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REPORT

OF THE

INTERNATIONAL METEOROLOGICAL CONFERENCE.

PARIS, 1896.

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REPORT

OF THE

INTERNATIONAL METEOROLOGICAL CONFERENCE.

At PARIS, in SEPTEMBER 1893.

First Meeting, Thursday, September 17th.

THE MEETING was opened at 10h. a.m. in the apartments of the Société d'Encouragement, No. 44, Rue de Rennes.

Present: Messrs. Angot, Anguiano, Baillaud, Becquerel, von Bezold, Biese, Billwiller, Ellis, Erk, Fines, Fron, Hepites, Hergesell, Hildebrandsson, Jaubert, Kesslitz, von Konkoly, Lancaster, Mascart, Moureaux, Neumayer, Paulsen, Riggenbach, van Rijckevorsel, Rotch, Rykatcheff, Schmidt, Scott, Snellen, Stupart, Symons, Tacchini, Teisserenc de Bort, Thévenet, Watzoff, Wragge.

Mr. SCOTT rose and said that, as sole representative of the Executive Officers of the International Committee, it was his duty to open the Meeting. The first thing to be done was to appoint a President; he proposed to nominate M. Mascart, who had already discharged the duties of President at Upsala.

This proposal was agreed to by acclamation.

M. MASCART accepted the position of President, and thanked the Conference for the honour conferred upon him. He then submitted the draft programme of questions proposed for the Conference, and proposed the adoption of the following Byelaws for the conduct of the Meetings:—

1°. The Conference shall elect a President and two Vice-Presidents.

2°. The Conference shall then nominate three Secretaries: one for the French language, and two others for English and German respectively. The Protocols shall be drawn up in French and afterwards translated for publication in the other two languages.

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3°. The Protocols of each Meeting shall be drawn up and printed in French, to be presented at the following Meeting.

4°. The questions shall be discussed in French; but communications may be made in German or in English.

These Byelaws were adopted.

Mr. SCOTT read the following Report:—

"Gentlemen,—The International Meteorological Committee, at its Meeting at Upsala, in August 1894, adopted the following resolution:—

> "The Committee is 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 are requested to make the arrangements necessary for carrying out the proposal.

"Since that Meeting, our President, Dr. Wild, has been obliged, by considerations of health, to tender his resignation.

"In view of the approaching convocation of the present Conference, the members of the Committee have not thought it necessary to proceed to the election of a President by means of correspondence to replace Dr. Wild.

"Thus, the duty of presenting a report upon the work done since the Meeting at Upsala, has fallen upon me, as Secretary and sole remaining member of the Executive Officers.

"We have also had the misfortune to lose another of our colleagues, but happily not from reasons of health. Professor Harrington, on resigning the directorship of the Weather Bureau of Washington, in August 1895, addressed a letter to the Secretary stating that he resigned also his seat on the International Committee.

"Since the Meeting at Munich, we have to regret the loss of Professor Lang, who had filled the post of President at that Meeting with great distinction, and, more recently, of Padre Denza, whose work in our science is so well known.

"The question of the acceleration of meteorological telegrams was discussed at Upsala, where the following resolution was adopted:—

> "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.

"In order to give effect to this wish of the Committee, I had the honour, on the 8th July 1895, of transmitting a copy of the

resolution to our colleague, Dr. Billwiller, for communication to the International Telegraphic Bureau, so that it might be submitted to the next Telegraphic Conference, which was to be held at Buda-Pesth in the present year.

"As to the question of cloud observations, the Secretary, in accordance with the instructions of the Committee, addressed, on the 6th July 1895, a circular to 72 meteorologists, requesting them to state if they intended to co-operate with the proposed system of observation.

"To this 21 replies have been received direct, only six of which were negative and two doubtful. In addition, several Directors sent their replies to Dr. Hildebrandsson, who has communicated them to the Office.

"More recently, on the 10th April 1896, a second circular was sent to the gentlemen who had given their adhesion to the scheme, asking if they were disposed to continue their observations until the 1st August 1897, so that the period of observations should cover 15 months instead of 12. To this circular 11 favourable replies were received.

"The institutions which have notified their agreement with the plan are:—

	II. Class Stations.
Alsace-Lorraine, Dr. Hergesell	1
Austria, Admiral Kalmar	3 (and two war vessels).
Belgium, Dr. Lancaster	12
Denmark, Dr. Paulsen	3
France, M. Teisserenc de Bort, near Paris (photogrammeter).	
Netherlands, Dr. Snellen	4–5
Norway, Dr. Mohn, Bossekop (theodolite).	
Portugal, Admiral de Brito Capello, Lisbon (theodolite)	
Prussia, Dr. Sprung, Potsdam (photogrammeter).	
Roumania, Dr. Hepites	3
Russia, Major-General Rykatcheff. — Pavlovsk (photogrammeter).	
Ekaterinburg, Yakutsk, Tiflis, Yuriev (Dorpat), Moscow	Theodolites and Nephoscopes 10
Dr. Broounof — Nizhni Novgorod (photogrammeter).	
Sweden, Professor Hildebrandsson, Upsala (photogrammeter).	
United States, Professor Moore, Washington (theodolites)	10
Mr. A. L. Rotch, Blue Hill (theodolite).	
India, Mr. J. Eliot — Calcutta, Allahabad, Kodarkanel, Simla	6
Mr. Mitchie Smith — Madras.	

Phillippine Isles, Rev. Father Faura, Manilla (photogrammeter).
Java, Dr. Van der Stok, Batavia (photogrammeter).
Victoria, Mr. P. Baracchi, Melbourne (photogrammeter), 50.
South Australia, Sir Charles Todd, Adelaide.

"The provisional Programme, which you have no doubt received, contains all the questions of which the text has been received at the Office, up to the date of posting it, on the 20th March 1896.

"Among the communications which have been received since, we have only to mention a proposal by Dr. Paulsen, of Copenhagen.

"Dr. Adam Paulsen will have the honour of presenting to the Conference some charts on the distribution of floating ice, at different periods, in the Arctic Ocean. If the Conference is of opinion that these charts possess scientific importance, Dr. Paulsen will request the representatives of the various institutions, in connexion with which any nautical service exists, to obtain for him observations to complete this work of the Meteorological Institute of Denmark."

(Signed) ROBERT H. SCOTT.

The Report was adopted.

M. MASCART thanked Mr. Scott, who in the interval of the Conferences had alone performed the administrative duties of the Committee. After consultation with the members of the International Committee, he proposed, in accordance with Article I. of the Byelaws, the following nominations, which were adopted by the Meeting:—

Vice-Presidents: Messrs. von Bezold and Tacchini.
Secretaries: Messrs. Scott, Erk, and Angot.

The Vice-Presidents and Secretaries thanked the Meeting for the honour bestowed upon them.

Mr. SCOTT read the list of the gentlemen who had received invitations (App. I., p. 45).

Messrs. Hann, de Brito Capello, Arcimis, Prof. W. M. Davis (Harvard College), Viniegra (San Fernando), Eginites (Athens), Admiral Barbera (Brazil), and Wild excused themselves for not being able to attend the Conference for reasons of health or owing to their distance from Paris.

M. MASCART proposed to admit to the Conference MM. Dufour (Lausanne), James Page (Hydrographic Office, Washington), Tolnay (Buda-Pesth), Chauveau, Mathias, and W. de Fonvielle, with consultative votes.

The provisional Programme previously distributed was adopted, with the addition of the question proposed by Dr. Paulsen (No. 37), and specified in Mr. Scott's Report, and of the three following questions:—

No. 38. Dr. Neumayer: The simplification of meteorological telegrams.

No. 39. Dr. Hann: The regular publication in each country of the complete list of all the establishments or societies which publish observations or works relating to meteorology.

No. 40. Dr. Hildebrandsson: The establishment of meteorological stations in the regions of the great centres of action of the atmosphere.

The Committee for Terrestrial Magnetism and Atmospheric Electricity was constituted in the following manner:—

Messrs. von Bezold, President; Ellis, Neumayer, Paulsen, van Rijckevorsel, Rücker, Schmidt, Chauveau, Mathias, Moureaux.

This Committee was appointed to meet on Friday, the 18th September, at 3h. p.m.

The Committee for the Study of Clouds was constituted in the following manner:—

Messrs. Hildebrandsson, President; Lancaster, Riggenbach, Rotch, Rykatcheff, Angot, Jaubert, Teisserenc de Bort, Thévenet.

This Committee was appointed to meet on Friday, 18th, September, at 3h. p.m.

Dr. NEUMAYER—(Question 38. The simplification of meteorological telegrams.)—urged the importance of the simplification of meteorological telegrams, and gave a summary account of the proposals which he had had printed and distributed. (App. IV., p. 54.)

After some remarks by Messrs. RYKATCHEFF and BILLWILLER, the following Committee was nominated for the study of this question:—

Messrs. Billwiller, Erk, Fron, Neumayer, Rykatcheff, Scott, Snellen, Tacchini.

This Committee was appointed to meet on Thursday, 17th September, at 3h. p.m.

With reference to the study of aerostatic meteorology, Dr. VON BEZOLD dwelt upon the interest that would be attached to balloon ascents carried out to great heights and made simultaneously in different countries.

The discussion of this question was fixed to be resumed at the General Meeting on Friday.

The Conference then proceeded with the discussion of the first question of the Programme (Question 48 of the Munich Conference):—

Question 48:—

"As the climatic conditions and established practices of different countries render absolute uniformity in the

modes of observation unattainable, is it not desirable that at one or more stations in each country duplicate observations be made and published *in extenso*, one set being made on the system adopted in the country, and one set on an international system to be fixed rigidly by the Congress?" (Mr. Symons.)

The question was briefly discussed, and the following resolution was adopted :—

"The Conference refers the subject of the establishment of double stations, with observations on the local and the international scheme, to a future Conference for discussion, and requests Mr. Symons to be so good as to define his proposal more accurately, and give fuller details."

In reply to this request, Mr. Symons has prepared the following note :—

"In the first place, it will be well to state what led me to make the suggestion. In July 1868 the heat was excessive. I collected returns from a considerable number of stations, but found that it was impossible to determine the geographical distribution of the high temperature, because the exposure of the thermometers differed, and thus introduced a disturbing element. I then decided that I would find an open field, have constructed specimens of all the patterns of stand known to me, mount verified thermometers on each, and have them carefully recorded. Thanks chiefly to the help of the late Rev. C. H. Griffith, and to a small grant from the Royal Society, we were able to carry out the Strathfield Turgiss thermometer experiments, a general idea of which is given in the engraving annexed to the original paper, *vide* Symons's Monthly Meteorological Magazine, April 1869. The results were worked up by Mr. F. Gaster, F.R.Met.Soc., and are given in the Quarterly Report of the Meteorological Office for 1879.

"That was nearly 30 years ago. Twenty years later, in 1886-87, a similar and useful comparison was carried out, by Dr. Gross, in an experimental field near Berlin, in which the French, Russian, German, and English patterns were compared. The results were discussed by Dr. Sprung in the Abhandl. des K. Preussischen Met. Inst. Band I.

"In several of the recent Congresses extreme precision in the accuracy of meteorological instruments has been desired. It appeared to me to be a necessary corollary that the instruments be so exposed that equal accuracy be obtained thereby. As uniformity of exposure seems unattainable, I thought that Congress might accept some one form as international, and might desire that in each country, at one station, the thermometric record should be kept *in duplicate*, one record on the international system, and one on that used at all other stations in the country.

"As it may be difficult to recognise any one plan as international, I should be glad to be permitted to modify my suggestion as follows :—

"That in each country the Director be requested to select some one station, and, in addition to its ordinary equipment, to have erected there two thermometer stands each of the exact dimensions and pattern employed by any other two countries, with max. and min. thermometers and hygrometer, and that the readings of the three sets be taken for two consecutive years, and be published *in extenso*."

Dr. VON BEZOLD proposed to compare everywhere the observations made in each country in the screen usually employed with those that would be furnished by the aspiration psychrometer of Dr. Assmann.

Professor TACCHINI asked Mr. Symons if it would not be sufficient to compare the screens employed in each country with one other screen, always using the same, and to specify this screen?

General RYKATCHEFF asked whether, in these comparisons, Assmann's psychrometer should be used with or without a screen?

M. ANGOT supported Dr. von Bezold's proposal. The most simple means of obtaining the inter-comparison of different screens would be to take observations simultaneously at a few stations with the usual screen, and with the aspiration psychrometer placed in the open air, without screen. This method, however, would have the drawback of not furnishing the maximum and minimum temperatures requested by Mr. Symons.

As to the publication of these comparisons, Dr. VON BEZOLD held that it would be sufficient to give the monthly means and the extreme values of the differences.

M. LANCASTER requested that a detailed description of all kinds of screens employed should be published.

Several members remarked that such a description, accompanied with illustrations, is generally contained in Meteorological Instructions.

Mr. WRAGGE (Queensland) drew attention to the interest which observations made in Tasmania, at the summit of Mount Wellington, would possess. This station is at the same altitude as Ben Nevis. The observations ought to be made in exactly the same manner as at Ben Nevis, and with similar instruments, and it would be necessary to publish hourly values.

Dr. NEUMAYER supported Mr. Wragge's proposal. He said that the situation of Mount Wellington was excellent; at Hobarton, on the seashore, not far distant, observations had been regularly made during the last 50 years.

After some remarks, the following proposal was unanimously adopted:—

"The Conference has heard Mr. Wragge's communication with great interest; it is of opinion that the station on Mount Wellington possesses a really scientific importance, and that it will be useful to publish *in extenso* the hourly observations made there."

Dr. SNELLEN inquired whether it would not be useful to appoint a special Committee to consider the different questions relating to instruments and methods of observations, especially those of solar radiation. This proposal was fixed to be discussed at a subsequent Meeting.

The next Meeting was fixed for Friday, 18th September, at 9h. 30m. a.m.

The sitting was closed at 11h. 50m. a.m.

Second Meeting, Friday, September 18th, 1896.

The President, M. MASCART, opened the Meeting at 9h. 30m.

Present:—Messrs. Angot, Anguiano, Baillaud, von Bezold, Biese, Billwiller, Chauveau, Dufour, Ellis, Erk, Fines, de Fonvielle, Fron, Hepites, Hergesell, Hildebrandsson, Jaubert, Kesslitz, Lancaster, Mascart, Mathias, Mohn, Moureaux, Neumayer, Page, Paulsen, Riggenbach, van Rijckevorsel, Rotch, Rykatcheff, Schmidt, Scott, Snellen, Stupart, Symons, Tacchini, Teisserenc de Bort, Thévenet, Watzoff, Wragge.

The PRESIDENT announced to the Meeting the arrival of M. Mohn, and welcomed him.

The minutes of the General Meeting of September 17th were read and adopted, with some modifications.

The Report of the Committee on Meteorological Telegraphy (p. 25) was read and adopted.

The PRESIDENT announced that M. Moureaux would, on the afternoon of Sunday, hold himself in readiness at Parc St. Maur to receive any members of the Conference who might wish to visit that observatory. If any members wished to see the Bureau Météorologique, M. Angot would always be there to receive them at any hour at which the Conference was not actually sitting, and finally, the visit to the Eiffel Tower would take place on Tuesday, September 22nd.

The PRESIDENT announced further that Messrs. Hermite and Besançon would be ready in the afternoon of this day to receive any gentleman who wished to visit their aerostatical establishment. It was proposed that the start should be made from

the Rue de Rennes at 3h. 30m. In consequence, the Committee on Magnetism and Electricity would commence its Meeting at 2 o'clock, and the Meeting of the Cloud Committee would be postponed until Saturday, the 19th, at 2h. 30m. p.m.

Mr. WRAGGE handed in a paper containing 17 questions, on which he wished for a decision from the Conference.

The SECRETARY read the questions, and the PRESIDENT announced to the Conference that the 1st and 2nd questions had already been discussed at the previous Meeting. As to the others, some were of such a character that the Conference could not pass any resolution thereon which should not interfere with the free action of Governments. The others were all contained in the Programme of the Conference, a copy of which had been forwarded to Mr. Wragge, and they would come up for discussion in their turn.

Messrs. SYMONS, ANGOT, and TEISSERENC DE BORT, after a re-consideration of Question 48 of the Munich Conference, which had been discussed at the previous Meeting, proposed that at one station in each country there should be maintained simultaneously with the screen in local use, at least two of the following types of screens, Stevenson's, the French Screen, and Assmann's Aspiration Thermometer.

After a discussion, in which Messrs. Angot, von Bezold, Erk, Hildebrandsson, Lancaster, Rykatcheff, Teisserenc de Bort, and Thévenet took part, the Conference adopted the following resolution:—

"It is desirable that at least at one station in each country there should be employed simultaneously along with the ordinary screen, other arrangements such as Stevenson's Screen and the French Screen and at all events the Aspiration Thermometer of Dr. Assmann, large size, in its actual form (Fuess 1896). The comparisons should be carried on for two years, and if it was found impracticable to publish the observations *in extenso*, the means and extreme values should be given for each month.

"It is considered to be very important that in each country one uniform pattern of screen should be employed, and that a detailed description of it, with sketches and descriptive lettering, should be published, so that the screen could be reproduced exactly in any other place."

M. TEISSERENC DE BORT suggested that illustrations of the screens might be given in the Appendices to the Report of the present Meeting. (Appendix V., p. 59.)

Dr. BIESE requested the Conference to assist him in obtaining from his Government the establishment of a section for Maritime Meteorology in connexion with the Central Meteorological Institute at Helsingfors.

Mr. SCOTT read to the Meeting the resolution adopted 16th August 1872, at the Conference at Leipzig, on the importance of establishing such special sections in every country in which the interests of navigation justified such a measure.

Dr. BIESE requested the Conference to repeat the wish expressed in the resolution which had just been read.

On the proposition of M. MASCART "the Conference decided "that it must confine itself to the statement that it had "received with interest the communication made to it by "Dr. Biese as to the scheme for creating an office for maritime "meteorology at Helsingfors."

The Conference resumed the discussion of the questions of the Programme.

Agricultural Meteorology.

Question from the Munich Programme (p. 38) :—

"As it appears to be too late to consider the subjoined new question in this Conference, it should be imposed upon the International Committee which may be appointed, or else on a special Committee appointed for the purpose, to consider the subject of the proper method of extending meteorological observations and publications in the interest of agriculture, so that a report on the subject may be submitted to the next General Congress."

At Upsala the Committee announced that no report had been received on the subject, and it was referred to the next Conference.

Mr. SCOTT stated that the Weather Bureau of Washington had forwarded, for distribution to the members of the Conference, a number of very interesting notices, and of specimens of the bulletins of weather predictions for agricultural purposes in different parts of the United States.

Thanks were voted to Professor Willis L. Moore, Director of the Weather Bureau.

Question 1. Dr. PAUL SCHREIBER, Chemnitz :—

"The meteorological day should be reckoned from 9h. p.m. to 9h. p.m., and designated by the same number as the civil day, in which the greater part of the meteorological day falls. Meteorological extremes and sums, *e.g.*, of rain fallen, should be measured at 9h. p.m., the close of the meteorological day."

Mr. SCOTT reminded the Meeting that this question had been already decided at the Congress of Vienna (5th Meeting, September 10, 1873), and that the use of the civil day had been adopted. It seemed to him undesirable to depart from that decision.

Mr. SYMONS agreed with Mr. Scott, and held that the Conference ought not to begin to discuss questions formally settled at previous Meetings.

Question 2. Professor WATZOFF, Sophia :—

"Is it not desirable to recommend a method for the calculation of means from hourly readings ?

In Austria, Russia, and Prussia the formula used is—

$(1+2 \text{ - } \text{ - } \text{ - } +23+24) : 24$

At Zikawei, &c.—

$(0+1 \text{ - } \text{ - } \text{ - } +22+23) : 24$

At Chemnitz, in Belgium, and Bulgaria—

$(0+1 \text{ - } \text{ - } \text{ - } +23+24) : 25$"

Professor WATZOFF read a note, in which he showed the differences between the results according as each of the three formulæ was employed.

M. ANGOT remarked that it seemed to him to be difficult to adopt any of the three formulæ which were cited. The only exact formula deduced from the method of Quadratures is as follows :—

$$\left(\frac{0+24}{2}+1+2+ \text{ - } \text{ - } \text{ - } +23\right)=24.$$

That expression does not take longer to calculate than the others.

Mr. ELLIS remarked that the third of the formulæ quoted by Professor Watzoff had no significance. The first gave the mean for a day commencing at 0h. 30m., the second gave the mean for a day commencing at 23h. 30m.

Question 3. Professor WILLIS L. MOORE, Washington :—

"The solar magnetic period 26·67928 days as the natural mode of classifying solar, physical, and terrestrial meteorological phenomena. The desirability of its introduction for general use in the year 1901."

Dr. VON BEZOLD was of opinion that the question was not ripe enough to be actually discussed, and proposed that it should be referred to a subsequent Conference.

This proposition was adopted.

Question 4. Dr. P. SCHREIBER, Chemnitz.

"Classification of days of rain :—

"1. Every day on which measurable precipitation occurs is a day of rain.

"2. Such days are subdivided according to the occurrence of any of the following :—Rain, snow, hail, fog, dew, hoar-frost, silver thaw, glazed frost.

"3. It seems unnecessary to fix any inferior limit for precipitation."

Mr. SCOTT proposed to abide by the decisions on this subject which had been taken at the Congress of Vienna (September 12, 1873), and at the Conference of Munich (August 29, 1891).

"It is proposed to give in the résumés the number of days on " which, at least, 0·1 mm., and, if possible, those also on which " 1 mm. is collected, independently of other limits which may " have been introduced in individual systems." Report, Munich, p. 13.

This decision was adopted.

Question 5. Mr. A. L. ROTCH :—

"The definition of thunderstorms, &c."

Mr. ROTCH read a note on this question, but at the suggestion of Dr. Snellen the Conference decided to appoint a Committee which should discuss all the questions relating to instruments and methods of observation. These questions bear in the Programme the following numbers :—5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17, and 18. The Committee entrusted with the discussion of these questions was nominated as follows :—

Messrs. Tacchini, President; Angot, von Bezold, Billwiller, Fines, Hergesell, Lancaster, Mohn, Rotch, Rykatcheff, Scott, Snellen, Teisserenc de Bort, Thévenet. It was appointed to meet on the following day, Saturday, September 19th, at 9h. 30m. a.m.

Accordingly the Third General Meeting was fixed for Monday, September 21st, at 9h. 30m. a.m.

The Meeting terminated at 11h. 40m.

Third Meeting, Monday, September 21st, 1896.

M. MASCART opened the Meeting at 9h. 30m.

Present : Messrs. Angot, Anguiano, von Bezold, Biese, Billwiller, Chauveau Dufour, Ellis, Erk, Fines, Fron, Hepites, Hergesell, Hildebrandsson, Jaubert, Kesslitz, Lancaster, Mascart, Mathias, Mohn, Moureaux, Page, Paulsen, Riggenbach, van Rijckevorsel, Rotch, Rücker, Rykatcheff, Schmidt, Scott, Snellen, Stupart, Symons, Tacchini, Teisserenc de Bort, Thévenet, Watzoff, Wragge.

The PRESIDENT announced to the Meeting the arrival of Professor Rücker, and welcomed him.

The minutes of the General Meeting of the 18th instant, of the Meeting of the Committee for Magnetism and Electricity of the 18th (p. 27), and also of those of the Committees for Instruments and Methods of Observation (p. 38), and for Clouds (p. 43), of the 19th, were read and adopted, with some modifications.

Question 19. Dr. P. SCHREIBER, Chemnitz :—

"The development and amplification of observations on Sea Temperature, &c. over the North Atlantic Ocean."

The Conference was of opinion that it was not necessary to formulate any resolution on this question, the importance of the development of meteorological observations over the entire surface of the sea not admitting of a doubt.

Mr. WRAGGE urged on the Conference the great importance which would be attached to an expression of opinion on the part of the Conference as to the utility of maintaining meteorological stations in Tasmania and the regions adjacent.

After some discussion M. MASCART said that the Conference could not but repeat, conformably to the declarations of the previous International Meetings, that great interest attaches to the multiplication of observations of every character in all parts of the world, and to the publication of the results.

Professor TACCHINI proposed the following resolution :—

"That the Conference has heard with great interest the proposals of Mr. WRAGGE with reference to Tasmania."

Approved.

Question 40 :—

"The establishment of meteorological stations in the regions of the great centres of atmospheric action."

Dr. HILDEBRANDSSON re ad a note (Appendix VI., p. 64) on the utility of establishing stations of observation around the great centres of action of the atmosphere.

On the proposition of M. MASCART the following resolution was adopted :—

"The Conference appreciates to its full extent the scientific value of the remarks made by Dr. Hildebrandsson, and hoped to be able to find means to carry out the wishes which he has expressed."

Mr. WRAGGE called on the Conference to express its opinion as to the possibility of predicting weather in Australia several months in advance.

The Conference declared that it could only confine itself to the statement that, in the meteorological services of Europe and North America it has not yet been found possible, in a general way, to extend the forecasts to more than one or two days.

Question 22. Dr. SNELLEN, of Utrecht :—

"The introduction of telemeteorographs."

Dr. SNELLEN read a note, *Meteorologische Zeitchrift*, vol. XIII., p. 365, on the employment of the telemeteorograph made by Olland, of Utrecht. The instrument is working at present in a satisfactory manner between Utrecht and Flushing.

In his opinion it was desirable to extend the employment of this apparatus

M. LANCASTER reminded the Conference, that about 20 years ago a telemeteorographic system (van Rysselberghe's) had been established in Belgium, and had remained in regular action between Ostend and Brussels for about two years. The continuous employment of the apparatus could not be maintained for a longer interval, owing to the great cost of maintenance of the telegraphic line.

Question 23. Rev. Father FAURA, S.J., Manilla :—

"The time seems to have arrived to settle the question of air motion in cyclones, and to finally disprove the theory of descending currents in these phenomena."

Question 24. Rev. Father FAURA, S.J., Manilla :—

"The time has perhaps arrived for assigning an origin for cyclones and tornadoes."

Question 25. Rev. Father FAURA, S.J., Manilla :—

"It would be very convenient to institute international investigations into the distribution of meteorological elements around the cyclonic centres."

Question 26. Professor WILLIS L. MOORE, Washington :—

"The best means of separating the cyclonic components from the general wind velocities of the upper air."

With reference to the above questions M. MASCART communicated to the Conference a letter which he had received from M. MALTEZOS, of Athens.

The Conference was of opinion that it could not formulate any opinion on Questions 23 and 24. Their character was such that the Conference is not competent to discuss them.

The extension of the observations indicated in Question 25 is evidently desirable. Finally, as to the Question 26, on which a note by Mr. Bigelow, published by the Weather Bureau, had been received, the question was purely theoretical, and there was no possibility of the Conference taking any decision in regard to it.

Question 36. Dr. PAUL SCHREIBER, Chemnitz :—

"The organisation of the future International Committee to be appointed by the Paris Conference."

Mr. SCOTT read a letter from Dr. Schreiber, in which he stated his views on the question.

The discussion of the subjects was postponed until the next Meeting, but after some remarks by M. Mascart, the Conference decided that it was desirable that the International Committee should preserve a semi-official character, and should hold to the organisation which had been adopted at the Conference at Munich.

Question 37 :—

"The distribution of floating ice in the North Atlantic."

Dr. PAULSEN submitted to the Conference monthly charts, showing the distribution of floating ice in the North Atlantic, north of 60° N. These charts embrace the coasts of Greenland and Iceland, and the sea between Greenland and Spitsbergen. For Davis Strait and the sea about Iceland, they are based on the observations of Danish ships, for the other parts the observations have been obtained from Norwegian whalers. These charts are not yet complete, but Dr. Paulsen is of opinion that they would have a great importance for meteorology if they could be continued and completed.

Messrs. MOHN and HILDEBRANDSSON pointed out the relations which existed between the position of the ice and certain other phenomena, such as barometrical pressure in Norway, temperature on the coasts, dates of freezing of lakes in Sweden, &c.

Mr. SCOTT inquired if the inquiry was not of the same character as those of Messrs. Petterson and Cleve into the temperature and salinity of the sea, and the types of microscopic creatures (Plankton) to be found in the sea water. *Meteorologische Zeitschrift*, vol. XIII., p. 285.

Dr. VON BEZOLD inquired if the Pilot Charts published monthly by the Hydrographic Office, Washington, did not contain a part of the information required by Dr. Paulsen.

Mr. PAGE observed that while the Pilot Charts extended to 60° N., the entries of ice on them were not carried beyond 52° N.

Dr. PAULSEN requested that the different Meteorological Institutes would co-operate with his work, and supply him with observations.

The following resolution was adopted :—

"The Conference recognizes the high scientific value of the work which Dr. Paulsen has undertaken. It expresses the wish that the institutes which have any relation with seamen navigating in high latitudes north of 60° will communicate to Dr. Paulsen any observations which may have reached them."

Dr. BILLWILLER, on the part of Dr. HANN, submitted the following proposal :—

Question 39 :—

"The Directors of the Meteorological Services in different countries are requested to publish in their annals a list of all publications relating to Meteorology or Terrestrial Magnetism which may have appeared in their country." (M. Hann.)

This proposal was adopted.

Mr. WRAGGE read a note on the actual state of the Meteorological Service of Queensland. (Appendix VII., p. 68.)

The Conference thanked Mr. Wragge for his communication.

Dr. SNELLEN submitted a question with reference to Maritime Meteorology.

The discussion of this was remitted to the next Meeting.

The PRESIDENT announced that the Second Meeting of the Committee for Magnetism and Electricity would take place that afternoon, at 2h. 30m.; the Second Meeting of the Committee for Instruments and Methods of Observation would take place on Tuesday morning, at 9h. 30m.; and the Fourth General Meeting would take place on Tuesday, September 22nd, at 3h. 30m.

M. TEISSERENC DE BORT requested the members of the Conference who were interested in cloud observation to visit, that very afternoon, the observatory he had established for that object at Trappes. The start for Trappes, at Mont Parnasse Station (Chartres Line), would be at 4h. p.m.

The Meeting was closed at noon.

Fourth Meeting, Tuesday, September 22nd, 1896.

The President, M. MASCART, opened the Meeting at 4h. 30m.

Present: Messrs. Angot, Anguiano, von Bezold, Biese, Billwiller, Chauveau, Ellis, Erk, Fines, de Fonvielle, Fron, Hepites, Hergesell, Hildebrandsson, Jaubert, Kesslitz, Lancaster, Mascart, Mathias, Mohn, Moureaux, Page, Paulsen, Riggenbach, van Rijckevorsel, Rotch, Rücker, Rykatcheff, Schmidt, Scott, Snellen, Stupart, Symons, Tacchini, Teisserenc de Bort, Thévenet, Watzoff, Wragge.

The minutes of the General Meeting of September 21st were read and adopted.

The discussion of Question 35, the nomination of the International Committee, was resumed.

Mr. SYMONS said that it appeared to him that the Conference should express its thanks to the Committee appointed at Munich for the manner in which it had discharged its functions.

This proposal was unanimously adopted.

Mr. SYMONS then proposed that the new International Committee should be constituted in the same way as its predecessor, and should discharge the same functions. If no person raised any objection, he considered that the simplest way to avoid the process of voting, which always takes up time, would be to re-elect by acclamation all the members of the old Committee elected at Munich, with the exception of three modifications, rendered necessary by resignations, &c. Mr. Ellery (Melbourne) was to be replaced by Mr. H. C. Russell (Sydney); Mr. Harrington by Mr. Willis Moore, his successor as Director of the Weather Bureau, Washington; and, finally, Dr. Wild was to be replaced by General Rykatcheff, his successor in the Directorship of the Central Physical Observatory of St. Petersburg.

As no person demanded a vote the proposal made by Mr. Symons was adopted by acclamation and unanimously. Consequently the International Meteorological Committee is constituted as follows:—

Messrs. von Bezold (Germany).	Messrs. Mohn (Norway).
Billwiller (Switzerland).	Moore (United States).
de Brito Capello (Portugal).	Paulsen (Denmark).
Davis (Argentine Republic).	Russell (New South Wales).
Eliot (India).	
Hann (Austria).	Rykatcheff (Russia).
Hepites (Roumania).	Scott (England).
Hildebrandsson (Sweden).	Snellen (Holland).
Mascart (France).	Tacchini (Italy).

M. HILDEBRANDSSON requested the Conference to decide that the International Committee had the right of filling up directly any place which might be left vacant owing to any circumstances.

M. MASCART supported Dr. Hildebrandsson's proposal. This faculty did not exist for the previous Committee, and it seemed to be necessary for the conduct of business, for when the President had sent in his resignation his place could not be filled up, in the absence of any Meeting of the Committee, and Mr. SCOTT, the Secretary, had therefore been obliged to assume all the responsibility and to do all the work. In order to define exactly the proposal, it should be understood that if any modifications in the constitution of the officers of the Committee became necessary these should be carried out, not by correspondence, but by a Meeting of the Committee.

The proposals of Messrs. Hildebrandsson and Mascart were put to the vote and adopted.

Mr. SCOTT submitted two new proposals from Mr. Wragge. The first concerned the establishment of an observatory on the top of Mount Kosciusko, in the south-eastern extremity of Australia, at the height of about 8,000 feet. The Conference decided that the name of the station of Mount Kosciusko shall be added to that of Mount Wellington in the resolution adopted at the First Meeting (p. 10).

In his second proposal Mr. Wragge demanded that the Conference should express its opinion as to the necessity of securing observations from the Antarctic regions, in order to be

able to frame forecasts for Australia for a long period in advance.

After some observations from Messrs. Hildebrandsson, Angot, and Rykatcheff, and on the proposal of Dr. Hildebrandsson, the Conference declared that it recognised the value of Mr. Wragge's work, and, further, that it was evident that observations from the Antarctic regions would possess very high scientific value, but it held that it could not pronounce any opinion on the importance which such observations might have on weather forecasting for Australia, especially not for forecasts of long duration.

It was announced that the last Meeting of the Committee for Magnetism and Electricity would be held next morning, Wednesday, at 9h. 30m., and that the final General Meeting would take place on the same day, at 3h. p.m.

The Meeting was closed at 5h. 40m.

Fifth Meeting, Wednesday, September 23rd, 1896.

The President, M. MASCART, opened the Meeting at 3h. 30m.

Present: Messrs. Angot, Anguiano, von Bezold, Biese, Billwiller, Chauveau, Ellis, Erk, Fines, de Fonvielle, Fron, Hepites, Hergesell, Hildebrandsson, Jaubert, Kesslitz, Lancaster, Mascart, Mathias, Mohn, Moureaux, Page, Paulsen, Riggenbach, van Rijckevorsel, Rotch, Rücker, Rykatcheff, Schmidt, Scott, Snellen, Stupart, Symons, Tacchini, Teisserenc de Bort, Thévenet, Watzoff, Wragge.

The minutes of the Fourth General Meeting (September 22nd), of the Committee for Instruments and Methods of Observation (September 22nd), p. 41, and of the two Meetings of the Committee for Magnetism and Electricity, pp. 29 and 34 (September 21 and 23) were read and adopted, with some modifications.

A Special Meeting of the members of the Conference who take a special interest in aeronautical observations, consisting of Messrs. von Bezold, Erk, de Fonvielle, Hergesell, Jaubert, Rotch, and Teisserenc de Bort, reported that they had met, and proposed the following resolutions:—

"1. The Conference recognises the great importance for the Science of Meteorology, of aeronautical observations, and expresses a wish that balloon ascents should be encouraged and multiplied.

"2. The Conference expresses the wish that aeronautical experiments, either with ordinary or with unmanned balloons, should be made simultaneously at different stations.

"3. In the actual state of the question, the Conference is unable to recommend special methods or to specify

instruments, but it expresses the wish that in the case of simultaneous ascents of unmanned balloons the patterns of instruments employed should be as far as possible identical.

"4. It is of the highest importance that the actual observations should be published as quickly as possible, especially in the case of simultaneous ascents.

"5. It is desirable that observations in unmanned balloons should be conducted in a regular manner.

"6. In consideration of the satisfactory results which have been obtained at Blue Hill by the use of kites, carrying self-registering instruments, to the height of 2,000 metres, it is very desirable that similar experiments should be carried on elsewhere." After these resolutions had been read Dr. Hergesell made some explanatory remarks.

With reference to the last question, M. MASCART requested that Mr. Rotch would kindly supply for the Appendices a sketch, with descriptions, of the kites which he had employed. (Appendix VIII., p. 68.)

Mr. SYMONS requested that the altitudes in balloon ascents should be determined by trigonometrical observations as frequently as circumstances would admit.

General RYKATCHEFF remarked that it was very desirable that mercurial barometers should be employed on balloon ascents.

Dr. SCHMIDT drew attention to the variations of gravity caused by the acceleration of the balloon, which would exercise some influence on the mercurial barometer.

M. DE FONVIELLE was of opinion that it would be very difficult to employ a mercurial barometer in a balloon.

After some further remarks the six proposals relating to aeronautical experiments, which have been cited above, were adopted.

The Conference instructed the International Committee to appoint a Special Committee for questions relating to aerostation.

Dr. SNELLEN observed that it was very difficult to deal with questions relating to Maritime Meteorology at a full Meeting of the Conference, and requested that these questions should be referred to a Special Committee.

General RYKATCHEFF supported Dr. Snellen's proposal. After some conversation the following resolution was adopted:—

"The Conference requests the International Committee to convene a Meeting of the Directors of the different offices which deal with Ocean Meteorology, in order to establish uniformity in the methods of observation and of publication. It hopes that a report on the subject may be prepared for the next Conference."

Some remarks on the subject of maritime meteorology, by Dr. Neumayer, will be found at Appendix XV., p. 78.

Professor MOHN reported that Dr. Nansen had secured, between the latitudes of 81° and 86° N., three complete years of observations made every four hours, and, in addition, a continuous register of temperature and pressure, as well as observations in magnetism, hydrography, &c. Professor MOHN undertook to use his best endeavours to reduce and publish all these observations on the systems adopted by the various International Congresses and Conferences.

The Conference, on the motion of General RYKATCHEFF, expressed its entire admiration for the remarkable results which Dr. Nansen had been able to accomplish, and its thanks to Professor Mohn for his readiness to secure their publication.

Dr. HILDEBRANDSSON handed to the Secretary a copy of the *Atlas International des Nuages*, published in accordance with a resolution of the Committee by Messrs. Hildebrandsson, Riggenbach, and Teisserenc de Bort.

The PRESIDENT expressed to Messrs. Hildebrandsson, Riggenbach, and Teisserenc de Bort the hearty thanks of the Conference for this work, which they had so rapidly brought to a satisfactory conclusion.

M. MASCART remarked that at Munich in 1891 (Meeting of September 2), p. 46, it had been decided that a Conference should be reassembled at the expiration of five years, and inquired if the Conference wished now to adopt a similar resolution as to the date of the next Meeting.

The Conference adopted the same interval, and decided that the next Meeting should take place in 1901.

Dr. VON BEZOLD proposed that the selection of the place of Meeting be left to the International Committee. This proposal was adopted.

Dr. VON KONKOLY, who had been obliged to leave Paris, had written a letter to the President, in which he proposed that a Meeting of the Conference, or of the International Committee should take place at Buda-Pesth, where the members would be sure of a most cordial reception.

Messrs. TACCHINI and RYKATCHEFF declared that they would be much pleased respectively if the place of meeting were Catania or St. Petersburg.

General RYKATCHEFF read the following communication:—

"The Minister of Public Instruction has has had the kindness to honour us with his company at the *déjeuner* given by M. Mascart to the Meteorological Conference on the Eiffel Tower.

"His eloquent speech has established two facts of importance."

1. That meteorology and the prediction of weather render actual services to the public.
2. That the Government appreciates our labours.

"This speech is encouraging not only for the meteorologists of France but for those of all countries, for it is perfectly true, as the Minister remarked, that meteorology is not specially either French, German, Russian, or English, the science is the same for all the countries of the civilized world.

"I think, therefore, that I may express the sentiments of my foreign colleagues by proposing our thanks to the Minister of Public Instruction for the interest which he has evinced in our science, and particularly for the kindly attention which he has paid to the Conference."

This proposal was adopted unanimously.

M. MASCART stated that he would do himself the honour of conveying this resolution to the Minister of Public Instruction.

M. MASCART further announced that the International Committee had been pleased to entrust the functions of its President to him, and had requested Mr. Scott to retain his post as its Secretary.

The French edition of the report of the present Conference would be published and distributed as soon as possible, Mr. Scott had undertaken the English and Dr. von Bezold the German edition, with the reservation to himself of the rights of giving only an abstract of the more lengthy appendices.

He further reported that the International Committee had nominated the several Committees as follows:—

Committee for Magnetism and Atmospheric Electricity.—Messrs. Rücker, President; Eschenhagen, Liznar, Moureaux, Palazzo, Paulsen, van Rijckevorsel, Rykatcheff.

Committee for Aeronautical Questions.—Messrs. Hergesell, President; Assmann, Erk, de Fonvielle, Hermite, Jaubert, Pomortzeff, Rotch.

Committee for Radiation and Insolation.—Messrs. Violle, President; Angström, Chistoni, Chwolson, Snellen, Stupart, Tacchini.

Committee for Cloud Observations.—Messrs. Hildebrandsson, President; Mohn, Riggenbach, Rotch, Rykatcheff, Sprung, Teisserenc de Bort.

All the Committees have the power of co-opting other members.

M. MASCART terminated the proceedings by expressing his thanks to the foreign meteorologists who had attended the meeting in Paris in so great numbers. Thanks to their assistance, the success of the Conference may be said to have been complete.

The Meetings had been numerous and regular. The discussions had presented features of great scientific interest, and important resolutions had been adopted. M. Mascart hoped that

the memory of this friendly Meeting would be such as to induce the majority of the members to revisit Paris at the time of the Universal Exhibition of 1900.

Professor TACCHINI requested his foreign colleagues to tender their warmest thanks to M. Mascart and the other French members for the reception which had been accorded to them.

The Conference requested M. Mascart to examine and sign the minutes of the actual Meeting, as it had been impossible to prepare that in time for submission to the Meeting.

The Meeting was terminated at 5h. p.m., and the Conference was declared closed.

Meeting of the Committee for the International Telegraphic Service, September 17th, 1896.

THE COMMITTEE met at 3h. p.m.

Present: Messrs. Billwiller, Erk, Fron, Kesslitz, Mascart, Neumayer, Rykatcheff, Scott, Snellen, Tacchini.

The Committee requested Dr. Tacchini to act as President and M. Fron as Secretary.

Question 21. Dr. SNELLEN, Utrecht:—

"The introduction of the circular system in the international meteorological telegraphy."

Dr. BILLWILLER explained the proposal, relative to the more rapid transmission of meteorological telegrams, which had been put forward by the offices of Hamburg and Utrecht. That exchange could be effected in Europe on the same plan as the circuit system adopted in America, if the Central Meteorological Offices could be placed in direct telegraphic communication with each other, and that the exchange of despatches could be made in an order fixed beforehand.

This proposal had been submitted to the International Telegraphic Congress at Buda-Pesth.

At that Meeting the delegate from Great Britain and successively those of France and Germany were of opinion—

"That it appeared to be impossible to comply with the proposal which had been submitted on account of the difficulty which it involved, in the service of transmission, of interrupting the course of the messages on lines which were fully occupied. The proposal is worthy of notice, without doubt, but at present, at least, it seems impossible to receive it favourably, and all that can be done is to take special note of it."

After some observations from Messrs. Tacchini, Neumayer, Mascart, and Snellen, the following resolution was adopted:—

"The Committee is of opinion that the best mode of improving the international meteorological relations between the different services would be to establish a system of circular despatches between the different offices at a determined hour. However, owing to the difficulty of carrying out such an organisation at present, it appears desirable that all the reports for each country should be collected at its central office in sufficient time that the international exchanges should take place before 11h. a.m., Greenwich time."

The Committee expressed its thanks to the Swiss Government for having taken care to interpret the wishes of meteorologists to the Congress at Buda-Pesth. It appeared to be very useful to make a trial of the circular service between adjacent countries.

The Committee examined various proposals which had been made as to changes in the form of the despatches, in order to reduce the number of groups.

Question 20. Dr. SCHREIBER:—

"The inclusion of hygrometrical information in the international scheme of telegraphy."

Question 38. Dr. NEUMAYER:—

"The simplification of meteorological telegrams." (Appendix IV., p. 56.)

It was pointed out that it was not the number of the groups which caused delay, and that great inconvenience would result if the form of the telegrams adopted by all nations were to be changed.

The hours of observation must also be left, for the present, to the convenience of the different States, but the Committee expressed its earnest desire that the arrival of the information in Paris should be accelerated as much as possible, especially it regretted seriously that the despatches from the Iberic Peninsula, which frequently are of the greatest importance, often arrived too late to be of any use.

In conclusion, with reference to publications, the Committee is of opinion that the study of meteorological phenomena over a large extent of the earth's surface demands the study of simultaneous observations, and it repeats its earlier recommendations, that in every country the hourly observations shall be published for a certain number of the principal stations.

The Committee finally expressed its wish that the central offices should publish regularly and speedily the monthly means of the observations made at the telegraphic stations.

The Meeting was closed at 4h. 30m.

Committee for Terrestial Magnetism and Atmospheric Electricity, September 18th, 1896.

THE COMMITTEE met at 2h. p.m. under the presidency of Dr. von Bezold.

Present: Messrs. Biese, Billwiller, Chauveau, Dufour, Ellis, Erk, Fines, Hepites, Hergesell, Kesslitz, von Konkoly, Mascart, Mathias, Moureaux, Neumayer, Paulsen, Riggenbach, van Rijckevorsel, Rykatcheff, Schmidt, Snellen, Tacchini.

The Committee selected M. Moureaux as Secretary.

Question 28. M. MASCART:—

"Terrestrial magnetism."

The PRESIDENT proposed to allow Dr. Neumayer to make the first remarks, as that gentleman was obliged to leave Paris very soon.

Dr. NEUMAYER said that for the last 10 years he had been occupied with the work of collecting magnetical observations all over the globe. The discussion of the old observations had presented great difficulties, and frequently some discordances had appeared. The abundance of materials which he had been able to get together had enabled him to prepare the Magnetic Charts of the Globe for January 1885, which had appeared in Berghaus' Atlas. During the last 10 years the study of magnetic phenomena had been greatly developed, and also great improvements had been effected in methods of observation and in apparatus.

Dr. NEUMAYER cited in particular the work done in England by Messrs. Rücker and Thorpe, and in France by M. Moureaux, and expressed the hope that such surveys should be carried out generally in the different countries of the globe. He exhibited a map on which he had coloured all the countries in which the distribution of the magnetic elements had been determined, by recent observations, with sufficient accuracy. This map is instructive, it shows how much remains to be done, both on land and at sea, before our knowledge of magnetic phenomena is sufficiently exact. Dr. Neumayer thought that the authority of the International Conference would be such that it might exert a healthy influence on the development of magnetic investigations in all countries.

M. MASCART supported Dr. Neumayer's proposal, and pointed out its importance. The regularity of the distribution of the magnetic elements over the globe had long been recognised, but that regularity was frequently contradicted by observations. The naval expeditions sent out by France last year had not completely carried out the programme of their investigations.

There was reason to hope that similar expeditions might again be undertaken and that these would furnish the materials which were required for the preparation of new magnetic charts of the globe.

Dr. VON BEZOLD said that Prussia would be surveyed magnetically in the course of the coming year.

Professor TACCHINI said that the survey of Italy had been commenced 13 years ago, and that its completion in two or three years might be hoped for.

Dr. VON RIJCKEVORSEL announced that he had recently published a complete magnetical investigation of Holland.

M. MASCART said that it should be remembered that the reduction of observations made in the field, to one epoch, supposed that the observations could be compared with the simultaneous indications of a magnetograph located in the country surveyed. The distance between such a magnetograph and the place of observation may be considerable, since the curves for Parc St. Maur and Perpignan, when superposed, might really be taken as copies of one original.

Dr. VAN RIJCKEVORSEL stated that in order to correct the observations he had taken on the Rigi, with M. van Bemmelen, in the course of 1895 and 1896, he had obtained copies of the magnetograms taken at Utrecht, Potsdam, Parc St. Maur, and Perpignan. The intercomparison of these curves had shown that the error would have been very slight if he had employed one only of these four sets of curves.

M. MOUREAUX said that he had compared the curves of perturbations observed at Parc St. Maur with those of Greenwich and Potsdam, and also with those which he had obtained from the magnetograph established at Kursk, when he was carrying out in the spring of this year his magnetic tour in the neighbourhood of that city, under the auspices of the Imperial Geographical Society of Russia. All these curves had a general resemblance in their broad features, but there were sometimes differences in details. Dr. Wild had also pointed out that the commencement of the great perturbation of February 13–14, 1892, had manifested in all three elements, deviations in different directions at Parc St. Maur and at Pavlowsk. The irregular oscillations of the magnets thus became modified at great distances, as had been shown by curves taken in America. The law of these modifications was absolutely unknown. M. Moureaux thought that the regular interchange of disturbance curves, between the different magnetic observatories over the globe, might possibly throw some light on the point.

M. MASCART was of opinion that attention should now be drawn, as Dr. Neumayer had done already in 1882, to the fact that Gauss's theory was insufficient to represent magnetic phenomena. If the magnetic condition of the globe for any

given instant could be defined by a potential, the curves normal to the magnetic meridians ought to be closed. The graphic reproduction of these curves suffices to show that they do not terminate at their origins. A portion of the phenomena must therefore, in all probability, be due to electrical currents between the atmosphere and the earth.

M. MOUREAUX exhibited the apparatus which he had employed for his magnetic observations in France, the survey of which, comprising 640 stations, had been completed in the year 1895. The field outfit consisted of a declination theodolite which could be used at will to measure the declination and the horizontal component, and a dip circle. He gave a description of the apparatus and explained the methods which he had employed in field observations. He pointed out the advantages offered by small instruments, under the conditions that certain previous precautions were observed.

On the proposal of the President, the Committee decided that the communication made by M. Moureaux should be printed in the appendices. (Appendix IX., p. 70.)

The Meeting closed at 3h. 30m.

Second Meeting, September 21st, 1896.

THE MEETING was opened at 2h. 30m. under the Presidency of Dr. von Bezold.

Present: Messrs. Biese, Billwiller, Chauveau, Dufour, Ellis, Fines, Kesslitz, Mascart, Mathias, Mohn, Moureaux, Paulsen, Riggenbach, van Rijckevorsel, Rücker, Rykatcheff, Schmidt, Snellen, Tacchini, Thévenet.

Dr. VON BEZOLD, finding himself obliged to take part in the discussion of several points of the Programme, requested the Committee to appoint a Vice-President. He proposed the name of Professor Rücker for that office. Professor Rücker was elected and took the chair.

The Committee then proceeded to discuss the questions of the Programme.

Question 29. Professor von BEZOLD, Berlin, and Professor ESCHENHAGEN, Potsdam :—

"General principles should be introduced for the publication of magnetic observations :—

"*a*. The values obtained should be given for the different observing hours in absolute measure, freed from the variations of the zero of the scale (base value) and of temperature."

Adopted.

M. MASCART reported that Dr. Wild, in a letter addressed to Mr. Scott, had stated that it was very important to give, in the introductions to publications, a table of the absolute measures made for the control of the variation apparatus.

"*b.* It should be stated accurately in what way the scale readings have been converted to absolute measure, and to what extent the temperature has been taken into consideration."

Adopted.

"*c.* It is desirable that for each day the values should be given for each complete hour."

This paragraph was adopted in the following terms:—

"It is desirable that, for each day, the values should be published for the commencement of each hour (local time)."

"*d.* The same notation should be employed in all countries—

H for horizontal force.
X „ the northern component.
Y „ the *western* component.
Z „ the vertical force.
V „ the potential."

M. MASCART reported that M. Bauer had written to him proposing that the vertical component should be designated by V. As this letter had been everywhere, and for a long time, used to designate the potential, the Committee considered that it was advisable to keep to the letters employed by most authors, according to Gauss's notation.

Dr. VON BEZOLD explained the reasons which existed for maintaining the uniformity of that notation, and proposed to adopt it with one exception, viz., that the letter Y should indicate the *eastern* component.

The paragraph *d.* was adopted with that modification.

"The declination shall be indicated by the letter D. The direction west or east of magnetic north in relation to the geographical north should also be stated."

M. DUFOUR demanded that the different elements should be always indicated by the letters given above, that is to say, by Roman capitals.

"*e.* In calculating monthly means all days are to be taken into consideration. It is left open to each Director to give, in addition, means calculated without taking disturbed days into account."

Professor RÜCKER observed that at the four magnetic observatories in England, the means of the different elements were calculated for five calm days in each month, the dates being

selected by the Astronomer Royal, at Greenwich. In order to secure uniformity, dates might be fixed and communicated to all observatories by the International Committee. Professor RÜCKER requested, also, that the publication of the means of the calm days should be obligatory, while that of the means of all the days of the month should be optional.

Dr. SNELLEN reminded the Committee that Dr. van der Stok, of Batavia, had indicated a scientific method for distinguishing calm days from disturbed days.

After a discussion in which Messrs. RÜCKER, VON BEZOLD, MASCART, VAN RIJCKEVORSEL, FINES, MOUREAUX, TACCHINI, and RYKATCHEFF took part, the Committee, on the proposal of Messrs. VON BEZOLD and MASCART, decided to refer the question to a Special Committee, which should determine how, in the calculation of monthly means, account could be taken of the perturbations.

f. It is very desirable that for the monthly means there should be calculated and published at least the values of the components X, Y, Z, and also, for the monthly means of the separate observation hours, the differences of the components Δ X, Δ Y, Δ Z, from the mean of the month."

Dr. VON BEZOLD remarked on the importance of these data for the discussion of the distribution of terrestrial magnetism, of the secular variation, and of perturbations. The knowledge of them would permit us to verify the theory of the potential. He exhibited a planisphere on which he had represented the diurnal variation of the magnetic force for the summer months, according to the data given by M. Arthur Schuster. They present great interest at the parallels of 40° N. and 40° S., and these correspond very closely to a change in the general circulation of the atmosphere. It would appear that there may be some relation between the two different classes of phenomena.

General RYKATCHEFF fully appreciated the importance of the data of which the publication was demanded, but he observed that the tables Δ X, Δ Y, Δ Z required long calculations, and that very few observatories could undertake such work.

Professor RÜCKER said that calculations might be limited to the opposite months of January and July.

M. MASCART proposed the following resolution:—

"It is desirable to publish the monthly means of the components X, Y, Z, and, at least, for the months of January and July, the differences Δ X, Δ Y, Δ Z of the hourly means from the preceding means."

The study of the question was referred to the Committee above mentioned.

Question 31. Messrs. VON BEZOLD and ESCHENHAGEN :—

"*a.* The distribution of observatories over the globe should be discussed."

Dr. VON BEZOLD exhibited a map of the distribution of magnetic observatories over the globe. Inspection of that map shows how unequal and insufficient that distribution is, and indicates how necessary it is to study magnetic variations at a certain number of new points, especially in the regions of which mention was made in the discussion of paragraph *f.*, Question 29.

General RYKATCHEFF said good results would be attained if a number of temporary magnetic observatories were established to work for three or four years only, and he made the following proposition :—

"It is desirable, for the progress of terrestrial magnetism, that temporary observations should be installed in certain localities, especially in tropical countries."

The examination of that question was referred to the Committee above mentioned, which was requested to point out the spots where these temporary observatories should be established.

"*b.* It is desirable that all institutes which publish magnetic charts should give additional tables containing the magnetic elements, and, if possible, also the components for convenient points of intersection of the geographical co-ordinates.

"It is equally to be desired that the data on which these charts have been constructed should be published in the fullest detail possible."

Some discussion arose on this, and the following resolution was proposed by M. MASCART and adopted :—

"It is desirable that the publication of magnetic charts should be accompanied by tables of the elements, derived from observation and calculation which have been employed in the construction of the charts"

Question 30. Messrs. VON BEZOLD and ESCHENHAGEN :—

"General principles should be laid down for magnetic surveys :—

"*a.* The density of the system (*i.e.*, the closeness of the stations *inter se*)."

Dr. VAN RIJCKEVORSEL thought it was not possible to lay down fixed rules for this distribution. The number of stations, over a definite area, must necessarily have relation to the greater or less regularity of distribution of the elements over that area.

Dr. VON BEZOLD read an extract from a note from Dr. Eschenhagen, who recommended the following classification,

proposed by Dr. Neumayer, the surveys should be termed as of the *first*, *second*, or *third* order, according as the distances between the stations were respectively 40, 18, or 12 kilometres.

Professor RÜCKER was disposed to distinguish two classes of surveys; a fundamental survey, in which the stations should be about 50 kilometres apart, and a local survey, for which it is impossible to lay down any rule.

"*b.* The elimination of variations by means of the observations at the base stations."

This was adopted.

"*c.* The reduction of the observations to a definite epoch."

Dr. VAN RIJCKEVORSEL proposed that the elements for January 1, the date which is generally used, should be deduced from observations extending over a long period. At Parc St. Maur the elements for January 1 are deduced from the mean of the hourly observations of December and January. Dr. van Rijckevorsel would prefer that the period should be even longer than that.

"*d.* The comparison of the instruments employed in the different surveys."

Dr. VAN RIJCKEVORSEL gave an account of the differences which he had observed between three dip circles of the same pattern, and fitted with needles of the same length.

Professor RÜCKER stated that he also had observed differences in the indications of different dip circles. The instruments of the most recent construction furnished results sufficiently comparable *inter se*.

M. MOUREAUX said that he had two dip circles by Brunner, the needles of which had respectively the lengths of 7 and 12 cm. These two needles gave the same value of dip within 1′ or 2′. Most of Brunner's dip circles gave indications comparable with each other. However, the dip circle of Perpignan Observatory gave a dip about 4′ higher than the travelling dip circle of Parc St. Maur Observatory.

Dr. VAN RIJCKEVORSEL proposed to establish a standard observatory, which should be at the service of other establishments, for the purpose of comparison of instruments.

General RYKATCHEFF thought that it would be very difficult to establish a standard for inclination. Experience shows that an observer, using the same apparatus and the same needle, may obtain different results. The large induction apparatus at Pavlovsk, which, as is well known, has yielded much more accurate results (up to $\pm$ 3″) has unfortunately been burnt. At present we employ a portable induction apparatus which gives excellent results, but it is still too new to be proposed as a standard.

As a conclusion to the discussion on this paragraph, M. MASCART proposed the following resolution :—

"In order to compare the magnetic surveys of different countries, it is necessary that the instruments which have been employed in the different magnetic surveys shall be repeatedly compared with each other."

This resolution was adopted.

M. MASCART reminded the Committee that for some years past short magnets had been employed. It appeared to him to be important that the Committee should express an opinion on the relative advantages of short and long magnets.

General RYKATCHEFF was of opinion that this question should be considered at leisure, and that with that object it was desirable to draw special attention to it by referring it for consideration to the Committee above mentioned.

Question 27. Professor E. MASCART, Paris :—

"Atmospheric electricity."

M. CHAUVEAU handed in a series of photographs relative to the registration of atmospheric electricity at the Eiffel Tower, and announced that on the following day he would hold himself at the disposal of the members who should take the opportunity of their presence on the tower to inspect the apparatus he had erected there.

The discussion of this question was adjourned till the next Meeting.

The Meeting was closed at 5h. 25m.

Third Meeting, September 23rd, 1896.

THE MEETING was opened at 9h. 30m. under the presidency of Dr. von Bezold.

Present: Messrs. Biese, Billwiller, Chauveau, Ellis, Fines, de Fonville, Hepites, Hergesell, Jaubert, Kesslitz, Mascart, Moureaux, Paulsen, Riggenbach, van Rijckevorsel, Rotch, Rücker, Rykatcheff, Schmidt, Teisserenc de Bort, Thévenet.

The discussion was opened on Question 32 of the Programme.

Question 32. Messrs. VON BEZOLD and ESCHENHAGEN :—

"Arrangements should be made for taking international simultaneous observations."

Dr. VON BEZOLD stated that at the request of Dr. Eschenhagen, he had, in the month of December 1895, proposed to certain magnetic observatories to make arrangements that on four

fixed dates, observations of the variations of declination and of horizontal force should be made at intervals of five seconds during one complete hour. He exhibited diagrams constructed from the data he had received for the 28th of February 1896, from 6h. to 7h. p.m., Greenwich mean time. These diagrams show that these variations are identical only at adjacent stations, the differences being more or less decided according to the distances between the different observatories of Europe; they become excessive if the figures obtained in Europe are compared with those from the American stations. Finally, disturbance which is strongly marked at stations in the middle latitudes disappears almost completely in the equatorial regions. Dr. von Bezold requested that these observations should be continued.

M. MOUREAUX was of opinion that observations rigorously simultaneous would be of very great importance, but he pointed out the difficulty for a single observer, of watching a chronometer, making an accurate reading, and writing down a number, every five seconds.

Dr. VON BEZOLD mentioned an apparatus devised by M. Schering, which would allow of the scale reading to be photographed at every 10 seconds, or even more frequently, and exhibited a specimen of a photograph obtained in that manner.

M. MASCART was of opinion that, no matter how remarkable were the results obtained by M. Schering, discontinuous photographic observations did not secure any progress in the method, and that it was preferable to obtain the results directly from the curves, because then graphical reproduction could always be effected.

The Committee, on the proposal of M. Mascart, adopted the following resolution :—

"The Conference is of opinion that it would be useful to take measures to organise, at definite epochs, simultaneous observations of the declination and the horizontal force, in particular by photographic methods, more rapid and more sensitive than the ordinary recording apparatus. It is preferable to employ similar apparatus."

Professor RÜCKER remarked that if it was decided to use Mr. Boys' quartz fibres he would undertake to furnish these to observers.

M. MASCART thanked Professor Rücker for his offer, and requested him to ask Mr. Boys if he would kindly furnish a special note on the attachment of these fibres. (Appendix IX., p. 71.)

Dr. ESCHENHAGEN, who had sent in a report on the question of simultaneous observations, was requested to send in an abstract to be inserted in the appendices. (Appendix XI. p. 72.)

Dr. VON BEZOLD remarked that Dr. Eschenhagen was of opinion that the temporary simultaneous observations should be made

for one hour in each month. This question was referred for consideration to the Special Committee.

Dr. SCHMIDT gave an account of the experiments which he had made with a new seismic apparatus, which allowed him to observe the smallest variations of gravity produced by slight shocks of the ground, and also the vertical components of earthquakes. The idea of the apparatus was derived from the bifilar magnetometer, the horizontal component of magnetism being replaced by the tension of a spring.

Dr. SCHMIDT considered that it would be useful to add to every magnetometer, whether unifilar or bifilar, this special apparatus, with the same moment of inertia, so as to admit of studying separately, on the indications of the magnetometer, these two phenomena, the variations of gravity and the variations of magnetic force.

M. MASCART described the gravity barometer which he had devised, and which the members of the Conference might have seen in use at the observatory of Parc St. Maur.

The Committee then proceeded to the discussion of Questions 33 and 34.

Question 33. Professor S. LEMSTRÖM, Helsingfors :—

"The investigation of earth currents."

Question 34. Rev. Father FAURA, S.J., Manilla :—

It is desirable that the International Conference should give practical instructions as to how earth currents are to be observed in order to find out their intensity and direction, and their relation to other meteorological phenomena."

Mr. ELLIS stated that earth currents had been recorded at the observatory of Greenwich for a long period. His study of the registers had impressed him with the great importance of establishing, at all important magnetic observatories, a continuous photographic register of earth currents. He exhibited curves which showed a clear connexion between the variations of potential between the extremities of the lines and the magnetic variations. He had to express his regret that these investigations had become very difficult at Greenwich owing to the establishment of a line of underground electric railway, passing at a distance of 4 kilometres from the nearest earth plate of the earth current system.

M. MOUREAUX said that magnetic observations in general were menaced by the establishment of this class of tramways. It is in this way that Clermont-Ferrand, Toronto, and Washington, as well as Greenwich, were from henceforth obliged to modify the programme of their investigations.

M. MASCART announced that he had received a letter from M. André, Director of the Lyons Observatory, who had also

drawn attention to the influence exerted by the electric tramway of St. Genlis on the magnetic variation apparatus.

General RYKATCHEFF stated that he intended to resume the study of earth currents at Pavlovsk, and to increase the length of the lines which had hitherto been employed.

The Committee adopted the following resolution :—

"It will be important to develop the study of earth currents. This investigation, like that of terrestrial magnetism, can only be carried out in the open country, at a distance from all industrial electrical installations."

The discussion of Question 27 (atmospheric electricity) was resumed. M. CHAUVEAU described the conditions which must be observed for the study of atmospheric electricity. One of the reasons why that inquiry has been hitherto neglected has been, doubtless, the apparent difficulty of securing a suitable exposure. The variations of potential are so rapid that direct observations will not suffice for their registration ; it was absolutely necessary to have recourse to continuous registration.

M. CHAUVEAU described the method which he had adopted, and concluded by drawing the attention of the Committee to the necessity of multiplying the stations for the observation of atmospheric electricity.

The Committee requested M. Chauveau to supply, for insertion in the appendices, a resumé of his interesting communication. (Appendix XII., p. 73.)

It finally adopted the following resolution :—

"The Committee is of opinion that the study of atmospheric electricity by means of self-registering apparatus should be developed."

The Committee decided to propose to the Conference to instruct the International Committee to nominate a Committee for the consideration of the questions from the Programme which had been referred to it.

The order of the day having been discharged, the Meeting was closed at 11h. 10m.

Committee for Instruments and Methods of Observations, First Meeting, Saturday, September 19th, 1896.

THE MEETING was opened at 9h. 30m. under the presidency of Professor Tacchini.

Present: Messrs. Angot, von Bezold, Billwiller, Dufour, Erk, Fines, Hergesell, Jaubert, Kesslitz, von Konkoly, Lancaster, Mascart, Mathias, Mohn, Riggenbach, van Rijckevorsel, Rotch, Rykatcheff, Schmidt, Scott, Snellen, Tacchini, Teisserenc de Bort, Thévenet.

Question 5. Mr. A. L. ROTCH, Boston:—

"The entry of thunderstorms. Is the rule laid down by the Vienna Congress, that the symbol for 'thunderstorm' is only to be employed when both thunder and lightning occur, to be strictly observed?"

Mr. ROTCH read a note on this question, and after a discussion, in which he and Messrs. Scott, Angot, Tacchini, von Bezold, and Lancaster took part, M. ANGOT proposed the following resolution, which was adopted by the Committee.

The Committee recommends:—

"(1.) That the symbol ⊤ be added to the international symbols adopted by the Congress of Vienna to indicate the days on which distant thunder has been heard, and conformably to the decisions of that Congress.

"(2.) The symbol ≺ should be reserved for distant or diffused lightning, *Wetterleuchten*, sheet lightning.

"(3.) The symbol ⊼ should indicate all the cases where both thunder and lightning has been observed.

"(4.) In the resumés the number of days of thunderstorm shall be, as far as possible, taken out separately for each of the three cases."

Mr. SCOTT announced that he had received from M. Durand-Greville a note on the study of thunderstorms. Thanks were voted to M. Durand-Greville for his communication, the character of which was not such as to form a subject for discussion at the Meetings of the Committee.

Question 6. THE ROYAL METEOROLOGICAL SOCIETY, LONDON:—

"The registration of bright sunshine."

Mr. SCOTT submitted some remarks made by Mr. Ellis, on the part of the Royal Meteorological Society, and also a memoir by M. Koenig (*Dauer des Sonnenscheins in Europa, Halle*, 1896).

Mr. SCOTT stated that, in his opinion, the differences which M. Koenig had found between the Jordan and the Campbell-Stokes instruments were mainly due to defects in the adjustment

of the latter, all the glass spheres which were employed having not exactly the same focal length.

Messrs. THÉVENET, RYKATCHEFF, and VON KONKOLY described various methods of registration of the hours of sunshine.

Dr. SNELLEN was of opinion that it was necessary to register also the intensity of solar radiation.

Messrs. MOHN, TACCHINI, and DUFOUR pointed out the difficulty which was experienced in registering the duration of sunshine in certain countries where the sun does not rise much above the horizon, being obstructed by mountains.

General RYKATCHEFF remarked:—

In order to measure the intensity of the light, it might be very useful to employ the Photographic Heliograph of General Welitchko, which consists of a cylinder fixed with its axis parallel to that of the globe. This cylinder is enveloped in photographic paper and is closed by a cylindrical cover in which there is a slit. The cover is kept in motion by clockwork, and it makes a revolution in twenty-four hours, the slit following the sun. The distance between the cover and the paper is very small, so that no light can reach the paper except the rays which pass through the slit. The slit is wider at the top than at the bottom, so as to give better traces at the bottom when the sun is near the horizon, and when consequently its rays have less intensity, while the upper portion of the slit, with an opening of 0·05 mm., serves for the hours near noon.

With this apparatus you obtain very neat traces from sunrise to sunset, and you can recognise the passage across the sun of the very lightest clouds.

Professors TACCHINI and MASCART proposed the following resolution:—

"In the actual state of the science, it should only be proposed to register the duration of visibility of the sun. The question of intensity should form the subject of special investigations.

"For the purposes of general climatology it is necessary that the instrument shall be so placed as to have an uninterrupted horizon. The number of hours of sunshine should be referred to the total apparent duration of the day.

"It is desirable that the sensitiveness of the apparatus be increased, if possible."

This resolution was adopted.

On the proposition of Dr. Snellen it was decided to request the International Meteorological Committee to nominate a Special Committee to consider the question of solar radiation.

Question 7. THE ROYAL METEOROLOGICAL SOCIETY, LONDON:—

"The desirability of more extended observations on infiltration into the soil, and uniformity in the same."

Dr. HERGESELL pointed out the importance of this question in the determination of the temperature of the ground.

After some remarks from Messrs. von Bezold and Rykatcheff, the note forwarded by the Weather Bureau, Washington, was read, and the Committee recorded that they had listened with much pleasure to the discussion to which the question had given rise, but that it appeared to be impossible, in the actual state of the question, to frame any resolution thereon.

Question 8. THE ROYAL METEOROLOGICAL SOCIETY, LONDON :—

"The general adoption of a standard anemometer for the determination of the velocity of the wind."

Question 9. THE ROYAL METEOROLOGICAL SOCIETY, LONDON :—

"The general adoption of a uniform system of exposure for anemometers."

Question 10. Professor SPRUNG, Potsdam :—

"The reduction of anemometrical records should be carried out at all stations on the basis of the indications of the small portable anemometers introduced by, and tested at, the Seewarte in Hamburg."

Question 11. Professor SPRUNG, Potsdam :—

"The formula to be employed is simply the equation $V = a + bA$.

Where V represents the velocity of the wind.

A " " " centres of the cups."

(Appendix XIII., p. 75.)

Mr. SCOTT, on the part of Mr. Ellis, submitted a report on these questions.

M. TEISSERENC DE BORT stated that he had some years ago proposed to test standard anemometers by determining, at two instants in close sequence, the movement of small balloons, started suitably, and drifting with the wind. The organisation of stations supplied with photographic theodolites, which had recently been carried out, would render it comparatively easy to effect these measurements.

Messrs. VON BEZOLD and HERGESELL gave detailed explanations on the subject of Recknagel's anemometer and proposed its adoption.

Mr. SCOTT said that the investigations of Mr. Dines in England were not favourable to such a proposal, the note by Mr. Marvin, forwarded by the Weather Bureau, led to the same conclusions.

M. MASCART pointed out the difficulties which were experienced when anemometers were compared by means of apparatus rotating in closed chambers.

M. THÉVENET inquired if in dealing with frictional apparatus, like Robinson's cups, or with mechanical reaction, the pressure

of the air should not be taken into consideration, the motive couple being proportional to the specific mass of the fluid in motion, so that a graduation obtained at the sea level is not applicable to a station at an appreciable altitude.

After some remarks from Messrs. HERGESELL, VON BEZOLD, RYKATCHEFF, and TEISSERENC DE BORT, M. MASCART proposed the following resolution :—

"The Committee is of opinion that it is not possible, in the present state of the question, to recommend the use of any existing instrument as a standard, or of any mode of erection identical at all stations."

This resolution was adopted.

The Meeting closed at noon.

Second Meeting, Tuesday, September 22nd, 1896.

THE MEETING was opened at 9h. 30m. under the presidency of Professor Tacchini.

Present: Messrs. Angot, Biese, Billwiller, Fines, Erk, Hepites, Hergesell, Hildebrandsson, Jaubert, Kesslitz, Lancaster, Mascart, Mohn, Moureaux, Riggenbach, Rotch, Rykatcheff, Schmidt, Scott, Snellen, Tacchini, Teisserenc de Bort, Thévenet, Watzoff, Wragge.

Question 13. M. ANGOT, Paris :—

"Two new symbols should be added to the international system—

"One to indicate the days when drops of rain have fallen, but the quantity has been too small to be measurable.

"One to indicate 'haze,' a phenomenon quite distinct from 'mist' and 'fog,' which are, at present, represented by a symbol."

M. ANGOT proposed to introduce special symbols to show the days in which a quantity of rain had fallen which was not measurable, and also for haze.

General RYKATCHEFF asked also for a symbol to indicate a special form of hoar frost.

After some remarks from Messrs. BILLWILLER, SCOTT, VON BEZOLD, and LANCASTER, Messrs. Angot and Rykatcheff withdrew their proposals.

Question 12. THE ROYAL METEOROLOGICAL SOCIETY, LONDON :—

"Uniformity of conditions under which earth temperatures should be taken."

Mr. SCOTT stated that at present experiments were being made at Kew Observatory with electrical thermometers based on the variations of resistance.

M. ANGOT reminded the Committee that for many years observations with thermo-electrical couples had been conducted by M. Becquerel at the Museum d'Histoire Naturelle in Paris.

It was recommended to continue investigations into the subject and to prepare a report for the next Conference.

Question 15. Professor H. MOHN, Christiania :—

"On the possibility of determining the pressure of the air by means of the observation of the boiling point of water (the hypsometer) with the accuracy necessary for meteorological purposes."

Question 16. Professor MOHN : —

"On the use of the hypsometer as a controlling instrument for station barometers, the force of gravity being known."

Question 17. Professor MOHN :—

"On the determination of the gravity correction for mercurial barometers by simultaneous observations of the hypsometer and the mercurial barometer."

Professor MOHN read a note on these three questions (*see* Appendix XIV., p. 76).

The Committee expressed its thanks to Professor Mohn for his interesting communication.

Question 18. Dr. BILLWILLER, Zurich :—

"The necessity of the introduction of a uniform method of reduction of barometer readings to the sea-level for the construction of synoptic weather charts."

Dr. BILLWILLER pointed out the necessity for the construction of synoptic charts, and of introducing a method for the reduction of barometer readings to sea-level which should be uniform.

After some remarks had been made by Messrs. Scott, Thévenet, and Teisserenc de Bort, the Committee suggested that the directors of the different services might arrive at a mutual understanding on this question.

Mr. WRAGGE inquired :—

"I. If the Committee would sanction the placing of terrestrial radiation thermometers on black boards in localities where grass did not exist throughout the year?

"II. If the use of absolute time was not preferable to that of local time in the construction of Pressure Charts for Australia?"

The Committee considered that it could not express any opinion on these questions.

Mr. WRAGGE then inquired if, in order to avoid the effect of resilience of rain drops falling on a very dry soil, the rain gauges might be placed at a level higher than one foot?

Several members of the Committee remarked that in several countries the gauges are placed at a height of 1·5 metres (5 feet) as adopted at the Congress of Rome.

The Meeting was closed at 10h. 45m.

Report of the Committee on Clouds, September 19th, 1896.

THE COMMITTEE met at 2h. 40m. under the presidency of Dr. Hildebrandsson.

Present: Messrs. Angot, von Bezold, Billwiller, Erk, de Fonvielle, Hergesell, Jaubert, Kesslitz, von Konkoly, Lancaster, Mascart, Mohn, Paulsen, Riggenbach, Rotch, Rykatcheff, Schmidt, Tacchini, Teisserenc de Bort, Thévenet.

Dr. RIGGENBACH was elected Secretary.

M. MASCART exhibited to the Meeting, as articles of historical interest, a large number of cloud photographs made by M. Victor Regnault about 50 years ago.

Question 14. M. L. TEISSERENC DE BORT, Paris:—

> "Description of the methods employed for the measurement of the velocities of clouds at the stations established in conformity with the recommendations of the International Meteorological Committee."

The PRESIDENT handed in the replies which had been received to the circular of May 6, 1895, with reference to the organisation of the cloud observations.

The Directors of the several services made the following reports on the actual condition of the observations.

Sweden.—M. Hildebrandsson. Measurements with a photogrammeter at Upsala three times daily, with a base of 923 metres, and in addition observations at Luleä, Wisby, Linköping, Skara, and Kalmar. The new measurements made at Upsala go to confirm in general the altitudes determined by Messrs. Ekholm and Hagström.

Norway.—Professor Mohn. Theodolite measurements at Bossekop, and, since the month of June, direct observations at Christiania, Bergen, Trondhjem, and Lödingen.

Denmark.—Dr. Paulsen. Observations of the direction and apparent velocity of motion of the clouds have been made with a mirror since the first of May in Denmark, properly so-called at Copenhagen, and at two stations in Jutland, and, since the first of August, in the Faroe Islands, at Reikjavik (Iceland), and at Angmaksalik (east coast of Greenland).

Russia.—General Rykatcheff. Measurements are being taken with the photogrammeter at Pavlovsk, with the theodolite at Irkutsk and Ekaterinburg. Observations of various kinds are made three times a day at 300 stations.

General Rykatcheff handed in a number of cloud photographs which had been obtained at Pavlovsk. He stated that the Universities of Russia had been invited to undertake these observations, and that the War Ministry would also contribute to the inquiry by means of the numerous balloon ascents conducted in connexion with that office.

Finland.—Dr. Biese. At Helsingfors the elevation is measured with theodolites, the base being 2 kilometres in length, and, further, direct observations are made hourly day and night. Direct observations are made three times a day at Torneå and Wiitasaari.

France.—M. Teisserenc de Bort has had observations made with a photogrammeter at the observatory of Trappes, twice a day since July 1st and four or five times a day since September 1st. In order to measure the pictures he employs a divided scale which he lays on the picture of the cloud. By this method he attains a precision of 1·5 minutes. He handed in a printed report on these investigations, and also some cloud photographs taken on a large scale.

M. Angot submitted specimens of his cloud photographs, and gave an account of the observations at Parc St. Maur and at various other meteorological stations.

Belgium.—M. Lancaster. Photographs are taken at Uccle, but no measurements are made. Direct observations, as complete as possible, are made three times a day at a hundred stations.

Italy.—Professor Tacchini. There is no special organisation for cloud observations.

Prussia.—Dr. von Bezold. At the observatory of Potsdam observations with the phototheodolite of M. Koppe have been carried on at two-hourly intervals from 4h. a.m. to 8h. p.m. The base was originally 369 metres, but this has been replaced by one of 1,469 metres. An automatic phototheodolite will shortly come into use. In addition a phototheodolite is employed at Brunswick and a theodolite at Danzig. Direct observations are carried on at six or eight stations.

Hungary.—Dr. von Konkoly. Observations with the phototheodolite and the nephoscope will be commenced next year.

Austria Pola.—Lieut. Kesslitz. Direct observations with Fineman's nephoscope are made nine times a day. Similar observations are made six times a day on board the ships stationed at Sebenico and Teodo, and also on board ships at sea.

England.—No regular system of cloud observations has been organised, but Mr. A. W. Clayden has made some measurements during the spring and summer of the present year. His method will be described in the Report of the British Association for 1896.

India.—It is believed that two pairs of theodolites have been ordered.

The United States.—Mr. Rotch. Observations with the theodolite have been made twice a day at Blue Hill since May

1st. There are two bases of 1,300 and 2,700 metres respectively. Nephoscopic observations are made three times a day.

The Weather Bureau at Washington has established one station provided with a phototheodolite, and six stations for observations with the nephoscope.

Switzerland.—Dr. Billwiller. Direct observations are carried on at several stations.

Württemberg.—Dr. Schmidt. Observations are carried on at Hohenheim with Dr. Sprung's mirror.

Strassburg.—Dr. Hergesell. Direct hourly observations, day and night, are carried on on the platform of the Cathedral.

Bavaria.—Dr. Erk. No special observations are being carried on.

Holland.—Dr. Snellen. Direct observations are made three times a day, at three stations.

Roumania.—Dr. Hepites. The nephoscope is employed at Bucharest. Direct observations are made at several other stations.

Canada.—Mr. Stupart. At Toronto, for the last two months, observations have been made with phototheodolites three times a day. The length of the base is 1,650 metres.

The PRESIDENT mentioned that observations with photogrammeters were being carried out at Manilla and at Batavia, and that probably two stations with photogrammeters would be established at Sydney.

General RYKATCHEFF observed that several stations would not have completed twelve months of observations at the close of the period which had been fixed at Upsala, and asked whether the period of observations could not be prolonged.

On the proposition of General Rykatcheff the following resolutions were adopted:—

> "It is desirable that direct observations of the clouds should be conducted at the secondary stations up to the close of the year 1897.
>
> "The present Committee proposes to the Conference that it should instruct the International Committee to nominate the members of a new Cloud Committee."

The Meeting was closed at 3h. 45m.

APPENDIX.

APPENDIX I.

LIST OF THE GENTLEMEN INVITED TO TAKE PART IN THE CONFERENCE.

EUROPE.

AUSTRIA.—Hofrath Dr. J. Hann, Director of the Central Office for Meteorological and Terrestrial Magnetism, Vienna.
Rear-Admiral Kalmar, Hydrographic Office, Pola.
Baurath P. Ballif, for Government of Bosnia and Herzegovina, Sarajevo.

BELGIUM.—M. Folie, Director of the Royal Observatory, Uccle, Brussels.

BULGARIA.—Professor Watzoff, Central Meteorological Station, Sofia.

DENMARK.—Dr. A. Paulsen, Director of the Meteorological Institute, Copenhagen.

FINLAND.—Professor S. Lemström, Sec. Academy of Science, Helsingfors.
Dr. E. Biese, Director of the Central Meteorological Institute, Helsingfors.

FRANCE.—Professor E. Mascart, Director of the Central Meteorological Office, Paris.
M. E. Fron, Chief of the Telegraphic Branch of the Central Meteorological Office, Paris.
M. V. Fournié, Inspector-General of Bridges and Highways, Paris.
M. J. Jaubert, Chief of the Meteorological Service of the Municipal Observatory of Montsouris.
Dr. Fines, Director of the Meteorological and Magnetic Observatory, Perpignan.
M. B. Baillaud, Director of Observatory, Toulouse.
M. A. Angot, Chief of the Services of Climatology, Instruments, and General Meteorology, Central Meteorological Office, Paris.
M. Th. Moureaux, Chief of the Magnetic Service, Meteorological and Magnetical Observatory, Parc Saint-Maur, Paris.
M. Léon Teisserenc de Bort, General Secretary of the Meteorological Society of France, Paris.
M. H. Becquerd, President of the Meteorological Society of France, Paris.
M. F. Tisserand, Director of the National Observatory, Paris.
M. Ch. André, Director of the Observatory, Lyons, Saint Génis Laval.
M. Ch. Gruey, Director of the Observatory, Besançon.
M. Ch. Hurion, Directory of the Observatory, Puy de Dôme, Clermont-Ferrand.
M. Ch. Marchand, Director of the Observatory, Pic-du-Midi, Bagnères de Bigorre.
M. G. Rayet, Director of the Observatory, Bordeaux.
M. Stephan, Director of the Observatory, Marseilles.

GERMAN EMPIRE.—Professor Dr. W. von Bezold, Director of the Royal Meteorological Institute of Prussia, Berlin.
Geheimrath Dr. G. Neumayer, Director of the Deutsche Seewarte, Hamburg.
Professor Dr. Paul Schreiber, Director of the Royal Meteorological Institute of Saxony, Chemnitz.

GERMAN EMPIRE—*cont.*
Dr. Erk, Director of the Royal Meteorological Central Station of Bavaria, Munich.
Dr. A. Schmidt, Director of the Royal Meteorological Central Station of Württemberg, Stuttgart.
Professor Honsell, Superintendent of the Central Office for Meteorology and Hydrography of the Grand Duchy of Baden, Carlsruhe.
Dr. Hergesell, Superintendent of the Meteorological System of the Imperial Territories, Strassburg.
GREAT BRITAIN.—The Secretary of the Royal Meteorological Society, London.
Mr. Alexander Buchan, F.R.S.E., Secretary Scottish Meteorological Society, Edinburgh.
Mr. W. H. Mahoney Christie, F.R.S., Astronomer Royal, Greenwich.
Mr. G. J. Symons, F.R.S., London.
Mr. R. H. Scott, F.R.S., Secretary to the Meteorological Council, London.
The Royal Society, London.
The Magnetic Committee of the British Association, London.
GREECE.—The Director of the Observatory, Athens.
HUNGARY.—Dr. N. von Konkoly, Director of the Central Meteorological Institute, Buda Pesth.
ITALY.—Professor Tacchini, Director of the Italian Central Office for Meteorology and Geodynamics, Rome.
The Italian Meteorological Society, Moncalieri.
THE NETHERLANDS.—Dr. M. Snellen, Chief Director of the Royal Meteorological Institute of the Netherlands, Utrecht.
Dr. Van Rijckevorsel, Rotterdam.
NORWAY.—Professor Dr. H. Mohn, Director of the Meteorological Institute, Christiania.
PORTUGAL.—Rear-Admiral J. C. de Brito Capello, Director of the Observatory, Lisbon.
ROUMANIA.—Professor St. Hepites, Director of the Meteorological Institute, Bucharest.
RUSSIA.—General Rykatcheff, Director of the Central Physical Observatory, St. Petersburg.
SPAIN.—Señor A. Arcimis, Director of the Central Meteorological Institute, Madrid.
Captain Don Juan Viniegra, Director of the Institute and Marine Observatory, San Fernando.
SWEDEN.—Professor R. Rubenson, Director of the Central Meteorological Institute, Stockholm.
Professor H. H. Hildebrandsson, Director of the Meteorological Observatory, Upsala.
SWITZERLAND.—Dr. R. Billwiller, Director of the Central Meteorological Institute, Zurich.
Dr. Wild, Zurich.
TURKEY.—The Director of the Imperial Meteorological Observatory, Constantinople.

ASIA.

HINDOSTAN.—Mr. J. Eliot, M.A., F.R.S., Meteorological Reporter to the Government of India, Simla.
Mr. C. Michie Smith, Government Astronomer, Madras.
CHINA.—Rev. S. Chevalier, S.J., Director of the Observatory, Zi-ka-wei, Shanghai.
Dr. Doberck, Government Astronomer, Hong Kong.
JAPAN.—The Director of the Imperial Meteorological Observatory, Tokio.
THE PHILLIPPINE ISLANDS.—Rev. M. Faura, S.J., Director of the Observatory, Manilla.
JAVA.—Dr. van der Stok, Director of the Observatory, Batavia.

AUSTRALASIA.

NEW SOUTH WALES.—Mr. H. C. Russell, C.M.G., F.R.S., Government Astronomer, Sydney.
NEW ZEALAND.—Sir James Hector, K.C.M.G., F.R.S., Colonial Museum, Wellington.
QUEENSLAND.—Mr. C. L. Wragge, F.R.G.S., Government Meteorologist, Brisbane.
SOUTH AUSTRALIA.—Sir C. Todd, K.C.M.G., F.R.S., Government Astronomer, Adelaide.
TASMANIA.—Mr. H. C. Kingsmill, Government Meteorologist, Hobart.
VICTORIA.—Mr. P. Baracchi, Government Astronomer, Melbourne.
Mr. R. L. J. Ellery, F.R.S., Melbourne.
WEST AUSTRALIA.—Mr. W. E. Cooke, M.A., Government Meteorologist, Perth.

AFRICA.

ALGIERS.—M. Thévenet, Director of the Meteorological Service, Algiers.
SOUTH AFRICA.—The Secretary of the Meteorological Commission, Cape Town.
MADAGASCAR.—Rev. E. Colin, S.J., Director of the Royal Observatory, Antananarivo.
MAURITIUS.—Dr. C. Meldrum, F.R.S., Royal Alfred Observatory, Pamplemousses, Mauritius.

NORTH AMERICA.

CANADA.—Mr. R. F. Stupart, Meteorological Office, Toronto.
THE UNITED STATES.—Professor W. L. Moore, Chief of the Weather Bureau, Washington.
Professor Frank H. Bigelow, Weather Bureau, Washington.
Mr. A. L. Rotch, Director of the Blue Hill Observatory, Readville, Mass.
Mr. R. De C. Ward, Secretary of the New England Meteorological Society, Cambridge, Mass.
Mr. E. C. Pickering, Director of the Harvard College Observatory, Cambridge, Mass.
Commander C. D. Sigsbee, Hydrographic Office, Washington.
MEXICO.—The Director of the Central Meteorological Observatory, Mexico.
Señor A. Anguiano, Director of the Tacubaya Astronomical Observatory, Mexico.

WEST INDIES.

CUBA.—The Director of the Royal College of Belen, Havanna.
JAMAICA.—Mr. Maxwell Hall, F.R.A.S., Montego Bay, Jamaica.

SOUTH AMERICA.

ARGENTINE REPUBLIC.—Mr. W. Davis, Director of the Central Meteorological Office, Cordoba.
BRAZIL.—Senhor L. Cruls, Observatory, Rio de Janeiro.
Captain A. P. Pinheiro, Director-General of the Meteorological Department of Brazil, Rio Janeiro.

APPENDIX II.

List of the Members and Guests present at the Conference.

Europe.

Austria.—Lieut. W. Kesslitz, Hydrographic Office, Pola.
Belgium.—M. A. Lancaster, Royal Observatory, Uccle, Brussels.
Bulgaria.—Professor Watzoff, Central Meteorological Station, Sofia.
Denmark.—Dr. A. Paulsen, Director of the Meteorological Institute, Copenhagen.
Finland.—Dr. E. Biese, Director of the Central Meteorological Institute, Helsingfors.
France.—M. A. Angot, Central Meteorological Office, Paris.
M. B. Baillaud, Director of Observatory, Toulouse.
M. H. Becquerel, President of the Société Météorologique, Paris.
M. A. Chauveau, Central Meteorological Office, Paris.
Dr. Fines, Director of the Meteorological and Magnetic Observatory, Perpignan.
M. de Fonvielle, Representative of the Aëronautical Societies, Paris.
M. E. Fron, Central Meteorological Office, Paris.
M. J. Jaubert, Municipal Observatory of Montsouris.
Professor E. Mascart, Director of the Central Meteorological Office, Paris.
Professor E. Mathias, Observatory, Toulouse.
M. Th. Moureaux, Observatory, Parc Saint Maur, Paris.
M. Léon Teisserenc de Bort, General Secretary of the Meteorological Society of France, Paris.
German Empire.—Professor Dr. W. von Bezold, Director of the Royal Meteorological Institute of Prussia, Berlin.
Dr. Erk, Director of the Royal Meteorological Central Station of Bavaria, Munich.
Dr. Hergesell, Superintendent of the Meteorological System of the Imperial Territories, Strassburg.
Geheimrath Dr. G. Neumayer, Director of the Deutsche Seewarte, Hamburg.
Dr. A. Schmidt, Director of the Royal Meteorological Central Station of Württemberg, Stuttgart.
Great Britain.—Mr. W. Ellis, F.R.S., representing the Royal Meteorological Society, London.
Professor A. Rücker, F.R.S., representing the Royal Society, London.
Mr. R. H. Scott, F.R.S., Secretary to the Meteorological Council, London.
Mr. G. J. Symons, F.R.S., London.
Hungary.—Dr. N. von Konkoly, Director of the Central Meteorological Institute, Buda Pesth.
M. Tolnay, Central Meteorological Institute, Buda Pesth.
Italy.—Professor Tacchini, Director of the Italian Central Office for Meteorology and Geodynamics, Rome.
The Netherlands.—Dr. M. Snellen, Chief Director of the Royal Meteorological Institute of the Netherlands, Utrecht.
Dr. van Ryckevorsel, Rotterdam.
Norway.—Professor Dr. H. Mohn, Director of the Meteorological Institute, Christiania.
Roumania.—Professor St. Hepites, Director of the Meteorological Institute, Bucharest.

Russia.—General Rykatcheff, Director of the Central Physical Observatory, St. Petersburg.
Sweden.—Professor H. H. Hildebrandsson, Director of the Meteorological Observatory, Upsala.
Switzerland.—Dr. R. Billwiller, Director of the Central Meteorological Institute, Zürich.
Dr. A. Riggenbach, Basle.

Australasia.

New South Wales, South Australia, and Victoria.—Represented by Mr. R. H. Scott, F.R.S.
Queensland.—Mr. C. L. Wragge, F.R.G.S., Government Meteorologist, Brisbane.

Africa.

Algiers.—M. Thévenet, Director of the Meteorological Service, Algiers.

North America.

Canada.—Mr. R. F. Stupart, Meteorological Office, Toronto.
The United States.—Mr. J. Page, Marine Meteorologist, Hydrographic Office, Washington.
Mr. A. L. Rotch, Director of the Blue Hill Observatory, Readville, Mass.
Mexico.—Señor A. Anguiano, Director of the Tacubaya Astronomical Observatory, Mexico.

APPENDIX III.

PROGRAMME.

Two questions remain over for consideration from the Protocols of the Conference of Munich in 1891.

Page 31, Question 48.—"Double stations, observing according to local and international systems."—Mr. Symons.

Resolution.—"The Conference refers the subject of the establishment of double stations, with observations on the local and international scheme, to a future Conference for discussion, and requests Mr. Symons to be so good as to define his proposal more accurately, and to give fuller details."

Page 38.—Messrs. Wild and Harrington proposed the following resolution:—

"As it appears to be too late to consider the subjoined new question in this Conference, it should be imposed upon the International Committee which may be appointed, or else on a special committee appointed for the purpose, to consider the subject of the proper method of extending meteorological observations and publications in the interest of Agriculture, so that a report on the subject may be submitted to the next general Congress."

The International Committee, at its meeting at Upsala, in the absence of any report from the proposers of the above suggestion, obtained from the different Chiefs of meteorological services reports on the measures adopted in different countries for the distribution of forecasts to agriculturists, and on the results of climatological discussions carried out from the point of view of the productions of the soil.

The following questions and propositions have been received in reply to the circular of May 1895:—

GENERAL METEOROLOGY.

1. *Dr. P. Schreiber, Chemnitz.*
   The meteorological day should be reckoned from 9 h. p.m. to 9 h. p.m., and designated by the same number as the civil day, in which the greater part of the meteorological day falls. Meteorological extremes and sums, *e.g.*, of rain fallen, should be measured at 9 p.m., the close of the meteorological day.

2. *Professor Watzoff, Sophia.*
   Is it not desirable to recommend a method for the calculation of means from hourly readings?
   In Austria, Russia, and Prussia the formula used is—
   (1+2 - - - +23+24) : 24
   At Zikawei, &c.—
   (0+1 - - - +22+23) : 24
   At Chemnitz, in Belgium, and Bulgaria—
   (0+1 - - - +23+24) : 25

3. *Professor Willis L. Moore, Washington.*
   The solar magnetic period 26·67928 days as the natural mode of classifying solar, physical, and terrestrial meteorological phenomena. The desirability of its introduction for general use in the year 1901.

4. *Dr. P. Schreiber, Chemnitz.*
   Classification of days of rain:—
   1. Every day on which measurable precipitation occurs is a day of rain.
   2. Such days are subdivided according to the occurrence of any of the following:—Rain, snow, hail, fog, dew, hoar-frost, silver thaw, glazed frost.
   3. It seems unnecessary to fix any inferior limit for precipitation.

5. *Mr. A. L. Rotch, Boston.*
   The entry of thunderstorms. Is the rule laid down by the Vienna Congress, that the symbol for "thunderstorm" is only to be employed when both thunder and lightning occur, to be strictly observed?

6. *The Royal Meteorological Society, London.*
   The registration of bright sunshine.

7. *Idem.*
   The desirability of more extended observations on infiltration into the soil, and uniformity in the same.

8. *Idem.*
   The general adoption of a standard anemometer for the determination of the velocity of the wind.

9. *Idem.*
   The general adoption of a uniform system of exposure for anemometers.

10. *Professor Sprung, Potsdam.*
    The reduction of anemometrical records should be carried out at all stations on the basis of the indications of the small portable anemometers introduced by, and tested at, the Seewarte in Hamburg.

11. *Idem.*
    The formula to be employed is simply the equation $V=a+bA$.
    Where V represents the velocity of the wind.
    A " " " centres of the cups.

12. *The Royal Meteorological Society, London.*
    Uniformity of conditions under which earth temperatures should be taken.

13. *M. Angot, Paris.*
    Two new symbols should be added to the international system—
    One to indicate the days when drops of rain have fallen, but the quantity has been too small to be measureable.
    One to indicate "haze," a phenomenon quite distinct from "mist" and "fog," which are, at present, represented by a symbol.

14. *M. L. Teisserenc de Bort, Paris.*
    Description of the methods employed for the measurement of the velocities of clouds at the stations established in conformity with the recommendations of the International Meteorological Committee.

15. *Professor H. Mohn, Christiania.*
    On the possibility of determining the pressure of the air by means of the observation of the boiling point of water (the hypsometer) with the accuracy necessary for meteorological purposes.

16. *Idem.*
    On the use of the hypsometer as a controlling instrument for station barometers, the force of gravity being known.

17. *Idem.*
    On the determination of the gravity correction for mercurial barometers, by simultaneous observations of the hypsometer and the mercurial barometer.

18. *Dr. Billwiller, Zurich.*
    The necessity of the introduction of a uniform method of reduction of barometer readings to the sea-level for the construction of synoptic weather charts.

19. *Dr. P. Schreiber, Chemnitz.*
    The development and amplification of observations on sea temperature, etc. over the North Atlantic Ocean.

20. *Idem.*
The inclusion of hygrometrical information in the international scheme of telegraphy.

21. *Dr. Snellen, Utrecht.*
The introduction of the circular system in the international meteorological telegraphy. M. Billwiller has kindly undertaken, at Upsala, to bring this matter before the Bureau Télégraphique International at Berne, with a view to its being discussed at the International Telegraphic Congress to be held in Buda Pesth in June 1896.

22. *Idem.*
The introduction of telemeteorographs.

23. *Rev. Father Faura, S.J., Manilla.*
The time seems to have arrived to settle the question of air motion in cyclones, and to finally disprove the theory of descending currents in these phenomena.

24. *Idem.*
The time has perhaps arrived for assigning an origin for cyclones and tornados.

25. *Idem.*
It would be very convenient to institute international investigations into the distribution of meteorological elements around the cyclonic centres.

26. *Professor Willis L. Moore, Washington.*
The best means of separating the cyclonic components from the general wind velocities of the upper air.

Electricity and Magnetism.

27. *Professor E. Mascart, Paris.*
Atmospheric electricity.

28. *Idem.*
Terrestrial magnetism.

29. *Professor von Bezold, Berlin, and Professor Eschenhagen, Potsdam.*
General principles should be introduced for the publication of magnetic observations:—
a. The values obtained should be given for the different observing hours in absolute measure, freed from the variations of the zero of the scale (base value) and of temperature.
b. It should be stated accurately in what way the scale readings have been converted to absolute measure, and to what extent the temperature has been taken into consideration.
c. It is desirable that for each day the values should be given for each complete hour.
d. The same notation should be employed in all countries:—
H for horizontal force.
X ,, the northern component.
Y ,, the western component.
Z ,, the vertical force.
V ,, the potential.
e. In calculating monthly means all days are to be taken into consideration. It is left open to each Director to give, in addition, means calculated without taking disturbed days into account.
f. It is very desirable that for the monthly means there should be calculated and published at least the values of the components X, Y, Z, and also for the monthly means of the separate observation hours, the differences of the components Δ X, Δ Y, Δ Z from the means of the month.

30. *Idem.*
General principles should be laid down for magnetic surveys:—
a. The density of the system (*i.e.*, the closeness of the stations *inter se*).
b. The elimination of variations by means of the observations at the base stations.
c. The reduction of the observations to a definite epoch.
d. The comparison of the instruments employed in the different surveys.

31. *Idem.*
The distribution of observatories over the globe should be discussed.
It is desirable that all institutes which publish magnetic charts should give additional tables containing the magnetic elements, and, if possible, also the components for convenient points of intersection of the geographical co-ordinates.
It is equally to be desired that the data on which these charts have been constructed should be published in the fullest detail possible.

32. *Idem.*
Arrangements should be made for taking international simultaneous observations.

33. *Professor S. Lemström, Helsingfors.*
The investigation of earth currents.

34. *Rev. Father Faura, S.J., Manilla.*
It is desirable that the International Conference should give practical instructions as to how the earth currents are to be observed in order to find out their intensity and direction, and their relation to other meteorological phenomena.

International Meteorology.

35. *Dr. Paul Schreiber, Chemnitz.*
The organisation of the future International Committee, to be appointed by the Paris Conference.

36. *Idem.*
It seems desirable that at the time of the Conference there should be organised an exhibition of instruments for the following purposes:—
a. Solar radiation.
b. The phenomena of absorption by the spectrum.
c. Scintillation.
d. The position of clouds.

37. *Dr. Paulsen, Copenhagen.*
The distribution of floating ice in the North Atlantic.

38. *Dr. Neumayer, Hamburg.*
The simplification of meteorological telegrams.

39. *Dr. Hann, Vienna.*
The regular publication in every country of a complete list of all the establishments or societies which publish meteorological observations.

40. *Dr. Hildebrandsson, Upsala.*
The establishment of meteorological stations in the regions of the great centres of atmospheric action.

APPENDIX IV.

Deutsche Seewarte.

Remarks and Proposals relating to the Programme for the International Meteorological Conference in Paris, by Dr. G. Neumayer.

It appears to the Directorate of the Seewarte to be particularly important that the following subjects should be discussed at the International Meteorological Conference in Paris, in September, 1896 :—

I.—Improvement and Simplification of the Telegraphic Weather System in Europe.

Twenty years have elapsed since the adoption, in the years 1875-76, of the international (Utrecht) telegraphic code, and the collective telegrams between central offices, and the entry of Germany into this system at the same epoch. The telegraphic weather exchange has not made considerable progress since. It should be pointed out that the interchange of weather telegrams between various countries in Europe still takes about four times as much time as is the case in North America. The Seewarte therefore most warmly supports the proposals of Dr. Snellen, Director of the Meteorological Institute in Utrecht, to introduce into Europe the American Circuit System, and also at least a small number of telemeteorographs.

But as the experience of these 20 years has shown that some of the data of the existing international code of weather telegrams can be dispensed with, because they are of little or no use, it is desirable to abridge the telegraphic code, in the interest of simplicity, of the reduction of expense, and the rapidity of the telegraphic weather exchange, as well as of its improvement in the direction specified. The Seewarte therefore proposes to omit entirely the reading of the wet-bulb thermometer in the international exchange, and in place of the tenths of degrees of air-temperature, to substitute the rainfall according to nine gradations, somewhat as follows :—

Rainfall: Millimetres	≧ 0·2	1	2½	5	7½	10	15	20	25
Rainfall: Inches	≧ 0·01	0·04	0·1	0·2	0·3	0·4	0·6	0·8	1·0
To be sent in the telegram as	1	2	3	4	5	6	7	8	9
To be entered in the Weather Report as "mm. (in round numbers)"	0·5	2	4	6	9	12	17	22	27

or corresponding values in inches.

A rainfall exceeding 30 mm., or 1·2 inches, should always be noted by words, together with the exact amount of the fall.

In the international messages, the maximum and minimum temperatures can generally be omitted, as they have no material influence on the representation of the weather conditions as a whole, and agriculture would be satisfied with the indication of these values for each individual country. The data of the international telegrams relating to the latest observation can then be limited to two words instead of four, viz. :—

B B B W W F S T T R

both for metric and English measures.

(Wind-forces above 9 to be stated in words in both instances.)

Note.—B = Barometer; W = Wind Direction; F = Wind Force; S = State of Sky; T = Dry Thermometer; R = Rain.

Atmospheric pressure over flat countries and seas is so closely connected with the great movements of the atmosphere, as compared with the extremely local values of atmospheric humidity, air-temperature, and rainfall, that the omission of tenths of millimetres would be a loss for the weather charts, especially as regards secondary depressions, which are very important for practical weather knowledge.

II.—The Uniformity of Hours of Observation.

If the desired system for the circulation of international weather telegrams is introduced, the change to uniform simultaneous observations for weather telegraphy in Europe will follow as a matter of course. No institute would wish to receive a part of its telegrams late, or to delay their publication, if the telegraph offices would transmit them as quickly as is done in America.

But even if the circuit system should not yet be adopted, the present conditions, in which the times of observation suddenly change one or two hours at the frontiers of different countries, cannot be considered to be permanent. The Seewarte therefore repeats its proposal, made at the meeting of the International Meteorological Committee in Paris, on the 7th September 1885,* for uniformity in hours of observation, at least in those transmitted by telegraph. The grounds for the proposal were then given, and this office now begs to put it in the following definite form :—

1°. The more rapid does the telegraphic transmission of observations become, the more necessary becomes simultaneity in weather observations in Europe.

2°. The choice of uniform hours must depend upon the practical requirements of weather telegraphy.

3°. As the eastern institutes have greater interest in this question than the western, the general arrangement must as far as possible adapt itself to that which holds in the western systems.

4°. The telegraphic transmission of two observations daily for the study and prediction of weather phenomena must at present be considered as necessary, but at the same time sufficient.

5°. For all these reasons the following hours—

7h. a.m. and 6h. p.m. Greenwich time, or

8h. a.m. and 7h. p.m. central European time—

seem to be the most suitable international European hours for meteorological observations to be reported by telegraph. The adoption of these hours requires very slight changes in the telegraphic weather services of France, England, Germany, Scandinavia, and the Netherlands; and the changes will really be perceived to be of practical advantage.† The following summary shows the amount of the change of time (— being earlier, + later than at present) :—

At Present.		Change.	
		Morning.	Evening.
France	7h. a.m. and 6h. p.m. Paris time	+ 6h. 9m.	+ 0h. 9m.
England	8h. a.m. and 6h. p.m. Greenwich time	— 1h.	None.
Germany, Norway‡, Netherlands	8h. a.m. and 8h. p.m. local time	— 0h 40m. to + 0h. 24m.	— 1h. on an average. — 2h. on an average.
Denmark, Sweden	8h. a.m. and 9h. p.m. local time	+ 1h. on an average.	— 2h. on an average.
Austria	7h. a.m. and 9h. p.m. local time	+ 2h.	— 1h
Russia	7h. a.m. and 9h. p.m. local time	St. Petersburg. + 0h. 50m.	St. Petersburg. + 0h. 50m.
Italy	7h. a.m. and 6h. p.m. Rome time	— 2h. 25m.	— 0h. 25m.
Spain	9h. a.m. and 6h. p.m. San Fernando time		

* See page 14 (English edition).

† For practical purposes the adoption of the agreement by the countries named would be sufficient. For the scientific use of synoptic charts the co-operation of the others (Russia, Austria, Italy, &c.) is very desirable.

‡ Partly Christiania time.

6°. The telegraphic collection of observations between 8h. a.m. and 7h. p.m. central European time, from more limited systems, is left to the decision of individual institutions. This time is not suitable for the international exchange of messages, owing to the pressure of work on telegraphists during business hours.

7°. The connexion on synoptic charts of the observations now made in North America at 8h. a.m. and 8h. p.m., according to the time of the 75th west meridian,—equivalent to 2h. a.m. and 2h. p.m. mean European time, with the European observations,—is effected, at least for the morning, without any considerable jump, by those made on ships at 8h. a.m. and 8h. p.m. local time, and is, therefore, effected in a thoroughly useful manner from a scientific point of view. The connexion of the observations on board ship, made at the usual division of the day into watches, with these observations, in order to obtain numerous and accurate observations, has proved too advantageous to allow the institutions which adhere to this method to think of giving it up.

III.—Extension of the International System of Meteorological Publications.

(*a.*) To tabular monthly reports appearing promptly to date (with or without text).

(*b.*) To a five-yearly summary on the pattern of the International Yearly Summary at the end of each international lustrum.

As the detailed occurrences can be taken from the Daily Weather Reports, the monthly reports need only contain the monthly means of the meteorological phenomena of a sufficient number of stations. The publication of the daily registers is effected in the annual reports, which bring together the observations of the whole year in a very convenient way. To split them up into different parts throws difficulties in the way of arranging and summarising them. But it is not convenient to have to wait for the appearance of the annual reports to investigate the larger anomalies of temperature and air-pressure in the monthly means.

IV.—Greater Attention to Meteorology in Schools and Universities.

Professor W. M. Davis and Mr. R. De C. Ward, both of Cambridge, Mass., have quite recently published very clear and noteworthy statements upon the subject of the educational value of meteorology, and its treatment in schools and universities.

In order to provide that our science may become properly understood by the public, and to secure its further useful development, we must endeavour—

(*a.*) To introduce problems of meteorology and climatology in a correct and satisfactory manner into the lectures of physics and geography to scholars between 12 and 19 years of age.

(*b.*) To have special lectureships of meteorology established and properly endowed in our high schools for the instruction of more advanced students.

V.—Comparison of different Sunshine Recorders, uniform Instructions for observing and exposing the Instruments.

Particular attention has recently been paid to the duration of sunshine, and special instruments for the continuous registration of this phenomenon have been erected in many parts of the globe. We must endeavour to obtain a knowledge of this important element in all climates of the earth; it is, therefore, absolutely necessary that the records of the different instruments should be inter-comparable. It is, therefore, proposed that the Conference should declare it to be very desirable that the instruments in use at various stations should be directly compared with each other, that the instructions for the observers should be prepared upon a uniform plan, and that the instruments should all be similarly exposed. The details of the decisions to be taken should be referred to a Committee.

APPENDIX V.

Description of the Thermometer Screens used in England, France, and Russia.

England.

The thermometer screen used in England is the Stevenson screen. We reproduce here the description of it contained in the report inserted in the *Quarterly Journal of the Royal Meteorological Society*, Vol. X., No. 50., April 1884, p. 92 :—

1. *Material.*—The screen is constructed throughout of the best yellow pine, and all its different parts are put together with tenons, mortices, and brass screws, with the exception of the louvres, which are fastened together and secured in their places by brass rivets.

2. *Dimensions.*—Its clear internal dimensions are:—Length, 18 ins., width, 11 ins., and height, 15 ins.

3. *Framework.*—This framework consists of four corner posts connected above and below by rails.

The two front posts are 1½ in. square, 20½ ins. long, and 19½ ins. apart; the two back posts are 1½ in. square, 19½ ins. long, and 19½ ins. apart.

The clear distance between the front and back posts is 12¾ ins. The under sides of the lower rails are all 1½ in. above the bottom ends of the corner posts, and 1½ in. square in section. The upper rails are 1½ in wide and 1 in. deep, and the clear space between the upper and lower rails measures 15 ins.

4. *Louvres.*—The screen has double louvres. The outer louvres are 2 ins. wide and ¼ in. thick. The inner louvres are 1 in. wide, and ¼ in. thick. The double louvres are formed by nailing the inner louvres to the outer, in the manner indicated in the accompanying sketch (Fig. 1). The double louvres (or rather the outer louvres) are slipped into shallow grooves, ¼ in. wide, cut in the inner sides of the four corner posts of the screen at an angle of 45° and ½ in. apart (*i.e.*, ¾ in. from centre to centre, measured square to the groove).

Fig. 1.

At the two back inner corners of the screen the louvres are roughly mitred.

The external edges of the outer louvres are cut off so as to make them flush with the corner posts.

5. *Door.*—The door, which forms one of the longer sides of the screen, is a rectangular frame of 1½ in. × 1 in. material, fitted with double louvres similar to those above described. It is hung by its outer bottom edge to the lower front rail by two strong brass butt hinges, and closes with its outer surface flush with the corner post. The door is fastened with a brass hasp, staple, and padlock.

6. *Bottom of Screen.*—This is formed by three ½ in. boards, 4 ins. wide, arranged longitudinally across the lower part of the screen as follows:—The centre or upper board is let in at each end flush with the top of the lower side rails, while the other two are screwed at the ends to the under side of these same rails, in such a way that one overlaps the back, and the other the front of the centre board by ½ in. (Fig. 2).

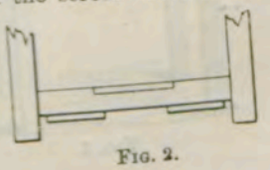


Fig. 2.

7. *Roof.*—The roof is double. The inner roof is a board ¼ in. thick, resting upon the upper rails, and cut away to receive the corner posts. It has 10 1 in. holes, drilled in it at equal

distances all round, 2 ins. from the edge, as shown in the sketch (Fig. 3).

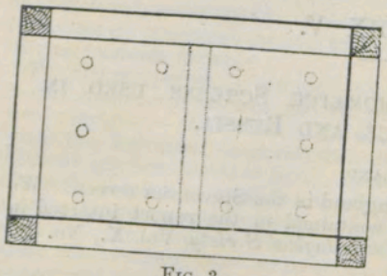


FIG. 3.

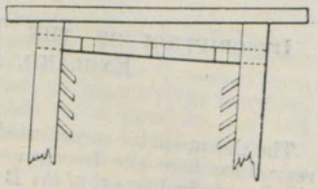


FIG. 4.

The outer roof is a 1 in. board screwed on to the top of the corner posts, and also to a narrow bearing of wood $\frac{3}{4}$ in. wide, running across the centre of the inner roof from front to back. Its under side is $1\frac{1}{2}$ in. above the inner roof in front, and $\frac{1}{2}$ in. above it at the back, and projects 2 ins. beyond the sides of the screen all round—thus leaving a clear space between the two roofs (Fig. 4). In order to partly close the $1\frac{1}{2}$ in. space in front, a small lath $\frac{3}{4}$ in. wide and $\frac{1}{2}$ in. thick is fastened across the centre of it.

8. *Position of Thermometers.*—The position of the thermometers in the screen is to be the same as described in the "Hints to Meteorological Observers," page 10.

The upright for the dry and wet bulb thermometers, which is $2\frac{1}{2}$ ins. wide and $\frac{1}{2}$ in. thick, is let into the middle of the back of the centre bottom board; and those for the maximum and minimum thermometers are screwed to the front of it. The upper ends of these uprights are screwed to a fillet attached to the under side of the inner roof.

9. *Painting.*—Previous to being put together, all the different parts should be painted with two coats of white lead paint; and when completed, the whole screen should receive a finishing coat composed of white zinc paint and copal varnish.

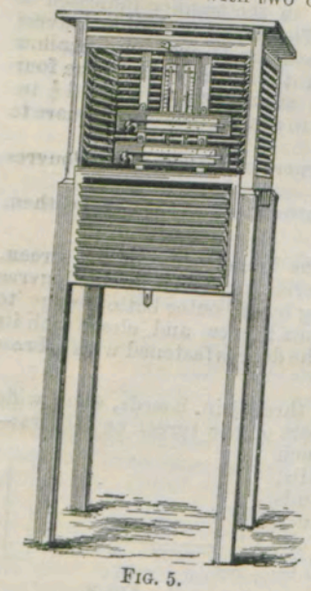


FIG. 5.

We now reproduce the remarks as to erection of the screen, given in the "Hints to Meteorological Observers," 3rd edition.

The screen should be placed over short grass in a freely exposed situation; it is desirable that it should never be in the shade or within 7 feet of any wall, especially of one having a southerly aspect. It is to be mounted on four stout posts, with the door opening to the north (Fig. 5), so that the bulbs of the dry and wet thermometers shall be 4 feet above the ground. The thermometers should be suspended on uprights near the middle of the screen, the maximum and minimum being in front of the dry and wet, and arranged in such a way that the scales of the latter can be seen above or between the two former. It is desirable that the screen be repainted during the spring of each year.

FRANCE.

The screen used at the French stations is constructed on the plan proposed by MM. C. Sainte-Claire Deville and Renou.

It consists (Figs. 6 and 7) of a double roof, formed of wooden boards covered with a sheet of zinc. This double roof is supported by four wooden posts, each pair being alike, driven into the earth at the top of

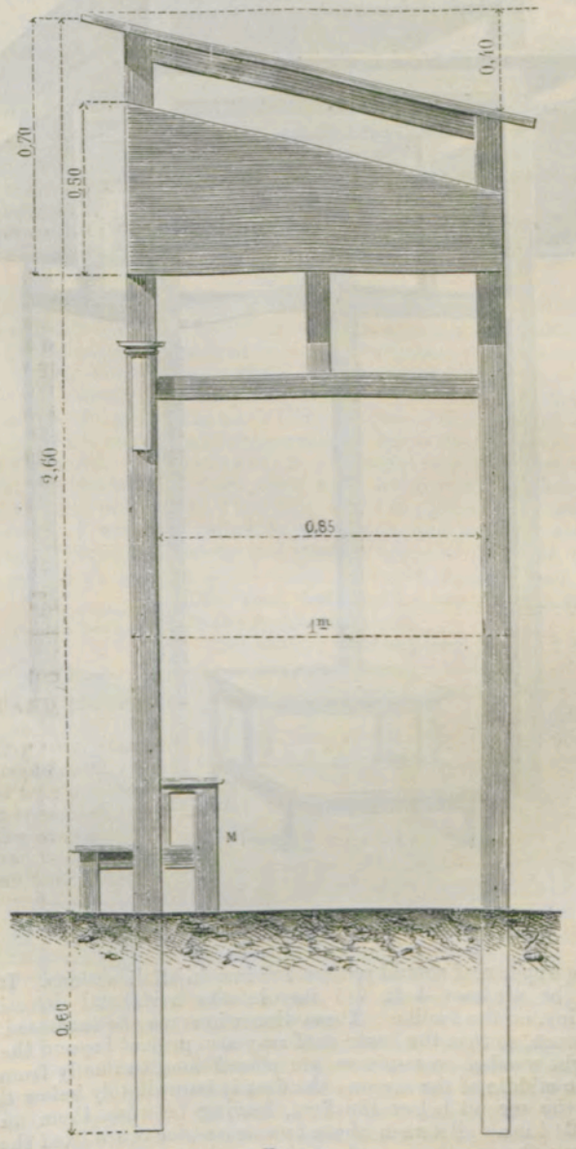


FIG. 6.

a square of 39·4 inches a side, and of which the sides are respectively parallel and perpendicular to the geographical meridian. The two large posts are on the north side of the square, so that the incline of the roof is directed from north to south. The length of these posts, exclusive of

the part driven into the ground (about 23·6 inches) is 8 ft. 6·4 ins. for the large ones and 7 ft. 2·6 ins. for the small ones. The space between the two roofs is 7·9 inches. The lower roof may be limited to the four

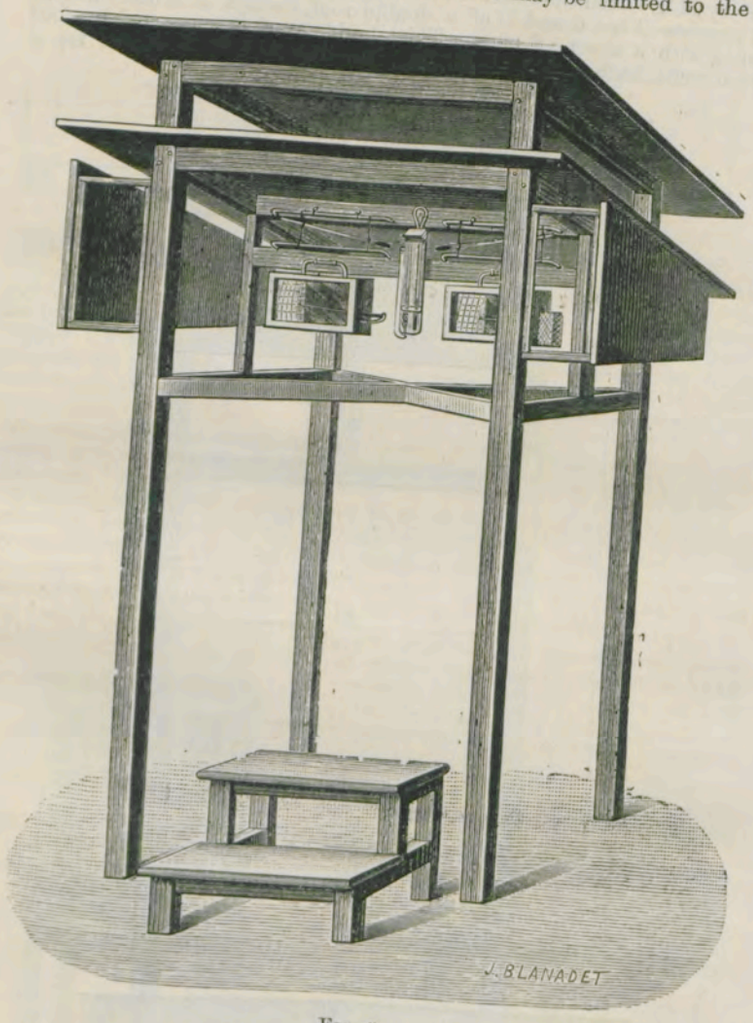


Fig. 7.

posts; the upper roof should project 7·9 ins. in all directions. It should, therefore, be at least 4 ft. 7·1 ins. in the horizontal direction, and 4 ft. 10·3 ins. on the incline. These dimensions may be increased without inconvenience, so that the lower roof may also project beyond the posts.

Two light wooden cross-pieces are placed longitudinally from east to west in the middle of the screen; the first is immediately below the lower roof, and the second below the first, leaving between them an empty space of 2·4 ins. Between these two cross-pieces are fixed the frames which carry the maximum and minimum thermometers. The dry and wet-bulb thermometers are fixed exactly in the middle of the screen, so that the bulbs are at a distance of 5 ft. 11 ins. to 6 ft. 3 ins. from the ground. Lastly, at stations possessing Richard instruments, the thermometer and hygrometer are suspended, by the handle of their box, to two open screw rings screwed into the upper cross-piece. The bulb of the

self-recording thermometer, and the bundle of hairs of the hygrometer, is thus on the same level as the bulbs of the dry and wet thermometers.

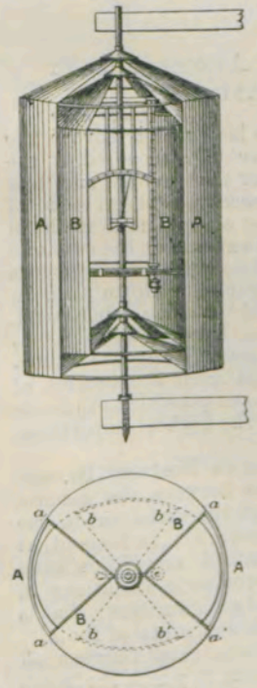
As these thermometers may be reached by the sun in the morning and evening, care should be taken to protect them laterally by a solid wooden shutter, hung laterally, as shown by Fig. 6, at 7·9 ins. off the screen. This shutter descends just to the level of the bulbs of the thermometers; on its upper edge it stops from 0·8 to 1·2 ins. below the lower roof. As shown by Fig. 6, a shutter may be fixed on each side of the screen. But in order to prevent all reflexion upon the inner side of the shutter, it is preferable to use only one, which is hung on the eastern side of the screen after sunset, and on the western side after noon.

All the parts of the screen are painted in light grey. Below the screen should be grass; two little steps, placed on the south side, allow of reaching the height of the thermometers when reading. Lastly, it is recommended to arrange, at a certain distance to the east and west of the screen, a thin curtain of evergreens, to prevent the sun striking directly upon the screen, without, however, obstructing the free circulation of the air.

Russia.

The thermometer screen used in Russia has been described by Dr. H. Wild in a memoir entitled *Aufstellung der Thermometer zur Bestimmung der Wahren Lufttemperatur* inserted in the *Repertorium für Meteorologie*, vol. vi., No. 9 (St. Petersburg, 1879). In its general features the screen resembles the French one, but it is higher. It consists of four wooden posts sunk into the ground so as to form a square, the sides of which are 59 inches, and are parallel and are perpendicular to the meridian. The two posts on the north side are 14 ft. 9 ins. high and those on the south, 13 ft. 1 in., exclusive of the part sunk into the ground. These posts are joined at the top, and also at 9 ft. 10 in. above the ground, by cross-pieces.

The roof is of wood, is nailed to the posts, and projects about 4 ins. on all sides. Above the eastern and western edges of this roof, two ledges about 4 ins. high are fixed, to which a second wooden roof is nailed. The space between the two roofs is freely open to the north and south.



Figs. 8 and 9.

The eastern and western sides of the screen are fitted with louvres which reach from the lower roof as far as the cross-piece which joins the corner posts; they therefore end at a height of 9 ft. 10 ins. from the ground. Lastly, to the exterior and interior of the two posts of the south side, boards which form a double solid partition upon this side are nailed from the bottom of the roof to the same height of 9 ft. 10 ins. The screen is painted white.

The two lower cross-pieces of the east and west sides are joined at the centre by an intermediate rail. Lastly, from the centre of the upper cross-piece of the south side a wooden bracket projects to the middle of the screen. Between this bracket and the intermediate rail a second metal screen is placed, which contains the thermometers.

The second screen is constructed in the following way:—In the centre a vertical iron axis is provided with the fittings necessary for supporting the instruments (dry and wet bulb thermometers, minimum thermometer, and hair hygrometer). These instruments are enclosed by the segments of two zinc cylinders, A B, having a conical roof, and also a conical bottom pointing upwards. These two cylinders are borne by the central axis, and can move round it. They are shown in perspective in Fig. 8 and in section in Fig 9.

The interior cylinder B is elliptical, and is supported upon the axis, so that the instruments occupy the centre of the cylinder in the direction of axis major; the instruments can, therefore, be read at the open spaces b, b^1, comprised between the two segments of this inner cylinder.

The outer cyclinder, A, is circular and has a diameter slightly greater than the major axis of the inner cylinder; its diameter is 18·1 ins. and its height. 23·6 ins.; it is formed of two segments, $a\ a$, $a^1\ a^1$, larger than openings $b\ b^1$ of the inner cylinder. This cylinder can turn round the vertical axis; and in the position of Fig. 9, it leaves the openings of the interior cylinder free, and does not interfere with the reading of the instruments; but if, on the contrary, it is turned through 90°, its two segments completely enclose the openings b, b^1 of the inner cylinder; the same thing holds good with respect to the corresponding segments of the roof and bottom, so that the instruments inside are completely protected on all sides without obstructing the circulation of the air. At the stations situated in the southern governments of Russia especially, it is recommended to replace the bottom of the small metallic screen by a ventilator, which is put into action for two minutes before each observation (*Repert. für Meteorologie*, vol. x., No. 4).

The outer cylinder is always placed in such a way as to keep the openings of the interior cylinder closed, except at the time of observation, when it is momentarily turned in the position shown by the figure, in order to read the instruments. Access is gained to this small screen by means of a ladder attached to the large wooden screen above described, and in the centre of which the small metallic screen is placed. In the more recent instructions, it is directed to keep the ladder quite independent of the screen, in order to prevent any shaking of the small screen when using the ladder for the purpose of taking the observations.

APPENDIX VI.

On the Centres of Action of the Atmosphere, by Dr. H. Hildebrand Hildebrandsson.

It has been recognised for a long time that the laws which govern the general movements of the atmosphere will never be discovered, if the taking of observations is limited to the surface of the ground, and to a few civilised countries. A commencement has accordingly been made of studying the upper regions of the atmosphere, by observations made in balloons, and at observatories established at great expense at the summits of high mountains. At the same time, observations and measurements of the clouds are now being carried on, according to a uniform plan, in nearly all the meteorological services of the world. On the other hand, Meteorological Conferences and the International Meteorological Committee, have continually urged the necessity of establishing new observatories in the countries which are most distant from the centres of civilisation. It appears to us that it has now become possible to indicate the regions of the earth from which it would be of the highest importance to obtain observations.

In fact, thanks to the labours of M. Teisserenc de Bort and Dr. van Bebber, it is known that a certain relation exists between the general character of the weather of a season in Europe, and the variations in the barometric heights at the surrounding *centres of action*, viz., in Iceland, at the Azores, and in Siberia. Again, Messrs. Blanford and Eliot have pointed out that a relation exists between the barometric variations in India and those which are observed in Siberia and at Mauritius; that is to say, in the centres of action situated to the north and south of India.

It seems probable, therefore, that intimate relations exist between all the centres of action of the earth, namely, the regions in which the mean

barometric maxima and minima are situated. A closer study of these relations would be of the highest importance, and promises even to lead to practical results for the prediction of weather for long periods. But in order to attain this result at some future day, it is necessary to obtain continuous observations (it would be best to have self-recording instruments) from these centres of action. At the present time sufficiently complete observations are being made in three centres of action: Iceland, the Azores, and Siberia. The maximum of the Indian Ocean is well provided for to the westward by the excellent observatory of Mauritius, and to the eastward, on the coasts of Australia, some stations have been established during recent years. But the observations are still very incomplete, or at least very difficult to get, in the South Pacific (Tahiti, Viti-Levu, and Noumea), in the Behring Sea, and in Tierra del Fuego. They have recently commenced in the Sandwich Islands, and do not exist at all for St. Helena. In a word, the *intermediate* regions, such as Europe, India, and North America, are covered with observatories, while the centres of action, from which information would be of the highest importance, are, partially at least, almost unknown regions from a meteorological point of view.

It would, therefore, be extremely desirable that observatories, as completely equipped as possible, should be established without delay in these important regions.

In order to prove this, I have presented to the Conference some results of a provisional investigation into the simultaneous variations of weather over the whole globe. Evidently we cannot hope to arrive at present at definite results in this inquiry; but an investigation of this nature, in an almost unknown field, is at all events indispensable in order to indicate the direction in which more serious researches should be undertaken, and especially to determine what observations should primarily be made, in order that such researches may become possible. From this point of view this work, which has occupied some time, has given some results which are, perhaps, worthy of attention. We shall here give a brief resumé of these results; the paper will very soon be published *in extenso*, with the necessary tables, charts, and diagrams.

We have considered the pressure of the air as being the most important meteorological element. We have studied the differences from the barometrical means for the years 1875-84, at 68 stations, distributed as much as possible over the whole surface of the globe.

We at first calculated for these years the monthly barometrical means for each station, we then ascertained for each month the difference of the air-pressure from the corresponding mean for the 10 years; then we calculated the mean difference for each month, independently of the signs.

I. Mean Differences.

We plotted the mean differences upon 12 charts, one for each month, and drew lines of equal differences.

These charts prove:—

1°. *That the differences are greater in winter than in summer.*

2°. *That the differences increase from the Equator towards the Polar regions.*

3°. *That the greatest differences are found in January and July, in the vicinity of Greenland and Iceland on the one hand, and to the north of Russia, between the White Sea and St. Petersburg, on the other.*

II. Relations between the different Regions.

We have compared the barometric variations in the different centres of action, and also in the intermediate regions. The mean of the differences for several stations in the same region (if there were any) have been calculated for each month, and in order to eliminate accidental disturbances, we have taken, as the difference for the region in question, the mean of the differences for the month under consideration, and of the preceding and following months. Thus the value given for January

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is the mean for December, January, and February; that for February is the mean for January, February, and March, and so on. The results are represented by tables and diagrams.

As a specimen, we here give the table relating to the minimum of Iceland and the maximum of the Azores. The first figures are the mean of Stykkisholm, Beru-fjord, and Thorshavn, and the second are the mean of Ponta Delgada, Funchal, and San Fernando.

—	1875.		1876.		1877.		1878.		1879.	
	Iceland.	Azores.	Iceland.	Azores.	Iceland.	Azores.	Iceland.	Azores.	Iceland.	Azores.
January	+0·181	+0·008	−0·004	−0·039	−0·102	−0·008	+0·020	+0·106	+0·193	−0·063
February	+0·158	−0·032	−0·035	−0·012	−0·134	+0·035	+0·114	+0·091	+0·055	+0·020
March	+0·181	+0 043	0·000	+0·028	−0·008	+0·004	+0·114	−0·024	−0·024	+0·047
April	−0·016	−0·024	+0·020	+0·056	+0·059	−0·047	+0·004	−0·004	−0·004	+0·055
May	−0·134	+0·008	+0·024	+0·060	+0·067	−0·055	−0·004	−0·028	−0·012	+0·024
June	−0·106	+0·012	−0·063	+0·020	0·000	−0·024	+0·012	−0·008	+0·004	0·000
July	0·000	+0·020	−0·122	+0·020	+0·024	−0 024	+0·087	−0·008	−0·008	−0·020
August	+0·114	0·000	−0·012	−0·004	+0·095	−0·032	0·000	−0·024	−0·091	+0·016
September	+0·024	+0·004	+0·063	−0·039	+0·091	−0·028	−0·051	−0·035	−0·071	+0·024
October	+0·114	−0·012	+0·158	−0·102	−0·118	+0·024	+0·032	−0·083	+0·071	−0·028
November	+0·083	−0·030	+0·098	−0·138	−0·224	+0·098	+0·221	−0·150	+0·177	−0·059
December	+0·067	−0·035	−0·004	−0·098	−0·142	+0·130	+0·331	−0·138	+0·189	−0·087

—	1880.		1881.		1882.		1883.		1884.	
	Iceland.	Azores.	Iceland.	Azores.	Iceland.	Azores.	Iceland	Azores.	Iceland.	Azores.
January	−0·024	−0·055	+0·280	−0·130	−0·114	+0·114	−0·106	+0·028	−0·110	+0·024
February	−0·012	+0·039	+0·217	−0·205	−0·150	+0·138	−0·079	+0·012	−0·161	−0·008
March	−0·118	−0·008	+0·095	−0·095	−0·083	+0·126	−0·047	+0·012	−0·126	−0·079
April	+0·004	−0·004	+0·047	−0·055	−0·067	+0 083	+0·039	−0·012	−0·091	−0·043
May	−0·012	+0 008	+0·047	−0·008	+0·087	+0·028	−0·051	0·000	−0·039	+0·024
June	+0·095	−0·016	−0·020	+0·028	+0·004	+0·008	+0·047	−0·008	+0·012	+0·004
July	+0·083	0·000	−0·051	+0·012	−0·071	+0·035	+0·032	0·000	+0·035	−0·012
August	+0·047	−0·016	+0·004	0·000	−0·098	+0·043	+0·016	+0·020	−0·008	+0·004
September	+0·130	−0·043	+0·095	−0·004	−0·055	+0·051	−0·106	+0·051	−0·087	+0·035
October	+0·087	0·000	−0·020	+0·028	−0·095	+0·087	−0·185	+0·067	−0·035	+0·028
November	+0·150	+0·020	−0·150	+0·083	−0·032	+0·063	−0·209	+0·075	−0·091	+0·039
December	+0·169	−0·059	−0·252	+0·114	−0·102	+0·051	−0·165	+0·083	—	—

This table shows not only that the variations are greater in winter than in summer, and increase from the Equator towards the Polar regions, as we mentioned above, but also that *the barometrical variations at the Azores and in the vicinity of Iceland are almost always opposite in sign*, especially when the figures are large.

We have proved in the same way that *the variations in Siberia and in Alaska are also opposite in sign*; the observations, which are unfortunately very incomplete, seem to indicate that *the same opposition exists between*

Tahiti and Cape Horn, viz., between the maximum of the South Pacific Ocean and the antarctic minimum.

We have no observations in the North Pacific Ocean, but there is a good agreement between the variations at San Diego and Key West, which indicates that the influence of the northern maximum of the Pacific extends towards the east as far as Central America and the Gulf of Mexico. The variations at these stations do not agree with those of the Azores, and consequently the curve of Key West is not in opposition to that of Iceland. But it is already known, from the researches of Hoffmeyer, in 1878, that the minimum in the vicinity of Iceland is accompanied by a secondary minimum over Baffin's Bay, and that the variations of this minimum do not agree with those of the principal minimum. In fact, the variations in Greenland do not agree with those of Iceland, while the curves of Greenland and Key West take a sensibly inverse direction, although not so clearly marked as those of Iceland and the Azores.

Thus it seems well established that a kind of oscillation exists in the pressure of the air between a centre of action of high pressure and another adjacent centre of low pressure.

Siberia exhibits a maximum. With regard to the intermediate regions, we know that Europe is influenced by the three adjacent centres of action. That is especially evident in the region of the Baltic. Sometimes the winter in Sweden is mild and rainy, as in Scotland, and sometimes it is severe, as at Moscow; and the curve for Upsala is the most irregular of all. Central Europe, on the contrary, is especially influenced by the Azores.

As we have stated above, Blanford pointed out a long time ago that the fluctuations of the barometer in India and Western Siberia are generally opposite in sign. Mr. Eliot has recently made the same remark with regard to India and the Mauritius Observatory. We have found, however, that the inverse range is more pronounced between India and Siberia than between India and the Indian Ocean. But it is strange that there is a rather remarkable resemblance between the barometrical variations in Siberia and at the Azores on the one hand, and in Siberia and the Indian Ocean on the other.

III. Monthly Charts.

We have plotted the differences for each month of the ten years 1875–84, upon charts, and we have added the twelve months of 1874, making altogether 132 charts. The differences above the mean of the ten years for the month in question are in red, and those below the mean are in black. We found the unexpected and surprising result *that the differences with the same sign almost always extend over very considerable surfaces.* In fact, in January 1874, the barometrical pressure was below the mean over the Northern Hemisphere, and above it over the Southern Hemisphere. In June 1880, the reverse took place. In November 1884, and in December 1878, the division occurred rather along two meridians. But the line of separation between the high and low pressures presents considerable sinuosities. In November 1880, and in March 1881, there was a large band of high pressures all round the earth, with low pressures in the Polar regions.

In examining the charts from month to month, we have not been able to trace any law for the successive transformations. The sinuosities of the curve limiting the high and low pressures are transformed sometimes in one sense and sometimes in the other, in the most irregular manner. The tendency to an opposition between certain centres of action, which we have shown to exist above, is generally shown upon the charts. Thus the Azores and Iceland, for instance, have most frequently opposite signs, and if they have the same sign, it is then found that the difference is very slight in one region and very considerable in the other. But there are variations of a higher order which tend to mask the more simple relations between the adjacent centres of action. At the present time the laws of these great changes are quite unknown.

But above all it is indispensable that new observatories should be established in distant parts, and especially in the different centres of action of the atmosphere.

APPENDIX VII.

Note on the Queensland Weather Service, by Mr. Clement L. Wragge, Meteorologist to the Government of Queensland.

Since the last Conference we have made great progress in the meteorological service of the government of Queensland. I have travelled much during the last eight months in northern, western, and central Queensland to inspect stations and to establish others. We have now 17 stations of the First Order, 34 of the Second Order, 80 climatological, and 500 rainfall stations. We have also stations in New Caledonia, The New Hebrides, and in Lord Howe and Norfolk Islands. We continue regularly to send weather forecasts to each colony and to New Caledonia, the per-centage of success being from 85 to 90; the forecasts are also telegraphed to the newspapers, and to Noumea, New Zealand, and Tasmania.

I desire specially to thank our much esteemed friends in New Caledonia, for instance, M. Pottier, principal apothecary at the Military Hospital, Noumea, and M. Marie, chief of the submarine telegraph station at Zomen, for the very valuable observations which they send twice daily to Brisbane.

We publish an isobaric chart daily for the whole of Australasia and the adjacent seas, and also a large chart which covers the region lying between lat. 40° N. and 55° S., and between long 30° E. and 130° W. We receive regularly observations from captains of vessels, which are corrected as may be necessary, from correspondents in Hawaii, Japan, China, East Indian Archipelago, India, Ceylon, &c. We have also established a great international service for observations of ocean currents. I have the honour of submitting to the Conference specimens of the forms and publications of the Brisbane office. We have also many cloud photographs.

(Signed) Clement L. Wragge,
Government Meteorologist and Director of the Office.

September 21st, 1896.

APPENDIX VIII.

The Use of Kites for elevating Self-recording Meteorological Instruments at Blue Hill Observatory, Massachusetts, U.S.A., by A. Lawrence Rotch, Director.

Kites have been used for this purpose at Blue Hill since August 1894, but recently important improvements have been effected in the kites and apparatus. The kites are either of Hargrave's cellular construction, or of Eddy's Malay tail-less type. Figs. 9 and 10. They have various dimensions,

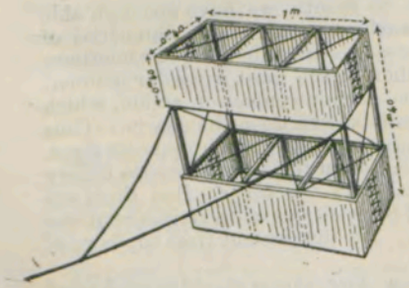

Fig. 9.

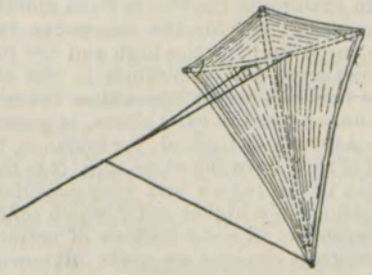

Fig. 10.

those shown in the accompanying drawings representing average sizes. The proportions, however, must be exact. The frames are of spruce wood, and, in the Hargrave, the principal members are 1 centimetre square; in the Eddy, fig. 10, they have a T cross-section of about 45 square millimetres, and their ends are connected by cord. The frames are covered with nainsook cotton cloth, and the kites, complete, weigh about 600 grammes per square metre of lifting surface. These kites fly in winds varying from 6 to 15 metres per second, and in all kinds of weather.

Several of these kites are attached by independent cords to a steel wire, 0·7 millimetres in diameter, weighing 3·1 kilogrammes per kilometre, and having a tensile strength of 109 kilogrammes. The wire is coiled upon a drum which revolves when the kites are rising, and which two men turn to lower the kites. A counter measures the length of wire uncoiled.

Self-recording instruments record the meteorological conditions upon cylinders turned by clock-work. The meteorograph, constructed by M. Richard, of Paris, weighs only 1,270 grammes, and records atmospheric pressure, air temperature, and relative humidity—see *La Nature*, 8th February 1896. That made by Mr. Fergusson, of the observatory, weighs less, and records air temperature and wind velocity. One of these instruments is suspended from the wire between two of the highest kites, and its altitude is measured by triangulation, fig 11.

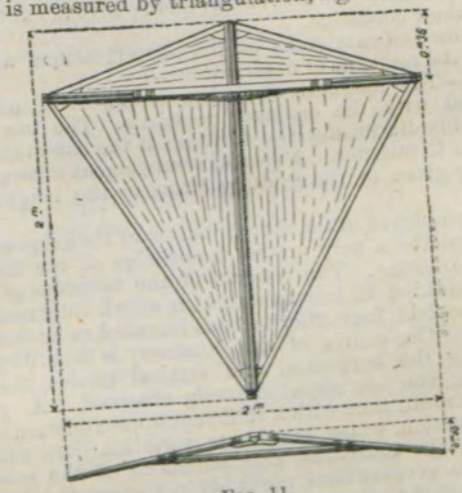

Fig. 11.

Several good records have been obtained at heights exceeding 2 kilometres, and the altitude of clouds has been measured in this way. The greatest height reached in October 1896 was 2,650 metres above the summit of Blue Hill, or 2,840 metres above the neighbouring ocean. The length of wire in the air was 5,470 metres, and nine kites, presenting a total surface of 15·8 square metres, were used, giving a maximum pull at the ground of 45 kilogrammes.

The discussion of the observations made during the past year, with a description of the method employed, will be published as an appendix in the Blue Hill observations for 1896, in the Annals of the Astronomical Observatory of Harvard College.

APPENDIX IX.

Note upon French Portable Magnetic Instruments, by M. T. Moureaux.

The difficulties of conveying ordinary magnetic apparatus are the principal obstacles to the multiplication of the observing stations and the extension of the surveys. This main inconvenience has been obviated in France for the last 13 years by the introduction of two really portable travelling instruments of satisfactory construction. One of these instruments serves for the measurement of the declination and the horizontal component, and the other of the inclination.

The detailed description of these instruments having been already published,* it is unnecessary to repeat it here. The circles are divided into half degrees, the verniers read to minutes, and the half minutes may be estimated, which is a sufficient approximation for field determinations. The total weight of the two instruments, enclosed in their boxes, does not exceed 13 lbs. Under these conditions, the observer can choose his stations, and take up a position, without too much trouble, at a suitable distance from accidental disturbing influences. He can also keep the instruments with him when travelling, and so save much time in verifying or rectifying their condition.

We shall now indicate some of the simplifications which have been introduced in the methods of observation:—

Declination.—The magnetic meridian is observed under the usual conditions, and with the ordinary reversals. The use of short bars, however, notably diminishes the duration of the observation, which only lasts from 12 to 15 minutes. A special arrangement allows of all desirable precision being given to the readings although the length of the bars is only 2½ inches.

The method employed in the determination of the geographical meridian does not necessitate a very precise knowledge of the time, a condition which is very irksome. The reticule of the telescope of the theodolite comprises, in addition to the two threads which intersect each other in the centre of the field, four other threads intended to enclose the apparent disc of the sun. The centre of that luminary is thus directly observed, and, by reading the horizontal and vertical circles, the altitude and azimuth of the sun are simultaneously observed. A good ordinary watch gives the mean time with a sufficient approximation for calculating the sun's declination, whose maximum variation does not reach 1′ per hour. In fact, the individual determinations of the azimuth reading corresponding to geographical north do not generally differ more than half a minute from their mean.

Horizontal Component.—The method supposes that necessary precautions have been taken for establishing, as far as possible, uniformity of temperature between the external air and the box containing the magnet. The apparatus will of course be protected from the direct action of the solar rays.

In determining the product H M., the correction due to torsion may be obviated by the judicious choice of a very fine thread; nor will there be any reason to take into account the correction due to the amplitude of the oscillations if, at the beginning, this amplitude does not exceed 1°.

The measure of the ratio $\frac{H}{M}$ also requires certain corrections.

The magnetometric coefficient is determined previously at the observatory itself; it is deduced from a large number of experiments made during periods of magnetic calm. By considering this term as constant, and introducing it directly into the calculation, we escape the necessity of observing the deviations at the second distance.

* *Annales du Bureau Central Météorologique* for 1884, Vol. I.

The influence of dilatation of the supporting arms and bars, involving a correction of less than 0·0002 for a difference of 10° in temperature, may in most cases be disregarded.

The temperature correction may be reduced to a minimum if the apparatus be placed in the shade, and the observations of deviation are preceded and followed by a series of oscillations of the magnet.

Lastly, the coefficient of induction may be established at the outset, and considered as constant, if the magnetic intensity of the bars does not diminish to any sensible extent.

Account must also be taken of the variation of the horizontal component during field measurements, by comparison with the curves of the magnetograph of the base station.

To sum up, if we omit corrections whose influence upon the final result is comprised in the errors of observation, and if the different constants are united in a single constant C, we shall only have to take account of the time t of an oscillation, and of the angle of deviation α at the lesser distance.

The formula for calculating the horizontal component H is therefore expressed by:—

$$H = \frac{C}{t\sqrt{\sin \alpha}}$$

$$\log H = \log C - \log t - \tfrac{1}{2} \log \sin \alpha.$$

And if it has not been possible to secure properly the uniformity of temperature between the observations of oscillation and those of deviation, the final expression may be replaced by the following:—

$$\log H = \log C - \log t - \tfrac{1}{2}\{\log \sin \alpha - \log [1 + c\,(\theta - \theta')]\}$$

in which c is the coefficient of temperature previously determined, θ is the temperature during the oscillations, and θ' the temperature during the deviations.

The method is doubtless not absolutely rigorous, but we are liable to no greater errors than in calculating certain corrections. It appears to be somewhat difficult, for instance, to be sure that under the various conditions that an observer in the field meets with, that the temperature of the magnetised bar is exactly that shown by a thermometer placed near it.

Inclination.—The inclination is obtained by the direct method, with all the usual reversals. Two concave mirrors, fixed at the extremities of a diameter of the vertical circle, allow of great precision being given to the readings. Moreover, Brunner's needles are of such accuracy that the angles observed in the different positions of the needle or of the instrument agree to within a few minutes.

Two hours are sufficient to observe the complete series of magnetic elements at one station, but whenever it is possible, the observations should be repeated with a second magnet. In fact, during my different explorations in France, I have nearly always determined the three elements at two different stations in the same day.

APPENDIX X.

On the Employment of Quartz Fibres in Magnetometers by Mr. C. V. Boys, F.R.S.

* This memorandum will be published by the Committee on Terrestrial Magnetism and Atmospheric Electricity.

APPENDIX XI.

Notice by Dr. Eschenhagen, of Potsdam, on Simultaneous Magnetic Observations.

The Magnetic Association under Gauss and Weber instituted a system of taking accurate simultaneous term observations of magnetic variations on an extensive scale, and it was agreed to observe on term days every five minutes.

The stations which, according to international agreement, took part in the Polar exploration in the years 1882–83 undertook readings every 20 seconds during certain hours, in addition to the observations taken every five minutes. Latterly (in the years 1895 and 1896) attempts have been made to reduce the intervals of observation still more, as readings were made every five seconds. (See Terrestrial Magnetism, 1896, No. 2.)

After some experiments had been made at the observatories of Wilhelmshaven and Potsdam, the observatories at Pavlovsk, Kiel, Wilhelmshaven, Potsdam, Utrecht, Göttingen, Kew, Darmstadt, Paris, Vienna, Pola, Washington, Manilla, Batavia, and Melbourne took part in the observations, at the request of the Director of the Royal Prussian Meteorological Institute, and made observations of the declination and intensity every five seconds during one hour on four days. Among the observations for these four term days, those for February 28th, 6h.–7h. p.m. Greenwich time, have furnished the most interesting results.

From the curves drawn from the figures so obtained, and which will be published later on, we learn that the observations made at extra-European stations show that no relation is recognizable between these and those made in Europe, while in the case of the observations made at the different European stations, a connexion is plainly visible. The curves at adjacent stations show transitions very clearly.

While, for instance, the curve at Pavlovsk, with regard to the occurrence of the maximum and minimum, appears to differ very considerably from the other European stations, it is found, on a closer comparison, that here the principal extremes, which at the other stations fall at nearly the same epochs, are retarded, while the secondary extremes of the latter have developed themselves to maximum and minimum values.

If comparison is made between stations lying closer together, *e.g.*, Paris and Darmstadt, or Kew and Utrecht, we are likewise led to believe in such a metamorphosis. For instance, at most stations a principal maximum of declination occurs about 6h. 13m., and a secondary maximum about 6h. 17m., but at Kew and Paris the latter becomes a principal maximum.

It would be interesting to ascertain the cause to which such differences are attributable. The further study of these changes will perhaps form the starting point for the comparison of more distant stations, and give a key to the explanation of the not inconsiderable differences which occur, especially at Polar stations.

The small oscillations which occur at Washington and Pola, as well as at Utrecht and Wilhelmshaven, are noteworthy. We do not know at present to what extent these are to be ascribed to instrumental causes.

At all events, the results hitherto obtained make it desirable to continue these investigations. It is, perhaps, important to use similar instruments at all stations, and a simple magnetometer, with a small, strongly-damped needle of short duration of oscillation might be most suitable.

By fitting this instrument with a quartz fibre, it might be used as a very sensitive intensity-variometer, if the needle is directed at right angles to the meridian by turning the upper suspension. The instrument thus replaces a bifilar, and is well adapted for a recorder with great acceleration. At Potsdam the length of an hour was 24 centimetres. (See Sitzungsbericht der Preussischen Akademie der Wissenschaften, 30th July 1896.)

But in order not to collect more observations than it would be possible to discuss, it might be advisable to observe only at a relatively small number of term hours in the year. One hour in each month should be devoted to the simultaneous observations, or to take them more frequently at the epochs of the maximum disturbances (February, March, October, and November).

These investigations would also possess special interest for magnetic surveys, as the simultaneous observations show to what distances the variations at distant observatories might be used for the purposes of reduction.

APPENDIX XII.

Registration of Atmospheric Electricity in the Vicinity of the Summit of the Eiffel Tower, by M. Chauveau.

These experiments were commenced in the month of August 1892. In order to complete the regular observations made at the Eiffel Tower since 1889, the Central Meteorological Office of France wished to have in the vicinity of the summit an ordinary electrometer, with a water-dropping collector, whose indications might be directly comparable with those obtained near the ground at some hundreds of yards from the tower, by the apparatus in to the central office.

The metallic cistern, forming the water reservoir, enclosed in a solidly constructed oak box, is placed above the platform of the third story, at the extremity of one of the four archways (western archway) which support the lantern of the signal-tower. Its altitude is about 935 feet. The conducting pipe projects beyond the metallic framework of the archway, about 20 feet above the terrace.

Under these conditions, and although the collecting jet is produced entirely within the imaginary surface which would connect the points of the lateral lightning-conductors of the terrace with the central lightning-conductor erected on the summit, the intensity of the phenomena observed at about 5 feet from the framework of the tower is about 30 times greater than in the neighbourhood of the ground, and the potentials measured frequently exceed 5,000 volts. The water-dropping apparatus, therefore, behaves like a statical machine of low energy, and constantly gives very appreciable sparks, as with a clear sky their length may exceed 0·04 inch.

Immediately below the archway, among the light constructions erected upon the terrace, a small dark chamber has been fitted up for the reception of the electrometer and photographic recorder. The latter consists of a Richard cylinder, mounted horizontally, and revolving inside a metallic envelope, on which is a narrow slit along a generatrix. The photographic paper is rolled round the cylinder, the sensitized face being applied to the metal in such a way that the back of the sheet is presented towards the light. Perfectly sharp curves are obtained through the thickness of the paper, and in this way the contact of the fingers on the sensitized face is obviated, which would otherwise be unavoidable while the sheet was being put on.

The electrometer is connected with the collector by means of an insulated metal stem, which passes through the side of the chamber, and at the outside end of which is fixed a metallic wire more than 17 feet long, quite in the open air, connecting this stem with the support of the collecting tube.

It may seem difficult under such conditions, and with such considerable differences of potential, to ensure the insulation of the different parts of the apparatus in a continuous manner. But at this altitude the absence of dust in the air increases in a singular manner the efficacity of the usual insulating supports, and we have been able to use indifferently, with equal success, either paraffin insulators, or glass insulators dried with sulphuric

acid. Both have remained in continual use for more than six months without losing any of their insulation.

The real difficulty lies in measuring these high potentials.

For the registration of atmospherical electricity, no other instrument seems to answer better than Professor Mascart's symmetrical electrometer, but in practice it presents, in the usual form, an inconvenience which has often discouraged observers: viz., the displacement of the zero. We have succeeded in obviating it by the following arrangement. In the glass vessel containing the sulphuric acid, and in which the conductor is plunged, a smaller vessel is placed, weighted with mercury, and containing glycerine. The stem of the needle dips into this liquid, without touching the mercury. A platinum rider thrown over the edges of the vessel establishes a conducting communication between the sulphuric acid and the glycerine, by means of which the needle is charged.

In the instrument which we have used, and which is insulated in a very remarkable manner, the very heavy needle (154 grains) is suspended by a hook about a quarter of an inch in size. The bifilar, whose torsion couple is thus rendered very considerable, is formed of two carefully untwisted silk threads.

This arrangement allows of the measurement, with sufficient accuracy, of potentials increasing to about 2,500 or 3,000 volts. If it is wished to go beyond that, the sensibility decreases when the charge increases, and the deviation of the needle attains a limit value corresponding to an *apparent* potential at near 4,000 volts. In reality it then passes through a maximum, and afterwards decreases. This apparent limit of the charge, independent of the difference of potential of the sectors, varies in the same sense as the torsion couple, and diminishes when the sensibility of the bifilar increases. It may thus vary on the same instrument from 4,000 to 2,000 volts if the upper distance of the suspension threads is reduced from a quarter of an inch to ·04 inch. This remark is important, for it shows immediately that the state of insulation of the apparatus counts as nothing in the existence of the limit of deviation.

We have shown that this phenomenon, previously pointed out by Mr. Hopkinson, and afterwards by Messrs. Ayrton, Perry, and Sumpner, with quadrant electrometers of quite another pattern, is a consequence of the more complete theory of this instrument, given by M. Gouy. It results in reality from the existence of the directing electric couple, and from the fact that it is practically impossible to obtain a perfectly rigorous symmetry of the system formed by the needle and the sectors.

In order to make use of the electrometer in measuring potentials above 3,000 volts, and at the same time keeping within the limits of charge assigned to its use, we have had recourse to the following artifice: we interpose between the source and the electrometer a series of small well-insulated condensers. The first armature is connected with the collector, the last with the ground, and the one before the last with the electrometer. By varying the number of the elements of the series, we can thus give to the needle such fraction of the primitive potential as may be desired.

The experimental process, of which we can here only mention the principle, has given excellent results, and, during the two seasons of 1893 and 1894, we were able to record continuously the differences of potential between the metallic framework of the tower and a point situated about 5 feet from its surface. The daily maxima, in clear weather, might exceed 6,000 volts.

The arrangement usually adopted for the water-dropping collector presents the serious inconvenience of producing a jet of variable length, according as the level of the liquid in the reservoir becomes lower. Consequently, the position of the point explored is not fixed. We have remedied this by giving to this reservoir the form of a large shallow vessel, terminated below by a tube of 2 to 3 feet, the length of which represents the charge, which is nearly constant, from which the dropping of the water goes on. The apparatus rests, by the bottom of the basin, upon three glass insulators.

Instead of a pipe with a single orifice, we use a kind of small watering rose, pierced with a few very small holes. The flow is regulated so that

under the minimum charge, represented by the height of the vertical tube, the jets may be very short. Owing to their extreme fineness, they are immediately disseminated into small drops, and the influence of the wind upon the position of the point explored becomes negligeable.

The drops of water being very small, this arrangement has the further advantage of increasing the electric discharge for the same expenditure of water.

The employment of this collector has allowed us to use very short tubes, giving a measure of the potential at 16 to 20 inches from the surface in a region where, the equi-potential lines being extremely close together, the variations of length of the jet are of considerable importance. The mean potential is then below 2,000 volts, and we have thus been able to check, by direct electrometric measurements, the results obtained with long tubes, by the method of the series of condensers.

Since 1892 the experiments have been resumed each year during the period of the regular working of the lifts. Unfortunately, it is impossible to continue them during the winter; the water would fail, and the maintenance of a flame, however much it might be protected, would not be possible at such an altitude. Besides, the continual supervision that the apparatus requires, by necessitating daily ascent of 1,800 steps which lead to the summit, is of a nature to discourage the most devoted observers.*

APPENDIX XIII.

Report upon the Reduction of Anemometrical Observations, by Dr. A. Sprung.

The following resolution was adopted at Munich in the year 1891:—

"The Conference is of opinion that it is desirable to give in the tables wind velocities in metres per second, the values to be obtained from the instrumental indications by means of a formula of reduction of which the constants have been determined either directly or indirectly."

The construction of this resolution is rather far-reaching.

The constant 3 of the Robinson's formula, viz.:

$$V = 3A$$

where V is the wind velocity, and A the velocity of the centre of the cups of the anemometer, can certainly be reckoned among the constants which are determined directly or indirectly. In fact, the anemometrical records of many observatories are still reduced by this simple formula.

But this formula gives values which are generally higher than those obtained by the strict formula, and so the velocities deduced from the two formulæ are not comparable.

In the case of the first *ad interim* anemometer used at Potsdam, for instance, of which one revolution of the cups measured 1·111 metres, the respective relations were as follows:—

No. of Contacts per hour.	Wind Velocity in Metres per Second according to the	
	Correct Formula.	Robinson's Theory.
0	0·9	0·0
50	6·8	6·9
100	12·3	13·9
150	17·4	20·8
200	22·1	27·8
250	26·4	34·7

* For the general results relating to the diurnal variation, see *Comptes Rendus de l'Académie des Sciences*, Vol. CXVII., p. 1069 (26th December 1893).

and for the new arms, one revolution measured 3·333 metres, the following formula was deduced :—

$$V = 0{\cdot}50 + 2{\cdot}504\ A$$

so that all the indications were nearly one sixth less than those by the Robinson formula.

There is no doubt that we must gradually adopt rational methods, because it would be a retrograde step if the observatories which have recently been established reverted to Robinson's theory for the comparison of the indications.

Owing to the courtesy of Dr. Neumayer, Director of the Deutsche Seewarte, however, it is quite possible to make use of a rational formula for reduction, because the small and portable Recknagel anemometer is being constructed at the Seewarte under his supervision, and carefully compared on the rotating apparatus. Dr. Neumayer is willing to furnish to those interested in the subject either the data obtained from the trial, or the formula calculated at the Seewarte.

In order to deduce the constants of the revolution of the cups of any anemometer already erected it is only necessary to give this little verified anemometer a corresponding exposure for a short period. At Potsdam, for example, it is erected about one metre above the other instrument, the arms of which project about eight metres above the parapet of the tower.

With regard to the formula for reduction, I have arrived at the conviction that it is desirable to omit the squared term of the equation which is frequently employed,* for the coefficient of this value is generally uncertain, so that it ought not to be used in deducing the velocity. And in the process of extrapolation values are sometimes obtained which are quite absurd. This never occurs with the linear formula, which is also much more convenient. If the velocity is very high, one can never obtain correct absolute values by the ordinary means, but very good comparisons can be got by the method I have indicated.

I therefore venture to submit the following propositions to the Conference :—

1°. The reduction of anemometer records shall in future everywhere be made upon the basis of the small, portable anemometer which was introduced and verified by Professor Neumayer at Hamburg.

2°. The simple linear formula to be used for reduction is :—

$$V = a + b\,A.$$

where A indicates the velocity of the cups of the anemometer and V the wind velocity.

APPENDIX XIV.

On the employment of the Hypsometer in determining the Pressure of the Air and the Correction for Gravity for Mercurial Barometers, by Professor Mohn.

The correction for gravity which must be applied to the height of the mercurial barometer in order to obtain the true pressure of the atmosphere, makes it necessary to know the true value of gravity. The recent geodetical surveys have shown that the actual gravity of any locality generally differs more or less from that calculated according to the formula

* Dr. Neumayer has informed me personally that he has also arrived at the same opinion in his detailed work on anemometry (which it is to be hoped will soon be published). I may mention that I have known cases where the course of the curve furnished by the small Recknagel anemometers has been such that the use of the linar formula was compulsory. It may also be remarked that the re-determination of the constants of two such anemometers on the rotation apparatus at St. Petersburg has resulted in a very good agreement with the values obtained in the Hamburg experiments. (Repert. für Meteor., Band XI.)

those which we have adopted. Although the difference between the true and the calculated value of the correction for gravity is not large, yet it may exceed ·002 in., which is the value we wish to retain as the proper limit of accuracy in our barometrical observations. Hitherto we have had to seek for the values of the gravity corrections by means of the observations obtained from the oscillations of a pendulum.

But it would be impossible to have such observations at all meteorological stations possessing a barometer. Under these circumstances I have thought that it would be important for meteorologists to find another means of determining this correction, so that each meteorologist might be able to determine the gravity correction for each station by a more simple and, so to speak, a more meteorological method than by the oscillations of the pendulum.

The recent development of thermometry, for the advancement of which we are chiefly indebted to the International Bureau of Weights and Measures at Bréteuil, has rendered it possible to carry out the idea of determining the pressure by observing the boiling point of water by means of a very delicate mercurial thermometer. The boiling point in degrees, converted, for instance, by Broch's or Wiebe's tables into millimetres of pressure, gives the absolute pressure. The height of the mercurial barometer, correctly reduced, gives the pressure minus or plus the correction for gravity. Thus the difference in millimetres between the readings of the two instruments gives the required correction for gravity.

I have received from M. Tonnelot two thermometers graduated from 95° to 101° C., each degree being divided into 50 parts. The bulb is about 2 ins. in length and 0·4 in. in diameter. By means of a magnifying glass I can easily read the tenths of a division, that is $\frac{1}{500}$th part of a degree, or 0°·002. That corresponds to a pressure of 0·05 mm.

I have suspended the two thermometers in a telescope tube, fixed above a boiler of 2 ins. in diameter and 2·8 ins. in height, filled with pure water. I always keep the same distance of 1 inch. between the lower part of the bulbs and the surface of the water, and a spirit lamp is placed underneath the boiler. The thermometers are suspended in holes made in an india-rubber plate, which serves as a lid to the telescopic tube. The reading is made by means of a telescope.

When the water has begun to boil, I tap the top of the thermometers with a piece of wood, to overcome a little inertia which always exists. In order to determine the corrections of the thermometers for the different degrees, I have made several sets of comparisons between the boiling point thermometers and the mercurial barometer at Christiania, where we know the gravity and can deduct the true pressure. In the comparisons between 28·74 and 30·32 ins., I only found a mean deviation of $\pm$0·01 to $\pm$0·02 in., between the simultaneous readings of the two instruments. But in each fresh set of comparisons I was suprised to see that the thermometers had increased their negative corrections, or risen, from one set of comparisons to another. The reason of this was quite incomprehensible to me. Last summer I went on a tour of inspection after the end of May, and at all the stations I visited I made comparisons between my check barometer and the boiling point thermometers. Among the stations there are several at which my colleague, Professor Schiötz, had determined the gravity by Sterneck's method, and at which I consequently obtained new corrections for the boiling point thermometers. I must admit that, unfortunately, these corrections have not remained constant, having first risen and then fallen. In the month of August, I found that in Finmark the boiling point thermometers seemed to have retained their corrections very constant.

I think it would be possible, by means of Professor Schiötz's gravity stations, to interpolate the true corrections of the boiling point thermometers for the other stations; then I shall have the gravity correction determined for all the stations visited, with an error which would scarcely exceed a few hundredths of a millimetre.

If the boiling point thermometers could retain their corrections constant, we should be able to find the pressure by their help with a mean

error not exceeding ± 0·02 in., and consequently the correction for gravity with the same accuracy.

It is unnecessary to say how convenient it would be if we could check our barometers at the stations by means of the boiling point of water, instead of having to carry heavy mercurial barometers.

I think it would be important that similar experiments should be made by my colleagues, under other conditions than those I experienced. If we should arrive at an accurate and incontestable method of determining the boiling point of water to about 0°·002, we should have gained much as regards accuracy and convenience. As soon as Professor Schiötz has reduced the pendulum observations which he made this summer, I shall carry out the calculations for all my experiments, and publish the results, together with a detailed account of the method followed, in order to submit them to the criticism of my colleagues and of physicists. If an accurate method be found, we shall attain the end I proposed to myself, and meteorologists will have in their own hands the means of determining the correction for gravity, without having need of pendulum observations.

H. MOHN.

APPENDIX XV.

International Co-operation in prosecuting Work and publishing Results in Ocean Meteorology, by Dr. G. Neumayer, Director of the "Seewarte."

In my opinion it is necessary, in dealing with important questions which are connected with the prosecution of maritime meteorology, to get a clear idea of the manner in which this branch of meteorology has been developed, and of the results that have hitherto been obtained. This is the more necessary for the advancement of the science, because from the very first the idea was to set the organisation of the work on an international footing. The Maritime Conference held at Brussels 33 years ago, and the resolutions at which it arrived, afford the clearest proof of this.* As our present object is to answer questions similar to those which were there discussed and partially solved, we must naturally refer—however cursorily—to those fundamental decisions. The following points were most emphatically urged:—(1) Uniformity in the method of keeping the meteorological log; (2) comparison, *i.e.*, agreement of the instruments used for observing; (3) uniformity, as far as practicable, in the reduction and discussion of the observations; (4) establishment of central offices for the prosecution of maritime meteorology in those countries where the need exists, that is, where there is a possibility of such an organisation, owing to the existence of seaborne trade. The question of the mode of publishing the results was not discussed.

The following extract from the report of that Conference is applicable at the present time, and worthy of consideration:—

> "The Conference, having brought to a close its labours with respect to the facts to be collected and the means to be employed for that purpose, has now only to express a hope that whatever observations may be made, will be turned to useful account when received, and not be suffered to lie dormant for the want of a department to discuss them; and that should any Government, from its limited means, or from the paucity of the observations transmitted, not feel itself justified in providing for their separate discussion, it is hoped that it will transfer the documents or copies of them to some neighbouring power, which may be more abundantly provided, and willing to receive them."

* Abstract of copy of Report of Conference held at Brussels respecting meteorological observations. Ordered by the House of Commons to be printed, 8th of February 1854.

The following countries were represented at that Conference:—Belgium, Denmark, France, Great Britain, the Netherlands, Norway, Portugal, Russia, Sweden, and the United States.

As will be seen, Germany, which did not then exist as a united country, and a number of other maritime states, were not represented. The advantageous results of that Conference were soon perceptible; the importance of the subject was recognised on all sides, and the prosecution of maritime meteorology experienced a powerful impulse. If Mr. Robert H. Scott, the Director of the London Meteorological Office, could, nevertheless, say in his valuable paper,* "Remarks on the present condition of Maritime Meteorology":—

> "The only nations which have systematically pursued the study of the subject since November 1853 have been the United States, Holland, and this country (Great Britain)."

This was due, in a certain sense, to the political circumstances of the ten or fifteen years which followed the Conference.

But it may be mentioned, as supplementary to that statement, that a considerable amount of work was done in some countries, as circumstances allowed, on the basis of the resolutions of the Brussels Conference. We only refer here to the activity of the Flagstaff Observatory in Melbourne (1857–1864), of the Alfred Observatory in Mauritius, and of the Norddeutsche Seewarte at Hamburg (1868–1874). It is unnecessary to enter into more detail here as to what has been done from time to time in the domain of ocean meteorology, especially as this is stated in a competent manner in the above-mentioned paper by Mr. Scott, and can be read at any time.

It appears to us to be more important upon this occasion to recapitulate the opinion expressed by one who, next to Maury, incontestably earned the greatest merit among the scientific men who worked on this subject. We refer to Professor Buys Ballot, the founder and director of the celebrated Meteorological Institute of the Netherlands at Utrecht. That noble mind, without regarding favourable or unfavourable opinions, held firmly to the views expressed in his treatise entitled, "Suggestions on a Uniform System of Meteorological Observations," and "A Sequel to the Suggestions on a Uniform System of Meteorological Observations." These works have gained a high reputation, especially in the subject of maritime meteorology, and an extract from the latter, with regard to co-operation in ocean meteorology, will not be out of place here. On pp. 48 and 49, we read as follows:—

> "The material of the observation is not so well provided that, if distributed over three or four institutes, each, England, France, Germany, even England, to which the lion part belongs, would have a sufficient number of them, in a certain part of the ocean, to be able to derive therefrom the details, and to be certain that these details are not only apparently true. So it might be that another nation had published charts of the same region which gave, or appeared to give, different details, no more true and exact than the other, from the same cause, want of sufficient information.
>
> "Now, we must conclude that even this nonconformity in some points shows us the uncertainty of these points; but it would have been better to join the two sets of observations, and to derive from the whole number a more reliable result. Were the two charts precisely after the same model, every one could combine them afterwards; but such is not always the case, and not always reciprocally. England can make use of the Dutch charts, and Mr. Scott has trusted so much the Dutch sailors that he has done them the honour of inserting their detailed observations into his charts. Would it not have been preferable and less expensive, if one of us had the whole material, and had given only one chart?

* Quarterly Journal of the Meteorological Society, Vol. III., p. 185.

"So our chart of icebergs is, considering the time when it was given out, a good chart, but we are the first to complain of the scantiness of observations recorded. Therefore, when one institute declares that it will study the physiognomy of a district in a given direction, we earnestly implore all other institutes to supply it with all possible information they possess, gratuitously, as we are willing to do."

It must be admitted that the above views and arguments are perfectly valid at the present time, although we must agree that the circumstances of the various countries concerned have changed, and that the position of the science has in many respects altered. Naturally also, in the course of time, modifications have had to be made in the stipulations for the promotion of international co-operation. From this conviction arose the necessity of submitting the principal points to another congress for discussion and possible decision. The first incentive to such a congress came from the Meteorological Conference held at Leipzig, in August 1872. A series of resolutions was there arrived at, which might serve as preliminary to a discussion of the subject of maritime meteorology at the Congress of Vienna. The proposals of the Leipzig Conference were as follows:—

"1st. Thorough uniformity in methods and instruments should be aimed at, in the same measure as for observations on shore. This will be most satisfactorily attained by the chiefs of the central institutes—the establishment of which in all countries, in which they do not already exist, and in which the maritime interests demand them, must be declared as absolutely necessary—entering into relations with each other and agreeing on the separate details, the construction of the instruments, the hours of observation, the journal, &c.

"2nd. Unity of measures and scales is desirable, and to this end the introduction of millimètres for the barometer and the centigrade scale for the thermometer should be aimed at. While, however, the comparison of standard instruments of the individual central stations must be insisted on, the uniformity of scales is at present only declared as desirable.

"3rd. The committee would urge the importance of the co-operation of the Navies, inasmuch as by their assistance, and by the opportunities afforded thereby of completeness in certain observations, the determination of factors and constants is rendered possible, which can be used with advantage for the reduction of certain results derived from the general system of observations.

"4th. With reference to the utilisation of the results, the committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith was the carrying out of the division of labour of the central stations of the individual states. This principle must be recognised as of the greatest importance for the further development of marine meteorology. The overlapping of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development."

At its meeting of the 16th September 1873, the Congress of Vienna adopted the following resolution:—

"In consideration of the fact that it will not be possible to devote to maritime meteorology at the present Congress a comprehensive consideration, corresponding to its importance, but, on the other hand, as it seems that a mutual understanding of the individual maritime nations in regard thereto is necessary, the Meteorological Congress declares that the convening of a Maritime Meteorological Conference is desirable."

The preparations for this Conference were entrusted to the Permanent Committee, who fixed upon London as the place of the Conference, and September 1874 as the date of the meeting.

In consequence of the above resolution, a second Maritime Meteorological Conference took place in London, which adopted the above-mentioned resolutions, and submitted a report upon the proceedings of the

Permanent Committee at Utrecht, appointed by the First Meteorological Congress in Vienna, 1873.*

In addition to certain general resolutions relating to observations at sea, and to the keeping of the meteorological log, the report contained the following stipulations upon the points in question:—

1°. "That it is desirable that every institution should publish the observations and results in such a manner that every foreign institute can incorporate them with its own observations and results in the easiest way possible, that is, by preserving the *number* of observations, together with any means derived from them, for single degrees square.

That it is further desirable that whatever charts be published, the results for single degrees square should be published in a tabular form.

2°. That the division of labour, as regards investigations, can only be carried out by mutual agreement between the several institutions, and each institution should announce to other institutions what investigations it proposes to undertake.

It is very desirable that such divisions of labour should be effected.

3°. That the sailor wants the results of experience alone, and he must receive assurance that his observations have been turned to use. When these results of experience have been given, the theorist may point out the reason why certain routes are the best."

Again, when the Meteorological Congress of Rome considered the question of the re-organisation of maritime meteorology, and adopted the resolutions of the Conference in London, upon which a report was submitted by Mr. Scott, it reiterated its opinion of the importance of prosecuting this branch of investigation. In the reports of the Permanent Committee, which were laid before the Congress, it was stated, *inter alia*:—"The Permanent Committee may point out as an indirect result "of the Conference in London, the recent organisation in more than one "European country, of special offices for the discussion of maritime "meteorology as recommended by the Vienna Congress."†

In connexion with this, we quote the following passage from the end of Mr. Scott's frequently cited article—"Remarks on the present condition of Maritime Meteorology":—

"It is not too much to say that we cannot pretend that a sufficient knowledge of the conditions of the lower strata of the atmosphere over the sea has been attained until, at the very least, monthly charts for all the elements for 5-degree squares over the whole navigable globe shall have been published. When these are complete, the requirements of scientific men, both seamen and landsmen, will demand far more minute work for any regions which will afford sufficient material to repay discussion.

"The resolution of the London Conference should again be repeated if any one should be found to maintain that general charts, for three months at a time, meet the wants of the public:

"'It is desirable that, whatever charts be published, the results for single-degree squares should be published in a tabular form.'"

Everything that is necessary for a solution of the foregoing question is contained in these resolutions, and arguments which have been made at various times and by various bodies fully competent to express opinions. The fundamental and cardinal question is now, as it was at the time of the Vienna Congress, the organisation of maritime meteorology, and its centralisation at the principal Meteorological Office; whether, and in what manner the Central Offices, which have been established, are related to each other as regards exchange of materials. Whether this exchange

* Report of the Permanent Committee, &c., 1874. Meetings held at Vienna and at Utrecht, 1873-7, pp. 31-37.

† Report of the Proceedings of the Second International Congress at Rome, 1879, p. 39.

should be quite gratuitous, or paid for, is a secondary matter, and need not be considered. So much is certain, all that was necessary or expected for the successful advancement of maritime meteorology has not been hitherto effected. The central offices are still few in number, and those which exist cannot be considered as being sufficiently closely related to each other.

In order to obtain information what each country had already done, the Permanent Committee issued a circular on the 21st May 1877 to all those institutions who paid attention to the prosecution of maritime meteorology. A number of replies were received, from which Mr. Scott drew up a report, of which the following is the concluding summary*:—

"The only publications of importance which have appeared between the years 1874 and 1877, have been, in Russia, wind charts for the Baltic; in France, M. Brault's wind charts for the North Atlantic; in England, the charts with a volume of remarks for the equatorial region of the Atlantic; in Austria, reports and papers have been issued relating to various subjects; in Calcutta, reports on the cyclones of 1874 and 1876 have appeared, and in Mauritius the synoptic weather charts for the Indian Ocean for the month of February 1861.

"As regards the relative utility to the seaman of graphical and tabular publications respectively, the general expression of opinion is strongly in favour of the first-named method of representation of results, but no one has ventured to propose any plan for general adoption. The opinion of the German authorities is, however, decidedly in favour of tabular publications as compared with graphical.

"In conclusion, your reporter would remark that, in his opinion, the information elicited by the circular is very satisfactory and highly encouraging. It is evident that the subject of ocean meteorology is attracting an amount of attention which is steadily increasing, and which encourages the hope that within the next few years the additions to our knowledge of the meteorology of the ocean will be both numerous and important."

Although, upon the whole, we agree with the facts and opinions therein expressed, we think it necessary to make some additions, as it refers to a period of 17 years ago, and therefore scarcely holds good at the present time. I do this the more readily as it affords a good opportunity of answering the question with which we are dealing.

In Mr. Scott's report mention is made of the establishment of the DEUTSCHE SEEWARTE by the Government, and it is only right to point out that from the 1st January 1876, a year after its coming into existence, a monthly report appeared, "Monatliche Uebersicht der Witterung für jeden Monat des Jahres 1876 (I Jahrgang)." The object of this publication was to further the interests of navigation, as well as to promote practical weather knowledge. The first effort of the Seewarte was to publish as much as it could, and as quickly as possible, for the North Atlantic Ocean, from the meteorological observations contained in ships' logs, first as a resumé and then in a tabular form, and to distribute these publications as widely as practicable. The July number for the year 1877 contained a tabular compilation of original observations, taken at 8h. a.m., over the whole area of the North Atlantic Ocean.† This publication was undertaken in the hope that other central meteorological offices would co-operate, and publish observations in a similiar manner, and thereby pave the way for an exchange of materials on a very extensive scale. These publications were carried on in the strictest manner during 30 months, and were only discontinued when it was found that there was no prospect that other offices would follow the example of the Seewarte. This was in December 1879.

* Reports to the Permanent Committee of the First International Meteorological Congress at Vienna, &c., 1878, p. 23.

† From the II. Jahresbericht of the Seewarte, No. 2, "Aus dem Archiv der Seewarte," 1879, pp. 46-7, and pp. 54-6.

In accordance with the various resolutions taken at international meetings, the Seewarte endeavoured to come to an understanding with kindred institutions, with the object of defining the field of labour of each, and of putting each in possession of all the available materials. In the beginning of the year 1878, an arrangement was agreed upon between Professor Buys Ballot, Director of the Meteorological Institute at Utrecht, and Professor Neumayer, Director of the Deutsche Seewarte at Hamburg, for an exchange of observations, and for their publication in one-degree squares, in the hope that this might serve as a basis of procedure for other institutions. The Deutsche Seewarte was to undertake the discussion of the one-degree squares of the district lying between lat. 20° and 50° N. from the European to the American Coasts, and the Dutch Meteorological Institute, the one-degree squares of the China Sea, in a similar manner to that in which the Meteorological Office in London had undertaken the discussion of the one-degree squares of the Atlantic Ocean lying between lat. 20° N. and lat. 10° S. It was arranged that, so far as the question of international interests was concerned, the publication of the results was to be only in a tabular form. But a general participation in this work could not be effected. This did not, however, prevent the Deusche Seewarte from discussing, printing, and widely distributing 17 ten-degree squares, each sub-divided into squares of one degree of latitude by one degree of longitude. In Holland one such square was discussed and published for the China Sea. The title of these publications is "Resultate "meteorologischer Beobachtungen von Deutschen und Holländischen "Schiffen für Eingradfelder des Nordatlantischen Oceans (or China Sea) "Quadrat No. ."

It is clear that the tabular grouping for one-degree squares must cease at a fixed period. It was impossible to include all the registers which were constantly arriving without drawing a line somewhere: it was, therefore, necessary to fix a period after which no further observations should be included. This period was fixed somewhat earlier for the first of the squares published by the Seewarte, for those published later, the 31st December 1884, was adopted, that is, all the observations contained in the meteorological registers of the Seewarte and of the Dutch Institute, received after the 31st of December 1884 were not entered in the data books intended for the first publication, and were, therefore, not used in the means deduced. A second series will follow the first, which, in accordance with the practice hitherto observed, will end with December 1894, thus embracing a complete decade. In strict accordance with the international decisions, all data necessary for forming an opinion of the value of the observations, and of their number and distribution for daily and monthly periods, were to be carefully stated in the publication, so that—

1° the combination of a second series of observations issued by the Seewarte, and

2° their combination with any series of other countries,

would be possible.

In order to meet these requirements, all that is necessary for understanding the tables is contained in the introduction to each volume. All the values allowing of a combination in the above sense, according to international stipulation, are contained in the tabular matter (pages xv-xxvi). Although there is no doubt that the action of the Dutch and German Institutes in issuing tabular statements containing the necessary data for further combination, which was specified as a first desideratum for an international publication, completely carried out the international agreement, nevertheless this proceeding was not initiated. The publication of maritime meteorological observations in a tabular form has been to some extent adopted by the Russian Central Physical Observatory, as two series of observations from a number of ships have been published *in extenso*.*

* The details of the agreements, especially as regards the form, &c., are published *in extenso* in the I Jahresbericht der Deutschen Seewarte (1875-8), No 1. Aus dem Archiv der Deutschen Seewarte, pp. 72-8, and Appendix, pp. xiii.-xxiv.

The publication above mentioned bears a climatological and statistical character, and undoubtedly lays claim to be of high international value; but we have now to speak of a second kind of work which has an equal right to this character, viz., the Synoptic Weather Charts, extending over various parts of the ocean. It is, perhaps, not superfluous to define briefly what we understand by the term "international character." Firstly, it is of real importance that observations at sea should be made and discussed by all seafaring countries, and that the results should furnish important contributions to the knowledge of the physical conditions of the oceans, provided they are carried out strictly in accordance with international instructions. Secondly, the international character requires that results of international value should be published for the purposes of investigations, and without regard to the special requirements and peculiarities of any particular country. From what has been said it will be apparent that synoptic work over the ocean possesses such an international character. The Directors of the Meteorological Institutes of Denmark and Germany, Captain Hoffmeyer and Professor Neumayer, bearing in mind the importance of the international arrangements, agreed, in the summer of 1878, to issue jointly daily synoptic weather charts for the North Atlantic Ocean, and to make use of as much of the international material for this purpose as it was possible to obtain.*

It is hardly necessary to mention that the late Captain Hoffmeyer had already issued synoptic weather charts for the North Atlantic Ocean from September 1873 to November 1876. It was arranged between the two institutions that the new series of these charts should begin with December 1880,† leaving the missing years to be filled up subsequently. The London Meteorological Office undertook to discuss and publish independently daily meteorological charts of the North Atlantic Ocean for the year 1882–3 from all available materials, this being, it will be remembered, the period of the system of international Polar investigations‡. As it was, therefore, unnecessary for the institutes of Copenhagen and Hamburg to publish charts for this period, they resumed the work in September 1883, and have continued it up to the present time; the charts for the last part of 1892 being nearly ready for publication. The eleventh yearly volume of this important international publication will, therefore, appear in a few months.

In order to fill up the gap which occurred by the omission of the Polar year, the German Polar Committee, co-operating with the system of Polar investigation, undertook the preparation of daily synoptic weather charts for the South Atlantic Ocean from all available ships' observations, combined with the observations of the German South Georgian Station and of the French Station at Orange Bay, Cape Horn, for the period September 1882–August 1883, but these charts have not yet been published.

It is also well known that the United States Signal Office has published synoptic charts for the Northern Hemisphere, extending over many years, and that the daily weather charts for the Southern Indian Ocean, which were prepared for the three first months of the year 1861, were published by Dr. Meldrum some years ago. In all the works mentioned it was of the first importance to make use of all the materials that were available, so that, in fact, they may be considered as representing international co-operation. A difficulty here arose from the fact that, owing to the defective organisation of maritime meteorology in most countries, it was hardly practicable to carry out a mutual exchange of materials. Although it was known that several institutes existed, a number of observations had to be neglected, because little or nothing was known as to the extent and value of the materials in individual countries. The International Meteorological Committee certainly endeavoured to obtain information upon the

* Aus dem Archiv. der Deutschen Seewarte, No. 2, 1879, p. 82.

† Jahresbericht, vi., p. 20. See the terms of the agreement in "Monatliche Uebersicht der Witterung, January 1878, &c. Report of the Proceedings of the Second International Meteorological Congress at Rome, p. 40.

‡ The documents prepared by the Seewarte for this period were placed at the disposal of the Meteorological Office in London. (Jahresbericht viii., p. 30.) Synchronous Weather Charts of the North Atlantic and adjacent Continents for every day from 5th of August 1882 to 3rd of September 1883.

subject, but it was only possible in a few cases to obtain satisfactory replies. On the 31st of December 1882 the committee issued a circular in which, among other matters, questions as to the condition of maritime meteorology in the different countries were asked.*

We learn from the numerous answers received that only Great Britain, the Netherlands, and Germany have given attention to the establishment of central offices for the prosecution of maritime meteorology, and therefore to the principal condition for successful work in this branch. In Sweden, Norway, and Denmark, funds were provided by the authorities concerned for the establishment of a maritime meteorological service, but the number of ships co-operating was too small to repay an independent discussion, and this branch of meteorological investigation was crowded out by others which had to be attended to at the same time. In Sweden only was a department established, and it set the praiseworthy example of forwarding its observations to the Dutch Institute for discussion.

In France and Russia the meteorological work was divided between two different departments, viz., the Central Offices for Meteorology and the Hydrographic Departments of the Admiralties; but this separation was not advantageous to the work.† Both countries and both offices issued important publications. Special reference may be made to the works of the late M. Léon Brault, an officer in the French Navy. Between the year 1880 and the time of his death, in 1885, several excellent works appeared. M. Brault's death was a loss to the cause of maritime meteorology, so far as France was concerned, for success depends finally upon the zeal and talent of individuals, and M. Léon Brault was such a man.‡ In his work upon the meteorology of the winds of the North Atlantic Ocean he combined the tabular form with graphical representation in a very successful manner.

The observations contained in ships' logs were printed *in extenso* by the Russian authorities, first by the Central Physical Observatory of St. Petersburg, in 1883, and afterwards by the Hydrographic Department of the Admiralty, at that place, in the year 1887.

It is much to be regretted that, so far as maritime meteorology is concerned, the United States have not been represented at the different conferences and congresses, and that no reply was sent to the circulars of the International Committee as to the organisation and pursuit of maritime meteorology in that country.§ No attention has been paid there either to the resolutions of the Maritime Conference in London (1874), nor to the subsequent decisions of the International Committee, owing to which maritime meteorological investigations have entered upon new lines, nor are the publications emanating therefrom in accordance with these decisions.

We hope, however, that the energetic appeal made at the close of the Brussels Conference will be borne in mind, and that international co-operation in the sense there expressed will be the result.

The Hydrographic Department of the United States published, in December 1883, under the very promising name of "The Pilot Charts," the monthly chart of weather conditions and other elements affecting the navigation of the North Atlantic Ocean. This publication was very favourably received by nautical men, and is much appreciated by them at

* Report of the Second Meeting of the International Meteorological Committee at Copenhagen, pp. 33–115. The Second Meteorological Congress had already drawn up a circular, and the replies are printed in the Report of that Congress. This was the result of question 22 (p. 69 in the English edition).

† Since 1887 it appears, from information we have obtained, that the care of ocean meteorology has been transferred to the Hydrographic Department of the Ministry of Marine (see Wild's Jahresbericht for 1887 and 1888, p. 41). And in France the maritime meteorological service seems recently to have been transferred to the Service Hydrographique de la Marine. At all events this Service publishes Reports upon the logs received from merchant vessels (see Annales Hydrographiques). Information has been received to this effect from private communications.

‡ Brault, Océan Pacifique, Cartes de la direction et de l'intensité probable des vents. Depôt des Cartes et Plans de la Marine, 1880. Ocean des Indes, &c. Études sur la Météorologie des vents dans l'Atlantique Nord.

§ This is not quite correct. Commodore Wyman, Hydrographer to the United States, sent a detailed reply to the questions contained in the circular of 1877. This is printed in the Report to the Permanent Committee on Maritime Meteorology, published in 1878.—*R. H. Scott.*

the present time. However much we are disposed to acknowledge its value, we can only consider it to possess an ephemeral importance. From its nature, it cannot furnish fundamental meteorological data such as that which was contained in the publications of Maury, the great founder of the international pursuit of ocean meteorology.

The Royal Meteorological Institute of the Netherlands has steadily continued to distribute valuable materials in its publications, both as regards practical navigation and investigation in a more restricted sense. The most striking proof of this is afforded by the different parts of the "Waarnemingen" in the Indian Ocean which have appeared since 1889. The London Meteorological Office has issued some valuable publications, in addition to those in 1891, already mentioned. We will only mention "Cyclone Tracks in the South-Indian Ocean," "Meteorological Charts "of the portion of the Indian Ocean adjacent to Cape Guardafui and Ras "Hafún," and "Daily Weather Charts for the period of six weeks ending "June 25th, 1885, to illustrate the tracks of two cyclones in the Arabian "Sea." All these publications are worthy successors of the beautiful publication of the year 1884: "Charts showing the surface-temperature "of the Atlantic, Indian, and Pacific Ocean."

In addition to the publications already mentioned, the Deutsche Seewarte has, in compliance with a long-felt need, issued a commentary upon the daily synoptic weather charts of the North Atlantic Ocean, commencing with the autumn of 1883, and based upon the daily weather charts for that district. The title of this publication is "Vierteljahrs-Wetter-Rundschau."

We take it to be the duty of every country which has a considerable maritime trade to see that all available scientific materials are placed at the disposal of that trade, and in such a way as is suited to the national requirements. With this view, the Seewarte has issued works in the form of text, tables, and diagrams, which place the practical navigator in possession of all useful and available information. "Der Pilote, ein Führer für Segelschiffe," of which the 7th vol. has appeared, and the Sailing Directions for the Atlantic, Indian, and Pacific Oceans, each with an atlas of about 30 charts, originated in this way. These are looked upon as national works, and by the introduction of foreign materials they can rank as international publications, without assuming an international character.

In this cursory summary we have abstained from giving a complete list of the various publications in the domain of maritime meteorology since the date of the Meteorological Congress at Rome. We have also omitted to mention a number of excellent publications of this nature which have appeared in India, Japan, and elsewhere, because this would lead us too far. In conclusion, we propose to give a concise account of what we consider indispensable for the successful prosecution of maritime meteorology from an international point of view. In doing this we expressly take as our basis the various international agreements which have been made from time to time and referred to in the preceding remarks.

Before doing this we may be allowed to mention that the discussion of the maritime meteorolgical questions was not considered to be possible or admissible at the International Conference of the representatives of the meteorological services of all countries, which was held at Munich between 26th August and 2nd September 1891.

After some remarks, the members present at the Conference, and especially the Directors of Nautical Meteorological institutions agreed upon the following resolution*:—

> "That owing to the irregularity in the distribution of materials for maritime meteorology, due to the variety of ships' tracks over the different oceans, it is impossible to lay down strict rules for the uniform mode of publication."

* See Report of the Proceedings of International Meteorological Conference at Munich, 1891, p. 31.

General Opinion respecting International Co-operation in obtaining and publishing the Results of Maritime Meteorology.

For our present purposes, we mean by maritime meteorology only that portion of meteorological research which deals with the taking of meteorological observations on ships, their collection and discussion, and the publication of results. Observations of a meteorological or hydrographical nature which are made at coast stations are not included in the scope of the present article.

After various conferences and congresses have gone thoroughly into the question of the organisation of the systems of ocean meteorology, and have laid down the general principles to be followed, it cannot be difficult to briefly summarise the subject.

And, again, as the first condition arising out of the resolutions of those conferences is uniformity in keeping the meteorological log, and the comparison of the instruments used in one system with those of other systems, it only remains to point out that it is incumbent upon those countries, in which the need exists, to establish a central office, on which should devolve the management, collection, and discussion of observations, and the publication of results. The marine branches of the Meteorological Office in London, of the Meteorological Institute in Utrecht, and of the Deutsche Seewarte at Hamburg, may serve as patterns of such establishments.

It is not desirable that two offices in any one country should devote themselves to the work of ocean meteorology, as the subdivision of the data would be unavoidable, and international relations would be obstructed. Whether the department in question is attached to the Central Meteorological Office or to the Hydrographic Office of the Admiralty is beside the question, as this must be decided according to existing circumstances.

In any case the Navy should take part in the observations, and the data should be deposited in the same place as those made in ships of the mercantile marine, in order that they may be collated and discussed, and the results finally published.

Those countries in which there is no need of a central office for ocean meteorology, but which have the opportunity of having observations taken in the Navy or on merchant vessels, should take care that such observations are collected at the Central Meteorological Office and transmitted to one of the fully organised central offices for discussion. In such cases the arrangement should be made known by circular or otherwise, so that the other central offices may co-operate with the institutions in question.

If this system of international co-operation is established there will be no difficulty in conducting the co-operation in a proper way.

As the principles have been laid down by the Congresses, all agreements with the object of international co-operation should be made through the directors of the central offices; in doing this attention should be paid to the possible division of labour and to the exchange of materials.

As it is assumed that the various directors taking part in these agreements are well aquainted with the publications, and with their scope and form, they will be in a position to make such arrangements as are required by their own interests and those of international co-operation. In this respect it is desirable that a complete resumé of the subject and progress of the labours of any institution should be rendered in the annual reports, in the same way as is done by the English Meteorological Office and the Deutsche Seewarte. And if reference is made therein to any agreements which have been arrived at, together with a notification of all details of importance to international relations, this would smooth the path for further international co-operation.

A division of labour according to ocean-districts is undoubtedly the ideal of co-operation in investigations of a maritime meteorological nature; this is so apparent that nothing further need be said in support of it. The general interests would be served in the most complete manner if we could succeed in carrying out a plan for the division of the most important districts that would meet with international approval, and if we could

also make it a condition that the whole of the data should be distributed. In the division of the field of labour and of the materials it is of course understood that the various central offices would possess the fullest confidence of all those who took part in the arrangement. This ideal cannot be reached for a long time, but we must endeavour to approach it as nearly as possible. The following will explain briefly how this can be done.

In the first we must pay attention to those maritime meteorological researches which are to be considered as fundamental, and which possess an international character in the most suitable form, viz., the publications of climatological statistics and synoptic charts for large ocean districts, as, for instance, for the North Atlantic Ocean.

The exchange of data is of prime importance as regards *temporary* completeness. The directors of various institutions taking part in the plan must agree among themselves, in order that all requirements may be taken into account. This would principally include the mode of exchanging the data, the form in which it should be furnished, and whether only the idea of reciprocity should be taken into account, or whether payment should be made for the extraction of the observations.

If an agreement were come to with respect to the exchange, there should also be an understanding as to the method of publication. In the case of the publication of climatological statistics, it should be decided whether preference should be given to the graphical or the tabular method. According to the international stipulations, tables are absolutely required under all circumstances, but there is no uniformity of views about the matter, nor has any decision been arrived at with regard to all the parts of the ocean in which tracks have been laid down. There are undoubtedly certain districts that are not worthy of tabular representation, which is the most complete method, as the materials are far too scanty. In such cases we must be content with a graphical representation, but this certainly cannot be reckoned among the definite and final publications. In many cases an intermediate method must be selected—a combination of the graphical and tabular forms. The charts of the North Pacific Ocean, published by the Hydrographic Office of the United States,* might serve in many respects as a pattern, excepting that, although they are prepared for each month, they are only for five-degree squares. The tabular form of publication must be recommended for those districts in which copious materials are available by exchange. The directors of the participating institutions will here, too, agree upon the details, and, under all circumstances, the subdivision into one-degree squares and into single months should be insisted upon. The time of closing the first series for any one district should be determined, and the steps necessary for combining a further series of observations for the same district should be published.

The tables for one-degree squares published by the Seewarte and the Dutch Institute may serve as patterns of what is required. It should, however, be stated that the plan previously agreed upon and published need not be adhered to; the experience gained during the last 15 years makes it advisable to consider whether a change should not be proposed. In accordance with the views expressed at the Munich Conference in 1891, we are of opinion that it is not desirable in the present stage to make definite or binding proposals.

The graphical method, with accompanying text, such as was employed with success in the great publication of the English office on the nine squares of the Atlantic Ocean, from 10° S. to 20° N. latitude, might, if so decided, be selected as a pattern.

We are convinced that an agreement of the directors of the principal institutions for ocean meteorology would be easily obtained, if the Conference were restricted to those persons who have experience and special knowledge of the subject, and if the form of publication, whether tabular or graphical makes no matter, is not to be decided at present.

* Meteorological charts of the North Pacific Ocean from latitude 45° N., and from the American Coast of the 160th meridian. Washington, 1878.

The materials may not be fully sufficient for synoptic work, any more than for climatological statistics for the ocean, but whatever good observations are available for the hours for which daily synoptic charts are to be drawn, should be utilised. As in the preceding case, the exchange of materials should be arranged on a somewhat different plan. As it is desirable that the charts would appear as soon as possible after the date to which they refer, care should be taken in the exchange of materials that the form is not too complicated. If the subject is discussed by men who are conversant with the matter, a suitable agreement will speedily be arrived at.

It may here be mentioned that it appears to be highly desirable to publish an explanatory text to accompany each series of daily synoptic weather charts. The Vierteljahrs-Wetter-Rundschau with generalised charts, published by the Seewarte, might serve as a pattern. In preparing this, all available materials should be utilised. It is assumed that in undertaking the investigations here specified that a definite district will only be discussed by one institution, and that it will not be taken up by several offices. In this way a division of work will be effected such as has already attained with good results in other branches of science, *e.g.*, astronomy, geodesy, meteorology, &c.

If we assume that these fundamental and strictly international publications are not to be undertaken upon the principle of such a division of labour, but that investigation of the same district is left free to each Institution, the method of exchange must be of another kind, such as we shall have to refer to in the following remarks.

The Government of each sea-faring country should take care that the results of the maritime meteorological researches should be discussed in the interests of their maritime trade; the national publications in this department are intended for that purpose. They should contain everything which is available upon the subject up to the time of publication.

Whenever these works appear, they should be regarded as the most complete for the time being. In such publications there can be no question of future combinations, but rather of a new compilation. For this particular kind of work a graphical representation should be recommended as most suitable. It should also be stipulated that only one meteorological element at a time, and for separate months, should be represented; the grouping into quarters is no longer suitable to present conditions, however much it may have been so at a former time. The time will come when monthly periods will no longer suffice, and shorter intervals of time will have to be adopted. In the construction of such charts from the observations possessed by any one institution, the charts which have been published by other institutions should be utilised. In this way it is hoped that more light will be thrown upon any individual districts or subjects (whether storms or other phenomena) than would be possible from existing works or from one's own materials. An opportunity must be given to each institution, such as can only be obtained by an exchange of materials. The Seewarte endeavoured, unsuccessfully, to bring this about in the years 1877–79, in the "Monatliche Uebersicht der Witterung." For this purpose, an exchange of extracts from ships' logs would be effected, which each institution dealing with maritime meteorology could collate, multiply, and distribute to kindred institutions. An announcement of the proposed discussion should suffice to bring about the necessary exchange of observations.

We must proceed in this way, in the event of the adoption of a free choice of district being allowed to each institution, but this mode will encounter serious, and perhaps insurmountable, difficulties.

We shall not discuss here the minutiæ of carrying out the proposed exchange of observations, as these must be settled by the directors of the institutions dealing with maritime meteorology.

As examples of the publication in question we may mention:—

"Charts showing the mean barometrical pressure over the Atlantic, Indian, and Pacific Oceans," November 1887, &c., issued by the Meteorological Office in London.

"Waarnemingen in den Indischen Oceaan," &c., issued by the Netherlands Institute, in Utrecht.
"Meteorological charts of the North Pacific Ocean," 1878 (see above).
"The Pilot Charts," &c., issued by the Hydrographic Office in Washington.
The Atlases to accompany the Sailing Directions of the Atlantic, Indian, and Pacific Oceans, &c., issued by the Deutsche Seewarte in Hamburg.

The publication of sailing directions is a matter which concerns the individual institutions of various nations. They would not be referred to in international deliberations, excepting, perhaps, to indicate the desirability of preparing them for seamen, so that they may reap the results of their labours. A definite prescription would not be laid down upon the matter.

An exchange of materials is also desirable in the study of individual storms, typhoons, and cyclones, so that any particular institution can undertake the discussion of any special investigation, and obtain the necessary data.

It may be mentioned that an arrangement for the exchange of copies of observations, upon payment of the cost of copying, exists between the Deutsche Seewarte and the Meteorological Office in London. This is, of course, independent of the conventions for exchange of observations made between the Seewarte and the Dutch and Danish Institutes.

It is desirable, however, notwithstanding these satisfactory relations, that international co-operation in ocean meteorology should be more generally and definitely organised.

It may also be pointed out that international co-operation might be extended to scientific expeditions whose duty it is to collect special kinds of meteorological observations which cannot find a place in the general co-operation in maritime meteorological work. If such expeditions are indispensable for the improvement of our knowledge of the meteorology and hydrography of the ocean, and if it is shown to be necessary to undertake them from time to time, an international understanding should be come to that such expeditions should not only be undertaken on a uniform plan, but the choice of route should be arranged, so that they should supplement each other; and the vacant places which wait for serious discussion should disappear more and more.

We conclude these somewhat lengthy remarks with the hope that international co-operation in ocean meteorology, for which a way has been opened by the decisions of the Conferences and Congresses of the first meteorologists and nautical men of the day, and which have partially obtained a sound footing, may continually be further developed, both in geographical extent and in breadth of research. Success cannot fail if the leading men and institutions attack the solution of the important problem in a spirited manner, such as animated our predecessors, and especially the American delegate, 43 years ago.

Marine Discussions:—*cont.*

Contributions to our Knowledge of the Meteorology of the Arctic Regions. (Official, No. 34.) Vol. I.: Part I., 2*s.*; II., 10*s.*; III. and V., 6*s.* each; IV., 5*s.*

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 of the District between the Cape of Good Hope and New Zealand, (Official, No. 123.) (In the Press.)

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.*

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

Monthly Current Charts for the Indian Ocean. From Information collated and prepared in the Meteorological Office. Published by the Admiralty. (Official, No. 124.) 7*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.) [Out of Print.]

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:—

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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.*

* The observations at Stations of the Second Order for 1878-85 will be found in the Quarterly Weather Report for the respective years.

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