and has charged me to communicate them to you, in the hope that the distinguished Committee over which you preside may, by its support, contribute to their realisation.

1. The creation of an International Meteorological Institution, with the view of the preparation of synoptic weather charts embracing the entire northern hemisphere.

2. The systematic organisation of balloon ascents, undertaken with a view to meteorological investigations and the preparation of a programme of the observations to be carried out.

3. An agreement between the different Governments with the object of facilitating and augmenting telegraphic relations between the different meteorological institutes in connexion with weather prediction.

It seems to us certain, Mr. President, that if the views set forth in this letter are favourably received by the scientific men assembled at Upsala, their speedy realisation is certain.

We shall be glad to learn the decision on these important questions of the Upsala meeting, in order to include it in the Report of the Congress of Antwerp.

With the assurance of my profound respect.

(Signed) WAUWERMANS, Lieutenant-General,
President

APPENDIX VIII.

REPORT of the COMMITTEE on the CLOUD ATLAS.

(Revised in accordance with the discussion in the International Committee.)

FIRST SITTING.

August 21st, 1894.

President: PROFESSOR HILDEBRANDSSON.

Present: Messrs. HANN, MOHN, ROTCH, TEISSERENC DE BORT, WEILBACH.

The President proposed that the meteorologists present be invited to attend the sitting and take part in the discussion; they were, besides Professor v. Bezold, of Berlin, Director Billwiller, of Zürich, and Mr. Davis, of Cordoba, members of the International Committee—

Professor Broounof, of Kieff; Dr. Fineman, of Upsala; Dr. Hagström, of Upsala; Professor Riggenbach, of Bâle; Professor Sprung, of Potsdam.

The proposal was adopted.

Mr. Riggenbach was appointed Secretary.

The President gave a summary of the classification of clouds as determined by himself and Mr. Abercromby.

The President proposed to read the definitions given in the Cloud Atlas published by him, in conjunction with Messrs. Köppen and Neumayer.

At the suggestion of M. Teisserenc de Bort the word "diurnal" was added to the definition D, so that it should read—

D. "Clouds of the diurnal ascending currents."

In this way the cumulus, which is produced by a body of vapour ascending in a still atmosphere, may be distinguished from the nimbus which proceeds from the general ascent of all the mass of the humid atmosphere.

The Classification adopted is as follows:—

a. Separate or globular masses (most frequently seen in dry weather).
b. Forms which are widely extended, or completely cover the sky (in wet weather).

A. UPPER CLOUDS, average altitude 9,000 m.
  a. 1. Cirrus.
  b. 2. Cirro stratus.

B. INTERMEDIATE CLOUDS, between 3,000 m. and 7,000 m.
  a. { 3. Cirro cumulus.
       { 4. Alto cumulus.
  b. 5. Alto stratus.

C. LOWER CLOUDS, between 1,000 m. and 2,000 m.
  a. 6. Strato cumulus.
  b. 7. Nimbus.

D. CLOUDS OF DIURNAL ASCENDING CURRENTS.
  8. Cumulus; apex, 1,800 m., base, 1,400 m.
  9. Cumulo nimbus; apex, 3,000 m. to 5,000 m.; base 1,400 m.

E. HIGH FOGS, under 1,000 m.
  10. Stratus.

Explanations.

1. CIRRUS (Ci.).—*Detached clouds, delicate and fibrous looking, taking the form of feathers, generally of a white colour,* sometimes arranged in belts which cross a portion of the sky in "great circles," and by an effect of perspective, converge towards one or two opposite points of the horizon (the Ci. S. and the Ci. Cu. often contribute to the formation of these belts).

2. CIRRO STRATUS (Ci. S.).—*A thin, whitish sheet,* at times completely covering the sky and only giving it a whitish appearance (it is then sometimes called *cirronebula*), or at others presenting, more or less distinctly, a formation

like a tangled web. This sheet often produces halos around the sun and moon.

3. CIRRO CUMULUS (Ci. Cu.).—*Small globular masses or white flakes without shadows, or having very slight shadows, arranged in groups and often in lines.*

4. ALTO CUMULUS (A. Cu.).—*Largish globular masses, white or greyish, partially shaded, arranged in groups or lines, and often so closely packed that their edges appear confused.* The detached masses are generally larger and more compact (changing to S. Cu.) at the centre of the group; at the margin they form into finer flakes (changing to Ci. Cu.). They often spread themselves out in lines in one or two directions. (The title *cumulo-cirrus* is suppressed as giving rise to confusion.)

5. ALTO STRATUS (A. S.).—*A thick sheet of a grey or bluish color,* showing a brilliant patch in the neighbourhood of the sun or moon, and which, without causing halos, may give rise to coronae. This form goes through all the changes like the Cirro-stratus, but by measurements made at Upsala, its altitude is one half less. (The title *strato-cirrus* is suppressed as giving rise to confusion.)

6. STRATO CUMULUS (S.Cu.).—*Large globular masses or rolls of dark cloud, frequently covering the whole sky, especially in winter,* and occasionally giving it a wavy appearance. The layer of strato-cumulus is not, as a rule, very thick, and patches of blue sky are often visible through the intervening spaces. All sorts of transitions between this form and the alto cumulus are noticeable. It may be distinguished from nimbus by its globular or rolled appearance, and also because it does not bring rain.

7. NIMBUS (N.) RAIN-CLOUD.—*A thick layer of dark clouds, without shape and with ragged edges* from which continued rain or snow generally falls. Through the openings in these clouds an upper layer of cirro stratus or alto stratus may almost invariably be seen. If the layer of nimbus separates up into shreds, or if small loose clouds are visible floating at a low level, underneath a large nimbus, they may be described as *fracto nimbus.* ("Scud," of sailors.)

8. CUMULUS (Cu.) (WOOL-PACK CLOUDS).—*Thick clouds of which the upper surface is dome-shaped and exhibits protuberances while the base is horizontal.* These clouds appear to be formed by a diurnal ascensional movement which is almost always observable. When the cloud is opposite the sun, the surfaces usually presented to the observer have a greater brilliance than the margins of the protuberances. When the light falls aslant, these clouds give deep shadows, when on the contrary, these clouds are on the same side as the sun, they appear dark, with bright edges.

The true cumulus has clear superior and inferior limits. It is often broken up by strong winds, and the detached portions undergo continual changes. This may be distinguished by the name of *Fracto cumulus.*

9. CUMULO NIMBUS (Cu. N.) THE THUNDER-CLOUD; SHOWER-CLOUD.—*Heavy masses of cloud, rising in the form of mountains, turrets, or anvils, generally having a sheet or screen of fibrous appearance above ("false cirrus"), and underneath, a mass of cloud similar to "nimbus."* From the base there usually fall local showers of rain or of snow (occasionally hail or soft hail). Sometimes the upper edges have the compact form of cumulus, forming into massive peaks round which the delicate "false cirrus" floats, and sometimes the edges themselves separate into a fringe of filaments similar to that of the cirrus cloud. This last form is particularly common in spring showers.

The front of thunderclouds of wide extent frequently presents the form of a large bow spread over a portion of the sky which is uniformly brighter in colour.

10. STRATUS (S.)—A HORIZONTAL SHEET OF LIFTED FOG.—When this sheet is broken up into irregular shreds by the wind, or by the summits of mountains, it may be distinguished by the name of *fracto stratus.*

The members of the commission visited the Exhibition of Cloud Pictures and selected certain forms as types.

M. Teisserenc de Bort was elected Vice-President.

(Signed) A. RIGGENBACH.

Second Sitting.

August 22nd, 1894, 9.30 a.m. to Noon.

President: M. Teisserenc de Bort.

Present: Messrs. Broounof, Fineman, Rotch, Riggenbach, Sprung, Weilbach.

The Report of the last sitting was read and approved.

The Committee made a final selection of specimens for the Atlas of the clouds.

Cirrus. 4 forms.
Cirro Stratus. 1 form.
Cirro Cumulus. 1 form.
Alto Cumulus. 2 forms.
Alto Stratus. 1 form, made up of two parts.
Strato Cumulus. 1 form.
Nimbus. 1 form.
Cumulus. 2 forms.
Cumulo Nimbus. 3 forms.
Stratus. 1 form.
Fracto Stratus. 1 form.
Fracto Cumulus. 2 forms.
Mammato Cumulus. 1 form.

Two forms were chosen to illustrate the explanatory text—
1. The cirrus by Raymond, representing a simple undulation.
2. The cirrus by Riggenbach, representing a double undulation.

The sitting was concluded at Noon.

Third Sitting.

August 22nd, at 2.15.

President: Professor Hildebrandsson.

Present: Messrs. Billwiller, Broounof, Hann, Fineman, Mohn, Riggenbach, Rotch, Sprung, Teisserenc de Bort, Weilbach.

The President submitted the programme of publication of the Atlas, as well as several specimens of reproduction. He proposed to appoint a special committee for the publication of the Cloud Atlas.

The proposal was adopted.

The meeting decided that the Committee of Publication should have the right of determining the colour of each plate for the atlas, remaining as true to nature as possible.

The following were named as members of the Committee of Publication:—Messrs. Teisserenc de Bort, and Riggenbach, under the presidency of Prof. Hildebrandsson.

Prof. Hildebrandsson submitted the formula of Instructions for observing the clouds, and the following instructions were discussed and adopted.

Instructions for the Observation of the Clouds.

For each observation the following points are to be noted and entered in the register or schedule.

1. *The kind of cloud*, indicated by the initial letters of the name of the cloud (for greater precision, the number of the plate in the atlas which most nearly resembles the form observed might be given. (Ex. Ci. 3 of the International Cloud Atlas.)

2. *The direction from which the Clouds come.*

By remaining perfectly still for several seconds, the movement of the clouds may easily be observed in relation to a steeple or pole erected in an open space.* If the movement of the cloud is very slow, the head should be steadied by using a rest. This method of observing must only be used for clouds near the zenith, for if they are distant from it the perspective may lead to errors. In such cases the nephoscope must be used, and in each case the rules given for the kind of instrument in use must be followed.

3. *The point of radiation of the Upper Clouds.*

These clouds often take the form of narrow parallel lines, which by reason of the perspective appear to issue from a given point on the horizon. The "point of radiation" is the name given to the point where these belts or their prolongations meet the horizon. This point on the horizon should be indicated in the same manner as the direction of the the wind, N., N.N.E., &c.

4. "*Undulated Clouds.*"

It often happens that the clouds have the appearance of regular striæ, parallel and equidistant, like waves on the surface of water. This is mostly the case with the cirro cumulus, strato cumulus (roll cumulus), &c. It is important to note the direction of these striæ. When two distinct systems are apparent, as is often seen in clouds separated into globular masses by striæ in two directions, the directions of these two systems should be noted.

As far as possible, these observations should be taken of striæ near the zenith, so as to avoid errors caused by perspective.

5. *The density and situation of a Bank of Cirrus.*

The upper clouds often assume the form of a tangled web or sheet, more or less dense which, as it appears, above the horizon looks like a thin bank of a light or greyish colour. As this form of cloud is closely connected with barometrical depressions, it is necessary to observe:—

(*a.*) The density.
0 = very thin and irregular.
1 = thin, but regular.
2 = fairly thick.
3 = thick.
4 = very thick and of a dark colour.

(*b.*) The direction in which the sheet or bank appears thickest.

Remarks.—All interesting particulars should be noted, such as:—

1. During summer all lower clouds, as a rule, assume special forms, resembling more or less the cumulus. In such cases an entry should be made in the column for "Remarks," *stratus* or *nimbus cumuliformus*.

2. It sometimes happens that a cumulus presents a mammilated lower surface.

This appearance should be noted under the name of *mammato cumulus*.

3. It should always be noted whether the clouds seem to be stationary or in very rapid motion.

Translations into other languages must be made under the direction of the Committee of Publication, and therefore the right of publication of these translations is reserved.

(Signed) The Secretary,
A. Riggenbach.

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* M. Broounof points out that it is a very convenient plan to have a pole bearing a horizontal cross with its arms pointing N.-S. and E.-W. respectively.

APPENDIX IX.

List of Countries in which Cirrus Observations will probably be taken.

Country.	No. of Stations.	Instrument.	Remarks.
France - -	1	Photogrammeter	
Germany -	1	„	Station at Potsdam.
Java - -	1	- - -	Dr. van der Stok has obtained 2 photogrammeters and 2 theodolites.
Norway - -	1	Photogrammeter or theodolite.	
Portugal -	1	Photogrammeter	
Roumania -	1	„	Station at Bucharest.
Russia - -	—	- - -	Prof. Wild has 2 photogrammeters and M. Broounof 1 photogrammeter.
Sweden - -	1	Photogrammeter	
United States -	7	„	Prof. Harrington, 6 stations; Mr. Rotch, 1 station.

APPENDIX X.

Proposal for simplifying the Taking of Simultaneous Photographs of Clouds.

By A. Sprung, of Potsdam.

Any astronomer who wishes to determine the sun's parallax, by observing the transit of Venus, is able to make all necessary preparations, as he knows the exact time of this event.

The meteorologist, however, is not in such a favourable position; an interesting and important event may at any time come upon him unexpectedly. For this reason, he must look in all directions for methods of observation which do not require any preparation, or any arrangement with other observers.

As regards clouds in motion, an isolated observer may always provide himself with apparatus suitable for determining the direction or even the angular velocity.* But if he goes a single step beyond that, and wishes to know the linear velocity, or the absolute height of the clouds, he is obliged to have to recourse to another observer or to fortuitous conditions.

But such efforts could easily be dispensed with if there were a constant to be determined, like the sun's parallax, or the magnitude of a simple periodic change. But unfortunately the height of the clouds is a meteorological element, which, like all others, changes from one place to another and from one time to another. Even secular changes might perhaps be discovered, the knowledge of which might become of great importance.

To satisfy all requirements, methods must therefore be discovered which allow of the determination of the height of clouds with the same facility or

* See, for instance, A. Sprung. "Uber die Verwendung des einfachen Wolkenspiegels zur Bestimmung der Winkelgeschwindigkeit der Wolken." Zeitschrift fur Instrumentenkunde XI. 1891, p. 14.

regularity, as, for instance, the pressure of the air or the angular velocity of clouds.

But this end is still far distant. There are certainly many meteorologists who have thought of employing the common principle of the micrometer (The Distanz Messer) for measuring the height of clouds. But all attempts at working with a very short base must fail, owing to the indefinite form of the object, which does not allow of the use of an expedient which is quite natural in astronomy and in geodesy, viz., the telescope.

Why does this restriction exist? The characteristic contour of clouds is due to the distribution of the matter over a large angular space. But with a telescope, only a very small angle can be observed.

It is for this reason that we succeed best with clouds by entirely giving up the idea of enlarging the image furnished by the object glass. This consideration leads directly to the camera obscura, and the photography of clouds, a method of which the advantages and defects are well known. We must employ colours in photography (for instance, Zenker and Lippmann's method) to be able to distinguish with complete certainty the blue sky from the darker portions of the clouds.

There is certainly room for many improvements; this makes me more desirous of making a proposal for taking simultaneous photographs of clouds. My proposal is that the observer at the second station should be replaced by a mechanical contrivance which would allow a considerable number of simultaneous photographs being taken at the principal station.

My arrangement would be nearly as follows:—

1°. The optic axis of the two cameras should always be directed towards the zenith.

Consequent on this condition, the opportunity of taking good photographs is certainly limited to a great extent, more especially as the clouds in the zenith are not as well defined as those at less altitudes. But it should be mentioned that the observers at Kew Observatory have after many experiments ended by giving the photo-theodolite this position,* because the disadvantages referred to are more than compensated by the essential advantage of a very simple calculation of the observations. Moreover the mounting of a theodolite in the camera obscura may be obviated by the application of some other mechanical expedients for giving an exactly vertical position to the axis.

2°. The camera obscura with its pillar should be enclosed in a small house so as to shelter it entirely from wind and rain, and so that there shall be no inconvenience in recharging the apparatus with sensitive plates.

Before taking a photograph, a moveable portion of the roof should be opened, by using very powerful magnets, controlled by a separate electric current. (But it would be possible to use the same current for opening and shutting the trap.)

3°. When the trap is open, the favourable moment should be waited for, for taking by a second current the instantaneous photograph, which is followed immediately by a change of plate. All that is easily done by detaching, by the electric current, a mechanical contrivance (*e.g.*, a falling weight).

4°. As to the contrivance for changing the plates, it should be remembered in constructing it, that the question is a photo-grammmetric problem. If, for instance, a disc revolving on a vertical axis is used, as with the revolver, it would not be permissible to simply place the plates upon it with the bare surface downwards, because the different thickness of the plates might cause prejudicial differences in the distance from the sensible surface to the optic centre of the object glass. It will be necessary to make holes in the disc rather smaller than the plates, and to press the plates into it from below.

But the revolver arrangement is only one example; there are several ways of changing the plates.

It would be well, nevertheless, to repeat that it will not be necessary to put the camera on a theodolite; so that it may be made of larger dimensions.

* "Cloud photography conducted under the Meteorological Council at the Kew Observatory." By Lieut.-General Strachey and G. M. Whipple.—Proc. of the Royal Society, Vol. XLIX., p. 467.

(With a focus of 40 cm., for instance, instead of 18 to 28 cm.) Then the differences which arise from the variable thickness of the plates are not of great importance.

5°. A few remarks in conclusion.

The effective angle of the object-glass will be from 30° — 40°, and the size of the plates not less than 18 × 18 cm., or better 13 × 18 cm., at least, if the revolver arrangement is used.

Object-glasses have been recently made which allow of instantaneous views of clouds being taken, even by using yellow screens. But unfortunately these luminous object-glasses are all of a symmetrical construction, which invariably gives rise to reflected images, if the full sun is in the field of the object-glass. These reflections do little harm if it is only a question of measurement, and if the idea of obtaining sharp images of clouds is given up.

But this inconvenience may be completely remedied by using only a simple lens. The half of an "anastigmatic" lens by Goerz, for instance, gave me satisfactory results, with one exception, when the time of exposure had to be increased to one or two seconds. This would certainly militate against the simplicity of the apparatus which I have just described, and which is best adapted for high clouds (cirrus, alto cumulus, &c.), with a base of a 1,000 to 2,000 metres in length.

Potsdam,
July 1894.

APPENDIX XI.

Circular.

Meteorological Office,
63, Victoria Street, London, S.W.,
8th September 1894.

Sir,

I am instructed by the International Meteorological Committee to request that you will have the kindness to forward to me, at your early convenience, an account of the practice of your Office as regards the communication of meteorological information to agriculturists.

The Committee wish to insert such a résumé in the forthcoming report of their recent meeting at Upsala, showing what is being done, at the present date, in the way of—

1. Issue of weather forecasts to agriculturists.
2. The communication to agriculturists of climatological information which may be useful to them.

I am, &c.
(Signed) Robert H. Scott,
Secretary.

Replies to Circular.

AUSTRIA HUNGARY.

Vienna.—Hofrath, Dr. Hann.

1. For agriculturists, for climatic sanitary stations, and for localities much frequented by visitors, daily weather forecasts are issued by telegraph. Explanatory paper enclosed (not printed here).*

* The explanatory paper gives a map of Europe, marked in squares, distinguished by 30 letters (and diphthongs). Each telegram consists of one or two groups of five letters each.
The first group relates to the positions of barometrical maximum and minimum for the day. The first and third letters give by code the barometrical readings. The second, fourth, and fifth, the positions of maximum, minimum, and occasionally a second minimum.
The second group is the forecast.
The first letter is *Wind*, 10 grades; the second *Cloud*, 11 grades; the third *Precipitation*, 10 grades; the fourth *Temperature*, 15 grades; the fifth *Remarks*, 15 grades. Each of these grades is indicated by a code letter. The cost of one group daily is 4 fl. 70 kr.; of two groups, 5 fl. Telegrams must be fetched from the telegraph office.

In order to facilitate the use of these forecasts, *i.e.*, in order to specialise them more clearly, Austria is divided into six districts:—

1. Bohemia, Moravia, Silesia.
2, 3. Gallicia, West and East.
4. Lower Austria and Styria.
5. Upper Austria, Salzburg, and North Tyrol.
6. South Tyrol and Istria.

The telegrams are issued at 1h. or 1h. 30m. p.m., immediately on the arrival of the second collective telegram from Hamburg.

In addition, daily weather charts are issued. They are ready for posting at 5h. p.m., and are exposed to the public at several stations in the country.

II. No special communication of information is made to agriculturists, but the Ministry of Agriculture is supplied regularly, for its publications, with returns of temperature and rain (or snow) fall in the different parts of the empire.

Cracow.—Dr. Karlinski reports that no agricultural forecasts, &c. are issued by his Office.

Prague.—Dr. Anton Němec reports that his Office is mainly occupied with the rainfall of Bohemia, and its relation to the river discharge of the country, and that all forecasts, &c., for Bohemia emanate from the Hohe Warte in Vienna.

BELGIUM.

Brussels.—M. Folie replies that ever since his appointment he has devoted his attention to the development of a forecast service, &c., for the benefit of agriculturists. He has repeatedly approached his Government in order to obtain authority to organise such a system, but hitherto without any success.

The forecasts issued from Uccle during the summer are communicated to agriculturists as fully as possible, but it is to be feared that the intelligence does not reach its destination as promptly as would be necessary to ensure its practical utilization.

DENMARK.

Copenhagen.—Dr. Paulsen replies that in order to communicate to agriculturists information which may be useful to them, the Meteorological Institute of Denmark, in addition to its morning telegram, transmits every afternoon, except Sunday, a forecast of weather for the next day. This is exposed to the public at all railway stations and telegraph offices. At several stations the contents of these telegrams are communicated to the public by means of signals hoisted on hill tops.

ENGLAND.

London.—Mr. F. Gaster, in a report to Mr. R. H. Scott, says:—

In reply to the circular of September 8th, inquiring what steps are taken by the Meteorological Office, Telegraphic Branch, (1) as to the issue of weather forecasts to agriculturists, and (2) as to the communication to agriculturists of climatological information which may be useful to them; I have to report as follows:—

1. During the hay harvest season forecasts prepared at 3.30 p.m. on each week day are transmitted by wire gratuitously to certain leading agriculturists, situated in various parts of England, Scotland, and Ireland. They refer to the weather likely to be experienced in the respective neighbourhoods during the day following that on which the forecasts are issued. These usually reach the stations selected in less than an hour from the time of issue. The recipients undertake to make the forecasts known at once as widely as possible, sometimes by multiplying copies and spreading them about among their fellow agriculturists, at other times by posting them up in a conspicuous place, where they may be read by all who are interested in them. The local

post office has in some cases aided by allowing the telegram to be exhibited in the windows of the office, but this action is purely voluntary on the part of the postmaster. The recipients furnish also schedules giving a detailed account of the weather actually experienced, and by these the accuracy of the forecasts is carefully checked. This system has been carried out for 16 years entirely at the cost of the Meteorological Office, and during the season of 1893 the telegrams were sent for about five weeks to each of 34 recipients, by whom they were highly appreciated. Taking the telegrams as a whole, it appears that 64 per cent. of the forecasts were fully justified, 27 per cent. more than half justified, making 91 per cent. of really useful forecasts. The per-centage of success varies in different districts, that for the most western districts, such as Ireland and the north-west of England, being as low as 87 to 84, while in the east and south of England it varied from 95 to 97 per cent. The recipients are eager to receive these forecasts each year, and frequently ask for a continuation of them beyond the usual time.

During 1893 the Board of Agriculture tried the experiment of extending the issue to a still larger number of stations, and for this purpose the 3.30 p.m. forecasts were sent to a large number of centres in two of the English counties, viz., Northumberland and Essex, the telegrams being exhibited in the windows of the post offices of towns situated centrally in agricultural districts. The result of the experiment was such, that in the present year (1894) the issue has been extended to six counties, some in England and some in Scotland, the system being kept in operation for two months in each district.

In addition to the above, a considerable number of authorities have the telegrams sent to them at their own cost, either for the hay or the corn harvesting seasons.

2. In addition to the Daily Weather Report, which is issued post free to about 200 subscribers of 1*l.* per annum, and gratuitously to about 250 selected authorities, who will exhibit it to the public, or make use of it for public purposes. Meteorological information is conveyed to agriculturists mainly by the issue of a Weekly Weather Report, of which about 150 copies are sent to British and 80 to foreign authorities. This contains for the week :—

(*a.*) Report of the extreme and average temperature of the air, the number of rainy days, and the total fall at more than 70 stations in the United Kingdom, together with the differences between their values, and the means for the 25 years, 1866–90. The number of day-degrees of accumulated temperature, above and below the datum of 42° F., is given for each station also. There are in addition the numbers of hours of bright sunshine recorded at 35 of the stations, with differences from mean values for 10 years, 1881–90.

(*b.*) The stations are afterwards grouped into districts, and a summary of the above values for each district is given on the front page of each number, and early copies of those values are published by several of the leading agricultural and horticultural papers.

(*c.*) The third portion of the Report consists of synchronous charts of Europe showing the distribution of pressure and wind over that region twice a day, and of temperature and weather once a day for each day of the week, with notes as to the principal features exhibited. Monthly summaries also are issued.

These reports are sold to the public at 6*d.* per copy, or are supplied to subscribers, post free, for a charge of 1*l.* 10*s.* per annum.

FRANCE.

Paris.—M. Mascart.

A daily service of agricultural telegrams is established in France, and the Central Meteorological Office has been in charge of it since the year 1878.

The telegrams are sent from the office about 11.30 a.m. They are transmitted directly to all the places which have subscribed for them, and give, for the period of 24 hours, forecasts of wind direction, temperature, and state of sky.

France is divided into eight districts. In making this division, account has been taken first of the climatic conditions, then of the facilities for telegraphic communication. A special telegram is forwarded to the centre of each of these eight districts, from whence it is distributed to all the places which have subscribed for the information. It arrives generally speaking two hours after the time of dispatch. The eight districts are those of north-west, north, north-east, west, centre, east, south-west, and south.

The telegrams are subject to a charge which is paid by each commune. The charge is 40 francs a year, or 20 francs for a period of six months commencing on the 1st May. The application for them should be made by the mayor of the commune. If there is no telegraph at the place, the information must be fetched from the nearest telegraph office.

The places are expressly advised to provide themselves with a barometer, which should be erected in an open place and available to the public, so that the readings of this instrument may assist in the interpretation of the telegrams. A mercurial barometer is recommended, but most of the stations have an aneroid barometer, in which case the Meteorological Office furnishes to the places the means of adjusting them every three months.

The mean success of the forecasts issued during the last 10 years has been 90 per cent. for wind direction, 94 per cent. for temperature, and 88 per cent. for the state of the sky.

Besides this central service, which is carried on directly by the office, there is in nearly all departments a Meteorological Commission nominated by the prefect, and consisting generally of the chiefs of the large administrations and various persons interested in meteorology. Thanks to them, the study of rainfall, thunderstorms, and phenomena of importance to vegetation can be carried out on the spot; their peculiarities are thoroughly investigated, and the results which are transmitted to the office furnish materials for the general publication and discussions which appear in the "Annales." A whole volume is devoted to rainfall observations; thunderstorms and phenomena concerning vegetation appear in another. Charts are added, and complete each year the whole of the documents.

We may summarise here the means which agriculturists in France have of receiving information which interests them, viz. :—

1°. The "Bulletin International" publishes each day the general state of the weather over Europe and over France in particular. This bulletin is sent free to all the departmental commissions, to the various administrations, altogether to over 300 persons.

2°. The daily newspapers receive and publish the *résumé* of the general condition of the atmosphere which is contained in the bulletin. Some of them give complete observations from a certain number of stations. This is, therefore, a fresh source of information.

3°. A great number of towns which receive the "Bulletin International" have it posted up in a conspicuous place. The Northern Telegraph Company posts it up at its stations. The "Temps" newspaper publishes the weather chart daily.

4°. The places which subscribe receive their daily telegram.

5°. The meteorological commissions of certain departments make known the weather forecasts to the public, either by post, or by the semaphores established for announcing rain and atmospheric disturbances.

6°. Lastly, the Central Office replies to all inquiries for information.

GERMANY.

Berlin.—Prof. v. Bezold.

The Royal Meteorological Institute of Prussia does not issue forecasts for agriculturists. It does prepare detailed resumés of the amount of rain recorded which are printed monthly in the more important provincial newspapers dealing with agriculture. The Institute also at frequent intervals supplies information to the improvement engineering inspectors, whose duty it is to improve the land adjacent to the rivers which are too small for navigation, by regulating the flow of such streams.

Carlsruhe.—Dr. Honsell.

1. No forecasts for agricultural purposes are as yet issued.

2. No requests for meteorological statistics have as yet been received from agriculturists, and no such information is distributed.

Chemnitz.—Prof. Dr. Paul Schreiber.

The Royal Meteorological Institution of Saxony has been established chiefly on the initiative of agriculturists, its operations are in the first instance intended for their benefit.

I. The issue of forecasts for the ensuing day was suspended in 1877, but a daily weather report is issued.

The central office in Chemnitz receives from 10 stations weather reports on postal cards. These are despatched in the afternoon and reach the office next morning. One station, the Fichtelberg, sends a telegram.

Two daily telegrams are received from the Seewarte at Hamburg giving information from 45 stations.

Two classes of weather reports are issued. The first contains maps and tables, and the subscription for it, post free, is two marks per quarter. The second is supplied to newspapers.

II. Information useful to agriculturists is conveyed through various channels—

1. Many newspapers publish in more or less details the observations for the locality in which they are published, and some of these give summaries for months and years.
2. Monthly reports are supplied to the Kön. Leipziger Zeitung and to the Sächsische Landwirthschaftliche Zeitung.
3. On the occurrence of hail, notices are sent to the 4,306 local authorities, conveying to them the information which has reached the central office as to extent of damage reported, &c., and reminding them of the importance of sending in such information promptly.
4. Phenological observations, and records of depth of snow. The forest and agricultural officials take part in the phenological work, and the results of the reports are distributed yearly to more than 1,000 gentlemen officially connected with those departments. The measurements of snow depth are carried out at 200 stations and sent in on postal cards, and the results are communicated to the observers.
5. A special publication on the climate of the kingdom of Saxony has been commenced. Two reports of this nature have appeared.

The Central Institute has published numerous works bearing on the meteorology of the country.

Hamburg.—Captain Koldewey writes :

Up to the year 1884 daily forecasts were supplied by telegraph to several newspapers. This was for many reasons given up, and the Seewarte confined itself to the communication to the papers of detailed weather reports, and of material in the shape of telegraphic reports to private institutions proposing to forecast.

Daily weather charts are also published and these frequently contain intimations as to coming weather, which seem to meet the approval of the public. General dissatisfaction is expressed by the public at the forecasts only covering 24 hours.

The Seewarte never loses sight of the interests of agriculture, though its principal duty is the issue of storm warnings to the coasts.

Munich.—Dr. Erk writes :—

The Central Meteorological Station of the Kingdom of Bavaria issues a Daily Weather Report, of which the circulation increases year by year.

No special forecasts are issued to agriculturists, but any inquiries as to the weather are answered gratuitously.

In Bavaria, there exist distinct central stations for agricultural and forest meteorology. They are managed respectively by Professor Dr. Wollny and Professor Dr. Ebermayer. The latter will reply directly to you.

Dr. Wollny carries on numerous investigations in the department of agricultural meteorology which appear in the "*Forschungen auf dem Gebiete der Agricultur-physik.*"

Professor Dr. Ebermayer, says :—

The first organization of forest meteorological twin stations in Bavaria was set on foot by me in 1866. In the course of time there were altogether nine pairs of stations in the forest and in the open country, and they were distributed over the high mountains, the central hills, and the plain country. The observations were made twice a day, and were continued in some cases for 15 years and in some for 10 years, and they served to exhibit in sufficient detail the difference in climate between the forest and the open country. The results are to be found in part in my book "Die physikalischen Einwirkungen des "Waldes auf Luft und Boden," and in part in various articles in the "Zeitschrift für Agricultur-physik." In order to complete and extend these inquiries, I have conducted numerous investigations into forest air and soil and into ground air, in comparison with clear spaces, and published the results partly in the above-named journal, and of late years in the "Forstlich naturwissenschaftlichen Zeitschrift," under the title "The activity of forest "in the economy of Nature." I am at present engaged on a work which shall give an account of all the results hitherto established.

You see, sir, that the study of forest meteorology in Bavaria has not only been undertaken, but has been prosecuted and developed in all directions.

Strassburg.—Dr. Hergesell says :—

In Alsace Lorraine weather reports are published in the newspapers, which are drawn up as much as possible with regard to the requirements of agricultural meteorology. It is proposed to carry out observations and investigations into the climate of the country with reference to wine production, and in the first instance as to the duration of sunshine during the season of ripening of the grapes.

Stuttgart.—Dr. L. Meyer replies :—

In Württemberg, the system of forecasting for agriculturists is organised in the following way :—In the summer months, June to September inclusive, a daily despatch, limited to six words, and containing a forecast as regards cloud, rain, and temperature, is forwarded from the Central Office at Stuttgart to any district which has subscribed for it. In Württemberg there are 65 such districts, and of these 46 have subscribed in 1894.

The mode of communicating the forecasts to the public is arranged locally, and is different in different districts.

No other special information is supplied to agriculturists, but any inquiries from such gentlemen are answered gratuitously.

HOLLAND.

Utrecht.—Dr. M. Snellen writes :—

1. *Issue of weather forecasts to agriculturists.*—As soon in the morning as possible, the greatest barometric difference in the Netherlands, deduced from the observations at 8 o'clock, is telegraphed to the ports, and there communicated to shipmasters by means of a signal—the æroclinoscope.

Daily weather charts and forecasts are made up in Utrecht, Amsterdam, and Rotterdam. Only two newspapers in the Netherlands reproduce the former, but numerical reports and verbal weather reviews as communicated by the above-mentioned stations, are published by the most important journals.

Hektographic copies of the daily weather charts are published, by posting them up on several places in the above-mentioned towns, and from Utrecht they are sent free of expense to everyone who will pay the postage.

Besides this, daily telegraphic weather reports are communicated to the ports and published there by posting up tabular data.

All these informations to the public, concerning existing and probably coming weather, may of course be used by agriculturists, but, moreover, there is sent to other places in the Netherlands by telegraph a weather summary, specially established for the benefit of agriculture, called "*Telegrafisch Weer "bericht ten dienste van den Landbouw.*" These reports are published by harbour-masters, provincial newspapers, &c.

2. To everyone who addresses himself for that purpose to this office, all information about climatological data that may be wanted, is forwarded free of any charge, but no separate service in this direction is instituted for agriculturists specially.

ITALY.

Rome.—Professor Tacchini writes :—

In Italy the Minister of Agriculture has distributed meteorological instruments to the Agricultural Schools in the different provinces of the country, in order to secure special series of observations, the results of which are published in part in the "Bulletin Decadique," with which you are already familiar.

It has also been proposed to organise a system of forecasts for agriculturists, but the Council for Meteorology have with justice (in my opinion) declined to authorise such a measure, and have confined their operations to the communication of our daily weather telegraphic report to as many districts as possible, so that local authorities may be in possession of a sound basis for dealing with local circumstances in their predictions, while the entire responsibility rests on these authorities.

The number of stations receiving these despatches is at present 144, without counting the principal telegraphic stations which post up for public inspection the telegrams day by day.

NORWAY.

Christiania.—Professor Mohn writes :—

Weather forecasts are communicated daily, except Sundays, to the agricultural public.

From June to October inclusive, by signals from St. John's Hill, which are visible from all the environs of Christiania.

From July to September inclusive, the forecasts are telephoned to the railway terminuses, east and west of Christiania, and thence telegraphed to all the stations as far as Skien in the south, Kongsberg in the west, Hamar in the north, and the Swedish Frontier in the east, where they are posted up.

In addition, every train leaving Christiania about 3 h. p.m., carries on its luggage vans weather signals (a triangle and a square).

The forecasts are ready about 1 h. p.m.

In several localities they have arranged private lines of signals (masts and flags), starting from the stations at right angles to the line of railway, so as to warn adjacent districts.

The forecasts relate chiefly to wet or dry weather, and at Christiania we find that from 85 to 90 per cent. of the forecasts are justified.

Annually we publish tables of the mean temperature of each month and its deviation from the normal, as well as the amount of rain with its deviations (in per-centages) for all our stations. These tables appear in the Annual Report of the Director of the Department of Agriculture, and are distributed freely among agriculturists.

The establishment of local centres for distributing forecasts in other districts, such as Bergen and Trondhjem, is under consideration.

PORTUGAL.

Lisbon.—Rear-Admiral de Brito Capello writes :—

Forecasts are not issued to agriculturists.

It has been proposed to issue forecast telegrams to the governors of the 17 administrative districts of the country, which might be utilised by agriculturists, but the idea has been laid aside as difficulties almost insurmountable have appeared. The project is not, however, quite abandoned.

The daily weather report is supplied regularly to the School of Agriculture at Lisbon, and to several agricultural professors.

Various information as to climatology is sent on request to several professors and engineers in the Forest Department. Such inquiries are very numerous.

ROUMANIA.

Bucharest.—Professor Hepites writes :—

We have not yet commenced the publication of Daily Weather Charts, and consequently do not issue forecasts.

We confine ourselves to the daily announcement of the stations where rain has fallen, and what is its amount. This is arranged as follows :—All our meteorological or rain stations which lie near a telegraph office transmit to us every day the amount of rain which has fallen during the preceding 24 hours. Of these stations there are 92 at present.

These data, when combined with the fuller data, from the stations of the second order, which also send in their reports by telegraph, furnish the material for the preparation of a Daily Weather Report, which is published in the "Moniteur Officiel," as well as in the greater number of the Bucharest newspapers.

The Meteorological Institute of Roumania does not at present supply any other information to agriculturists.

RUSSIA.

St. Petersburg.—Professor Wild writes :—

The Central Physical Observatory in St. Petersburg is charged, as the Central Meteorological Office of the Russian Empire, with the duty of preparing forecasts for the benefit of agriculturists, and of publishing climatological data. At present this service is organised as follows :—

1. In the Daily Weather Bulletin the weather to be expected for the next 24 hours is announced for all the different parts of European Russia, with all details which are justified by the existing conditions exhibited by the synoptic chart for the day.

Inasmuch as the report transmitted by post arrives too late for use in the preparation of forecasts at stations which are not close to St. Petersburg, it has been arranged that anyone can for a double reply fee obtain from the Central Physical Observatory the information he required for his own district. Arrangements are made for despatch of the forecasts either (1) daily, (2) at regular intervals, or (3) occasionally whenever a change of weather is anticipated.

As a fact, the forecast telegrams, in all the above forms, are very generally in demand among the different districts, and among individual agriculturists.

Latterly the Central Observatory has made arrangements to forward daily to Elizabethgrad despatches containing the weather summary and the forecasts given in the bulletin.

The agricultural authorities in this district undertake the distribution of this information in the district. It is contemplated to organise similar arrangements in other districts.

2. The Central Physical Observatory publishes weekly in the Finanz Boten a bulletin containing for 104 stations in European Russia the meteorological data for the preceding week which are practically most useful, based on the Daily Weather Reports, together with a summary of the weather for the interval, and monthly, a report for the preceding month based on the daily telegraphic reports, and supplemented by information received by post. This report contains the information most practically useful especially for agriculturists, viz., pressure, mean temperature, and the normal temperature for the month, maximum and minimum temperature, number of days of frost, relative humidity, amount of cloud, and wind frequency for 76 stations, and for 324 stations the data for rain or snow, in summer for thunderstorms, in winter of the amount of snow lying on the ground, with a resumé of the month's weather, and a chart showing amount of rain, isobars, isotherms, &c.

This bulletin is printed to the extent of 300 copies, and sent free to all parts of the Empire. It can be obtained for an annual subscription of 3 roubles.

Odessa.—Professor Klossovsky writes :—

In reply to your circular, I have to inform you that the results of my feeble efforts to organise a central institution for agricultural meteorology are given in the accompanying pamphlet " organisation de l'étude climatérique spéciale " de la Russie et problèmes de la météorologie agricole."

It is difficult to realise at once the entire programme which I have sketched out, but I am proceeding very gradually towards its accomplishment. In 1886 I have commenced by organising a meteorological system which has by little and little attained a development entirely unexpected by me. The history of its progressive march will be found in my paper " Une page de l'histoire du " réseau météorologique privé du sud-ouest de la Russie."

At the present epoch the condition of our operations as regards the agricultural meteorology of south-west Russia are as follows :—

1. There is a central observatory at Odessa.
   (The description of this will be published shortly.)
2. There are 400 stations to observe thunderstorms.
3. There are more than 1,000 points for observing the depth of snow and agricultural phenomena, using two forms of report, the detailed and the abridged agricultural bulletins.

We publish—

a. Articles of which the titles are given in the above-mentioned " Une page &c."

b. The Meteorological Review, folio, of which 6 volumes have appeared, 73 pp. 28 charts.

c. The climate of Odessa, a monograph of the climate of our city which is unique (among the cities of Russia, with exception of the capitals) in possessing special climatological peculiarities.

d. We publish periodical crop reports alongside of the march of the meteorological elements.

e. Tables of the yield of crops (in poods per Deccatine).

This organisation which I have initiated and maintained is kept up by contributions which are entirely voluntary, and are therefore very uncertain. I have yearly to make application to the village authorities to collect the sum of 4,000 roubles.

SPAIN.

Madrid.—M. Arcimis writes :—

The Government has established some farms at which observations are made in connexion with agricultural meteorology.

Forecasts are not issued, nor are meteorological tables distributed to agriculturists.

SWEDEN.

Communication of Meteorological Information to Agriculturists in Sweden.

Stockholm.—Dr. Rubenson :—

1. *Issue of Weather Forecasts to Agriculturists.* From the first establishment of the Meteorological Office (Meteorologiska Central Anstalten), in Stockholm in 1873, daily weather maps (for 8 a.m.) have been prepared by means of reports from 22 telegraphically reporting stations. In 1877, the number was increased by seven German stations. A summary was sent telegraphically to some places in Sweden, and published in the newspapers. A weather bulletin (Väderleks-bulletin) was published lithographically from 1874 July, to 1877 December 31st, containing a weather map (8 a.m.), the greater part of the observations, and a summary of the weather. After this time the morning weather map, as well as the observations and the summary, has been published in the newspapers. From the 15th July 1880 the summary has been accompanied by forecasts giving the probable weather in Sweden from

the time of issue (about 1 p.m.) for the next 24 hours, chiefly with regard to precipitation. From the 29th August, 1882, a shorter summary with forecasts has been sent telegraphically along the State railways, and afterwards also along some private ones, and posted up at the stations.

In 1889, the Agricultural Society of the county of Stockholm had begun to distribute the forecasts to a great number of subscribers by means of telephone and signals during the summer and autumn (July–September).

The system of signals consists of flags or drums and cones flying on masts, and is as follows :—

Yellow flag or *cone point upward* = fine weather = no precipitation.
Red flag or *cone point downward* = doubtful weather or local showers.
Blue flag or *cylinder* = rainy weather.
Yellow flag over a blue one or *cone point upwards over cylinder* = still some local showers, clearing gradually.
Blue flag over a yellow one or *cylinder over cone point upwards* = rain to be expected after about a day.

From the year 1890 inclusive, a special weather service for agricultural purposes was established, during the months July–September, founded on afternoon reports taken at 4 p.m. at the Swedish stations, and at 2 p.m. at the foreign ones, the summary with forecasts for the whole following day being issued at about 6 p.m. Also the forenoon service was developed, two weather maps daily being prepared, viz., for 9 p.m. and 8 a.m., and generally, also a map of "isodenses" for 8 a.m. The summaries and forecasts (issued at 1 p.m. and 6 p.m. respectively) were sent telegraphically along the railways as before, and also to several agricultural societies of the kingdom and some private subscribers, and from thence widely spread by telephone and the above-described signals over this land. This arrangement has been maintained during the following years, the number of telegraphically reporting stations being gradually increased.

From this year, 1894 inclusive, the number of telegraphically reporting stations has been considerably increased, after the Riksdag has granted the means required for the purpose. The number of daily morning reports is now 67 during the months July–September, and 59 during the rest of the year, and that of the afternoon (Swedish 4 p.m. and foreign 2 p.m.) reports during July–September is 33. At present nine daily newspapers in Stockholm published more or less completely the morning weather reports, summaries, and forecasts, five of them giving daily weather maps for 8 a.m., and two publish the afternoon summaries and forecasts. Almost most of the daily newspapers of other cities in Sweden publish the morning and afternoon summaries and forecasts, that they obtain by telegraph or telephone. During the months July–September the forecasts are moreover spread, as said before, by telegraph, telephone, and signals.

2. *Communication to agriculturists of climatological information which may be useful to them.*—Since 1878 a special system of private observers of precipitation, a less number of them also observing temperature of air, night frost, thunderstorms, snow-covering, phenomena of vegetation, freezing and breaking up of the ice, &c., and some ones, moreover, wind, weather, and atmospheric pressure, has been obtained by means of subsidies from the agricultural societies of the kingdom.

The number of stations has been about 350, and during the last year, 1893, it was 380, the 86 State stations being not included.

Since 1881 a summary* of these observations, together with a number of such ones on earth temperature, evaporation, thunderstorms, aurora, snow-covering, &c., has been published monthly by Dr. H. E. Hamberg, under the control of "Meteorologiska Central-Anstalten." This summary is supported chiefly by subsidies from the agricultural societies and by the Meteorologiska Central-Anstalten, and is distributed every month gratis to the observers, public institutions, and some private persons interested in the meteorology of the kingdom, to several foreign meteorological institutes, and also distributed among the public by the booksellers. The present edition is 1,100 copies.

* Månadsöfversigt af väderleken i Sverige.

SWITZERLAND.

Zürich.—Dr. Billwiller writes :—

Ever since the year 1879 the Meteorological Institute of Switzerland has, by direction of the Government, appended forecasts to its daily bulletins, mainly for the use of agriculturists.

As our country has no seaboard, storm-warnings are not required, and so the forecasts are drawn up, not so much with regard to wind, as with regard to weather, precipitation, and temperature. They are intended for the use of agriculturists and of tourists. In spring the danger of night frosts is made a special point to which attention is paid. It has recently been attempted to make forecasts covering 48 hours, but none have yet been issued.

The Government has allowed a considerable reduction in the telegraphic charges for forecasts.

The subscription for 1 month is 10 francs.

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It was originally intended that the principal meteorological stations should prepare forecasts for their own immediate districts, but the Observatory of Berne is the only institution which carries this out, and this for its own Canton.

At present the Central Office in Zurich issues one forecast for Northern, Eastern, and Central Switzerland, and another for South-west Switzerland. For the narrow strip to the southward of the Alps, where the weather has a more constant character, the issue of forecasts is not as yet contemplated.

The local distribution of the forecasts to the public is entrusted to the individual parish authorities. It is effected partly by evening newspapers, partly by being posted up, and, in a few instances, by optical signals.

As regards the communication of results; this is, in general, only carried out in answer to inquiries.

The monthly bulletin, which has appeared since 1888, gives the general results from some 270 stations, which are in the first instance of interest to river engineers, &c.

UNITED STATES.

U.S. Department of Agriculture, Weather Bureau, Washington, D.C.—Professor M. W. Harrington writes :—

1. Issue of weather forecasts to agriculturists.
2. The communication to agriculturists of climatological information which may be useful to them.

With reference to the former, I beg to state that the forecasts prepared twice daily upon simultaneous observations taken at 8 a.m. and 8 p.m., 75th Meridian time, are usually ready for distribution within 2½ hours from the time of observation. The morning forecasts apply to the 36 hours beginning with the time of observation, and as soon as completed, about 10.30 a.m., they are telegraphed to the Weather Bureau officials at designated distributing centres throughout the country, from which points they are telegraphed to voluntary displaymen in outlying towns, and many of the latter, in turn, distribute the messages by mail to as many points as may be reached during the afternoon. After the forecasts leave the officials in charge of the distributing centres, which are also points at which meteorological observations are made and telegraphed to the central office, the work of dissemination is conducted by volunteers, and the information is given publicity by flag and whistle signals (circulars explaining system enclosed), and by being bulletined. Postal officials, educational institutions, and private individuals render voluntary services in distributing the forecasts. Many postmasters and voluntary displaymen are provided with a simple hand-printing outfit, containing logotypes of the words usually employed in expressing the weather conditions. With this outfit the message is quickly

composed, and in a few minutes the forecast can be stamped on a large number of cards (specimen enclosed). This system of stamping the forecasts upon postal cards is of recent origin, having been in operation less than one year. It has met with great success, and proves a most effective and economical method of giving to the public the weather forecasts. The cards, when received at destination, are bulletined for the benefit of the public.

Besides the regular daily distribution of weather forecasts, the Bureau has an additional system of stations, by which a more extensive distribution can be made of forecasts, classed as "Emergency warnings." These are warnings of the approach of storms, cold waves, killing frosts, &c., of exceptional severity. Such warnings are infrequent, but when issued it is of great importance that the most extensive publicity possible be given. This system of stations was recently used to great advantage in distributing warnings of the approach of the tropical hurricane which passed over the West Indies and the south-east coast of the United States during the last decade of September.

A special system of observations of temperature and rainfall in the cotton-producing states is conducted for the benefit of those interested in that important staple. Daily reports of observations of temperature and rainfall at more than 100 stations are placed upon telegraph circuits and given extensive circulation throughout the cotton region and to the more important commercial centres elsewhere, the information being published in bulletin form. The reports are first collected at 12 district centres, where local bulletins are issued and the information telegraphed to other centres, so that each cotton region centre not only publishes the data from the stations in its own district, but also a summary of the reports from all other cotton region centres.

Upon the second subject the following statement is submitted :—

There are 42 State weather services in the United States, each having its corps of meteorological observers and "weather-crop" correspondents. Monthly meteorological reports are issued the year round by each State, and during the season of planting, cultivating, and harvesting crops, weekly bulletins stating the weather conditions and their effects upon crops are issued from the central stations of each local weather service. The monthly publications are based upon the meteorological reports of the voluntary observers, and the weekly weather crop bulletins ars prepared from the reports rendered by special correspondents, which there are large numbers, whose reports are so mailed as to reach the state centre by Tuesday morning. Upon the receipt of the reports of the special crop correspondents, the State official issuest he local bulletin and telegraphs to the central office of the National Weather Bureau at Washington a brief summary of the weather and crop conditions for the national weather-crop bulletin (enclosed) which is issued Tuesday afternoon each week. Both the State and national bulletins are given wide circulation, and the newspapers, especially the agricultural journals, reprint them extensively. The full text of the national bulletin is telegraphed by the press associations, and by this means a very wide publicity is attained. The weather-crop feature of this Bureau has grown rapidly within the past few years, and is now classed with the most important work of this Bureau.

Enclosed are some of the publications issued in connexion with the weather-crop service, both State and national, together with some of the blank forms used in the collection and distribution of weather information.

Boston, Mass.—J. Warner Smith writes :—

DEAR SIR,

REFERRING to yours of the 8th ultimo, will respectfully state that the weather forecasts are being distributed as follows to the agricultural community in New England from the Boston office of the U.S. Weather Bureau :—

1. By telegraph at Government expense, giving 36-hour forecasts to about 90 places where whistles are blown or flags displayed for the information of the surrounding public.
2. By free telephone to a dozen places near the city.

3. By mail in form of bulletins, or on weather maps to nearly a thousand places, though many of those are for use in schools, and the forecast is not widely distributed; several hundred of these are displayed in post offices, where the general public can see them, and they are much discussed.
4. By handing bulletins wrapped and addressed to baggage master on express trains running out from this city, who drops them off at each station, the agent posting in frames furnished by the Bureau; about 500 places are daily reached in this way.

Special warnings of frost are telegraphed at Government expense to some 85 places; warnings of cold-waves to nearly 100, and special storm or "emergency warnings" to over 130 places.

All those receiving the forecasts or warnings are requested to further distribute them by free telegraph or telephone or mail, and many do so, so that the total number of people reached is very large. Forecasts are telegraphed from this office to other weather bureau stations in this district, and they are then duplicated and disseminated on maps, mail, R. R. bulletins, free telephone, &c.

A new system for rapid dissemination of forecasts to small agricultural places originated in this district last year, which is widely spreading and deserves more than a passing mention. We telegraph daily forecasts to the postmaster or other interested person in a large mail distributing centre in some part of the district too distant to be reached by mail from this office, and furnish him with rubber logotypes and stamping outfit. We also keep him supplied with cards addressed to the different post offices in his vicinity that he can reach on that day. Then on receipt of the forecast he duplicates it, as he can do that in a minute or two, having the logotypes, stamps the cards and mails them without delay. The telegrams are generally received before 11 a.m., giving the forecasts for all the following day; he has the cards in the mail in a very short time, and they are received and posted in the afternoon. This system has met with great favour, and in time I think we can easily reach every post office in the country. My plan is to have the post office department take the matter in hand and instruct their postmasters in all the large mail distributing centres to make the distributing part of their regular duties. I think that is the only way to get it down to a real system. Other State service directors depend mostly on the kindness of some signal displaymen, but I hardly think it so satisfactory as to have the postmaster attend to the work.

To question 2 I will state that the special climatological information is distributed by special and regular bulletins from the chief offices of the weather bureau; by the regular weekly or monthly publications of the different State services, and through the medium of the press. During the crop season we interest from one to two hundred different people in different sections of New England, send them blank cards, and have them report by mail each week on the state of the weather and its influence on the different crops. On receipt of the cards a summary is made up as quickly as possible, and distributed by mail; 3,000 copies were issued from this office during the present season. Reports were received by me Monday night, and the full issue of the printed bulletins containing about one thousand words was in the mail very soon after noon on Tuesday.

CANADA.

Toronto.—R. F. Stupart, Acting Director, writes:—

The meteorological observations telegraphed to this Central Office of the Canadian Meteorological Service for purposes of forecasting are made at 8.00 a.m. and 8.00 p.m. each day (75 meridian time). It is on the 8.00 p.m. chart that we base our daily forecasts. These forecasts do not come into force until 8.00 a.m. of the following day, and are for the succeeding 24 hours. By arrangement with the telegraph companies the forecasts are posted at every

telegraph station in the provinces of Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island; it is the duty of every telegraph operator to be on hand exactly at 8.00 o'clock each morning, and his first duty is to receive the daily probabilities, which are copied at the same time by the operators at every office on the line.

At 10.00 o'clock each evening the forecasts are supplied to the daily newspapers of the Dominion, nearly all of which give them a prominent place in their columns of the morning edition.

For the benefit of agriculturists in particular, between June 1st and September 30th the morning trains on nearly all railways in the older provinces carry a signal-disc on the baggage-van which indicates the weather for the next 24 hours. Fine weather is indicated by a clear white disc, showery by a crescent, and rain by a star. In this way wherever a farmer can see a passing train he may know the probabilities.

As regards communicating to agriculturists climatological information; we distribute to all volunteer observers, to town libraries, and also to many private individuals, our Monthly Weather Review, which contains monthly means of barometer, temperature, and rainfall; agriculturists can therefore obtain climatological information regarding districts, either by applying to local observers or to the head office in Toronto. Our Annual Report is distributed in the same manner. Many of our volunteer observers publish monthly summaries of their observations in the local newspapers of the district.

In connexion with the daily forecasts we issue a bulletin stating maximum and minimum temperatures at stations in various parts of the Dominion; this is also published in many of the morning papers of the Dominion.

INDIA.

Calcutta.—Mr. J. Eliot writes:—

The communication of weather forecasts to the main body of the Indian agriculturists or cultivators is hence an impossibility at the present time for various reasons.

The Department issues, for the information of the Government and its officers, more especially revenue, public works, and irrigation officers, daily weather reports and charts at Simla, Calcutta, Bombay, and Madras, which give full information of the weather of each day, and a complete comparison with the normal pressure, temperature, and rainfall data of the day, together with a general forecast of the weather of the next 24 or 36 hours. A summary of this is telegraphed daily to the local governments, and to a large number of high officials for their information and guidance. The Head of the Department prepares three or four seasonal forecasts every year; one for the whole monsoon period issued in June; a second in August for the latter half of the south-west monsoon period; a third in the beginning of December, which gives a preliminary forecast of the probable character of the cold weather rains; and a fourth in the beginning of January, the final forecast of the probable character of the cold weather rains.

The first and second are usually published in the Government gazettes and newspapers, and the knowledge filters down into the agricultural community, but to what extent I have no means of knowing. The latter two are not yet published for general information, but are merely communicated to the Government of India for information.

Finally, special local data and forecasts, daily, weekly, or seasonal, are supplied to the Government officials concerned in various ways in times of drought and famine.

All this information, although not directly available to the ordinary cultivator, is for his ultimate benefit.

VICTORIA.

Melbourne.—Mr. R. L. J. Ellery writes:—

The practice of our Meteorological Office in respect to information for agriculturists, I may inform you that for some years past it has been our practice to send a forecast daily about noon to all the country telegraph offices where it is posted on the *notice boards* shown publicly at such offices.

We issue a monthly sheet of rainfall, which is distributed pretty freely in the agricultural districts, and I am now preparing an average rainfall map showing the mean fall over each district for past 35 years—this will go among the farmers.

NEW SOUTH WALES.

Sydney.—Mr. H. C. Russell writes:—

I have the honour to acknowledge the receipt of your letter of September 8th from the International Meteorological Committee, requesting to be supplied with an account of our practice in regard to the distribution of meteorological information to agriculturists.

1st. Issue of weather forecasts to agriculturists.

2nd. The communication of climatalogical information which may be of use to them.

In reply I may say that in regard to the first question, we issue two forecasts every day except Sunday and Saturday, the two are combined, that is we wait for more telegrams. The usual course is to plot on to a chart at noon all the telegrams received up to that date, consisting, as a rule, of all but those from Western Australia, at half-past 12 a forecast is made upon this chart and at once issued and posted up at the central *Post Office*, the *Merchants Exchange*, *and the Post Office*. Special attention is given to rain and wind likely to affect agriculture, and the localities where it may be expected are named, and to certain principal localities the forecast is telegraphed. Agents also for country papers obtain copies and send them on for publication in local newspapers. Whenever possible the forecast includes two or three following days.

At 4 p.m. all the information for the day is collected on a second edition of the chart, and a fresh forecast is issued based upon the chart and a limited number of telegrams taken at 3 p.m. This chart is published at 4.30 p.m. in the same way as the one at 12.30 p.m. It has not been thought necessary or advisable, with our widely scattered patches of agriculture, to distribute the information by signs on railway carriages or other devices.

Our weather chart (sample sent)* shows in figures the rainfall and weather at 88 stations also, by shading, the area over which rain has fallen during the previous 24 hours *in all the colonies*. 2nd. The climatological information is given in annual volumes, one giving the general meteorological results, barometer temperature, wind, &c., and another giving rainfall at about 1,300 stations scattered over the colony; also a *spot rainfall chart* showing the relative amounts of rain at each place by the size of the spot. Also full information about river levels and floods and also about evaporation.

To these are added from time to time special studies, first in the volume for 1890. A chart showing isotherms for the whole colony. Second, in the volume on rain for 1892 is a chart showing the average rainfall for each square degree of the colony. The number of records on which each mean depends, and the number of years the mean is for. Into the volume sent I have put a copy of a chart to be issued with the Rainfall Report for 1893, this gives in each square degree the mean rainfall for each month of the year, and is intended as a guide to pastoralists and agriculturists how much rain to expect.

Another chart is now in preparation, and is to be issued shortly, giving for all places at which we have records the mean temperature, the extreme max. and min. and the mean temperature for each quarter of the year. These publications are distributed to all who take part in the work nearly 1,300 observers, to local schools of art, and to newspapers.

* Date of Chart, September 10th 1894, 1 p.m.

LIST OF PUBLICATIONS, &c.—*continued.*

Marine Discussions:—*cont.*

Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America. (Official, No. 11.) 2*s.* 6*d.*

Currents and Surface Temperature of the North Atlantic Ocean, from the Equator to Latitude 40° N., for each Month of the Year. With a General Current Chart. (Official, No. 12.) 2*s.* 6*d.*

Cyclone Tracks in the South Indian Ocean. From information compiled by Dr. Meldrum, C.M.G., F.R.S. (Official, No. 90.) 7*s.*

Daily Weather Charts for the period of six weeks ending June 25, 1885, to illustrate the tracks of two cyclones in the Arabian Sea. (Official, No. 80.) 10*s.*

Discussion of the Meteorology of that Part of the Atlantic lying North of 30° N., for the Eleven days ending 8th February 1870. With Charts. (Official, No. 13.) 5*s.*

Meteorological Charts for the Ocean District adjacent to the Cape of Good Hope, with accompanying Remarks. (Official, No. 43.) Charts, 25*s.*; Remarks, 7*s.*

Meteorological Charts of the Portion of the Indian Ocean adjacent to Cape Guardafui and Ras-Hafún. (Official, No. 92.) 6*s.*

Meteorological Charts of the Red Sea. (Official, No. 106.) 21*s.*

The Meteorology of the North Atlantic during August 1873, with 31 Synoptic Charts. (Official, No. 32.) With Book of Charts. 15*s.*

Notes on the Form of Cyclones in the southern Indian Ocean.—By C. Meldrum, M.A., F.R.S. (Non-Official, No. 7.) [Out of print.]

On the Physical Geography of the part of the Atlantic which lies between 20° N. and 10° S. and extends from 10° to 40° W. A Paper read before the British Association at Bristol, in August 1875.—By Capt. H. Toynbee, F.R.A.S. (Non-Official, No. 10.) 1*s.* 6*d.*

On the Winds, &c. of the North Atlantic along the Tracks of Steamers from the Channel to New York. Translated from a Paper issued by the Deutsche Seewarte, Hamburg. (Non-Official, No. 5.) 6*d.*

Report to the Committee of the Meteorological Office on the Meteorology of the North Atlantic.—By Captain H. Toynbee. (Non-Official, No. 2.) 1*s.*

Report on the Gales experienced in the Ocean District adjacent to the Cape of Good Hope between Lat. 30° and 50° S., and Long. 10° and 40° E., by Capt. H. Toynbee, F.R.A.S. (Official, No. 44.) 7*s.* 6*d.*

Routes for Steamers from Aden to the Straits of Sunda and back. Translated from a Paper issued by the R. Meteor. Inst. of the Netherlands. (Non Official, No. 4.) 6*d.*

Synchronous Weather Charts of the North Atlantic and the adjacent Continents, 1st August 1882 to 3rd September 1883. Parts I. to IV. (33 sheets each). (Official, No. 71.) 17*s.* each part.

Meteorological Atlas of the British Isles. (Official, No. 53.) 5*s.* 6*d.*

Meteorological Observations at Stations of the Second Order:—

*1876.	(Official, No. 33*a*.)	1884.	(Official, No. 78.) 32*s.*
1877.	(Official, No. 33*b*.)	1885.	(Official, No. 82.) 31*s.*
1878.	(Official, No. 39.) 20*s.*	1886.	(Official, No. 88.) 25*s.*
1879.	(Official, No. 45.) 20*s.*	1887.	(Official, No. 95.) 24*s.*
1880.	(Official, No. 57.) 31*s.* 6*d.*	1888.	(Official, No. 101.) 22*s.*
1881.	(Official, No. 66.) 35*s.*	1889.	(Official, No. 108.) 34*s.*
1882.	(Official, No. 69.) 35*s.*	1890.	(Official, No. 110.) 34*s.*
1883.	(Official, No. 73.) 30*s.*	1891.	(Official, No. 117.) In the Press.

Meteorological Observations at the Foreign and Colonial Stations of the Royal Engineers, and the Army Medical Department, 1852–1886. (Official, No. 83.) 23*s.*

Meteorological Observations made at Sanchez, Samaná Bay, St. Domingo, 1886–1888.—By the late W. Reid, M.D. (Official, No. 89.) 8*s.* 6*d.*

Monthly Weather Reports:—

1884. (Official, No. 62.) Jan.–March, May–Nov., 1*s.* 6*d.* each; April (with two Appendices), 2*s.* 6*d.*; Dec., 1*s.* 9*d.*
1885. (Official, No. 65.) Jan. to Dec., 1*s.* 6*d.* each.
1886. (Official, No. 68.) Jan. to Dec., 1*s.* 6*d.* each.
†1887. (Official, No. 77.) Jan. to April, 1*s.* 6*d.* each; May to Dec., in wrapper, 12*s.*

Principles of Forecasting by means of Weather Charts.—By the Hon. Ralph Abercromby, F.R.Met.Soc. Second Edition, Revised. (Official, No. 60.) 2*s.*

Quarterly Weather Reports:—

1869. (Official, No. 7.) Parts I. to IV. 5*s.* each.
1870. (Official, No. 9.) Parts I. to IV. 5*s.* each.

* The observations at stations of the Second Order for 1873-75 will be found in the Quarterly Weather Report for the respective years.
† Publication continued after this date as a Supplement to the Weekly Weather Report.

Quarterly Weather Reports—*cont.*

1871. (Official, No. 14.) Parts I. to IV. 5*s.* each.
1872. (Official, No. 16.) Parts I. to IV. 5*s.* each.
1873. (Official, No. 19.) Parts I. to IV. 5*s.* each.
1874. (Official, No. 25.) Parts I., II., and IV., 5*s.* each; Part III., 5*s.* 9*d.*
1875. (Official, No. 30.) Parts I. to IV. 5*s.* each.
1876. (Official, No. 33.) Part I., 6*s.*; Parts II., III., and IV., 5*s.* each.
1877. (Official, No. 52.) Part I., 10*s.*; II., 5*s.*; III., 4*s.* 6*d.*; IV., 6*s.*; Appendices and Plates, 27*s.*
1878. (Official, No. 55.) Parts I. to IV., 6*s.* each. Appendices and Plates, 28*s.*
1879. (Official, No. 49.) Parts I. to III., 6*s.* each; IV., 5*s.* 6*d.*; Appendices and Plates, 27*s.*
1880. (Official, No. 50.) Parts I. and II., 6*s.* each; III., 4*s.*; IV., 6*s.*: Appendices and Plates, 28*s.*

Rainfall Tables of the British Isles for 1866–80. Compiled by G. J. Symons, F.R.S. (Official, No. 47.) 7*s.* 6*d.*

Rainfall Tables of the British Islands, 1881–90. (Official, No. 114.) (In the Press.)

Report of an Inquiry into the Connexion between Strong Winds and Barometrical Differences.—By Robert H. Scott. (Non-Official, No. 1.) 6*d.*

Report on the Meteorology of Kerguelen Island.—By Rev. S. J. Perry, S.J., F.R.S. (Official, No. 37.) 3*s.*

Report on the Storm of October 13–14, 1881.—By Robert H. Scott, F.R.S. (Official, No. 46.) 1*s.* 6*d.*

Report to the Committee of the Meteorological Office on the Use of Isobaric Curves.—By Captain H. Toynbee, F.R.A.S. (Non-Official, No. 3.) 1*s.*

Reports of the Meteorological Committee :—

1867. (Official, No. 1.) 1*s.*
1868. (Official, No. 5.) 5*d.*
1869. (Official, No. 6.) 10*d.*
1870. (Official, No. 10.) 10*d.*
1871. (Official, No. 15.) 10*d.*
1872. (Official, No. 17.) 1*s.*
1873. (Official, No. 22.) 4*d.*
1874. (Official, No. 26.) 6*d.*
1875. (Official, No. 29.) 4*d.*
1876–77. (Official, No. 31.) 3*s.* 5*d.*

Reports of the Meteorological Council :—

1877–78. (Official, No. 35.) 1*s.*
1878–79. (Official, No. 38.) 5*d.*
1879–80. (Official, No. 41.) 1*s.*
1880–81. (Official, No. 42.) 1*s.* 2*d.*
1881–82. (Official, No. 48.) 1*s.*
1882–83. (Official, No. 58.) 10½*d.*
1883–84. (Official, No. 64.) 1*s.* 2*d.*
1884–85. (Official, No 67) 4*s.* 4*d.*
1885–86. (Official, No. 72.). 8*d.*
1886–87. (Official, No. 75.) 8*d.*
1887–88. (Official, No. 79.) 1*s.*
1888–89. (Official, No. 84.) 5½*d.*
1889–90. (Official, No. 91.) 7½*d.*
1890–91. (Official, No. 99.) 5½*d.*
1891–92. (Official, No. 104.) 6*d.*
1892–93. (Official, No. 109.) 8*d.*
1893–94. (Official, No. 112.) 7½*d.*
1894–95. (Official, No. 119.) (In the Press.)

Sunshine Records of the United Kingdom for 1881. (Official, No. 56.) 4*s.*

Ten Years Sunshine in the British Isles, 1881–90. (Official, No. 98.) 2*s.*

Weekly Weather Reports. With Appendices and Monthly Supplements, priced separately.

*1888. Vol. V. (Official, No. 85.) 4*d.* per week.
1889–95. Vols. VI.–XII. (Official Nos. 86, 87, 96, 100, 107, 111, 116.) 6*d.* per week.

* The publication of the Weekly Weather Report began in February 1878. Annual subscription, including supplements and appendices, post paid, 1878–1883, 12*s.* 6*d.*; 1884–1888, 21*s.* 2*d.*; from 1889, 30*s.*