FOR OFFICIAL USE.

M.O. 281.

AIR MINISTRY

METEOROLOGICAL OFFICE

INTERNATIONAL METEOROLOGICAL ORGANIZATION

COMMISSION

FOR THE

EXPLORATION OF THE UPPER AIR

REPORT

OF THE MEETING IN LONDON

April 16–22, 1925

Published by the Authority of the Meteorological Committee.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Adastral House, Kingsway, London, W.C. 2; 28, Abingdon Street, London, S.W. 1;
York Street, Manchester; 1, St. Andrew's Crescent, Cardiff;
or 120, George Street, Edinburgh;
or through any Bookseller.

1925.

Price 2s. Net.

LIST OF SOME OF THE PUBLICATIONS ISSUED BY THE AUTHORITY OF THE METEOROLOGICAL COMMITTEE.

Reports of Proceedings at International Meetings, etc. (8vo.).

International Codex of Resolutions adopted at Congresses, Conferences, and at Meetings of the Permanent International Committee, 1872–1907. (No. 200. 1909.) 1*s.* 3*d.*

Codes of Signals adopted and recommended by the International Meteorological Committee, 1910–13, for Storm Warnings, together with a list of the Maritime Weather Signals at present in use in the Various Countries of the Globe. (No. 206.) Fourth Edition, 1913, 4*d.*

Reports of Proceedings at International Meetings.

[20 reports were issued between 1872 and 1907 (Prices ranging from 6*d.* to 2*s.* 6*d.*)]:—

1909. London. Weather Telegraphy Commission.

1909. London. Maritime Weather Signals Commission.

1910. Berlin. Ninth Meeting of Committee. (No. 208). 3*s.*

1912. London. Second Meeting. Weather Telegraphy Commission. (No. 211.) 2*s.*

1912. London. Second Meeting. Commission for Maritime Meteorology and Storm Warnings. (No. 212.) 1*s.*

1913. Rome. Tenth Meeting of Committtee (No. 216.) 2*s.*

1919. London. (No. 237.) 1*s.*

1919. Paris. (No. 239.) 3*s.*

1920. London. Third Meeting of Weather Telegraphy Commission. (No. 242.) 5*s.*

1921. London. Eleventh Meeting of Committee. (No. 248.) 4*s.* 6*d.*

1921. London. Fourth Meeting of Weather Telegraphy Commission. (Reprint of Appendix VI of Report of the Eleventh Meeting of Committee, *see* No. 248.) (No. 251.) 1*s.* 6*d.*

1923. Utrecht. Fifth Conference. [Published by Seyffardt's Boekhandel, Gravenstraat 6, Amsterdam. Price 2 (Dutch) florins.]

Publications of Researches.

GEOPHYSICAL MEMOIRS. (4to):—

Vol. II.:—

No. 19. Hurricanes and Tropical Revolving Storms. By Mrs. E. V. Newnham, M.Sc. With an Introduction on The Birth and Death of Cyclones, by Sir Napier Shaw, F.R.S. (No. 220*i*. 1922.) 12*s.* 6*d.* Postage 6*d.*

No. 20. Variations in the Levels of the Central African Lakes Victoria and Albert. By C. E. P. Brooks, M.Sc. (No. 220*j*. 1923.) 1*s.* 6*d.* Postage 1*d.*

Vol. III.:—

No. 21. Pyrheliometer Comparisons at Kew Observatory, Richmond, and their bearing on data published in the Geophysical Journal. By R. E. Watson, B.Sc. (No. 254*a*. 1923.) 2*s.* Postage 1*d.*

24899

M.O. 281.

AIR MINISTRY

METEOROLOGICAL OFFICE

INTERNATIONAL METEOROLOGICAL ORGANIZATION

COMMISSION

FOR THE

EXPLORATION OF THE UPPER AIR

REPORT

OF THE MEETING IN LONDON

April 16–22, 1925

Published by the Authority of the Meteorological Committee.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Adastral House, Kingsway, London, W.C. 2; 28, Abingdon Street, London, S.W. 1;
York Street, Manchester; 1, St. Andrew's Crescent, Cardiff;
or 120, George Street, Edinburgh;
or through any Bookseller.

1925.

Price 2s. Net.

List of Members and others attending the Meeting

Dr. W. VAN BEMMELEN, Professor of Geography, University of Amsterdam, Holland.

C. J. P. CAVE, Stoner Hill, Petersfield, Hants, England.

L. H. G. DINES, Kew Observatory (Upper Air Section), Richmond, Surrey, England.

Prof. Dr. E. VAN EVERDINGEN, Hoofddirecteur, Koninklijk Nederlandsch Meteorologisch Instituut, de Bilt, Holland.

Professor P. GAMBA, Director, R. Osservatorio Geofisico, Pavia, Italy.

Lieut. Col. E. GOLD, Assistant Director, Meteorological Office, Air Ministry, Kingsway, London, W.C. 2.

Prof. Dr. H. HERGESELL, Direktor, Preussisches Aeronautisches Observatorium, Lindenberg, Germany.

Dr. Th. HESSELBERG, Director, Det Norske Meteorologiske Institut, Oslo, Norway.

Lt.-Colonel LUIGI MATTEUZZI, Sezione aerologica, S.S., 8 Lungo Tevere Michelangelo, Rome, Italy.

Colonel E. MESEGUER, Jefe del Servicio Meteorologico Español, Madrid, Spain.

Dr. P. A. MOLTCHANOFF, Chief of the Aerological Observatory, Slutzk (Pavlovsk), Russia.

L. F. RICHARDSON, 31, Bridge Lane, Golder's Green, London, N.W. 11.

Sir NAPIER SHAW, (*President of the Commission*), 10, Moreton Gardens, London, S.W. 5.

Sir GILBERT WALKER, Professor of Meteorology, Imperial College of Science and Technology, South Kensington, London, S.W. 7.

Capitaine Ph. WEHRLÉ, Office National Météorologique, Paris, France.

The following attended by invitation :—

Commander L. G. GARBETT, R.N., Superintendent of Navy Services, Meteorological Office, London.

Dr. G. C. SIMPSON, Director, Meteorological Office, London.

Mme. FOEHRINGER, for Dr. FRIEDMANN, Director, Central Geophysical Observatory, Leningrad.

INTERNATIONAL METEOROLOGICAL ORGANIZATION

COMMISSION FOR THE EXPLORATION OF THE UPPER AIR

MEETING IN LONDON, APRIL 16–22, 1925

INTRODUCTION

An international commission for the study of the upper air was first appointed as the Commission for Scientific Aeronautics, at the International Conference of Directors of Meteorological Institutes and Observatories, which was held at Paris in 1896. Professor Dr. H. Hergesell was appointed president, Prof. Dr. R. Assmann, secretary. At the international conference at Paris in 1919, the commission was reappointed for the Exploration of the Upper Air, with Professor V. Bjerknes president, and Director Th. Hesselberg as secretary.

Meetings of the Commission have been held as follows :—

Commission for Scientific Aeronautics (*President :* Prof. Dr. Hergesell).

Paris - - -	1900
Berlin - - -	1902
St. Petersburg -	1904
Milan - - -	1906
Monaco - - -	1909
Vienna - - -	1912

Commission for the Exploration of the Upper Air (*President :* Prof. V. Bjerknes).

Bergen - - -	1921

The publication of the results on an international basis under the care of the President, was arranged at the meeting of the Commission at St. Petersburg in 1904, and continued until the war.

At the end of the year 1921 Professor Bjerknes, with the assent of the Commission, desired me to take his place as President. A single session was held at Utrecht on September 14th, 1923, after the close of the International Conference which met there in the preceding week. A report of the proceedings is included in Appendix C (p. 101) of the Report of the Conference published in Utrecht in 1924.

x (5)24899 Wt 10715—12429/757 750 12/25 A 2

After the meeting a letter was issued to the countries who were known to take observations by ballon-sonde, stating that, in accordance with the proposal accepted at the meeting, the six ascents to be chosen by the President for 1923 were being allocated to special observations during the international cloud-week. It was suggested that, if possible, six soundings, at intervals of twelve hours, should be made on the days September 26th, 27th and 28th, 1923.

For the year 1924 I accepted the suggestion of Prof. Dr. Hergesell that the six special ascents should be used for the intensive investigation of the upper air on a single day and a circular (No. 8, p. 5) was accordingly issued to the members of the Commission on June 18th, 1924. At the same time I took the opportunity of reporting progress with regard to the methods of graphic representation of the results of soundings with ballons-sondes which had been a subject of discussion at Utrecht.

In January, 1925, the continent of Europe was covered by a notable anticyclone. Prof. Exner suggested by telegram that it should be made the subject of special investigation. Notice was accordingly sent by telegram to the co-operating institutions of Europe asking for special investigations on January 24th, and the notice was repeated in the meteorological messages sent out by wireless from London on the two days preceding that date.

The question of reviving the publication of observations on an international basis at the joint expense of the countries interested in the study, had not been solved at Utrecht, nor the question of the form which an international publication should take.

The questions could not be effectively approached until the countries interested had expressed a collective opinion in some form. The opportunity for such expression on the part of the countries adhering to the Union of Geodesy and Geophysics, was provided by a meeting of the Union at Madrid in October 1924 and the opinion took the form of allocating a sum of £500 towards the expense of the publication of a specimen volume which could form the basis of further negotiation.

After the conclusion of the Madrid meeting, therefore, and with the approval of the President of the International Meteorological Committee, a circular letter (No. 9, dated 31st October, p. 8) was issued to the members of the Commission, announcing the project of a meeting in London in the third week in April, 1925, to make arrangements for the proposed specimen publication. No objection was taken to the project and the Commission was accordingly summoned for April 16th to April 22nd, 1925, by circular letter (No. 10) dated February 10th, 1925, giving particulars of the business to be transacted.

Minutes of the proceedings of the meeting are presented in this report.

(Signed) NAPIER SHAW,
President.

November 13th, 1925.

Circular No. 8.

MEMORANDA BY THE PRESIDENT

(Circulated June 18th, 1924.)

I.—Form for the publication of the results of soundings with ballons-sondes

At the International Conference in Utrecht in September, 1923, I undertook to prepare a specimen of the data for the upper air with a view to the publication of the results of the days of international ascents upon a uniform plan.

In anticipation of a reminder of this obligation which has now come to me from the Bureau of the International Committee I had already studied the question of the most effective form of representation of the data obtained by means of ballons-sondes. I described the conclusions in the course of a lecture at Delft on April 25th to an International Conference on Applied Mechanics. The lecture had the title "The physical structure of the atmosphere regarded from the dynamical point of view." It will be printed in the report of the Conference.*

The form which I had selected as most suitable for ballons-sondes was obtained by plotting the result of an ascent as a continuous curve with *temperature* as one co-ordinate, *on a linear scale*, and *potential temperature* as the other co-ordinate *on a logarithmic scale*. Adiabatic curves of variation of temperature with potential temperature in saturated air are placed upon the diagram for comparison. The relation of these theoretical curves to the observed curves is of great dynamical importance.

Data for the curves can be obtained with sufficient accuracy by a simple geometrical process from original curves representing the direct results of the observations, referred to pressure and temperature, each on a logarithmic scale, or they can be easily derived from the original values of temperature and pressure by a simple kind of slide-rule.

I shall describe these processes later in another circular after I have obtained some illustrations of the application of the method for the consideration of the Commission. I hoped to include the illustrations with this letter but have not been able to complete them and I must not delay longer the communication to which I now proceed.

II.—Intensive investigation of the upper air on a single day

In the course of a meeting at Delft in connexion with the recent conference on Applied Mechanics held in that town attention was drawn by Dr. Hergesell to the fact that the relations of

* *Proceedings of the First International Congress for Applied Mechanics*, Delft, 1924. J. Waltman Jr., 1925, pp. 161–172.

temperature to pressure in the different levels, of a given distribution of pressure at the surface, were still waiting an intensive investigation by ballons-sondes which was only possible by international co-operation. It was suggested that the six soundings in any year which are to be fixed by the President of the Commission might with advantage be used in the current year in such a way as to contribute to the attainment of that desirable object.

According to the report of the Conference at Utrecht observations with ballons-sondes are included in the routine of aerological stations in Canada, France, Germany, Great Britain, Holland, Italy, Java, Spain, Sweden, possibly also in India, Russia and South Africa. It could not fairly be said that all these localities are covered by a single type of distribution of pressure but if the occasion is fortunately chosen those in Europe are sufficiently close together to exhibit different aspects of a recognised type. I may remark that in previous years for the purpose of tracing the changing conditions in the atmosphere over the larger areas by international co-operation series of soundings with registering balloons, shorter or longer, have been arranged with twenty-four hour intervals. For example, in the week from February 2nd to 7th, 1914, a sounding on each of six successive days was projected. It was, however, recognised at the time that the interval of twenty-four hours is too great even for the demonstration of the coarser outlines of the progressive changes of pressure and temperature. On that account, for example, in Lindenberg on February 5th, 1914, three ballons-sondes were released; on many other days two. It will also be remembered that on two occasions balloons were sent up at hourly intervals for a whole day from the station of the University of Manchester on June 2nd–3rd, 1909 and on March 18th–19th, 1910; the present suggestion aims at a repetition of a somewhat similar experiment on an international basis. Already the programme of international days provides for two soundings a day on three days of the year (November 11th–13th, 1924). The idea of the present communication is to utilise the six soundings which are to be fixed by the President in order to trace the changes occurring in the air above the several stations by observations with ballons-sondes every four hours. This would require six balloons in the course of the day.

Having regard to the vital influence of the transition from water to land I could have wished that it had been possible to include some observations from ships off the western coasts; but at the moment I know of no opportunity for observations by ballons-sondes at sea, although their importance is undeniable, and perhaps the co-operation in the investigation on the part of those observatories which have facilities for research in the upper air would be the best stimulus for the extension of the co-operation also to the air over the sea. I am therefore prepared to regard the suggestion as a legitimate and desirable occasion for the

special enterprise contemplated in the resolution of the Commission, which places the choice of occasion for six ballon-sonde ascents at the discretion of the President.

After careful consideration I am of opinion that, for the current year (1924), September 4th is the most suitable occasion among those which have already been agreed upon as international days, and I have therefore to ask whether, if you should find it possible to do so, you would be good enough to arrange for six soundings with ballons-sondes on that date at the following hours respectively: —3h., 7h., 11h., 15h., 19h., 23h G.M.T., and for any other supplementary or auxiliary observations that would assist in the identification of the details of the meteorological situation at those hours.

(Signed) NAPIER SHAW,
President.

School of Meteorology,
Meteorological Office,
South Kensington,
London, S.W. 7.

June 18th, 1924.

Circular No. 9.

Circular Letter of Invitation to a Meeting in London

10, Moreton Gardens,
London, S.W. 5.
October 31st 1924.

My dear Colleague,

With the approval of the President of the International Meteorological Committee, I have the honour to suggest a meeting of the Commission for the Exploration of the Upper Air to be held in London immediately after Easter next year (Wednesday, April 15th to Tuesday, April 21st, 1925,) to consider the position of the commission with reference to the publication of the results of observations of the upper air on an international basis.

A sum of 500*l.* has been placed at my disposal by the Union of Geodesy and Geophysics as a contribution on behalf of the countries adhering to the Union to the cost of publication of a specimen volume of a year's results of the investigation of the upper air, which may subsequently serve as the basis of an appeal for funds for the regular publication of aerological data. The Meteorological Institute of the Netherlands, through Professor E. van Everdingen has placed the sum of 83*l.* at the disposal of the commission towards the cost of publication. The sum represents the accumulation of two years' subvention.

According to the precedent of the publication before the war the data to be represented may include :—

(1) ballons-sondages, (2) avions-sondages, (3) observations of kites and kite-balloons (cerfs-volants et ballons-captifs), (4) pilot-balloons, (5) cloud observations, (6) observations from stations at high levels.

At the meeting of the commission in Bergen in 1921 a resolution was voted unanimously in favour of graphic representation for pressure and temperature (Resolution VII, Second Session, July 28th 1921). I have accordingly devoted some personal attention to the question of the best form of graphic representation for the consideration of the commission and in pursuance of the purpose indicated at the meeting of the commission at Utrecht*, I am submitting a note on the subject together with specimens of the sectional paper referred to in the note (Appendix I. of this letter).

Already Director Hesselberg, Secretary of the Commission, has circulated specimen forms for the publication of the numerical data (lettre circulaire, Kristiania, juin, 1924), and Professor E. van Everdingen has recently sent me a further suggestion as to such a form of publication which differs slightly from that set out in the report of the Utrecht meeting (p. 85). At his request I am enclosing some specimen sheets with this letter. I have also

* *Report of the International Conference of Directors at Utrecht*, p. 103.

received an expression of opinion from Professor F. M. Exner in favour of the publication of data in tabular numerical form and that view is also shared by Dr. G. C. Simpson.

I have no wish to offer a personal opinion but in order that the alternatives may be adequately set out for the consideration of the commission I take the liberty of asking those members of the commission who have available data, or access thereto, to send me a complete set of their data of temperature and pressure for the year 1923 represented graphically, as well as the numerical data in the form suggested by Director Hesselberg or Professor E. van Everdingen.

The simplest form of graphical representation is on the double logarithmic paper (Form A) but I ask also those who are interested in the transformations of energy in the atmosphere to let me have their data in the form of temperature-entropy graphs on the special paper (Form B) of which I enclose a number of sheets.

My aim is to exhibit the data for pressure and temperature on each of the international days of 1923 expressed in graphical form with one sheet for each day.

I hope later to make a further communication about those data which do not include pressure and temperature and in the meantime I shall be glad if members of the commission will send notice to me of any subjects which they wish placed upon the ordre du jour of the meeting in April and if they will also circulate to the members of the commission a note on each of the subjects.

Believe me, My dear Colleague,
Yours most truly,

NAPIER SHAW,
President.

Note on the graphic representation of pressure and temperature obtained from observations by balloons, aeroplanes or kites

(*Appendix I to Circular No.* 9.)

By Sir NAPIER SHAW.

So far as graphic representation is concerned I conceive that a graph of pressure-temperature is the nearest possible approach to the "original" or "direct observations." The introduction of height as one of the co-ordinates necessarily implies the assumption of some form of relation between temperature and height which the student of the data can neither check nor follow. This assumption is most conspicuously defective in those soundings which are most irregular and probably most worthy of close investigation. For the purpose of comparison with the data of pilot-balloons or kite-balloons some general formula such as Toussaint's, or a table, might be sufficient.

Graphs of pressure-temperature on logarithmic scales. (*Form A.**).

If a graph of pressure-temperature is desired I see no disadvantage in plotting it on logarithmic scales but on the contrary the advantage of having parallel straight lines to represent the adiabatic lines for dry air. I have accordingly had paper prepared upon which the direct graph of pressure-temperature can be plotted by those who will be so good as to give me the information in that form and I enclose some specimen sheets for that purpose.

A temperature-entropy diagram. (*Form B.**).

At the same time I may say that I have pursued my inquiries as to graphic representation in the direction of a diagram on which energy is represented by area, as giving the most direct access to the study of the transformations of energy in the atmosphere. I have found the representation known to engineers as a $\theta\,\phi$ (temperature-entropy) diagram (or, as I shall call it here, a $t\,\phi$ diagram) has the advantage of being in many ways more expressive than the direct pressure-temperature diagram as well as giving the energy relations. Such a diagram loses nothing of the directness of the representation because t is directly observed and ϕ is obtained from t and p, the original readings, by an invariable formula.

I have studied the representation of the data by the customary $p\,v$ diagram, the engineers' indicator-diagram, familiar to all students of thermodynamics: the data necessary for such a diagram can easily be computed by the inexorable formula $v = Rt/p$ and again area represents energy; but the result is not nearly so satisfactory as a $t\,\phi$ diagram. The acute inclination of the isothermal and adiabatic lines gives an "etiolated" diagram that uses a great deal of paper and cannot easily be interpreted by inspection.

The transformation from a pt diagram to a tϕ diagram. (*Form C.**).

In order to convert the direct readings of pressure and temperature into corresponding values for a $t\phi$ diagram all that needs to be done is to calculate the potential temperature T from the observed temperature t and pressure p by the formula:

$$\log T = \log t - \cdot 286\ (\log p - \log p_o)$$

where p_o is the standard pressure.

If then the potential temperature T be set out as an ordinate on a logarithmic scale the linear value of the ordinate will be proportional to ϕ measured from some conventional zero and the transformation can be made by the ruling of the graph.

The scale at the head of Form C expresses the entropy of 1 kilogramme of air as computed from the formula:—

$$\phi - \phi_o = c_p \log_e T/T_o$$

* Copies of the three forms A, B and C can be obtained from W. F. Stanley & Co. Ltd., 286, High Holborn, London, W.C. 1.

ϕ_o the datum point for entropy is taken as zero when the potential temperature T_o is 100t and the standard pressure is 1000 mb.

I have had paper ruled for this purpose on which temperature is set out as abscissa and potential temperature (referred to a standard of 1000 mb.) on a logarithmic scale as ordinate (Form B, *see* Plate I).

Instead of computing potential temperature by an algebraic formula it can be obtained graphically, using Form C which is merely an extension of Form A to higher temperature, as follows:

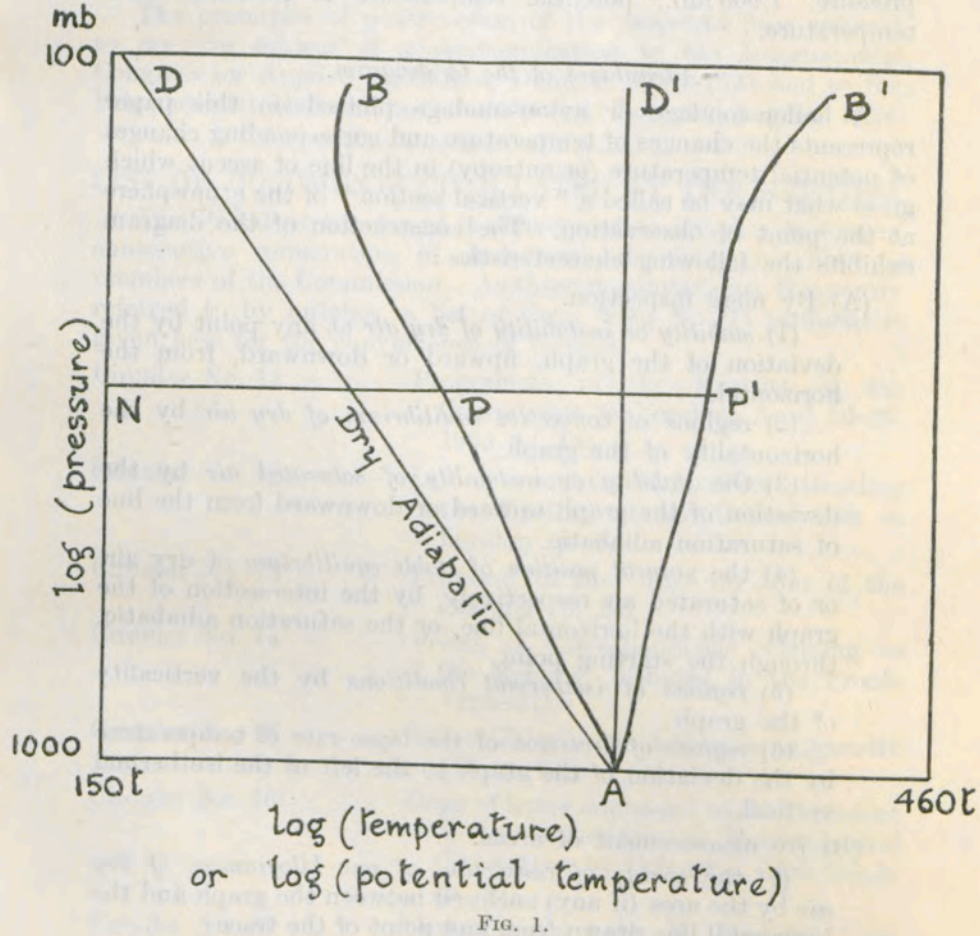


Fig. 1.

Prepare a curve AB as a pressure-temperature diagram on wide double logarithmic paper (*see* Fig. 1, which is reproduced from a diagram on Form C). Through the point A draw the dry adiabatic line AD. Next mark vertical line AD', that is the line of constant temperature. Set off horizontal distances from AD' equal to the horizontal distances between AD and AB. Then the line AB' so obtained represents the variation of potential temperature with falling pressure corresponding with the actual temperature of the curve AB. Thus for any

pressure P, NP is the temperature and NP' the corresponding potential temperature each in excess of the datum line 150t : these are plotted one against the other to give a diagram as represented on the enclosed specimen of Form B.

For facility of reference I have had superprinted upon Form B. the adiabatic lines of saturated air and also the lines of equal pressure and of equal vapour-content necessary to saturate one kilogramme of dry air. The accuracy of the printing may be checked by the consideration that along the line of standard pressure, 1,000 mb., potential temperature is identical with temperature.

Advantages of the tφ diagram.

A ballon-sondage or avion-sondage plotted on this paper represents the changes of temperature and corresponding changes of potential temperature (or entropy) in the line of ascent which gives what may be called a " vertical section " of the atmosphere at the point of observation. The construction of the diagram exhibits the following characteristics :

(A) By mere inspection.

(1) *stability or instability of dry air* at any point by the deviation of the graph, upward or downward, from the horizontal.

(2) regions of *convective equilibrium of dry air* by the horizontality of the graph.

(3) the *stability or instability of saturated air* by the deviation of the graph upward or downward from the line of saturation adiabatic.

(4) the *natural position of stable equilibrium* of dry air, or of saturated air respectively, by the intersection of the graph with the horizontal line, or the saturation adiabatic, through the starting point.

(5) *regions of isothermal conditions* by the verticality of the graph;

(6) *regions of inversion* of the lapse-rate of temperature by the deviation of the graph to the left of the isothermal vertical.

(B) By measurement of areas.

(7) the *energy of convection of one kilogramme of dry air* by the area (if any) enclosed between the graph and the horizontal line drawn from any point of the trace;

(8) *the energy of convection of one kilogramme of dry air loaded with water-vapour to saturation at any point*, by the area (if any) enclosed between the graph of the sounding and the curve of the adiabatic for saturated air which passes through the point.

The features numbered (1) to (6) can also be inferred from the graph on double logarithmic paper (Form A) but, with the exception of the isothermal condition, less easily than on the $t\phi$ paper (Form B) because the adiabatics for dry air on Form A

are oblique lines, whereas on Form B they are horizontal and easily distinguished from those for saturated air which are curved lines.

The features (7) and (8) are not shown on the double logarithmic paper.

For the expression of pressure I have used the millibar, but the principles are obviously applicable to any scale. The millibar scale is convenient for logarithmic representation because the range of observation accords so nearly with the range of the logarithmic scale 100 to 1,000.

The principles of construction of the diagrams here referred to are the subject of a communication to the International Congress for Applied Mechanics, Delft, in April 1924 and to the International Mathematical Association, Toronto, August, 1924.

LIST OF DOCUMENTS CIRCULATED AT THE MEETING.

The President has found it convenient to adopt a system of consecutive numeration of documents circulated by him to members of the Commission. As these documents are frequently referred to by number, a list of them from No. 11 onwards is given here for the convenience of readers.

Circular No. 11 - -	Programme of the Meeting of the Commission in London, April 16–22, 1925 (p. 15).
Circular No. 12 - -	List of members and others attending the Meeting of the Commission in London (p. 2).
Circular No. 13 - -	Proposal of the Ordre du Jour of the Meeting (p. 24).
Circular No. 14 - -	Précis of Correspondence referring to the Meeting (included in the Procès Verbaux).
Circular No. 15 - -	List of Telegraphic Addresses (Appendix III., p. 64).
Circular No. 16 - -	Copy of letter addressed to the President of the International Meteorological Committee, by Colonel J. Cruz Condé (p. 22).
Circular No .17 - -	Communication by M. Fontséré " On the oscillations of short period in the free air according to the character of the movement of pilot-balloons as seen in the theodolite " (p. 49).
Circular No. 18 - -	Memorandum by the Director of the Meteorological Office, London. " Scheme for Collection and Distribution of Results of Sounding-Balloon Ascents." (Appendix IV., p. 65.)

Circular No. 19 - (*a*) List of stations with list of data available for the international days of 1923. This will be revised and printed as table of contents in the specimen volume.

(*b*) The same for 1924.

(*c*) Specimen page showing tephigrams with aeroplane insets, wind-components and numerical data (*see* Plate I.).

(*d*) Specimen page of tephigrams for January 3, 1924, with a curve of humidity (*see* Plate II.).

(*d'*) Chart of isobars in the northern hemisphere.

Circular No. 19 - (*e*) Form of arrangement of numerical data of ballons-sondes (Dr. E. van Everdingen's form).*

(*f*) Form of arrangement of numerical data of pilot-balloons (Dr. E. van Everdingen's form).

Circular No. 20 - - Translation of letter from Professor Exner to Dr. G. C. Simpson, Director of the Meteorological Office (p. 30).

Circular No. 21 - - On homogeneous methods of determination of the rate of ascent of pilot balloons, by V. Kusnetzoff and I. Klado. (Appendix V., p. 66.)

Circular No. 22 - - Particulars of Balloons and Meteorographs used in upper air work. (Appendix II., p. 61.)

List of books of Technical Instructions for the Exploration of the Upper Air. (Appendix II.)

Circular No. 23 (1)–(4) Minutes of business meetings.

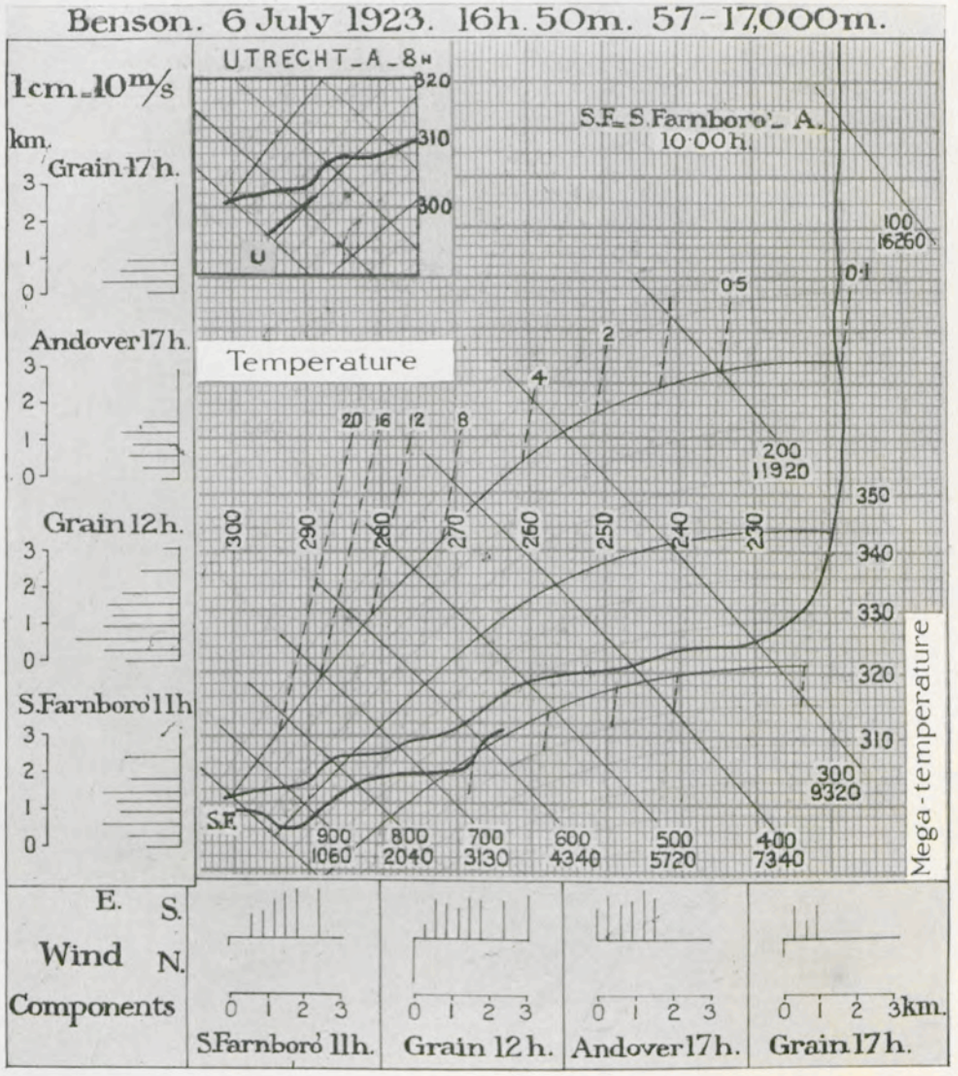
Circular No. 24 (1)–(3) Minutes of scientific meetings.

Circular No. 25 - - Au Sujet de la Technique des Sondages par Avion—Note de Mons Wehrlé.

Circular No. 26 - - Director Hesselberg's proposals as to the form of international publication (p. 32).

---

* This form is similar to that adopted for the publication of upper air data in Holland. *Ergeb. Aero. Beob.*, de Bilt., K. Ned. Met. Inst.



Surface 57m. —t. 1013 mb. —g/kg. **Wind.** 112½° 6·5 m/s.

km.	0	0·5	1·0	1·5	2·0	2·5	3	4	5	6	7	8
t.	...	299	295	290	288	284	279	271	266	260	251	243
mb.	...	963	908	857	808	760	716	632	558	489	427	372

km.	9	10	11	12	13	14	15	16	17	18	19	20
t.	235	227	221	219	218	219	218	218	219	...	...	...
mb.	323	279	239	205	174	150	128	109	93	...	...	...

Meteorograph Dines: with accessories 56 g. One balloon 350 g. Fell at 41 km. 36°.

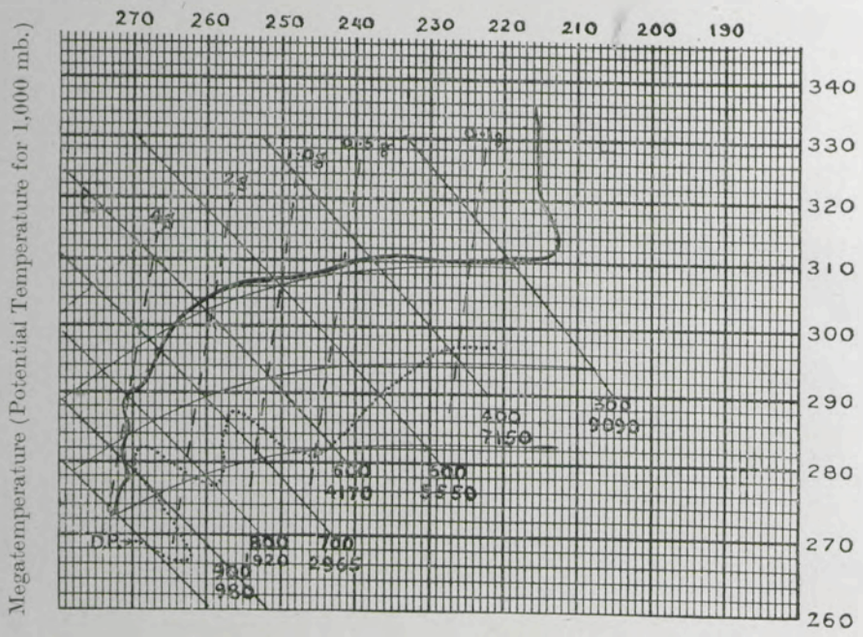
Auxiliary observations. **Aeroplanes.** S. Farnborough, Utrecht.

1923.7.6. **Pilot Balloons.** S. Farnborough, Grain, Andover.

PLATE II. to face p. 15.

(*Circular* 19*d*.)

TEPHIGRAM of 1924, January 3rd, PAVIA with a graph of DEW-POINT IN RELATION TO PRESSURE represented by a curve of dotted line the lower end of which is marked D.P.



The points on the dotted line are marked by obtaining the dew-point or saturation-temperature corresponding with the pressure and temperature of each point of the tephigram and passing along lines of equal pressure from each point of the tephigram to the temperature of the dew-point. It is to be noted that in a determination of the dew-point air is cooled *at constant pressure* until dew is on the point of being deposited.

EXPLANATION OF PLATES I. AND II.

The original groundwork of Plates I. and II. which face pp. 14 and 15, is prepared for a thermodynamic diagram known to engineers as an entropy-temperature diagram on which area represents thermal energy. For this purpose the co-ordinates are:—(1) from left to right, temperature on a linear scale decreasing from 280 tercentesimal on the left to 180 tercentesimal on the right; (2) from below upwards with a logarithmic scale, potential temperature on the tercentesimal scale for the standard pressure of 1,000 millibars, or 1 megadyne per square centimetre. For clearness and convenience potential temperature for that standard might be called *megatemperature*. The range on the diagram for megatemperature is from 260mt. at the foot to 340mt. near the top. A linear scale from bottom to top would represent the entropy of unit mass of air measured

from a conventional zero. The range of entropy on the diagram between 260mt. and 340mt. for 1 kilogramme of air is 270 joules/tercentesimal degree, and the entropy at 260 measured from an arbitrary zero at 100t. is 965 joules/degree.

The other lines in the groundwork of the diagrams are, first, lines of equal pressure which are diagonal lines in steps of 100mb. numbered at the lower end, with additional figures giving the height of the isobaric surfaces on the occasions, on Plate I. in dynamic metres and on Plate II. in metres.

Secondly, broken lines, slightly inclined to the vertical and numbered at the top, these are isograms to show the vapour-content of a saturated atmosphere in grammes per kilogramme of dry air.

Thirdly, curved full lines tending towards horizontal lines on the right. They show the relation of temperature to entropy (or log megatemperature) for adiabatic changes in a saturated atmosphere.

Circular No. 11.

PROGRAMME

OF THE MEETING OF THE COMMISSION IN LONDON, April 16–22, 1925.

Thursday, April 16,	8.30 p.m.	-	Reception at 10, Moreton Gardens.
Friday, April 17,	10–1	-	Business meeting. Ordre du Jour.
	3–5	-	Scientific meeting.
	7.45 for 8	-	Dinner by invitation of the Air Ministry.
Saturday, April 18,	10–1	-	Scientific meeting.
Sunday, April 19	-	-	Excursion to Stoner Hill, Petersfield.
Monday, April 20,	10–1	-	Business meeting.
	3–5	-	Scientific meeting.
Tuesday, April 21,	10–1	-	Business meeting.
Wednesday, April 22,	10–1	-	Final meeting.

April 8th, 1925.

The members of the Commission were also invited by the President and Council of the Royal Meteorological Society to attend the celebration of the 75th Anniversary of the foundation of the Society.

REPORT OF THE MEETINGS

OF THE

INTERNATIONAL COMMISSION FOR THE EXPLORATION OF THE UPPER AIR.

LONDON, APRIL 16–22, 1925.

MINUTES OF PROCEEDINGS OF THE BUSINESS MEETINGS.

By the invitation of the Director, all the meetings were held in the Library of the Meteorological Office, South Kensington.

First business meeting, Friday, April 17th, 1925, at 10 a.m.

Present : Sir Napier Shaw (*in the Chair*), Mr. C. J. P. Cave, Mr. L. H. G. Dines, Prof. Dr. E. van Everdingen, Prof. Gamba, Cdr. Garbett, Col. Gold, Prof. Dr. Hergesell, Dr. Hesselberg (*Secretary*), Dr. Matteuzzi, Col. Meseguer, Dr. Moltchanoff, Mr. L. F. Richardson, Dr. G. C. Simpson, Sir Gilbert Walker, Capitaine Wehrlé.

President's Report.—The President, in opening the reunion of the Commission expressed his apologies for occupying so prominent a position at the meeting.

He said that the Office of President of the Commission had been filled with distinction for many years by Professor Hergesell, he had been succeeded by Prof. Bjerknes, who presided over a meeting in Bergen in July, 1921. That meeting was followed by a meeting of the International Meteorological Committee in London in September, 1921, at which Prof. Bjerknes resigned; and after correspondence the Commission had expressed the wish that Sir Napier Shaw should become President in Prof. Bjerknes's place, and with some hesitation he had agreed to the election. A short meeting of the Commission was held at Utrecht in 1923, but the circumstances at that meeting were not favourable for a discussion of the details of an international publication.

The question of the best form of representation of the data had still to be considered: the conference at Utrecht was concerned with the efforts to obtain funds for an international publication, but these efforts had not proved entirely successful; accordingly when it was not obvious that funds would be forthcoming, the President next turned his attention to the meeting of the International Union for Geodesy and Geophysics in Madrid in 1924 and at that meeting the Union had voted a sum of 500*l.* for the publication of a specimen volume of upper air data on an international basis in order to give concrete form to the suggestion for a regular publication. To this sum Prof. E. van Everdingen had agreed to add a contribution from Holland.

The Commission was, therefore, now in a position to approach the question of a sample publication with the assurance that money was available for its production. It was on this account that he had felt justified in calling a meeting at the earliest opportunity in spite of the multitudinous international meetings of recent years.

Circulars issued to the meeting.—The President then read through the list of circulars (Nos. 8–19) which had been issued to the members of the Commission, and referring to Circular No. 12, the list of members, he welcomed Col. Meseguer, who had succeeded Col. Cruz Condé as Chief of the Spanish Meteorological Service, and who had been good enough to come to London for the meetings. He regretted that Prof. Exner, Dr. Cannegieter, M. Idrac, M. Wallén and Dr. Friedmann had all been prevented from attending.

With regard to Circular 15, the list of telegraphic addresses, the President requested that additions to the list should be sent in to the Secretary.

Circular 19, the list of data available for publication, was examined, and the President congratulated Dr. Moltchanoff on the numerous data forwarded from Russia. He then asked for additions to the printed circular and the following were forthcoming :—

Egypt - Col. Gold reported that observations by aeroplane in the neighbourhood of Helwan were available.

Germany - Prof. Hergesell reported that in addition to those from Lindenberg, ballon-sonde observations were also available at Munich, Hamburg and Königsberg. Observations with aeroplanes were made at Staaken near Berlin. Observations from several other stations will probably be available.

Holland - Prof. E. van Everdingen reported that kite observations were available at Duin Dal and that Helder should be omitted as it was the same as De Kooij.

India - The President reported that since the printing of the circulars four observations by ballon-sonde from Agra had been received; Sir Gilbert Walker stated that daily observations were made by pilot balloon at several stations.

Italy - Dr. Matteuzzi reported the addition of Rome (Vigna di Valle).

Russia - Dr. Moltchanoff stated that ballon-sonde observations were made at Kiev, aeroplane observations at Moscow and pilot balloon observations in the Crimea and other stations.

Iraq - Col. Gold reported that pilot balloon observations were made in Iraq.

Spain - Col. Meseguer stated that observations by ballon-sonde were made at Madrid once a month.

Prof. Hergesell asked that a list of mountain-stations should be added, and the President said that a list would be included in the publication.

The President said that the Bureau would be glad to receive further additions or corrections to the list, and added that in his opinion the international publication should be built round the records of ballons-sondes, and that aeroplane and pilot balloon observations, which throw light on the ascents, should be included.

Intensive Investigation of the Upper Air on a Single Day

The following have been received by the President :—

For September 4th, 1924.

BALLONS-SONDES.

Canada.—Five balloons of the six sent up at Woodstock were returned and the data will be forwarded by Mr. Patterson for publication.

Germany.—Six balloons were sent up of which four were returned. Data for six ascents at Munich at 4h., 8h., 12h., 16h., 20h., 24h., are published in " Deutsches Meteorologisches Jahrbuch für 1924." München, 1925; pp. D. 13–D. 20.

Great Britain.—Kew Observatory—ascents at 0700, 1851, 2300 G.M.T. Sealand—ascents at 0730, 1110 G.M.T.

Italy.—Pavia—six balloons were sent up, from which three records are available.

Russia.—Pavlovsk—Six balloons were sent up and two records were obtained at 1520, and 1925 G.M.T.

Sweden.—Abisko—Three records were obtained at 1059, 1859,2255.

AEROPLANES.

Holland.—Soesterberg—0620, 1010, 1410.

KITES.

Germany.—Lindenberg—0400–0800.

Russia.—Pavlovsk—2 records were obtained at 0804, 1120.

PILOT BALLOONS.

Azores.—Ponta Delgada, ascent at 0906.

Egypt.—Helwan, ascent at 0646 G.M.T.

Holland.—De Bilt 0630, 1240.

Japan.—Koso (1); Hiroshima (3); Tokyo (1).

Russia.—Five observations at Pavlovsk.

Cloud observations at two-hourly intervals during the day (7h.–18h.) have been forwarded from Sofia, Bulgaria.

For the European anticyclone of January 24th, 1925.

BALLONS-SONDES.

Great Britain.—Sealand : ascent at 0830.

AEROPLANES.

Great Britain.—Duxford : ascent at 0930.
S. Farnborough : three ascents at 1000, 1045, 1122.

KITES AND CAPTIVE BALLOONS.

Germany.—Lindenberg : ascent at 0400–0800.

Spain.—Plains of Vick : ascent at 0420–0515.

PILOT-BALLOONS.

Azores.—Angra : three ascents at 0931, 1317, 1605.

Finland.—Ilmala : ascent at 0700.
Sortavala : ascent at 0700.
Utti : ascent at 0700.

Great Britain.—Calshot : three ascents at 0002, 0705, 1145.
Cranwell : three ascents at 1140, 1600, 2315.
Felixstowe : three ascents at 0740, 1200, 1635.
Leuchars : ascent at 1225.
Renfrew : two ascents at 1145, 1515.
Sealand : two ascents at 0625, 1200.
S. Farnborough : two ascents at 0850, 1200.

Iraq and Palestine.—Aboukir : ascent at 0515.
Abu-Sueir : two ascents at 0157 and 0512.
Amman : ascent at 1355.
Heliopolis : two ascents at 0225 and 0530.
Ramleh : ascent at 0820.

Malta.—Pieta : ascent at 1315.

Spain.—Tortosa : ascent at 0700.

No observations were possible in Czecho-Slovakia owing to fog. A ballon-sonde was sent up at Pavlovsk but was not returned.

Correspondence.—(1) *Apologies for absence.* Reference was made to the précis of correspondence already circulated (Circular 14) which contained apologies for absence from Dr. C. Braak (Batavia, Dutch East Indies), Col. Chaves (Azores), Col. Delcambre (Paris), Dr. E. Fontséré (Barcelona), Dr. Fujiwhara (Tokyo), Dr. C. F. Marvin (Washington), Prof. Palazzo (Rome), Mr. J. Patterson (Toronto), Dr. S. Róna (Budapest), Dr. J. W. Sandström (Stockholm), Dr. R. Schneider (Prague). The President reported that since the précis was made he had received letters of apology for absence from Prof. F. M. Exner of Vienna, Mons. P. Idrac of Trappes, Dr. Wallén of Stockholm, Dr. la Cour of Copenhagen, Mons. Nell of Voorburg near the Hague and Mr. W. H. Dines of Benson Observatory.

The following notes from the correspondence were quoted :—

Dr. Braak (Batavia, Dutch East Indies). " I am indeed very sorry not to be able to send you any data for the upper air for the international days of 1923. Want of funds and scientific personnel have obliged me to discontinue the research of the upper air, and even at the present time I cannot say when it can be taken up again."—January 8th, 1925.

Col. Chaves (Azores). " Je désirerais assister à la réunion mais mon état de santé depuis quelques mois n'est pas excellent. A present je me porte mieux, mais pas encore en état de faire le voyage pour l'Angleterre. Je vous souhaite une excellente réussite à vos travaux. Mon pays traverse une époque de difficultés financières, qui l'empêchent d'aider ce Service Météorologique des Açores de manière à qu'il puisse réaliser tous ses désirs. Dans ces conditions par exemple il m'est impossible de faire tous les jours des ascensions de ballons-pilotes, de faire imprimer les résultats de nos observations, etc. Je vous communique cela pour faire connaître que toute résolution produisant une augmentation de depénses

à ce Service ne pourra pas, à present, être réalisée. Pour vous démontrer que mon Gouvernment continue à m'aider en tout ce qu'il peut j'ai le plaisir de vous communiquer que je viens d'obtenir la nomination d'un Chef de Service pour l'Observatoire de Horta (en substitution du Chef décédé il y a deux ans) de manière que prochainement on pourra commencer à envoyer de Horta les deux télégrammes supplémentaires à 10h. et 16h. du T.M.G. demandés dans la Conférence de Utrecht."—February 23rd, 1925.

Col. Delcambre (Paris). "Je vous serais trés reconnaissant de vouloir bien proposer, au cours de cette session l'admission, comme Membre de la Commission, de M. Idrac, docteur ès-sciences, repétiteur de physique à l'Ecole Polytechnique qui est chargé dorénavant de l'étude de la haute atmosphère à Trappes."—March 31st, 1925.

Dr. Fujiwhara (Tokyo, Japan). "Please kind regards to those members who will be present at the meeting of the Commission. Prior to the earthquake I got a fund £100 for the study of cloud. All equipments prepared with this fund were lost by the fire which followed the quake. But I am continuing the study with single photograph method. It is not yet completed."—January 22nd, 1925.

Dr. Wallén (Stockholm). "As for Sweden, certainly, we shall be satisfied with the proposal made by the Commission. But I think it necessary also to say that I believe it will be very difficult to get a higher grant for this publication than that one which was paid from Sweden before 1919."—April 7th, 1925.

(2) *Data available for publication.* The President reported the following communications (Circular 14).

Col. E. Delcambre (Paris). Publications françaises de sondages divers. (*a*) Ballons-pilotes: le Bulletin quotidien d'Etudes de l'Office contient chaque jour sous forme numérique les résultats des sondages par ballons-pilotes effectués dans 23 stations à 5h., 9h. et 18 heures G.M.T. soit, dans les conditions optima 25,285 sondages par an. Les altitudes types sont les suivantes: 500 mètres, 1,000 mètres, 2,000 mètres, 3,000 mètres, 4,000 mètres, 5,000 mètres (rose de 16 directions vitesse en kilomètre/heure).

(*b*) Ballons-sondes: 40 lancers de ballons-sondes ont été effectués à Trappes en 1923, 47 en 1924. Mais 19 lancers de 1923 et 13 de 1924 ont seulement pu être dépouillés, et seuls ceux de 1922 ont été publiés. Mon intention est de continuer la publication dès que le dépouillement de 1923 sera achevé."—March 9th, 1925.

Mr. J. H. Field (Director-General of Indian Observatories). "In reply to your circular letter No. 9 of October 31st, 1924, I send herewith 4 sample $\theta\phi$ diagrams of balloon-flights in November and December, 1923, with tables of relative figures, and a map to show balloon tracks. Work with recording meteorograph balloons was resumed at Agra in that November, after a period of several blank years, and consequently these four records are the only ones that come within the year you ask for, 1923, and only one of them is on an International day, the 6th December (Amundsen's expedition: *vide* Circular letter dated Kristiania, Dec., 1922, from Prof. Hesselberg). They will, perhaps, however, serve your purpose at the present stage.

In three cases the rising and falling traces, when not coincident, differ by amounts averaging 0·4°C. on 13th November, 2·5°C. on 6th December, and 2·2° C. on 13th December, but in the flight of 28th December the divergence is wider (average 4·4°) and the two courses for this case have been separately plotted. It may be noted that in India divergences between rising and falling traces are frequently wider than in England, for horizontal temperature-changes are large over the distances of 200 to 300 miles, which the balloons travelled in the present cases. Thus the mean difference between the Agra minimum and the minimum in or near

the places of descent was 3·8°C. on the nights of flight. The weather was dry except on December 28th, the day of greatest divergence of traces, when a little scattered rain fell in the region traversed by the balloon.

"I may assure you that as soon as a decision shall have been come to as to the form in which recorder and pilot-results are required by the International Commission, this department will make every effort to respond promptly with available results. Presumably any such special form as your Form B. will be made available for purchase, and it is perhaps possible that a larger size of B. might be preferable for continuous work."—March 18th, 1925.

Mr. C. Gómez (Jefe del Observatorio Central, Tacubaya, Mexico). "In accordance with the circular letter of the International Commission for the Exploration of the Upper Air, of December, 1923, observations with free balloons have been made from November 11th–13th of last year as we set up the aerological station in August last.

"You will find enclosed with the present letter the results of the above-mentioned observations; kindly let me know if you desire to have them entered upon any other form.

"The circular letter of October, 1924, has been received relative to the international aerological ascents for 1925, and in accordance with that we will proceed to made the ascents indicated there without anything further from you."—January 5th, 1925.

Dr. C. F. Marvin (Washington). ". . . funds have not been sufficient in recent years to enable us to carry out sounding balloon investigations, and at the same time to keep up the more intensive work in the lower levels in aid of aviation. We hope to resume the sounding-balloon work next year, but for 1923 the only data available are those from pilot-balloons and kites. Observations on all the international dates were made with kites at 6 stations: in some cases several successive observations were made on the same day."—December 4th, 1924.

Dr. S. Róna (Budapest). "As I had the honour of writing you already it is our intention of participating again in the international co-operation on the simultaneous days by means of registering instruments placed on aeroplanes. Till now we did not succeed in beginning with the ascents, but we hope that we shall be able to co-operate on the days fixed for April."—February 28th, 1925.

The President then read a letter from Dr. la Cour as follows :—

"I have the pleasure to let you know that in this summer four wireless stations will be set in operation on Greenland. The four stations are: Angmagsalik, 65° 36·5′ N., 37° 33·5′ W.; Julianehaab, 60° 44′ N., 45° 58′ W.; Godthaab, 64° 10·5′ N., 51° 43·5′ W.; Godhavn, 69° 14·2′ N., 53° 41·5′ W. (the geographical co-ordinates are only preliminary ones). Owing to the desolate nature of that country, the use of ballons-sondes there scarcely will give any results, but I intend to equip all the four stations nearly surrounding the high interior of Greenland with instruments for observations of pilot balloons.

"The main station for geophysical investigation on Greenland will be Godhavn, where a permanent magnetic observatory will be established within a few months and where meteorological seismological and level observations will be carried out under continuous scientific supervision. As to the observations of pilot-balloons, I fear that the weather conditions often will be of a prohibitive character, but, on the other hand, the scientist in charge of the Godhavn Geophysical Observatory will be instructed to arrange by wireless simultaneous ascents from the four above-named stations when the weather reports from these stations seem to him to be in favour of getting observations from great heights from all the stations."

The Commission expressed its gratification at the extension of upper air work to Greenland and wished Dr. la Cour success in his enterprise.

The President also reported the receipt of a letter from Mr. Patterson forwarding data of pilot-balloon observations at Toronto, giving a note on the observations of high lapse-rate at Calgary, and stating that he would try to get a trace of humidity on the ballon-sonde records. A note from Mr. Patterson as to the possibility of holding all meetings of international meteorological bodies in consecutive weeks was also referred to.

(3) *Letter from Col. Cruz Condé.*—The President read the following letter from Col. Cruz Condé :—

Servicio Meteorológico Español,
Madrid.

le 28 Mars, 1925.

M. le Président du Comité International Météorologique,
London.

Monsieur le Président,

Le Gouvernement de mon pays m'a fait l'honneur de me confier le charge de " Delegado Regio " de la zone Nord de la Peninsule. Ce charge étant non démissionable, je suis obligé de cesser dans les travaux météoro logiques et je viens d'adresser aux collègues étrangers une lettre-circulaire leurs présentant mon successeur M. Enrique Meseguer, lequel avait exercé auparavant la sous-direction de ce service.

Dans les quatres années que je suis occupé dans la direction de l'organisation météorologique espagnole, j'ai eu beaucoup des occasions dans lesquelles j'ai reçu avec grand plaisir les épreuves d'une collaboration cordiale et amicale de la part de mes collègues des autres pays, ainsi que leurs attentions affectueuses. C'est ma reconnaissance la plus sincère que je désire exprimer, mon cher président, dans cette communication que je vous adresse comme représentant le plus caracterisé de l'Organisation internationale.

Je désire aussi vous présenter mes excuses de n'avoir pas dédié toute mon attention à l'exécution soigneuse de certaines de nos résolutions collectives. J'ai consacré tous mes efforts à l'arrangement des nouveaux pavillons et des éléments nécessaires pour les fonctions plus complexes d'une véritable Office Central et à la création d'un réseau des observatoires aérologiques avec du personnel exclusivement occupé à la météorologie. C'était une promise que j'avais fait dans ma communication sur l'Organisation aérologique à le presqu'île Iberique à l'occasion de la Conférence de Bergen de 1921. Je crois déjà avoir rempli le programme alors dessiné parce qu'aujourd'hui fonctionnent normalement avec des sondages journaliers 19 Observatoires aérologiques (dont le nombre n'était que trois auparavant) instalés à Madrid, Coruña, Izaña (Tenerife), Gijón, Santander, Valladolid, Zaragoza, Barcelona, Torotosa, Alicante, Almería, Granada, Málaga, Sevilla, Badajoz, Cadiz, Melilla, Mahón et Santa Cruz de Tenerife.

J'avais considéré très important pour notre service de prévision et aussi pour ceux des autres nations la création du réseau aérologique, notre réseau climatologique et pluviométrique étant déjà serré.

L'unité de control des stations météorologiques qui dependent des Ministères de la Guerre, de la Marine, des Travaux publics, etc., demandait aussi mon attention, et les démarches exigées la consécution de l'unité mentionée furent couronnées par le succès.

Des autres améliorations pour le service ont été réalisées ou se trouvent en voie de réalisation immédiate. Ces sont : la mise au jour de nos publications climatologiques, l'installation d'un fil direct pour l'émission des messages collectifs par la station de T.S.F. de Carabanchel, afin d'éviter des erreurs des retransmissions, le recrutement du personnel observateur, l'établissement de l'horaire des messages collectifs d'accord avec les résolutions de la commission internationale, les installations de

laboratoires pour la comparation des instruments, l'observation de la poussière à l'atmosphère, etc.

En vous remerciant d'avance, si vous voulez bien transmettre cette communication aux membres du Comité, je vous présente, mon cher Président, l'assurance de ma considération la plus respectueuse et le témoignage de mes sentiments affectueux.

(Signé) JUAN CRUZ-CONDÉ.

The President then asked Monsieur Meseguer to convey to Col. Cruz Condé the thanks of the commission for his communication and their congratulations on the success with which he had carried out the objects which he had set before himself.

Col. Meseguer expressed his thanks to the Commission on his own behalf and on that of Col. Cruz Condé.

Membership of the Commission.—It was reported that no change in the membership of the Commission had been made since the meeting at Utrecht in 1923. The following nominations were made for election :—

Dr. Róna, Director of the Meteorological Institute of Budapest, proposed by the President.

Mons. Idrac, chargé des études de la haute atmosphère à Trappes, proposed by Col. Delcambre.

Prof. Friedmann, Director of the Central Physical Observatory at Leningrad, proposed by Dr. Moltchanoff.

Col. Meseguer, Chief of the Spanish Meteorological Service in succession to Col. Cruz Condé, proposed by the President.

Dr. Schmauss, Director of the Meteorological Institute of Munich, proposed by Dr. Hergesell.

Prof. Linke, Director of the Geophysical and Meteorological Institute at Frankfurt a/Main, proposed by Dr. Hergesell.

Prof. Georgii, Vorstand des Wissenschaftlichen Abteilung der Seewarte Hamburg, proposed by Dr. Hergesell.

All the gentlemen were unanimously elected.

Dr. Simpson raised the question of the conditions of membership of the Commission, and asked whether members once appointed were life members.

After some discussion as to limiting the number of members of the Commission, it was agreed :—

I.—" That it is desirable that the question of the membership of Commissions should be considered by the International Meteorological Committee before the next International Meteorological Conference."

Arrangement of the " Ordre du Jour."—The provisional Ordre du Jour (Circular 13) was considered.

In response to the invitation from the President, the following subjects were suggested for addition to the " Ordre du Jour."

Mr. Richardson : " What, if anything, is being done to observe wind above clouds ? "

Prof. Moltchanoff :

(1) On the observations of the upper air at the Aerological Observatory at Pavlovsk. (Appendix VI.)

(2) On the desirability of dressing a complete catalogue of aerological stations, with indications of the type of observations carried on.

3) On the publication of aerological observations conjointly with meteorological surface observations.

(4) A meteorograph for sounding balloon. (Appendix II.)

(5) Systematization of the network of aerology stations. (Appendix IX.)

(6) On cloud observations made on international days. (Appendix VII.)

(7) On changing the methods of organisation of aerology-observations for the purpose of increasing the number of observations made on days when big cyclones are passing (Appendix IX.), and other mathematical reports.

Dr. E. van Everdingen stated that Prof. van Bemmelen had subjects which he wished to bring forward.

The " Ordre du Jour " was approved as follows :—

ORDRE DU JOUR

Friday, April 17th, 10 a.m. (First business meeting).

1. *President's report.*—Institutes and observatories which have contributed data :—

(1) For the ordinary international days;
(2) for September 4th, 1924;
(3) for January 24th, 1925.

Promises of further contributions for the future.

2. *Correspondence* (Circular No. 14).

3. *Membership of the Commission.*—Proposals for the election of new members.

4. *List of telegraphic addresses* (Circular No. 15) and other arrangements for the transmission of requests for special observations on days selected by the President. (Mr. Patterson's proposal, p. 34.)

5. *Arrangement of the " Ordre du Jour " for future sessions.*—Provisional list of subjects for consideration.

6. *Questions concerning Technique of observations and computations :*—

(1) Types of instruments employed in the various countries and their supply.

(2) The supply of balloons and their cost.

(3) The formula for the rate of ascent of pilot-balloons (Dr. Weinberg's proposal, p. 27; Circular No. 14).

Friday, April 17th, 3 p.m. (Scientific meeting).

Discussion of the representation of data.

New instruments : Self-recording theodolites and Hill's mirrors : Sextant theodolite.

Saturday, April 18th, 10 a.m. (Scientific meeting).

Special observations. Communication by Mons. Fontséré " On the oscillations of short-period in the free air according to the character of the movement of pilot-balloons as seen in the theodolite." (Circular No. 17).

Lapse-rates beyond convective equilibrium of dry air; and other subjects.

Monday, April 20th, 10 a.m. (Second business meeting).

7. *Publication of a specimen volume at international expense.*—Shall the offer of a sum for the publication of a specimen volume by the U.G.G.I., supplemented by a contribution from the K. Nederlandsch Meteorologisch Instituut be accepted ?

If the offer is accepted, should the publication take the form of a report of the discussion explaining the conclusions arrived at, with the data for 1923 and 1924 in the agreed form or forms ?

Material to be submitted for approval :—

List of stations with list of data for the international days of 1923 and 1924 with results of ballons-sondes on international days. (Dr. Hesselberg's form.)

Form for arrangement of numerical data. (Dr. van Everdingen's form.)

Specimen page showing $t\phi$ diagrams with aeroplane insets wind-components in the margins and numerical data at the foot.

Specimen page of four diagrams with a curve of humidity and insets of vector-diagrams of wind.

Maps of the northern hemisphere on international days.

Should the form of publication aim at uniformity in respect of units, and if so should exceptional contributions be converted before publication ?

Monday, April 20th, 3 p.m. (Scientific meeting).

Are the upper regions of hot continents anticyclonic in summer ? The relation of Indian observations of the upper air to the computed distribution of pressure.

Other subjects.

Tuesday, April 21st, 10 a.m. (Third business meeting).

8. *General arrangements for the future.*

Choice of international days. (Mr. Patterson's proposal, p. 34.)

International or national publication.

Dr. Marvin's proposals. (Circular 14.)

Dr. Simpson's memorandum on Resolution 62 of the Utrecht Conference. (Circular No. 18.)

Monthly, quarterly, or annual publication.

Procedure with regard to the provision of funds for an international publication after the issue of the specimen volume.

Wednesday, April 22nd, 10 a.m. (Final meeting).

The Commission then proceeded to the detailed business of the meeting.

Technique of Observations and Computations :—(1) *Types of instruments employed in the various countries and their supply.*—The President emphasised that in resuming the study of the upper air on an international basis it was of great importance to have information available as to the details of the instruments used for ballon-sonde ascents in the different countries, together with their approximate cost and particulars as to where they could

be obtained. He read a provisional list and agreed to circulate it to members so that particulars might be added by the several members and corrections made.

The President read a list of books on the technique of upper air observations: certain additions were made by the members. A copy of Teisserenc de Bort's account of the methods of observation at sea with an English translation was circulated.

Dr. Hergesell then gave an account of a method used in Germany for making the records so that the trace would not be washed off if the instrument fell in the sea. The record is made by a sharp point scratching on smoked paper; the best paper for the purpose is found to be a nickel-paper highly polished; this is blackened with smoke from heavy petroleum, which gives also sufficient grease to cover the surface and prevent the record from being obliterated. Dr. Hergesell agreed to send a specimen of the paper to the Meteorological Office. He also explained that if ballon-sonde observations were made with two balloons it was easy to compute the place of fall of the instrument if the point of explosion of the first balloon could be seen. This was done by drawing the trajectory of the balloons from the origin to the point of bursting of the first balloon and constructing a similar trajectory for the track of the instrument during its descent, due allowance being made for any known difference between the rates of ascent and descent.

Dr. Hergesell also referred to a new sextant theodolite invented by Wegener, a description of which is given in the *Archiv der Deutschen Seewarte* for 1922.

(2) *The supply of balloons and their cost.*—The President referred to a list which he had drawn up giving particulars of the types of balloons used in the different countries, and a discussion followed on the possibility of ensuring a supply of reliable rubber balloons. Dr. Hergesell said that the balloons used at Lindenberg were obtained from the Continental Company at Hanover; some of the balloons carried the instrument to 24 or 25 kilometres, but the quality of the rubber was very variable; the main difficulty seemed to be in excluding dust during the processes of manufacture. The price of the balloons was from 60 to 70 marks. He further pointed out that the cost of the balloon varied with the weight of the rubber; and balloons of one price might be of thick rubber and small diameter or of thin rubber and large diameter.

Prof. E. van Everdingen emphasised the fact that if a large and constant demand for balloons were guaranteed it would be worth while for a manufacturer to overcome the difficulties of construction, which were undoubtedly great. It was suggested that it might be possible to invite the services to assist in overcoming the difficulty of the supply by finding an establishment where good balloons could be obtained and guaranteeing a definite sale to the manufacturer if the balloons were of reliable quality.

The President raised the question of the method of specification of the sizes of balloons, and especially of their diameter.

It was agreed that a note of the information available should be circulated to the members and that the whole question of the supply of balloons should be reconsidered at the final meeting (*see* p. 43).

(3) *The formula for the rate of ascent of pilot balloons.*—The President referred to the following request from Dr. Weinberg:—

"As it would be most desirable to follow a uniform method of computing the rate of ascent of pilot-balloons in connection to their free lift and diameter in cases of observation from a single point, the Central Geophysical Observatory will be greatly obliged if you kindly communicate the formulæ and tables obtained according to data which you would consider as being the nearest to the real rates of ascent and which you are making use of at the present time."—December 15th, 1924.

With regard to this suggestion Dr. C. F. Marvin wrote on March 27th, 1925.

"The proposal by Professor Weinberg (Leningrad) that a common formula be adopted for the rate of ascent of pilot balloons cannot, it seems to us, be accepted, unless balloons and gas of uniform quality be used in all countries. Neither the Hergesell nor the Dines formula is satisfactory here, and we have developed one based upon our own double-theodolite work. We should not, of course, consent to use any other that would give less dependable results."

The President asked that the members would send in particulars of the formulæ used in their own services. (*See also* p. 41.)

The meeting adjourned at 12.45 p.m.

April 22nd, 1925. (Signed) NAPIER SHAW.

Second Business Meeting, Monday, April 20th, 1925, at 10 a.m.

Present: Sir Napier Shaw (*in the Chair*), Dr. van Bemmelen Mr. L. H. G. Dines, Prof. Dr. E. van Everdingen, Madame Foehringer, Prof. Gamba, Colonel Gold, Prof. Dr. Hergesell, Dr. Hesselberg (*Secretary*), Dr. Matteuzzi, Colonel Meseguer, Dr. Moltchanoff, Sir Gilbert Walker, Capitaine Wehrlé.

Minutes.—The minutes of the first meeting were circulated, and it was agreed that they should be submitted for signature at the final meeting on Wednesday, April 22nd.

Publication of a specimen volume at international expense. (Order du Jour, Item 7).—The President asked for a resolution of the Commission as to whether the offers of sums for the publication of a specimen volume should be accepted. Prof. E. van Everdingen said that in his opinion the publication of a specimen volume would be the best method of showing the various countries that an international publication was being resumed and would give them a method of judging the relative value of the different forms of representation; it would also encourage the various services

to indicate what contributions they could make to the publications in the way of observational data or financial assistance.

Dr. Hesselberg supported Dr. van Everdingen, and the general opinion of the meeting was in favour of the publication of a specimen volume.

It was agreed, however, that the formal decision on the subject should be delayed in order that the form of resolution (Resolution III) might receive further consideration. The resolution as unanimously accepted in the afternoon meeting is as follows.

***III.—"That the Commission decides that the funds put at the disposal of the President shall be used for the publication of a specimen volume of international upper air results for 1923 and 1924."**

The form of publication. The following resolution was unanimously adopted.

IV.—"That the publication consist of a specimen volume containing the results of International Upper Air Investigation for the years 1923 and 1924."

The President drew the attention of the members to the various forms which had been submitted :—

(1) Director Hesselberg's circular of June 19th, 1924.

(2) A list of stations with lists of data for the international days of 1923 and 1924, in the form proposed by Dr. Hesselberg. (Circulars 19*a* and 19*b*.)

(3) A map of the distribution of pressure over the Northern Hemisphere on one of the international days. (Circular 19*d'*.)

(4) The form for numerical data of observations of ballons-sondes and aeroplanes proposed by Prof. E. van Everdingen. (Circular 19*e*.)

(5) The form for numerical data for pilot-balloons proposed by Prof. E. van Everdingen (Circular 19*f*.)

(6) A specimen page of graphic representation of *two* ballons-sondes ascents (tephigrams or $t\phi$ diagrams) with numerical data and auxiliary information concerning observations by aeroplane and by pilot balloon on a page of royal 4to. (Circular 19*c*). *See* Plate I.

(7) A second specimen page showing the representation by tephigram with a graph of dewpoints, *four* ascents to the page with space for auxiliary information. (Circular 19*d*). *See* Plate II.

It was suggested that the decision might be left to the Bureau as to which of the forms (Circular 19*c* or 19*d*) should be adopted in any particular case.

* The resolutions are numbered in chronological order, for No. II, *see* "Second Scientific Meeting," p. 51. A complete list of the resolutions is given in Appendix I, p. 58.

These forms are designed to give information of pressure, temperature, potential temperature, humidity, height, wind velocity and direction, and cloud.

The President also exhibited portfolios containing the data received for 1923 and 1924 and for a special day of investigation of the European anticyclone on January 24th, 1925.

Provisional approval was given to the following form of publication :—

(*a*) List of stations and data for international days. (Circulars 19*a* and *b*.)

(*b*) Map of the distribution of pressure over the Northern Hemisphere incorporating Indian, Egyptian, Siberian, European, American and Japanese data. (Circular 19*d'*.)

(*c*) Tables of ballons-sondes, aeroplane and pilot-balloon results on Prof. E. van Everdingen's form. (Circulars 19*e* and *f*.)

(*d*) Graphs of ballon-sonde ascents with auxiliary data in one or other of the two forms submitted, at the discretion of the Bureau de Rédaction. (Circulars 19*c* and *d*.)

(*e*) Observations from mountain stations.

(*f*) Cloud observations.

Colonel Gold asked for a clear understanding as to whether the publication was based on the hypothesis that the tables are fundamental and the charts supplementary or vice-versa, and proposed the following resolution which was approved :—

V.—"That in the specimen volume the ballons-sondes and similar records should be published in the form of tables giving full details and that the tables be supplemented by a graphical representation on tephigrams ($t\phi$ diagrams), i.e., diagrams based on temperature and potential temperature."

Prof. E. van Everdingen said that he was afraid that the data for 1924 might be more voluminous than was apparent at present, and said that if funds were not sufficient for the complete publication he would like an expression of opinion as to what should be omitted.

The following resolution was approved.—

VI.—"That complete data for 1923 should be published : in graphs and tables, but if funds are not sufficient to publish all the data for 1924 the tables should be complete."

Detailed consideration of the form of publication.—*The list of stations and data* (Circulars 19*a* and *b*) was indicated as approved in general principle, subject to such modifications as the Bureau might find necessary. Colonel Gold raised the question as to the specification of the height of the station for upper air work and a commission consisting of Colonel Gold, Prof. Gamba and Dr.

Hesselberg was appointed to consider the question and report on Wednesday (*see* p. 40).

Specification of height in dynamic or geometric metres (Circulars 19*e* and 19*f*). Dr. Hesselberg put forward a list of observations and units and suggested that it was desirable to choose between the expression of height in dynamic metres, and in geometric metres, and he expressed himself in favour of the adoption of dynamic metres throughout the publication (*see* p. 32).

Dr. E. van Everdingen pointed out that his forms for numerical data had been drawn up in accordance with existing international resolutions. They provide for the specification of pressure, temperature and humidity at given geometric heights, and also of geopotential, temperature, and humidity at the levels of the principal isobaric surfaces; an additional column is provided for remarks, inversions, &c.

After some discussion, the members were asked to express their opinion individually as to the adoption of dynamic or geometric metres for the expression of height in the specimen volume. The result was as follows :—

Seven were in favour of dynamic metres :—

Colonel Gold, Director Hesselberg, Colonel Meseguer, Dr. Moltchanoff, Sir Gilbert Walker, Capitaine Wehrlé, the President.

Two were in favour of geometric metres :—

Dr. van Bemmelen, Mr. L. H. G. Dines.

Three were neutral :—

Dr. Hergesell, Colonel Matteuzzi, Dr. E. van Everdingen.

Prof. Gamba expressed himself as personally in favour of dynamic metres, but said that as representative he did not feel himself able to vote in favour of their adoption.

Further consideration of the form of publication.—The President referred to the following expressions of opinion which had been received from absent members and had been reported in Circulars 14 and 20 and read a note on units by Director Hesselberg (*see* p. 32).

Prof. Exner (Austria).—In connexion with the proposed distribution of advance copies of upper air data by Dr. Simpson (Utrecht, 1924, resolution 62), writes: "(1) I agree that the temperature and humidity should be given also for heights of 1,000, 900, etc., in millibars; but should like to give the temperature in degrees Celsius as heretofore, the pressure might indeed be expressed in millibars.

"(2) It seems to me absolutely necessary also to insert the results of any ballons-sondes observations, as it is only in this way that reliable wind data for high altitudes can be obtained.

"(3) It is very important that in a general way data should be given which will render it possible to judge of the reliability of the figures, such as the clearly-marked beginning of a radiation effect, speed of ascent, temperature correction of the Bourdon tube, statement whether ascent

or descent was worked out, characteristic differences between ascent and descent curves, and particularly position and temperature of the stratosphere in the descent also.

"(4) It would be very desirable if the central station were to publish from time to time the results of all successful ascents, separated according to whether they were carried out singly or in series, as these would provide a general survey for the various data sheets to be collected for any particular date.

"(5) A uniform form should be adhered to, so that the various sheets can subsequently be bound. The result of each individual ascent or series of ascents should be printed on separate sheets and on both sides of the paper. I do not agree with the graphical representation suggested by Sir Napier Shaw. In my opinion the tabular form is better, as it can be used for all possible purposes."—17th November, 1924.

Dr. Fujiwhara (Tokyo).—"The current opinion in the meteorological circles in Japan is that it is desirable to have upper air numerical data adequate for the practical use to be published by the International Commission for the Exploration of the Upper Atmosphere; we are, however, not yet well accustomed to treat the upper air pressure and temperature. Hence we do not insist our opinion strongly. We hope, if possible, the complete representation in tabular form of the material will be accompanied by a graphic representation which may not demand severe exactness."—January 22nd, 1925.

Dr. C. F. Marvin (Washington).—"1. We believe that the Commission will accomplish most by concentrating its efforts upon a study of the upper part of the troposphere and all of the stratosphere that can be explored by whatever means now exist or may be developed. We therefore suggest that only those soundings be considered 'international,' and be forwarded to the Commission, that reach a height of 8 to 10 kilometres (the exact limit to be fixed at the April meeting). This action, if taken, will rule out kite, captive balloon, airplane, many pilot-balloon and some sounding balloon ascents. At the present time there will, perhaps, be little data left for the Commission to use, but it seems certain that within a very few years the exploration of the air at great heights will be materially extended, by sounding balloon or other means at present unknown. These data at great heights are essentially 'international' in interest; those at lower levels are no more so than are the surface data. If the latter are published by the Commission, there results a huge mass of material most of which will not be used in studies of other than local interest.

"(2) We believe that the original 'raw' data should be published, *i.e.*, the points on the traces showing changes in the gradients of the different elements. In addition, there may be included interpolated values at certain fixed altitudes, every kilometre for example. With the data thus presented every student can rearrange them in tabulated or graphic form to suit his own particular purposes. We are opposed to asking the various services to do more than furnish the data in the simplest, but at the same time in a complete form. Each service should, however, be willing to furnish the data in the units and in the tabular scheme adopted by the Commission.

"(3) We believe that each country should publish summaries of its own data for the lower levels, preferably one for each month, and a brief annual summary. Publication of data in detail, *i.e.*, individual observations, is out of the question owing to the large expense entailed. We are referring here to the daily soundings made by various means. If attention were confined to international days, results from selected stations might be multigraphed and circulated among the various services."—March 27th, 1925.

Mr. J. Patterson (Toronto).—"In regard to the form of publication of the numerical data I am strongly of the opinion that the pressure

should be published in millibars and the temperature in degrees absolute only."—March 4th, 1925.

Dr. Hesselberg said that he was of the opinion that it was not desirable that the salient points of the curves, which were marked by changes in lapse-rate or in some other manner, should be printed merely in a column for remarks; they were required in the table itself. A discussion followed as to how the data could be represented without destroying the regularity of the table.

It was suggested that any necessary modification of the form might be left to the discretion of the Bureau de Rédaction.

Further consideration of the details of publication was postponed to a subsequent meeting.

The meeting adjourned at 1 p.m.

April 22nd, 1925. (Signed) NAPIER SHAW.

Third Business Meeting, Tuesday morning, April 21st, 1925, at 10 a.m.

Present: Sir Napier Shaw (*in the Chair*), Dr. W. van Bemmelen, Capt. C. J. P. Cave, Mr. L. H. G. Dines, Prof. Dr. E. van Everdingen, Madame Foehringer, Prof. P. Gamba, Colonel E. Gold, Prof. Dr. H. Hergesell, Dr. Th. Hesselberg (*Secretary*) Dr. Matteuzzi, Colonel Meseguer, Dr. Moltchanoff, Mr. L. F. Richardson, Dr. G. C. Simpson, Capitaine Wehrlé.

Units.—The President asked for the opinions of the members on any points of general principle connected with Dr. Hesselberg's circular (No. 26) as set out below. After discussion Dr. Hesselberg's proposal was provisionally approved with permission to the Rédaction to make alterations which do not affect the general principle. The words "in degrees from north" were added under the heading "wind direction."

THE FORM OF INTERNATIONAL PUBLICATION.

Proposals by Dr. Hesselberg.

1. The following units are to be used in the forms and publications of the commission:—

Latitude in degrees and minutes.

Longitude in degrees and minutes, reckoned from Greenwich.

Geopotential in dynamic metres above sea-level.

Time in G.M.T.

Barometric pressure in millibars.

Temperature in degrees absolute and tenths.

Potential temperature in degrees and tenths, reduced to 1000 millibars.

Gradient of temperature (*Lapse Rate*) in degrees and tenths per 100 dynamic metres.

Humidity as relative humidity in per cent.

Wind direction in degrees from north or on the scale 01–36, where 36 is wind from north and 09 wind from east.

Wind velocity in metres per second.

Cloud forms in international scale.

Direction of cloud drift in scale 01–36.

Angular velocity of cloud drift in unit 1000 $\frac{v}{H'}$, where v = velocity in metres per second and H' = height in metres.

Amount of clouds in scale 0–10, separately for each form.

Weight of balloon in grammes.

Ascensional force of balloon in grammes.

Diameter of balloon in cm., when filled.

2. The ascents are to be performed as nearly as possible at one or more of the hours 01, 07, 13 and 18.

3. The pressure, the temperature and if possible the humidity are to be given (1) for all geopotentials where there are alterations in the lapse rate, (2) for standard pressures 1000, 900–100 mb. and (3) for standard geopotentials 500, 1000, 1500, 2000, 3000 . . . m.

4. The wind is to be given for the station and for the natural layers.

5. All stations partaking in the work are if possible to make observations at the station every three hours on international days (cloud observations included).

6. The observations are to be published in a complete numerical table. Further, there should be given diagrams showing the relation between temperature and potential temperature, and weather charts for the region from which observations are available.

Calibration of Instruments.—Dr. Hergesell emphasized the necessity of calibrating the instruments at low temperatures and simultaneous low pressures. M. Wehrlé explained that this practice had also been found necessary in the work at Trappes.

Mr. L. H. G. Dines described the method of calibration in use in Great Britain.

Temperature.—Mr. Richardson handed in the following resolution:—

"That the value for the thermodynamic temperature of the ice point shall be that recommended by the Bureau International des Poids et Mesures."

The President ruled that a proposal which opened so wide a field of discussion could not be accepted at this stage of the

meeting but should be circulated beforehand in accordance with the règlement.

New proposals.—Dr. Moltchanoff on behalf of the Central Geophysical Observatory at Leningrad put forward the following propositions :—

(1) On the publication of aerological observations conjointly with meteorological surface observations.—It would be desirable in publishing aerological observations to insert conjointly the data of meteorological observations made at the earth's surface—which has not been done up to now.

(2) On the desirability of establishing a fund for the organisation of aerological exploring expeditions.—It would be desirable to establish a special international fund intended to support the organisation of aerological observations to be produced in the course of exploring expeditions, polar expeditions being of special interest in this connexion.

(3) On the desirability of the elaboration of a simplified method of wind and cloud observations.—It would be desirable to discuss the subject concerning the elaboration of the methods of wind observations above the clouds, at the moment when the sounding balloon (or the pilot-balloon) has already vanished (the probable possibility of adapting sound or wireless signalization, etc.).

Choice of International days.—The President read the following proposals and remarks forwarded by Dr. Marvin, Mr. Patterson and Colonel Delcambre which had been reported in Circular 14 :—

Dr. C. F. Marvin (Washington). "The selection of certain days, isolated in most cases, for these observations is believed to be unwise. A better plan it seems would be to select a solid month in one year, the next month in the following year, etc. In this way, at the end of the 12 years, there would be as much data as by the present plan, the entire year would be covered, and, most important of all, these data would give information as to day-to-day changes entirely lacking now."—March 27th, 1925.

Mr. J. Patterson (Toronto). "In regard to the 6 ascents to be made during a period selected by the President of the Commission, it appears to be the general desire to have these ascents on one day in order to make an intensive study of the conditions. It would be impossible for me to have these ascents unless at least three days' notice is received, as it would require that time for me to calibrate the instruments and get them to the place where they are to be sent up. As one day of intensive study of the atmosphere is very desirable, would it not be much better to assign the 4 periods of 6 ascents each, having one of the periods for the 6 ascents in one day. This would make definite arrangements for 24 ascents in the year. Any special features of the weather could be investigated by having a fifth period assigned by the President. As it stands at present it is only the European countries that can participate in a fourth period at present and then for the investigation of special European weather conditions; on that account it is not representative of world-weather. In Canada it is hoped to investigate definite types of weather conditions as soon as satisfactory equipment can be obtained."—March 4th, 1925.

Colonel E. Delcambre (Paris). Désignation à courtes échéances par le Président d'un jour d'ascension internationale de ballons-sondes. "A ce propos et bien que la question ne soit pas directment posée par vous, je me permets de signaler l'intérêt considérable qu'il y a à faire dans les journées ainsi désignées non pas un, mais plusieurs et par exemple trois sondages."—March 9th, 1925.

The President then asked for proposals as to the choice of international days. He explained that the present arrangement was to have two groups of six days with one ascent per day, one group of three days with two ascents per day, and to leave the remaining six ascents to be fixed at the President's discretion. Dr. Marvin's proposal was to concentrate all the ascents in a single month of the year.

Dr. van Bemmelen and Prof. E. van Everdingen both expressed themselves as opposed to concentration of all ascents in one month. Colonel Gold said he welcomed Dr. Marvin's note. At the meeting of the Commission in Bergen in 1921 he had made a similar proposition to have ascents distributed over a month even if every country could not have *daily* ascents. He had done so on the ground that in the world investigation of the upper air meteorologists were not concerned with studying the small variations peculiar to one country or region but with a survey of the slower world-wide changes; he advocated the adoption of Dr. Marvin's proposal on the understanding that the observations in an international month should be in addition to ascents distributed on the international days throughout the year.

Dr. Hesselberg said that the adoption of the proposal excluded the possibility of getting a number of ascents concentrated at short intervals, such as would be required for dynamic studies of the changes of energy in the atmosphere. He was in favour of getting ascents at the international hours of observation 1h., 7h., 13h., and 18h.

M. Wehrlé pointed out that with a very close net-work of stations observations at different places might be regarded as in some degree taking the place of observations at short intervals of time but with the present net-work this was not the case.

Dr. Hergesell drew the attention of the Commission to two aspects of the work of exploration of the upper atmosphere, the first was to create a general view of the whole atmosphere over the globe, and the second to get a more detailed study for special regions.

The President then put forward a proposal suggesting that one month each year should be chosen as an international month during which observations should be made if possible once a day and that in that month an intensive investigation of six ascents should also be made. Dr. Simpson suggested as an alternative proposal that the President should select the month for the world-investigation but that the Commission should appoint local committees for the different regions to select the days of intensive investigation in their own region. The President suggested that the appointment of a Vice-President for each region would be sufficient and the commission assented thereto.

The regions suggested were N. America, S. America, Europe and Siberia, India and the Indies, Australia. Observations with ballons-sondes were at present available in N. America and in India.

Dr. Hergesell and M. Wehrlé put forward a proposition differing in some details from that suggested by the President, and it was agreed that Dr. Hesselberg, Prof. E. van Everdingen and the President should formulate a resolution combining the two proposals and that the formal vote on the question should be taken at the final meeting (*see* p. 39).

Ballons-Sondes Observations in Russia.—Colonel Gold proposed the following resolution, which was approved :—

VIII.—" That intensive observations of ballons-sondes in Russia and Siberia from 3–5 stations are of great importance in the investigation of the upper atmosphere."

International or National Publication and Preliminary circulation of Data.—The President read the following proposals forwarded by Dr. Marvin as to the desirability of a national rather than an international publication for upper air data :—

"In view of the limitations upon the commission's securing the prompt publication of free-air data, I am rather inclined to the theory that the different nations conducting the investigations should themselves endeavour to effect as prompt publication as possible, and it seems to me a good idea for the commission to concern itself actively with what constitutes an ideal type of presentation of observational work, including also discussions thereof and holding out encouragement to all agencies making the original observations to publish its results promptly along these lines. More prompt dissemination of information would, perhaps, be secured in this way inasmuch as institutions little disposed to publish it themselves will be more prone to rely upon the work being done by the commission with the result that long intervals are likely to elapse before recent observations become available. I hope you will communicate with me further if we can be of assistance in this matter."—December 4th, 1924.

He referred also to Dr. Marvin's suggestion, set out on p. 31.

Dr. Simpson referred to Circular 18 (Appendix IV), and said that in accordance with Resolution 62 of the Utrecht meeting he had issued an appeal by circular to 40 institutes asking them to forward to him 200 copies of their observations with ballons-sondes, so that he might circulate them to the various institutes. Only seven institutes found themselves in a position to take part in the scheme at once and these were chiefly institutes which were already publishing their results. He would, therefore, like the opinion of the Commission as to whether it was necessary to continue the arrangement suggested in the resolution at Utrecht. He expressed the opinion that it would be advisable to go back to the national publication and that the Commission should agree as to a suitable form.

Prof. E. van Everdingen suggested that it would be unwise to judge of the success of the experiment from the early results; he cited a similar arrangement made 20 years ago by which the Netherlands Institute agreed to publish data as to the magnetic character of the day. Originally only seven stations

co-operated, but the publication had provided a stimulus to other nations to contribute to the publication and at the present time 43 stations were co-operating regularly.

He expressed the opinion that separate national publications did not give sufficient facilities to the student for upper air research, and pointed out the great advantages of an international publication in assembling in one volume data for the year. He suggested that it would be desirable to continue the arrangement made at Utrecht for the data after 1924 until the specimen volume was issued and it was possible to make provision for a more regular publication.

Dr. Hesselberg suggested that the best way of assembling the data would be for the Bureau of the Commission to circulate forms to the several institutes to be filled in and returned to the Bureau.

The President then asked for information as to the present state of the publication of ballon-sonde data by the various countries and the following replies were received :—

Country.	*Year up to which publication of Ballon-sonde data is complete.*	
Canada - -	1917.	Data for 1923 have been forwarded to the President for international publication.
France - -	1922.	The deciphering of the curves for 1923 is now complete and the data will be published at an early date.
Germany - - (Lindenberg)	1921.	The annual volumes for 1917 and 1921 are issued but not for the intervening years. The volume for 1922 is now in the press. This year-book will also contain all the results of registering balloons from 1923–1925.
Great Britain -	1921.	Data for 1923 and 1924 have been sent to the Commission for publication.
Holland - -	1923.	Data for 1923 and 1924 have been sent to the Commission for publication.
Italy—Pavia -	1922.	Data for 1923 and 1924 are in the press.
Rome -	—	Data for ballons-captifs and cerfs-volants are published to the end of 1924 and those for 1925 are in process of publication. The material of ballons-sondes data for 1923 and 1924 is ready for publication.
Spain - -	—	It is proposed to publish the aerological data for 1923 and 1924 in three parts. Serie A.—Résultats directes d'observation. Serie B.—Etudes d'ensemble, d'après ces dates, mémoires, et traduction des travaux étrangers dont la diffusion est utile en Espagne. Serie C.—Instructions pour notre service. Toutes les publications seront numérotées correlativement dans chaque serie, et nous remettrons au Director Meteorological Office 200 exemplaires. D'ailleurs elles serons commencées dans un mois. Toutes les ascensions internationaux sont faites du commencement.
Russia - -	1924.	Data have been published for 1920, 1921, 1923 and 1924, but not for 1922.

The President said that in view of the information received it seemed desirable that advance circulation should be undertaken and it was resolved :—

IX.—" That the Bureau of the Commission should make arrangements with Dr. Simpson as to the preliminary circulation of the data."

Colonel Gold urged very strongly from the point of view of research students the advantage of having all the data collected in one volume rather than in several national publications; he had found by experience the advantage of having the data set out on a uniform plan.

As regards Dr. Marvin's proposal it was agreed :—

X.—" That the consideration of the question as to a national or international publication should be postponed until after the issue of the specimen volume, and that the question should be considered at the next meeting of the Commission, possibly in 1927."

Monthly, Quarterly or Annual Publication.—Dr. Hergesell stated that in the old international publication the data were issued separately for each group of international days, and he was of the opinion that this arrangement should be adhered to.

It was provisionally agreed :—

XI.—" That international publication should be according to groups of international days."

Funds for International Publication.—Professor E. van Everdingen expressed the opinion that it was desirable to follow the former practice of asking the several countries for free contributions as high as possible and urged the desirability of starting the collection of funds immediately, so that money might be available for a regular international publication as soon as the form was decided.

The following resolutions were unanimously adopted :—

XII.—" That the President be authorised to open a banking account for such donations to an international publication as may be put at his disposal from time to time by countries wishing to forward contributions before the issue of the specimen volume."

XIII.—" That when the first specimen volume is issued the Bureau should take steps to ascertain the opinion of the several services as to the possibility of obtaining funds for an international publication."

Weather Messages for the German Oceanographical and Meteorological Expedition in the South Atlantic Ocean.—The following resolution was adopted :—

XIV.—" The Commission has learned with great satisfaction that the German oceanographic and meteorological expedition to the Southern Atlantic, which will carry out its investigations during a year from April, 1925, will be able also to take aerological observations (kites, pilot balloons and registering balloons)."

" In order to ensure the largest possible benefit from these observations, it recommends the meteorological services in the countries bordering the Southern Atlantic to provide the expedition with wireless weather messages, so as to allow the aerological observations to be taken when the weather conditions are most interesting ; and to facilitate the recovering of registering balloons."

The meeting adjourned at 1 p.m.

(Signed) NAPIER SHAW.

April 22nd, 1925.

Final Business Meeting, Wednesday, April 22nd, 1925, at 10 a.m.

Present : Sir Napier Shaw (*in the Chair*), Dr. W. van Bemmelen, Capt. C. J. P. Cave, Mr. L. H. G. Dines, Prof. Dr. E. van Everdingen, Madame Foehringer, Prof. Gamba, Colonel Gold, Prof. Dr. Hergesell, Dr. Hesselberg (*Secretary*), Dr. Matteuzzi, Colonel Meseguer, Dr. Moltchanoff, Sir Gilbert Walker, Capitaine Wehrlé.

Choice of International Days.—In accordance with the decision of the previous meeting the President put forward a draft resolution as to the choice of international days. It was agreed that it would be more convenient for the Commission to nominate deputy-presidents rather than sub-commissions for the selection of days of intensive investigation in the several regions.

The following resolutions were adopted unanimously :—

XV.—" That the attention of meteorologists be drawn to the dual purposes of the exploration of the upper air, namely :—

(*a*) étude mondiale—the study of the general circulation of the atmosphere.

(*b*) étude régionale—the more detailed study of the structure of the atmosphere and its changes in the several regions of observation.

2. " That the several regions be provisionally indicated as follows :—

(*a*) North America.
(*b*) South America.
(*c*) Europe with Russia, Siberia and North Africa.
(*d*) The East Indies and the Philippines.
(*e*) South Africa.
(*f*) Australia.

3. " That the supervision of the organization of ' les études régionales ' in regions other than Europe be entrusted to deputy-presidents for the several regions.

The deputy-presidents should put themselves in communication with the president of the Commission with a view to fixing the days for the regional investigations which should include at least 3 soundings a day corresponding with the international hours of observation.

4. "That without changing the selection of international days arranged at the meeting at Bergen the commission should indicate one of the months of each year in which one of the selected groups of international days falls, to be called the 'international month,' and that during the international month daily soundings with ballons-sondes should be attempted as far as possible on consecutive days beginning with the first day of the month.

5. "That the six soundings at the discretion of the President should be assigned for an intensive investigation on one day or on two consecutive days within the international month to be selected for Europe by the President and for the other regions by the local deputy-presidents.

6. "That for the region of North America Dr. C. F. Marvin be designated as deputy-president, for the region of the East Indies Mr. J. H. Field.

7. "That for 1926 the month of May be indicated as the international month and for 1927 the month of October."

It was agreed that countries which were able to make auxiliary or additional observations with ballons-sondes during the current year, should be invited to make soundings in the month of August.

Minutes.—The minutes of the previous meetings (Circulars 23 and 24) were corrected and authority was given for their signature.

Height of Stations for Aerological Work (*see* p. 29).—The sub-commission put forward a resolution as to the specification of the height of the station in aerological work, and after slight modification it was adopted as follows:

XVI.—"That the height of the station is that of the barometer above mean sea-level and that the height of the pilot-balloon theodolite should also be given. For observations of clouds where there is no barometer the height of the nephoscope should be given."

Colonel Gold said that the sub-commission had been led to adopt the barometer as the standard of height in order to bring into relation the surface-pressure and the pressure recorded by the ballon-sonde.

Additions to Circulars.—1. *List of telegraphic addresses* (Circular No. 15). Additions were made to the list of telegraphic addresses.

Dr. Hergesell asked that the list of telegraphic addresses set out in Circular 15 should be supplemented by a list of addresses of the stations named in Circulars 19*a* and 19*b*.

Members were asked to send information for the completion of the list before June 30th, 1925.

[The information received by the Bureau is set out in Appendix III.].

Instruments for Upper Air work.—1. *Particulars of Meteorographs, Balloons and Books of Technical Instructions* (Circular 22). In this case also, June 30th was fixed as the last day for receiving information by the Bureau. [*See* Appendix II.].

2. *Note by M. Wehrlé on the Technique of Soundings by Aeroplane* (Circular No. 25). Mons. Wehrlé submitted the following proposal:

"La généralisation des sondages par avion pour la constitution d'un réseau quotidien d'altitude est hautement désirable. A cet effet il est nécessaire de mettre au point une technique simple et sure. Pour hâter cette mise au point en faisant profiter tous les pays de l'expérience de chacun, la Commission Internationale de la Haute Atmosphère prend résolution suivante:

XVII.—"Les services météorologiques qui se sont occupés de sondages par avion sont priés de vouloir bien adresser au Président de la Commission internationale de la Haute Atmosphère une description aussi complète et détaillée que possible des instruments (structure et suspension à l'avion) et des méthodes employées."

"Le représentant de la France fait connaître que l'Office météorologique français, sous réserve de l'approbation definitive de son Directeur, est prêt à assumer la charge de la concentration et de la publication des réponses au nom de la Commission."

Resolution XVII. The resolution set out in M. Wehrlé's note was approved.

Colonel Gold described a method invented by Dr. Simpson, of mounting instruments on aeroplanes, by which it was possible to avoid the difficulty of the effect of the warmth of the engines on the thermometer readings, and still ensure that direct eye observations should be possible. The method consisted in having a conducting air-channel leading from the front of the aeroplane to the thermometers, which were placed near the pilot, so that eye-readings could be easily made.

Rate of Ascent of Pilot-balloons.—Apropos of Dr. Weinberg's proposal (p. 27.) the President suggested that the most suitable course of action would be to collect together all the information that was available and to leave a definite resolution until a later meeting of the Commission. A note by Prof. V. Kusnetzoff and I. Klado on the comparison of the formulæ, which was circulated during the meeting, is printed in Appendix V.

Mons. Wehrlé read the following memorandum:

"Formule de Vitesse Ascensionelle des ballons pilotes."

"Le problème s'est posé en France et son étude a mis en evidence les difficultés suivantes.

" (1) Les formules déduites des series de mesures de la vitesse ascensionelle effectuées en salle close, très importantes à d'autres points de vue, ne sont pas d'un grand secours pour résoudre la question posée, à cause de la différence systématique (due principalement à la turbulence de l'air) entre les vitesses ascensionelles en salle close et à l'air libre.

" (2) On est donc réduit à utiliser les mesures directes à l'air libre avec plusieurs théodolites ou avec des miroirs, qui sont moins nombreuses que les mesures en salle close ou qui du moins ont fait l'objet de moins de publications systématiques. Il est nécessaire d'en discuter la précision de très près (étendue de la base, erreurs de visée et de mise de niveau, etc.). En outre, si on veut établir une formule valable pour différentes catégories de ballons il faut avoir soin de procéder par *interpolation* c'est à dire d'effectuer des mesures sur les categories extrêmes de l'intervalle considerée. (C'est ce qui à fait Rouch dont la formule, satisfaisante pour les ballons moyens est provisoirement employée en France) l'expérience prouve en effet qu'une formule établie d'après une seule categorie de ballons est inapplicable à d'autres catégories même assez peu différentes (formule de la Porte—expériences de Oâre). Le mieux serait sans doute de ne pas déformer les résultats experimentaux en les traduisant par une formule, mais d'opérer des déterminations directes sur les categories de ballons pratiquement employés. Il serait facile d'ailleurs d'uniformiser les types de ballons employés (il en suffirait de 3 ou 4 petits ballons pour l'évaluation des plafonds bas, ballons moyens pour les sondages courants, gros ballons pour l'exploration de la haute atmosphère) et de dresser une table numérique des vitesses ascensionelles les plus probables, après avoir effectué des determinations systématiques directes à l'air libre.

" (3) Il est inutile de rechercher une trop grande précision sur la vitesse ascensionelle, celle-ci en effet est pratiquement utilisée pour les sondages avec un théodolite. Or dans cette opération, il y a un ensemble de causes d'erreurs (mesure des angles, variabilité de la vitesse ascensionelle, etc.) qui limitent à ΔV la précision obtenue dans la détermination du vent horizontal. Il est donc inutile de rechercher sur la vitesse ascensionelle une précision supérieure à celle qui donne sur la vitesse horizontale du vent cette même approximation ΔV. Toutefois il y a lieu de tenir compte que dans les moyennes il y a une certaine compensation des causes d'erreurs accidentelles, de sorte que ΔV sur une moyenne de sondages est plus petit que dans un sondage isolé."

A discussion by Dr. Hesselberg, Prof. van Everdingen, Dr. Matteuzzi, Dr. Hergesell, Dr. Molchanoff and Dr. van Bemmelen followed as to the possibility of adopting a common formula in the several countries, and opinion was divided. Various suggestions were made and it was agreed that it was very desirable for the Commission to take steps to ensure that further investigations should be made on the subject.

It was unanimously resolved :—

XVIII.—" That a sub-commission consisting of Prof. Hergesell, Dr. Hesselberg, Mr. J. S. Dines, Dr. Moltchanoff, Dr. Matteuzzi, Dr. Marvin, M. Wehrlé, and Dr. Fujiwhara be appointed to consider the question of the rate of ascent of pilot-balloons and other matters connected with balloons, and to report to the next meeting of the Commission."

The appointment of Dr. Hergesell as President of the sub-commission was unanimously approved.

The following questions were referred to the sub-commission :

(1) The rate of ascent of pilot-balloons.

(2) The supply of balloons (Minutes of the First Business Meeting).

(3) The method of specification of balloons—especially as regards size and diameter.

Bureau.—Dr. Hesselberg said that in view of the great task in front of the Commission, it would be desirable that the President and Secretary should be of the same country, and asked the permission of the Commission to withdraw from his position as Secretary. He suggested that Mr. Lempfert should be appointed a member of the Commission and that he should act as Secretary ; he suggested, further, that in view of his great interest in upper air work, Dr. Simpson should also be appointed a member of the Commission.

The President said that he was entirely dependent on the good offices of the Director of the Meteorological Office for facilities for carrying on the work of the Commission and that it would be advantageous to have a new President ; as, however, this did not seem to be immediately practicable, he accepted Dr. Hesselberg's suggestion.

Prof. E. van Everdingen expressed the opinion that it was not desirable in general practice that both the President and Secretary should be in the same country as it would be difficult in such circumstances to ensure continuity in the work of the Commission. He proposed therefore that Dr. Hesselberg should continue as Secretary and that Mr. Lempfert should be asked to act as Assistant Secretary. Sir Gilbert Walker endorsed Professor van Everdingen's opinion as to the desirability of having two countries represented on the Bureau.

Dr. Hesselberg reiterated his original proposal but the general feeling of the meeting was unanimously in favour of his being asked to continue.

Colonel Gold intimated that Mr. Lempfert was willing to act as Secretary during Sir Napier Shaw's tenure of the Office of President.

Mr. Lempfert was accordingly elected a member of the Commission and it was unanimously agreed that two secretaries should be appointed of which Dr. Hesselberg should be one, and Mr. Lempfert the other.

As it was understood that Dr. Simpson did not desire to become a member, his election was not proceeded with.

Papers communicated by Dr. Moltchanoff.—The President asked Dr. Moltchanoff if he would be good enough to hand in abstracts of the papers he wished to communicate so that they might be added to the *procès-verbaux*. (*See* Appendix IX.)

Synoptic Charts in the International Publication.—Colonel Gold proposed the following resolution, which was approved :—

XIX.—"That the synoptic charts in the specimen volume be as far as possible charts of the whole world."

Votes of Thanks.—The President expressed on behalf of the Commission a very hearty vote of thanks to Dr. Simpson and the staff of the Meteorological Office for the admirable arrangements they had made for carrying out the details of the working of the meeting, and to Miss Austin for acting as Secretary.

The President also expressed the thanks of the Commission to the President of the Royal Meteorological Society for his cordiality in receiving the members of the Commission both at his house and at the rooms of the Society.

Dr. Moltchanoff expressed his thanks for the hospitality accorded to him by his colleagues on the Commission and especially by the English members.

Dr. van Bemmelen thanked Sir Napier Shaw on behalf of the Commission for his services as President and expressed the great gratification of the members that he was continuing in that office.

The President said that he thought the Commission had succeeded in putting the question of an international publication of upper air data on a satisfactory footing. He expressed his appreciation of the good-will with which the various propositions had been accepted and of the cordial manner in which every member had helped to bring the deliberations to a satisfactory conclusion. He was conscious that the formulation of the conditions of the future publication had left behind it the difficult task of carrying out the regulations, preparing the specimen volume and starting the international publication. He expressed his diffidence at undertaking so large a task and said that he could only hope to carry it through with the co-operation and assistance of the Meteorological Office. He thanked the Commission for the confidence which they had placed in him, a confidence which he would do his best to deserve.

The meeting terminated at 12.45.

(Signed) NAPIER SHAW.

May 25th, 1925.

MINUTES OF THE PROCEEDINGS OF THE SCIENTIFIC SESSIONS

First Scientific Session, Friday, April 17th, 1925, at 3 p.m.

Present : Mr. C. J. P. Cave, Mr. L. H. G. Dines, Prof. Dr. E. van Everdingen, Prof. Gamba, Cdr. Garbett, Col. Gold. Prof. Dr. Hergesell, Dr. Hesselberg (*Secretary*), Dr. Matteuzzi, Col. Meseguer, Dr. Moltchanoff, Mr. L. F. Richardson, Sir Napier Shaw (*President*), Sir Gilbert Walker, Capitaine Wehrlé.

The Commission assembled at 3 p.m.

The President asked the permission of the Commission for the attendance of Madame Foehringer at the meetings in place of Dr. Friedmann in order that she might act as interpreter for Dr. Moltchanoff. The Commission agreed.

The President then asked Dr. Hesselberg to take the chair.

The Representation of Data.—The President referred to the resolution of the Bergen meeting that a graphic form should be adopted for the representation of upper air data in an international publication; since his appointment as President he had given a good deal of attention to finding the most suitable graphical form and he was now in a position to put before the meeting a method of graphic representation of pressure, temperature, humidity, and wind, which brought all the necessary data simultaneously under review.

A proper representation must satisfy the following conditions :—

(*a*) It must afford an easy comparison with the physical properties of air.

(*b*) It must make it possible to form an opinion as to the conditions of the atmosphere in respect of energy.

(*c*) It must give a suitable display of the salient features of the ascent, such as the discontinuities.

(*d*) It must be compact.

In order to make possible the evaluation of the conditions of the atmosphere in respect of energy the method of representation of the data in the form of a p–v diagram had been explored. Such a diagram is well known in works on engineering and was the underlying basis of Professor Bjerknes' work on Dynamic Meteorology and Hydrography. The representation when made, however, was found to occupy a very large amount of space and the President had decided to adopt the second form of energy diagram, namely, a temperature-entropy diagram which for upper air data might be expressed as a temperature-log (potential temperature) diagram. A specimen of this type of diagram had been circulated to the members of the Commission in Circular 9 and also Circular 19*c*.

The President then exhibited diagrams which formed the steps in the evolution of the final diagrams :—

(*a*) A graph of temperature and pressure, both co-ordinates being on linear scale.

(*b*) A graph of temperature and pressure on double logarithmic paper which was designed so that the dry adiabatic should be represented by the diagonal of the paper.

(*c*) Saturation adiabatic lines plotted on the log p, log t, paper, and the same lines transformed to co-ordinates of log (pressure) and log (potential temperature).

(*d*) An example of the graphic method of transformation from temperature to potential temperature which was described in Circular 9 (*see* p. 9).

(*e*) The transformation of the saturation adiabatics to a $t\phi$ diagram (tephigram).

He pointed out that in the final diagram isotherms are vertical lines and dry adiabatic lines are horizontal. A particular advantage of the logarithmic paper (Forms A. and C.) is, that the curves are identical in whatever units of pressure they are plotted. The only difference is in the position of the diagram on the paper. The millibar scale is, however, the most convenient, as the paper is ruled from 100 to 1,000. Negative values of temperature cannot, of course, be employed if logarithmic paper is used.

[At this point the announcement by Col. Gold that the airship R33, which had been blown from its mooring mast in a gale on the previous day, had now returned safely to the aerodrome, was received with acclamation.]

Humidity was represented by plotting the graph of the dew-point and a specimen curve from data at Pavia on January 3rd had been circulated (Circular 19 (*d*)).

Tephigrams of monthly mean values of temperature and humidity for India were also exhibited.

Wind was represented on the specimen page by E–W. and N–S. components; an alternative method was the type of vector-diagram used at the Observatory at Lindenberg (specimens of which were shown); this method gave a clear representation of the data and might be put on to the vacant space of the diagram.

Dr. Hesselberg expressed the thanks of the Commission to the President for his work in evolving so excellent a graphic representation of the data. He thought the solution arrived at was a good one because all the interesting points were clearly set out in the diagrams.

A discussion followed on the various graphical forms in which Mr. L. H. G. Dines, Mr. Richardson, Col. Gold, Prof. van Everdingen, Sir Gilbert Walker and Dr. Moltchanoff took part. The general opinion was that the form suggested was suitable for the purpose and would afford a clear insight into atmospheric processes. The opinion was expressed by several members that the graphic representation should be supplemented by the publication of numerical data.

Mr. Dines pointed out that the transformation from temperature to potential temperature could be very easily performed by means of a simple special slider fitted to a common slide-rule, and emphasised the fact that the diagrams were extremely simple to plot.

Dr. Moltchanoff said that it would be of interest to use the same method of representation for observations from kites in the lower layers, and that this could be done by simply altering the scale of the paper. He had found by observations at Pavlovsk that the height of cloud was dependent on the difference between the actual temperature and the temperature of the dew-point.

Mr. Richardson added two criteria to those already suggested by the President :—

(*e*) That the data represented on the graph should be as near as possible to the original observations.

(*f*) That the graphs should be able to be reproduced cheaply.

In respect of (*e*) the President exhibited a copy of the French publication in which a *facsimile* of the actual record was reproduced.

Prof. E. van Everdingen recommended that the experiment of reproducing the curves should be tried for a period on a large scale in order to get the opinion of experts on the question of their practical value. He emphasised the need of a comparison of curves at different stations and also suggested an alternative method for the representation of wind direction by means of a series of single arrows at equal vertical distances.

New instruments ; self-recording theodolites and Hill's mirrors. Sextant theodolite.—Dr. Moltchanoff read a paper on a self-recording theodolite which was in use in Russia. He exhibited photographs of the instruments and specimens of the records obtained. The cost of the instrument was about 200 roubles (20*l*.).

The President said that the subject was of considerable interest because a continuous record of the change of wind was not obtained when readings were only taken at definite intervals.

An instrument designed by Dr. Schoute and described by him in a paper published by the Nederlandsch Meteorologisch Instituut De Bilt in 1921 was referred to, and Dr. Hesselberg reported that an instrument of the type had been used with success in Norway since 1921. The cost of the instrument was from 60*l*.–75*l*.*

Col. Gold said that in Great Britain the question of using only the tail-method of observation was under consideration.

Professor van Everdingen emphasised the advantages of the self-recording method because only one assistant was required. The adoption of the method had enabled the Dutch service to initiate observations of pilot-balloons in the West Indies.

Sir Gilbert Walker referred to a paper by Mr. Field on the Free Atmosphere in India (Indian Meteorological Memoirs, Vol. 24, Part V), which dealt with the inaccuracies of the tail-method and other kindred subjects.

The President then referred to the method of measurement of upper wind velocities by means of observations of artificial clouds, and distributed to the members a copy of *Professional Note* No. 38 recently published by the Meteorological Office which

* According to a letter from Professor E. van Everdingen dated May 22nd, 1925, the instrument is constructed by "Aktiengesellschaft Hahn für Optik und Mechanik," Cassel-Ihringshausen, at a cost of 75*l*.

dealt with the method. The method of mirrors was most easily used for observations of artificial clouds, but if a balloon could be made visible at great heights the method was equivalent to continuous observations with two theodolites.

The meeting adjourned at 5 p.m.

(Signed) NAPIER SHAW.

April 22nd, 1925.

Second Scientific Session, Saturday, April 18th, 1925, at 10 a.m.

Present : Sir Napier Shaw (*in the Chair*), Dr. W. van Bemmelen, Mr. L. H. G. Dines, Prof. Dr. E. van Everdingen, Prof. Gamba, Colonel Gold, Prof. Dr. Hergesell, Dr. Hesselberg, Dr. Matteuzzi, Colonel Meseguer, Dr. Moltchanoff, Mr. L. F. Richardson, Dr. G. C. Simpson, Sir Gilbert Walker, Capitaine Wehrlé.

Correspondence.—The President read the following letters (1) A letter from Dr. Wallén, Director of the Meteorological and Hydrographical Service of Sweden, enclosing the results of ballon-sonde ascents at Abisko in 1924 in both graphical and numerical form. Dr. Wallén said that in the opinion of the Swedish Service it would be preferable to give pressure in millibars on Dr. E. van Everdingen's form, and the temperature of the principal isobaric surfaces in absolute degrees (without omitting the figure 2).

(2) A letter from Dr. Friedmann, Director of the Central Geophysical Observatory at Leningrad, sending his greetings to the members of the Commission and expressing his regret that owing to official duties he was unable to be present at the meeting.

(3) A letter from Dr. Sampaio Ferraz, Director of the Meteorological Service of Brazil, expressing his best wishes for the success of the meeting and sending the data of pilot-balloon observations during 1923. Dr. Ferraz asked for further instructions as to the definite form of publication and stated that data from the kite-station were available for 1924 and would be forwarded when opportune.

Additional circulars were issued as follows :—

(1) Circular No. 21. A note by V. Kusnetzoff and I. Klado "On homogeneous methods of determination of the rate of ascent of pilot-balloons" (Appendix V) giving a comparison of the different formulæ used in the several services for computing the rate of ascent of pilot-balloons.

(2) Circular No. 22. A table of the specification of balloons and meteorographs (Appendix II).

Members were asked to add to both circulars any information they might have so that when the subjects were discussed at the final meeting on Wednesday complete information as to the

practice of the different countries might be available. [For the final resolution on the subject, *see* p. 42.].

M. Fontséré's paper "On the oscillations of short period in the free air according to the character of the movement of pilot-balloons as seen in the theodolite." At the President's request, the following paper by M. Fontséré (Circular 17) was read by Colonel Gold.

On the oscillations of short period in the free air, according to the character of the movement of pilot-balloons as seen in the theodolite.

Communication from M. Fontséré.

The fact of the irregularities of short period in the apparent movement of pilot-balloons is well known to all aerologists. To get some numerical idea of these irregularities, we have undertaken a set of systematical observations at our aerological station at Barcelona.

Though this work comprises only a little series of soundings (from the last days of January to the present) the numerical data seem to be sufficient to give a first vision of the results that can be obtained by this way.

The observations, as they are now continued, are made in the intervals between the ordinary readings of azimuth and altitude of the pilots, so that this task is easily possible during the routine determinations of the upper wind. The method consists in marking the time of the beginning of an oscillation of the globe, and then the times of ending of the 5th and of the 10th oscillations. First, we made these observations only when the periodicity was very conspicuous, but at present they are accomplished statistically as a routine for prefixed heights, and express the character of the irregularities (undulated trajectory, pushlike velocity), their intensity (strong, normal, weak) or whether they are absent at all or unobservable (too great velocity across the field of the theodolite, exaggerated effect of wind upon the stability of the instrument, etc.). It is to be remarked that the character of the irregularities is very different from one observation to another. Sometimes the undulated form of the trajectory is very well marked, and then our observations comprise, not only the period but also the amplitude, estimated in pilot's diameters. Sometimes the apparent trajectory is rectilineal and the fluctuations affect chiefly the angular velocity, but the period is also well observable, and in some cases a sort of stopping separates the instants of maximum speed.

The results that I have obtained are shown in the following table :—

Height.	*Mean period.*	*Mean difference between each single observation and the mean period at the same height.*
(Metres).	(Seconds).	(Seconds).
300– 800	3·04	0·5
800–1500	2·69	0·3
1500–2500	2·71	0·3
2500–3500	2·65	0·3
3500–4500	2·89	0·3
4500–5500	2·60	0·3
Greater than 5500	2·60	0·3

These results show a great uniformity in the period from the lowest layers to a height of 6 kilometres. Furthermore, this period does not depend on the velocity of the wind. The mean value of the duration of one single wave, as deduced from the totality of the series is 2·8 seconds, which is of the same order of that assigned sometimes for the gustiness

in the low layers of the atmosphere, but very inferior, as much in period as in amplitude, to the values ordinarily given for the turbulence of the free air. The largest observed amplitudes when the movement has an undulated character, computed from crest to valley, have reached a maximum of 2·5 to 3 diameters of the globe, this one being of about 70–80 cm. at the departure.

There is no doubt that this periodicity must be referred to a real oscillatory movement of the masses of air in which the globe is floating. The period is independent from the rate of ascent of the globe (2 to 3 metres per second) and from possible influences of the form of the latter and of its pendular movements upon the vertical ascent, as we have found the same results with perfectly spherical and well-inflated globes, with others more or less deformed and with some loaded with a lead weight of 65 grammes for that purpose. This movement of the air seems to be somewhat similar to that of the sound-waves, with its regions of interference, but with very great wave-lengths.

Perhaps the International Commission for the Exploration of the Upper Air could consider the opportunity to recommend to those aerologists who have undertaken their pilot-balloon ascents for scientific purposes, that some observations of the period, character and intensity of these irregularities should be systematically made and compared.

(Signed) E. FONTSÉRÉ.

Barcelona,
14*th March*, 1925.

A discussion followed in which Dr. van Bemmelen, Colonel Gold, Dr. Hergesell, Dr. van Everdingen, Dr. Hesselberg, Dr. Moltchanoff, Mr. Richardson and Sir Napier Shaw took part. Professor Gamba expressed some doubt as to whether it was possible to study the oscillations effectively by observations with one theodolite.

Dr. Hergesell said that in examining so difficult a subject it was preferable to deal with individual values rather than with mean values as the latter were apt to hide the most interesting part of the phenomenon; he gave a description of the tail-method of observation of pilot-balloons which was found to be very satisfactory, and said that a spiral form was found to be the most satisfactory for the tail. It was agreed that this method was much more accurate than the method of observation by a single theodolite for short distances, but when the distance of the balloons from the observer was great the method must be used with circumspection.

Dr. Hergesell also referred to a paper by R. Wenger (" Die Steiggeschwindigkeit der Gummiballone und die Turbulenz in der Atmosphäre " *Ann. Hydrogr.*, 1917, XXXXV Jahr. Heft IV) which showed that a balloon released in a perfectly quiet atmosphere necessarily made some oscillatory movements. He suggested that the actual launching of the ballon-sonde might itself be the cause of the oscillations.

The question as to whether the oscillations were true oscillations of the atmosphere or whether they were in some way connected with the form of the balloon was considered, Dr. E. van Everdingen said that similar phenomena were observed at de Bilt and that he was willing to arrange for further experiments to be made; Dr. van Bemmelen stated that the same period of

oscillation was present in equatorial regions. Dr. Hesselberg showed that it was to be expected that any oscillatory motion in the vertical velocity would be shown more clearly as the vertical velocity was diminished and asked whether this was brought out in the observations.

Mr. Richardson referred to observations by Schmidt (*Ann. Physik*, Bd. 61, p. 633) on the oscillatory eddies produced by a fixed sphere in a wind-channel, and said that in view of these observations the possibility must be considered that the oscillations observed by M. Fontséré might be explained as those characteristic of a mass of air in which a spherical cavity had been made artificially.

The general opinion was that in view of the variety of conditions under which M. Fontséré had conducted his experiments it was unlikely that the oscillations were entirely dependent on the balloon and many members emphasised the desirability of finding whether oscillations or similar period were observed in the tension of a kite wire.

It was agreed that M. Fontséré's paper should be reported in the proceedings with a note of the discussion and the following resolution was adopted:

II.—" The Commission draws the attention of those observing pilot-balloons to Dr. Fontséré's paper on the oscillations of short period in the free air and asks for confirmation of the results from other localities, and for investigations of the influence of the size and form of the balloon on the character of the oscillations and for a comparison with the oscillations observed in kite-work."

Lapse-rates beyond that of Convective Equilibrium.—The President said that in the collection of data forwarded to him for publication he had been impressed by the number of cases which showed lapse-rates equal to, or greater than, that appropriate to convective equilibrium for dry air. On the tephigrams the dry adiabatic is a horizontal line so that lapse-rates exceeding that of convective equilibrium are easily distinguished because they are represented by lines sloping downward from the horizontal

He then exhibited the following specimen curves.

(*a*) A curve for an ascent at 1546 G.M.T. on August 4th, 1923 at Benson Observatory showing a state of convective equilibrium in the lower layers. He added that such conditions were characteristic of the state of the atmosphere after prolonged solarisation.

(*b*) A curve for an ascent at Benson on May 24th, 1923 showing a lapse-rate slightly in excess of that of convective equilibrium.

(*c*) Several curves showing lapse-rates greatly in excess of the adiabatic. Typical examples of such excessive lapse-rates were found in the curves for Calgary at 1h. G.M.T. on May 5th, August 3rd, and September 18th, 1923, for de Bilt at 0815 on September 26th, 1923 and for Agra at 11h. G.M.T. on December 6th, 1923.

The curves for Abisko just received from Dr. Wallén were remarkable for the the large fall of temperature between the surface and the lowest point of the ballon-sonde record.

The President asked whether such excessive lapse-rates were due to instrumental errors and lack of experience or whether they were really a characteristic phenomenon of the atmosphere; and if so whether they were found in the free air as well as at the surface.

Mr. Richardson referred to a paper he had recently published ("Turbulence and Vertical Temperature Difference near Trees." *Phil. Mag.* Vol. 49, January, 1925, pp. 81–90), giving an account of experiments with two thermo-electric junctions at 4 metres and 18 metres above the surface. The experiments showed that lapse-rates greater than the adiabatic were observed near mid-day even when the lower junction only was shaded from the sun by the trees; the results obtained seemed to him evidence that excessive lapse-rates were a real phenomenon of the atmosphere and were not due to instrumental errors.

Dr. Hesselberg referred to an unpublished memoir in which he had shown that the limit between stability and instability was the same for moving air as for almost still air. He had formed an equation to evaluate the rate of change of the lapse-rate with time, and had shown that the change was affected by many causes among others by the variation of wind with height if the atmosphere had a horizontal gradient of temperature.

Dr. E. van Everdingen suggested that the criterion of stability for air at rest and in motion might depend on whether there were vertical motion or not. Air might be stable even in conditions of excessive lapse-rate provided there were no vertical motion.

With regard to the President's question as to whether the excessive lapse-rates could be regarded as true phenomena Dr. Hergesell said that the examples exhibited were all from records of ballons-sondes which had a comparatively high rate of ascent and that the possibility of there being a lag in the thermometer record could not be disregarded; the temperature recorded might be that of the instrument and not of the surrounding air. He referred to a discussion of the question by Prof. Exner in the *Meteorologische Zeitschrift* some years ago. Observations had been made at Lindenberg by suspending thermometers at intervals of 5–10 metres apart between two masts 30 metres high. Bimetallic thermometers were used with a ventilation of 5–6 metres per second, and lapse-rates one hundred times that of the dry adiabatic were sometimes observed. Lapse-rates greater than the adiabatic were observed during the day as well as during the night, and the experiments raised the question as to the true definition of the gradient of temperature. Dr. Hergesell expressed the opinion that the real curve of variation of temperature with height was probably very full of detail and very variable lapse rates might be found even in the free-air when cold air passes over warm air.

Dr. Moltchanoff said that the transfer of heat from the earth to the air depended on the lapse-rate of temperature, if potential temperature falls with height turbulent motion would cause a rise of potential temperature in the free air and a fall near the surface and vice versa. At Lindenberg the height of the surface layer in which lapse-rates greater than the adiabatic were found varied from month to month and was about 300 metres in May and 600 metres in June.

In closing the discussion the President referred to a paper by the late Lord Rayleigh " On Convection Currents in a Horizontal Layer of Fluid when the Higher Temperature is on the Under Side " *Phil., Mag.* Vol. 32, December 1916, p. 529) the results of which had recently been illustrated experimentally by Capt. Brunt (*Meteorological Magazine*, Vol. 60, 1925, pp. 1–5).

Report of the work of the Aerological Observatory at Sloutzk.—Dr. Moltchanoff read a report on the history of upper air investigation at Sloutzk (Pavlovsk) during the years 1912–1924, (Appendix VI) and exhibited photographs of the special meteorgraphs for the work with ballons-sondes.

Prof. E van Everdingen, Colonel Gold, Dr. Hesselberg and Capt. Wehrlé urged the desirability of having particulars of the various instruments used by the services for observations on aeroplanes and of the method of their attachment. Prof. E. van Everdingen referred to an instrument for aeroplanes in course of construction at de Bilt. It was agreed that the question of the various types of instruments should be reconsidered at the final meeting on Wednesday. [For the later discussion, *see* p. 41].

The President expressed the thanks of the Commission to Dr. Moltchanoff for his paper and congratulated him on the excellent work that was being done in Russia under somewhat difficult circumstances.

The Commission adjourned at 12.45.

April 22nd, 1925. (Signed) NAPIER SHAW.

Third Scientific Session, Monday, April 20th, 1925, at 3 p.m.

Present : Sir Napier Shaw (*in the Chair*), Dr. W. van Bemmelen, Capt. C. J. P. Cave, Mr. L. H. G. Dines, Prof. Dr. E. van Everdingen, Madame Foehringer, Prof. P. Gamba, Commander L. G. Garbett, Col. E. Gold, Prof. Dr. H. Hergesell, Dr. Th. Hesselberg (*Secretary*), Dr. Matteuzzi, Colonel Meseguer, Dr. Moltchanoff, Mr. L. F. Richardson, Dr. G. C. Simpson, Sir Gilbert Walker, Capitaine Wehrlé.

Contribution of Funds for the Specimen Volume.—Resolution III. (*see* p. 28) was formally adopted.

The President announced that he had received from the Director of the Observatory at Lindenberg the promise of a contribution of 25*l.* towards the specimen volume of upper air

data; and he expressed the thanks of the Commission to Professor Hergesell.

Are the upper Regions of hot Continents anticyclonic in Summer?—The President opened a discussion as to the existence of high pressure areas in the upper levels above areas of low pressure at the surface. He showed that such a reversal in the upper air of conditions at the surface occurred in the case of both temperature and density. The results of observations of ballons-sondes showed that the mean value of the lapse-rate of temperature with height was approximately constant all over the world, and, using this assumption, he had calculated, from the normal distribution of pressure and temperature at the surface, the distribution of pressure of the Northern Hemisphere at 8 kilometres. The results (reproduced in *The Air and its Ways*, Plate XVIII) showed a series of high pressures over the hot continents, the most remarkable of which was that enclosed by the isobar of 380 mb. which extended over northern India. Recent observations from India discussed by Mr. Harwood* gave a value of 377 mb. for the mean pressure at 8 kilometres in July at Agra, a point shown on the map as being on the low pressure side of the isobar of 380 mb. The agreement was perhaps fortuitous but it might, on the other hand, be an indication that the high pressure over the north of India is a true phenomenon. Confirmation of this supposition was given by the seasonal variation of pressure at 8 km. which showed a maximum pressure in the summer months.

The General Circulation of the Atmosphere as determined by Observations of Cirrus Cloud.—Dr. van Bemmelen said that it was over three years since, at a meeting in Bergen, he had seen Sir Napier Shaw's results of the computation of pressure at 8 kilometres. He had realised that observations of clouds at great heights, where friction was of little importance, would give an indication of the course of the isobars at those levels. He had accordingly made a collection of the observations of cirrus in the intertropical regions and the results had been published both in *Nature* and in the *Meteorologische Zeitschrift* (May, 1924, p. 133). His conclusions confirmed those of Sir Napier Shaw, and indicated the existence of a series of anti-cyclonic centres in about latitude 20°, the centres of these areas seemed to lie over the hot continents and showed a shift of about 15° towards the equator from the centres of high pressure at the surface. Since the publication of the results he had added to the maps the observations in the West Indies by Bigelow, in Quito, in Africa, and in Melbourne, all of which were in correspondence with the results already obtained, though Bigelow suggested the existence of two high pressures over the region of the West Indies one over the land and the other over the Ocean. In a recent memoir dealing with clouds and pilot-balloons over India, Mr. Harwood

* *Memoirs of The Indian Meteorological Department.* Vol. XXIV., Part VI., p. 201. Calcutta, 1924.

had accepted the existence of an anticyclonic region over that country but differed from Dr. van Bemmelen in not finding a continuous flow of air from east to west round the equator.

The observations of cirrus throw light also on the question of the existence of the anti-trade winds and on the division between the easterly and westerly drift.

Observations of cirrus-motion over South America would be especially valuable in giving evidence of anticyclonic centres in the upper air, especially if such observations were made in the coastal regions in about latitude 20° S. The pilot-balloon observations recently available from Brazil would be of interest in this connexion.

Sir Gilbert Walker said that observations of cirrus cloud did not give a true indication of the atmospheric circulation over India in summer because such clouds were only visible on somewhat rare occasions through the almost continuous sheet of lower cloud. The results of observations of pilot-balloons recently discussed by Mr. Harwood demonstrated the existence in summer of easterly winds in Central and Southern India and westerly winds in the north; this would indicate that a high pressure area was centred over northern India and a low over the equator. In April, the easterly winds did not extend so far north and were not shown in the observations from Bangalore.

Observations of Wind above Clouds.—Mr. Richardson showed that the gaps in the synoptic charts of the upper air were chiefly due to the lack of observations above clouds. Several methods, such as kites and sound-ranging, were available for obtaining the data. He drew attention to the method described in a paper he had recently published entitled "The Aerodynamic Resistance of Spheres, Shot Upward to Measure the Wind" (*Proc. Physic. Soc.*, London, vol. 36, pp. 67–80, 1924), copies of which were circulated to the members. The method was not practicable in thickly-populated places, but in countries such as Greenland, which were uninhabited and often foggy, it should be useful. Heights of 700 metres had been reached by the balls.

Prof. E. van Everdingen said that the discussion interested him as showing that meteorologists had ceased to be content to discuss a circulation of the atmosphere in belts of trades and anti-trades, which certainly did not exist, and which omitted the effect of land and water. He thought it specially desirable to take opportunities for observations of upper air motion which were offered by breaks in the lower cloud. The Netherlands Institute had interested marine observers on merchant vessels in the observation of the motion of upper cloud, and excellent results were being obtained by making observations of motion at night using the stars as a standard of reference.

Dr. Hergesell drew attention to the desirability of observations of air-motion in the upper layers over the sea, and referred to the work of Wegener and Kuhlbrodt over the Atlantic. The report of three later expeditions of a similar character would be

published in the *Archiv der Deutschen Seewarte*.* This work was carried on from a merchant-ship which provided free passages to the investigators. For observations at high levels a ballon-sonde was essential and for the highest levels two balloons in tandem. These observations, necessitating as they do the use of considerably more time and coal, must be carried on from a war-ship. He also indicated that Wegener and Kuhlbrodt had been able to obtain observations of cloud-drift by means of a special instrument which corrected for the motion of the vessel. The President suggested that pleasure-ships such as private yachts would be very suitable for ballons-sondes.

Commander Garbett said that four ships of H.M. Navy were already carrying out pilot-balloon observations, and that the Hydrographer had given permission for all surveying ships under his direction to take part in upper air investigations. The chief difficulty was in obtaining readings of the bearing, but an instrument was being tried which he hoped would enable the observer to follow the balloon with a compass for as long as it was visible in the sextant. As regards work with ballons-sondes he had himself obtained an observation over the English Channel in the summer of 1924, but the cost of coal and the amount of time required made frequent observations somewhat difficult.

Dr. W. van Bemmelen said that in his opinion frequent observations of clouds were of more importance than the more difficult and costly observations of balloons. The characteristic of the general circulation was its variability, and it was only by multitudinous observations that general results could be obtained. Surface observations were extremely simple, they could be made at any hour and the cost was practically nil.

Col. Gold said, that in general, low-pressure systems at the surface tended to intensify with height, and on general grounds he would have expected the low pressure over Asia to intensify itself relatively to the pressure further south. Observations of upper air temperature over China and Siberia would be very valuable, especially in summer.

Dr. Hesselberg pointed out the desirability of having such observations from special regions concentrated on the international days.

Cloud Observations on International Days.—A memorandum (Appendix VII) by Professor Kusnetzoff was read by Madame Foehringer.

Some results of Base-Line Observations at Pavlovsk.—A memorandum by Dr. Moltchanoff was read by Dr. Simpson (Appendix VIII). Dr. W. van Bemmelen said that similar observations were obtained from Batavia and were found to be connected with the vertical motion of the atmosphere. They were not shown in the observations from a small island. Colonel

* *Archiv der Deutschen Seewarte*, XLI. Jahrgang, 1923, No. 4; XLII, Jahrgang, 1924, No. 2.

Gold remarked that in order to get accurate observations with single theodolites it was desirable to have a vertical velocity large in comparison with the vertical velocities of currents in the atmosphere.

Dr. Hesselberg said that Dr. Moltchanoff's observations were in agreement with Dr. Wenger's theory that when the turbulence is great there will be a greater vertical velocity. He also showed that instead of using smaller balloons, as Dr. Moltchanoff suggested, larger balloons might be used. ("Uber die Steiggeschwindigkeit der Pilotballone," by Th. Hesselberg and B. J. Birkeland, *Ann. Hydrogr.*, XXXXV., Jahrg (1917), Heft IX, p. 313). Wenger had suggested certain methods for making the motion more stable, one of which was to roughen the surface and the other to attach a ring around the balloon and stabilise it by a weight below.

He said that the chief point was not so much to get pilot-balloons, the velocities of which agreed with the theoretical velocity, as to get balloons which are independent of turbulence.

Dr. Moltchanoff handed to the President a list of Aerological Stations of S.S.S.R. (Soviet Union), together with a catalogue of pilot-balloon ascents for 1923 and 1924.

As a result of the discussion on atmospheric circulation the following resolution was adopted :—

VII.—"The Commission heard with interest the results of the observations of clouds, pilot-ballcons and ballons-sondes in the Netherlands East Indies in relation to the problem of the circulation of the atmosphere, and expressed the hope that the observations would be resumed. Special importance is attached to the observations by ballcons on the selected international days.

The meeting adjourned at 5 p.m.

(Signed) NAPIER SHAW.

April 22nd, 1925.

LIST OF APPENDICES

APPENDIX I

Résolutions adoptées par la Commission Météorologique de la Haute Atmosphère à sa Réunion de Londres, 1925.

I.—Il est désirable que la question de la composition des Commissions soit examinée par le Comité Météorologique International avant la prochaine conférence météorologique internationale.

II.—La Commission attire l'attention de tous ceux qui observent des ballons-pilotes sur la note du Docteur Fontséré concernant les oscillations à courte période, dans l'atmosphère libre. Elle demande que l'on cherche à confirmer ces résultats en d'autres lieux, à établir l'influence de la dimension et de la forme du ballon sur le caractère des oscillations, et à les comparer à celles que l'on observe dans les ascensions de cerf-volant.

III.—" La Commission décide que les fonds mis à la disposition du Président seront utilisés pour la publication d'un volume spécimen d'observations internationales de la haute atmosphère pour 1923 et 1924.

IV.—" Que la publication consistera en un volume spécimen contenant les résultats des observations internationales de la haute atmosphère pour les années 1923 et 1924."

V.—" Que dans le volume spécimen les observations obtenues par ballons-sondes et par des procédés du même genre seront publiés sous forme de tables numériques complètes et qu'à ces tables seront jointes des représentations graphiques par ' téphigrammes '."

VI.—" Que la documentation complète pour 1923 sera publiée sous forme de diagrammes et de tables, mais qu'au cas où, les fonds ne seraient pas suffisants pour publier ainsi toute la documentation de 1924, on assurerait par priorité la publication intégrale des tables."

VII.—" La Commission a pris connaissance, avec beaucoup d'intérêt, des résultats d'observations de nuages, ballons-pilotes et ballons-sondes, effectuées dans les Indes Néerlandaises en connexion avec l'étude de la circulation générale de l'atmosphère, et elle exprime l'espoir que ces observations seront continuées. On doit attacher une importance spéciale aux observations par ballons les jours internationaux."

VIII.—" Qu'il serait fort important pour l'étude de la haute atmosphère que 3 à 5 stations en Russie et en Sibérie pratiquent, d'une manière intensive, des lancers de ballons-sondes."

IX.—" Que le Bureau de la Commission prenne avec le Docteur Simpson des arrangements pour une circulation préliminaire des résultats de sondage."

X.—" Qu'il convient de différer jusqu' après la publication du volume spécimen, l'examen des conditions de publication regulière, nationale ou internationale, et que la question pourrait être traitée lors de la prochaine session de la Commission, probablement en 1927."

XI.—" Que la publication internationale devra procéder par groupes de jours internationaux."

XII.—" Que le Président soit autorisé à ouvrir un compte en banque pour recevoir les donations au bénéfice de la publication internationale qui pourraient, éventuellement, être mises à sa disposition par les pays désireux d'apporter des contributions avant la publication du volume spécimen."

XIII.—" Dès que le premier volume spécimen aura paru, le Bureau entreprendra des démarches pour connaître l'opinion des différents services sur la possibilité d'obtenir des fonds destinés à la publication internationale."

XIV.—" La Commission a appris avec grande satisfaction que l'expédition allemande océanographique et météorologique dans l'Atlantique Sud, qui travaillera pendant une année à partir d'avril 1925, aura l'occasion de faire aussi des observations aérologiques (cerfs-volants, ballons-pilotes, ballons-sondes)."

" Pour assurer le maximum d'efficacité à ces observations il est recommandé aux services météorologiques des pays environnant l'Atlantique Sud de fournir à l'expédition des messages météorologiques par télégraphie sans fil afin de permettre que les observations aérologiques soient effectuées au moment où les conditions météorologiques sont les plus propices et pour faciliter la récupération des instruments enregistreurs des ballons."

XV.—(1) " L'attention des météorologistes est attirée sur la double tâche de l'aérologie."

(*a*) étude mondiale—Etude de la circulation générale de l'atmosphère;

(*b*) étude régionale—Etude plus détailiée de la structure de l'atmosphère et de ses changements dans les diverses régions où se font des observations.

(2) "Les diverses régions sont provisoirement définies comme suit":

(*a*) Amérique du Nord.
(*b*) Amérique du Sud.
(*c*) Europe avec la Russie, la Sibérie et l'Afrique du Nord.
(*d*) Les Indes et les Philippines.
(*e*) Afrique du Sud.
(*f*) Australie.

(3) "Les directives de l'organisation des études régionales en dehors de l'Europe seront données par les vice-présidents pour les diverses régions."

"Les vice présidents se mettront en rapport avec le président de la Commission pour fixer les jours d'étude régionale qui comporteraient au moins trois sondages quotidiens correspondant aux heures d'observations internationales."

(4) "Sans apporter de modification au programme des jours internationaux établi par le règlement de la réunion de Bergen, la Commission désignera, pour chaque année, comme 'mois international,' un de ceux comprenant déjà des jours internationaux; pendant ce mois international on opérera des sondages quotidiens par ballons-sondes autant que possible de jour en jour depuis le commencement du mois."

(5) "Les six ascensions à la disposition du Président seront consacrées à une étude intensive de la haute atmosphère durant une journée ou deux journées consécutives au cours du mois international; ces journées seront choisies pour l'Europe par le Président de la Commission et pour les autres régions par les vice-présidents."

(6) "Le Docteur C. F. Marvin est désigné comme vice-président de la région d'Amérique du Nord, M. J. H. Field comme vice-président de la région des Indes."

(7) "Le mois de mai est indiqué comme mois international pour l'année 1926, et le mois d'octobre pour l'année 1927."

XVI.—"Que la hauteur à attribuer à une station est celle de son baromètre au-dessus de la mer, mais que l'on indique aussi celle du théodolite pour ballon-pilote. Pour les observations de nuages là où il n'y a pas de baromètre, on indiquera la hauteur du néphoscope."

XVII.—"Les services météorologiques qui se sont occupés de sondages par avion sont priés de vouloir bien adresser au Président de la Commission Internationale de la Haute-Atmosphère une description aussi complète et détaillée que possible des instruments (Structure et suspension à l'avion) et des méthodes employées."

XVIII.—"Une Sous-Commission composée de MM. Professeur Hergesell, Docteur Hesselberg, Wehrlé, J. S. Dines, Moltchanoff, Matteuzzi, Marvin et Fujiwhara, est constituée pour examiner la question de la vitesse ascensionelle des ballons-pilotes, et tous autres sujets en rapport avec les ballons; elle présentera un rapport à la prochaine session de la Commission."

XIX.—"Que les cartes synoptiques dans le volume spécimen soient, autant que possible, des cartes du monde entier."

APPENDIX II.

Particulars of Balloons used in the several Meteorological Observatories for Soundings of the Upper Air.

	France.	Germany.	Great Britain.	Holland.	Italy.		Russia.	Spain.
					Pavia.	Rome.		
Manufacturer	Hutchinson, Paris.	Continental, Hanover.	Paturel (Paris), Pirelli (London) & Continental Rubber Co. (London).	Continental, Hanover.	Pirelli, Milano.	Pirelli, Milano.	"Tréougolnik," Leningrad.	Hutchinson, Paris. Delasson. Paris.
Material of the Balloon	—	Rubber	Rubber	Rubber	—	—	Rubber	—
Weight in grammes	1,140	1,430–1,650	400 800	1,000–1,100	700–720	700–750 feuille de para	80 470	450††
Thickness of the original rubber sheet in mm.	0·6	0·2	0·4 0·4	0·3	0·4	0·4	0·4 0·4	0·6
Diameter of the circle occupied by the material lying flat on the table. cm.	80	160	70 100	100	110	100	20 50	60
Circumference when filled with gas. m.	1·75	6·0	3·3 4·15	5·40	Pas toujours sphérique	4·4*	240 **	4·4
Rate of ascent m/min.	200	250	250 300	—	180	180	200 (sans	—
Volume of gas at standard pressure required for filling m^3	3	3·6	0·6 1·2	2·58	1·500	1·4	enrégistreur)	1·3
Free lift g.	950†	760–1,280	250–340 560–840	1,000–1,100	600	1,100	195 —	1,000
Price	90 fr.	50–60 Mark	10/– to 20/– to 20/– 40/–	15 fl.	75 It. lire	86 It. lire.	1r. 40k. 25 r. (about 3/–) (£ 5)	1,400 pts. (for 30) avec les droits de la Douane.

† Force ascensionelle 1,100 g. 450 g. (force ascensionelle libre).

* En effet on use au lieu d'un ballon unique No. 3 ballons gonflés respectivement à 750,500 et

** Les données pour les grands ballons, lancés jusqu'à 1914, sont imprimées dans les *Publications de la Comm. Intern. pour l'Aéro. Scient.* A présent des grands ballons ne sont lancés que très rarement et les coefficients correspondants ne sont pas encore determinés.

†† On emploie dans chaque lancement trois ballons, dont deux portent 1 kg. force utile et le troisième 0·8 kg. Ce dernière en sustitution du parachute.

Norway. Rubber balloons by Macintosh & Co. of Manchester, of weight 33-35 grammes.

APPENDIX II.—*contd.*

Particulars of Meteorographs used in the several Meteorological Observatories for Soundings of the Upper Air.

—	France. Stras-bourg.†	France. Trappes.	Germany.	Great Britain.	Holland.	Italy. Pavia.	Italy. Rome.	Russia.	Spain.**	United States.*
Manufacturer - -	J. & A. Bosch.	Observatoire de Trappes.	Bosch & Bosch, Hechingen	Short & Mason (London). Negretti & Zambra (London).	Bunge, Berlin.	L. Fascianelli, Rome.	Laboratorio R. Stazione Aerologica Principale di Vigna di Valle.	Observatoire Aérologique.	Bosch et Bosch-Hergesell.	—
Weight of Instrument, in grammes.	980–1,420 (including basket).	340	620	70 (including case).	260	250	437	180–200	800–1,000–1,250 (with all accessories).	180
Weight of Parachute, in grammes.	140 to 250	270	360	—	210–230	(200)	—	—	—	50
Weight of basket g.	—	180	300	43	70–80	80	158	—	—	45
" parasoleil"	—	120	—	—	—	—	—	—	—	—
Total weight, grammes	—	910	1,280	127	540–560	420	595	180–200	800–1,000–1,250	275
Cost of instrument -	—	440 fr.	250 Mark	£5	75 fl.	L. it. 800	L. it. 1271	£2·5	250 pts.	$100
Cost of accessories -	—	50 fr.	—	Negligible	15 fl.	L. it. 15	L. it. 45	Negligible	—	$3·50

† *Annuaire de l'Institut de Physique du Globe*, 1922, Strasbourg, p. 91.
* The data for the United States are taken from a paper by S. P. Fergusson entitled "New Aerological Apparatus" *Monthly Weather Review*, 48, 1920, pp. 317–322.
** Toute cet matériel doit être retiré dans cette année et sustitué par météorographes Dines.

Books of Instruction in the Technique of Upper Air Soundings by Ballon-sonde, Kite, Aeroplane and Pilot-Balloon.

Germany : (1) Anleitung zur Auswertung von Registrierballonaufstiegen nach den neuen Bestimmungen der Intern. Kommission für wiss. Luftfahrt : J. Reger. *Beitr. z. Phys. d. fr. Atmos.* Bd. V, 1913.

(2) Die Drachentechnik am Aeron. Obs. Lindenberg v. O. Tetens. *Jahrbuch*, Bd. IX, 1913.

(3) *Das königl. Preuss, Aeron. Obs. Lindenberg* v. Richard Assmann, 1915. (Braunschweig, bei Fried. Vieweg u. Sohn).

Great Britain : *Computer's Handbook.* Section II, Sub-sections I and II. (London : H.M. Stationery Office).

India : *Memoirs of the Indian Meteorological Department*, Vol. 24, part 5.

Italy : Il "Meteorografo Gamba" per palloni-sonda. Estratto dagli *Atti del Congresso della Società Meteorologica Italiana*, Torino, 1921.

I Lanci di Palloni-Sonda Eseguiti nel R. Osservatorio Geofisico di Pavia nell'anno 1906 dal Dott. Pericle Gamba. *Ann. dell'Ufficio Cent. Met. e Geo. Ital.*, vol. 28, parte 1, 1906. Rome, 1909.

United States : U.S. Department of Agriculture : Weather Bureau *Instructions for Aerological Observers*, by W. R. Gregg. Washington, 1921, W.B. 740.

For Observations at Sea.

Ballons-sondes and pilot-balloons.

"Exposé technique de l'étude de l'atmosphère marine par sondages aériens." Extrait du mémoire de MM. L. Teisserenc de Bort et L. Rotch. (*Travaux Scientifiques de l'Observatoire de Trappes*, vol. 4, 1909, pp. 39–51). Reprint by U.G.G.I., 1924.

"Sur les lancements de ballons-sondes et de ballons-pilotes au-dessus des océans." Note de S. A. S. le Prince de Monaco, *Comptes Rendus de l'Académie des Sciences*, 141, 1905, pp. 492–3.

Pilot-balloons.

"Pilotballonaufstiege auf einer Fahrt nach Mexiko März bis Juni 1922," von Alfred Wegener und Erich Kuhlbrodt. *Aus dem Archiv der Deutschen Seewarte*, 40 Jahrg, 1922, nr. 4.

A Meteorograph for Sounding Balloons.

(System of P. A. Moltchanoff).

In order to diminish the weight in the described apparatus the watch-mechanism is replaced by a propeller rotating around a vertical axis by the action of air moving round about the apparatus when the last is lifted in the air. The propeller gives motion to the cylinder on which the temperature and the pressure are being recorded and the rotation of which is definitely related to the vertical motion of the meteorograph depending but slightly upon the density of the air if the propeller is big enough. This circumstance may be useful for determining the altitude of the balloon in such layers where the indications of the barograph have a lowered precision.

The apparatus which is now used by the Aerological Observatory at Sloutzk is supplied by an indicator of temperature—a bimetallic plate—and by that of pressure—Bourdon's box—which are fixed at one end of a duraluminium tube, the other end of which is bearing the cylinder. The writing pens are connected with the indicators directly. The sensibility of the thermograph is 0, 6 mm. for 1° C., and that of the barograph 0, 5 mm. for 10 mm. of change of pressure. The total weight of the apparatus with its cover is about 200 gr.

APPENDIX III

List of Telegraphic Addresses.

For the communication of notices of request for special observations on the international days to be selected by the President.

Country.	*Telegraphic address.*
Argentine	Meteoro. Buenos Aires.
Australia	Weather, Melbourne.
Austria	Meteorwarte, Wien.
Azores	Servico Meteorologico, Ponta Delgada.
Brazil	Meteoro Rio, Brazil.
Canada	Observatory, Toronto.
Ceylon	Obs, Colombo.
Czecho-Slovakia	Meteorological Institute, Karlov, Prague.
Denmark	Metobs. Copenhagen.
Egypt	Physics, Cairo.
Finland	Ilmala, Helsinki; Tähtelä, Sodankylä; Sortavala, Ilmailuosasto Nr. 3.
France	Obs., Paris. Observatoire Trappes.
Germany	Observatorium, Lindenbergobservatorium. Seewarte, Hamburg. Geophysikalisches Institut, Leipzig. Meteorologische Versuchsanstalt, Hamburg-Grossborstel. Drachenstation Friedrichshafen-Bodensee. Wetterdienist, Frankfurtmain; Meteor, München;
Great Britain	Weather, London.
Greenland*	Observatorium Godhavn; Meteorolog Godthaab.
Holland	Meteor Utrecht; Nell KW-laan 204, Voorburg.
Hong Kong	Observatory, Hong Kong.
Hungary	Institut Météorologique, Budapest.
Iceland	Vedurstofan, Reykjavik.
India	Weather, Simla.
Iraq	(Per Air Ministry, London).
Italy	Osservatorio Geofisico, Pavia. Aerogenio-Aerologica Roma.
Japan	Met. Tokyo.
Malta	Meteorological Office, Pieta, Malta.
Mexico	Meteorológico México.
Norway	Met. Oslo; Gradient, Bergen; Met., Tromso.
Palestine	(Per Air Ministry, London).
Porto Rico	Observer, San Juan.
Roumania	Institutul Meteorologic, Bucuresti.
Russia	(1) Aerological Obs., Sloutzk, Leningrad. (2) Kutchinskaia Obs.; Obiralowka Obs.; Kiev Obs.; Sverdlovsk Obs.; Tiflis Obs.; Irkutsk Obs.; Jakutsk Obs.; Tashkent Obs.; Vladivostock Obs.
Samoa	Admor, Apia.
South Africa	Met, Pretoria.
Spain	Meteoespa, Madrid.
Sweden	(1) Hydrometeor, Stockholm. (2) Observatoire, Abisko.
Switzerland	Schweizer. Meteorologische Centralanstalt, Zürich.
United States	Observer, Washington, D.C.

* From about December, 1925.

APPENDIX IV.

Scheme for the Collection and Distribution of Results of Sounding Balloon Ascents.

MEMORANDUM BY THE DIRECTOR, METEOROLOGICAL OFFICE, LONDON.

At the meeting of the International Meteorological Conference held at Utrecht in September, 1923, the question of the distribution of results of sounding-balloon ascents was raised, and a scheme was suggested by which stations making ascents should have copies of their results duplicated locally and should send them to some central office, whence they would be distributed to Directors who required them. The Director of the Meteorological Office, London, offered to collect and distribute such results, and accordingly in October, 1924, addressed a circular letter to 40 Directors of Meteorological Services giving details of the scheme proposed and asking if those Directors who were willing to co-operate would send 200 copies of their results to London each month for distribution.

Five of the Directors who replied stated that, owing to financial or other difficulties, there was no prospect of sounding-balloon ascents being made in the near future. Eleven Directors who expressed their entire willingness to co-operate in the scheme, added, either that observations had not yet been instituted, or, in some cases, had not yet been resumed after a temporary break. Two Directors who wished to co-operate were unable to promise so many as 200 copies of their results. Only seven Directors gave definitely favourable replies, and of these, two stated that regular observations were not possible.

The following is a detailed summary of the replies received :—

Country.	Able to cooperate in proposed scheme at once.	Unable to cooperate in proposed scheme at present.	Remarks.
Norway	—	1	No prospect of ascents.
Denmark	—	1	ditto
Germany (Lindenberg).	1	—	
Egypt	—	1	No ascents yet made.
Alsace-Lorraine	—	1	Unable to meet cost of 200 copies monthly; results already published annually.
Bavaria	—	1	ditto
Finland	—	1	No prospect of ascents.
Switzerland	—	1	Observations suspended; unable to meet cost of 200 copies.
Austria	1	—	
Hungary	—	1	Observations suspended (finance)
United States	—	1	ditto
Czecho-Slovakia	—	1	No ascents yet made.
Bulgaria	—	1	No prospects of ascents (finance)
Argentine	1	—	Observations being resumed.
Brazil	—	1	No ascents made.
Portugal	—	1	ditto

Country.	Able to cooperate in proposed scheme at once.	Unable to cooperate in proposed scheme at present.	Remarks.
Java - -	—	1	Observations suspended (finance).
Sweden - -	1	—	
Canada - -	1	—	
Australia - -	—	1	No ascents made.
Japan - -	1	—	Regular ascents impossible owing to proximity to sea.
Holland - -	1	—	ditto
Poland - -	—	1	Observations not yet organised.
Azores - -	—	1	No prospect of ascents.
New Zealand -	—	1	No ascents made.
	7	18	

No replies were received from the following :—

South Africa (Pretoria).	Spain.	Italy.
Belgium.	France (Paris).	Jugo-Slavia.
Ceylon.	Greece.	Latvia.
Chile.	India.	Roumania.
China (Zikawei).	Iceland.	Russia.

APPENDIX V

On homogeneous methods of determination of the rate of ascent of pilot-balloons.

THE COMPARISON OF DIFFERENT FORMULÆ OF DETERMINATION OF THE RATE OF ASCENT OF PILOT-BALLOONS.
Proposed by V. KUSNETZOFF and I. KLADO.

The rate of ascent of pilot-balloons is being computed by means of the following formulæ :—

$$v = f\left[\frac{A}{(A+B)^{\frac{2}{3}} - 0{\cdot}8\,(A+B)^{\frac{1}{3}}}\right]$$

where A is the free lift in gr. and B is the weight of the envelope in gr.

The vertical velocity is determined graphically. (Hergesell " Bedeutung der Pilotballonaufsteige für die praktische Aerologie." VI Réunion de la Comm. Intern pour l'Aérostation scientifique à Monaco, 1909; *see also* Prof. Peters, " Gummipilotballone" Arb. der konig Preussischen Aeron. Obs. bei Lindenberg, 1910).

II. Hesselberg and Birkeland, tables of 1912, Hesselberg u Birkeland, " Steiggeschwindigkeit der Pilotballone," *Beitr. zur Physik der freien Atmosphäre*, Bd. IV, 1912, p. 196.

III. Hesselberg and Birkeland, 1917. *See* Hesselberg und Birkeland, Uber die Steiggeschwindigkeit der Pilot-ballone, *Ann, der Hydrogr. u. Marit. Meteorologie*, 1917, IX, p. 321.

IV. By Dines formula :—

$$V = a\,\frac{A^{\frac{1}{3}}}{(A+B)^{\frac{1}{3}}} \text{ where } a = 84.$$

See Met. Office, *Geophysical Memoirs*, No. 14, " Soundings with Pilot-Balloons in the Isles of Scilly," by Cave and Dines, 1920, p. 89.

V. By the formula of " Signal Corps " :—

$$V = H\left[\frac{A}{(A+B)^{\frac{3}{4}}}\right]^{\frac{1}{3}}$$

See *Monthly Weather Review*, XII—1920, Sherry, the " Rate of Ascent of Pilot-Balloons."

VI. By further modifications of this formula :—

$$V = H\left[\frac{A^3}{(A+B)^2}\right]^{0{\cdot}208}$$

Ibid., May 1924, Haines, " Ascensional Rate of Pilot-Balloons."

VII. Rouch's formula :—

$$V = 42\,\frac{A}{(A+B)^{\frac{1}{3}}} \qquad (\textit{See } \text{V}).$$

According to each of these methods were computed the vertical velocities for the envelopes of the type used in Russia (B = 70 gr.) upon supposition.

A = 50, 100, 150, 200, 250 gr.

The results proved to be as follows :—

A	50	100	150	200	250
I. Hergesell - - - -	107	147	178	202	222
II. Hesselberg and Birkeland 1912 - - - -	117	148	168	187	203
III. Hesselberg and Birkeland 1917 - - - -	120	152	171	206	229
IV. Dines - - - -	121	152	170	184	194
V. - - - - -	111	149	172	189	202
VI. - - - - -	111	148	171	189	202
VII. - - - - -	89	137	173	201	224

APPENDIX VI

On Observations of the Upper Air at Sloutzk (Pavlovsk), 1912–1924.

By V. V. KUSNETZOFF and P. A. MOLTCHANOFF.

Investigations in different layers of the atmosphere in the course of 1912, 1913, 1914 and 1915 were made by the Kites at their Section of the Observatory of Pavlovsk in the outskirts of Pavlovsk near the village Etup. Since the 1st January, 1913, the Kite Section of the Observatory at Pavlovsk was re-organised into an Aerological Observatory.

In 1913 a portion of land of 32 dessiatines was acquired for the new Aerological Observatory and a new building erected at 10 km. from Tsarskoje (Dietskoe) Selo in the vicinity of the village Ontolovo. But owing to the war one did not succeed to equip the ascents of kites and captive balloons in the new locality, so that the ascents of kites were effected on the old place, whilst the ascents of the sounding and of pilot balloons were made at the new Aerological Observatory.

In 1918, the ascents of the sounding-balloons were suspended, the Observatory not having received the table of International days, and besides it became more and more difficult to circulate in the country hunting after the balloons and almost all of them got lost. The ascents of kites were going on as systematically as it was possible, but the number of ascents and their altitude was gradually falling owing to a lack of technical means of the Observatory, especially of wire, the provisions of which were nearly exhausted. The ascents of kites were renewed in 1919 but their number and the altitudes reached were rather restrained. (*See* the annexed tables).

All the work of the staff was directed to the working out of the earlier observations and to preparing materials for print. The observations for 1914 were altogether ready for print, the materials composed, all the proofs read, but the issue could not be realised the typography having stopped working. In 1917 with the greatest difficulty, appeared W. Kusnetzoff's *Cloud Atlas*. Its edition could not be as carefully attended to as would have been done before the war.

The table inserted further on gives the number of ascents of ballon-sondes, kites and pilot-balloons, as well as the maximum heights they attained. The observations obtained by means of the balloons were collected both in the Kite Section and in the new Aerological Observatory.

For the sake of brevity we are giving here only the number of sounding balloons sent aloft on International days from Nijny Oltchedaev, Kharkov Kutchino, etc. The meteorographs for the sounding balloons (for all the Aerological Stations Oltchedaev, Kharkov, Kutchino, etc.) were constructed and verified at the new aerological observatory (Ontolovo).

In 1920 in connexion with a series of technical conditions which rendered inconvenient the residence of the Observatory on the chosen locality, it was transferred back to Pavlovsk, where the local Executive Committee allotted for this purpose a most suitable edifice. The Chief of the Observatory, W. Kusnetzoff, having given up his duties, the physicist of the same Observatory, P. A. Moltchanoff, who had attended to the kite ascents since 1919, was appointed as the chief of the Aerological Observatory. The pilot-balloons were all through this year sent aloft three times a day; simultaneous observations on the forms of the clouds were organized, whereat references were made not only of the form of the clouds to the International classification, but also of their type according to the atlases of Kusnetzoff, of Loisel and of the International Cloud Atlas. These observations were made every two hours during the light time of the day; they represent very interesting material in connection with the actual representation on cloud systems.

In 1925 the kite ascents would have been stopped, if by that time the Observatory had not received a certain quantity of steel-stringed wire as a scientific present from Prof. Hergesell. The Observatory finds it as its duty to announce this most important event of scientific solidarity and mutual assistance.

In 1921 the Observatory proceeded to the organisation of base-line observations, which were definitely accomplished towards 1923. Actually the observations of pilot balloons are effected nearly exclusively by application of the method of base-line observations. The length of the base-line represents 1,680 metres in the direction of N. 69° E. Up to the present date the quantity of base-line observations attains the number 1,500, out of which in one case the altitude, reached by the balloon (according to the records) was about 17,000 metres. The results of all these observations are actually being worked out and printed. In the same year (1922) the Observatory renewed the observations by means of sounding balloons, whereat owing to the absence of large envelopes, the question arose, whether it would not be possible to diminish the weight of the sounding meteorograph. To that effect the clockwork was replaced by a propeller, the rotary motion of which is produced by the vertical motion of the apparatus which puts in rotation the cylinder of the meteorograph. The general weight of the meteorograph, constructed at the Observatory, represents about 180 gr., so that it can be lifted by means of two pilot balloons. The maximum altitude reached by applying this method does not, however, exceed 9,000 metres.

In 1922 experiments were set on foot to have meteorographs lifted on airplanes. For that purpose a special meteorograph has been constructed which could be fastened to the wing of the airplane. The singularity of that meteorograph consists in its pens moving in a horizontal plane, by which means the influence of the bumping of the airplane is nearly quite set aside. The fastening of the instrument to the wing of the airplane is so simple that usual practice flights may be appropriated for lifting the meteorograph. The highest ascents took place in 1923, having reached the height of 7,300 metres.

All the results of observations made at the Observatory are printed in a small typographic establishment which was specially equipped for that purpose. Up to the present time the observations for 1920, 1921, and 1922 and for the first six months of the years 1923 and 1924 have been printed.

Note on the Work of the Aerological Observatory from 1912–1924 inclusive.

Number of Ascents with Pilot-Balloons, Sounding-Balloons, Kites and Aeroplanes.

Years.	Number of pilot-balloons.			Sounding Balloons.			Kites.		Aeroplanes.	
	From 1 point.	From 2 points.	Heights attained.	Number of ascents.	No. of instruments found.	Maximum heights attained.	Number of ascents.	Maximum heights attained.	Number of ascents.	Maximum heights attained.
			m.			m.		m.		m.
1912	165	—	8,300	25	—	19,000	223	4,150	—	—
1913	410	—	10,800	22	—	20,100	218	4,000	—	—
1914	572	—	24,400	24	—	21,100	241	4,000	—	—
1915	748	—	23,500	28	—	17,800	204	3,500	—	—
1916	757	—	26,300	22	—	16,700	243	4,000	—	—
1917	743	—	15,000	21	—	18,400	246	4,200	—	—
1918	764	—	25,030 (25 May 7h. p.m.) 126 minutes.	—	—	—	27 (to 11 Feb.)	2,500	—	—
1919	645	—	15,290 (29 Jan. 1h. p.m.) 71 minutes.	—	—	—	151	4,060	—	—
1920	883	—	19,300 (30 Mar. 5h. p.m.) 86 minutes.	—	—	—	123	2,880	—	—
1921	639	128	25,410 (7h. p.m.) 125 minutes.	—	—	—	90	1,980	—	—
1922	348	232	10,800 (24 June 7h. a.m.) from 2 points.	—	—	—	128	2,035	—	—
1923	108	504	12,000 (6 July 7h. a.m.) from 2 points.	11	1	5,200	185	Less than 2 km.	36	7,300
1924	102	438	16,500 (15 Aug. 7h. a.m.) from 2 points.	14	6	9,350	200	2,750	18	5,000

Ascents with Ballons-sondes on International Days.

Years.	Nijni Oltchedaev.		Kharkov.		Kutchino.	
	Number of ascents.	Maximum heights.	Number of ascents.	Maximum heights.	Number of ascents.	Maximum heights.
		m.		m.		m.
1912	23	18,200	2	—	1	—
1913	19	18,100	10	17,900	2	14,600
1914	22	18,900	15	20,100	6	17,300
1915	22	19,100	9	20,500	—	—
1916	17	17,600	11	18,700	—	—
1917	—	—	1	—	—	—

APPENDIX VII

On Cloud Observations made on International Days.

By V. V. Kusnetzoff.

Complete observations of clouds should not only be effected at aerological observatories but at ordinary pilot-stations as well. Every pilot-station should be provided with nephoscopes, and during the ascent of pilot-balloons, besides visual observations on clouds, similar observations should be made by means of nephoscopes.

Combined observations effected by means of pilot-balloons and nephoscopes will in many cases enable one to determine the altitude of clouds, to fix their absolute velocity and to state the direction of their motion.

In cases of base-line observations it would be very useful to have determinations of the altitudes of clouds and of their direction and velocity made by means of photogrammeters. If there is no possibility of applying photogrammeters, it would be necessary at least to determine the altitude of the clouds and the direction and velocity of their motion by means of theodolites which served for observing the flying pilot-balloons. As shown by observations made by Lundal and Westmann in Upsala in 1896–97 (international observations), visual observations are not less precise than the photogrammetrical ones. The latter offer, though, a certain advantage, as they record documental data relating to the observed form of the cloud and give the possibility of determining the height of the cloud as well as the motion of any particular point of the reproduced cloud. For those stations where it would be impossible to organise photogrammetrical observations it would be desirable to have photographs of clouds taken in the ordinary way. The copies of the photographs taken on international days should be forwarded to Aerological Observatories (if even one copy to every central aerological institution). The list of those institutions should be sanctioned by the International Commission.

The expenses connected with the acquiring of photographic plates and other materials would not be very great. If 40 dozen of plates (9 × 12 cm.) should be used yearly, this quantity would perfectly suffice for daily cloud photographing. The cost of the plates represents a sum of not more than 50 roubles, and the cost of paper and other materials

would not exceed that sum. Hence the yearly expense would be expressed in a sum of about 100 roubles, which is low in comparison with the expenses required by pilot-balloon observations.

The most typical of these photographs should be selected and an atlas composed. When the forms of the observed clouds are studied in detail, the original peculiarities of some forms of clouds will certainly come to light in connexion with the geographical situation of the point of observation: it is therefore necessary to use not only the international atlas but as well an atlas relating to such regions, which greatly differ in respect of their geographical position and climate.

In the international atlas it should be necessary to point out the peculiarities of some forms of clouds in connexion with the geographical situation of the point of observation.

In the atlas edited by the Central-Geophysical Observatory in 1917, each of the five classes are marked by letters A, B, C, D or E according to the international notation. Every class of clouds inserted in the atlas has its individual numeration, and it was considered that if new clouds were added in a new edition of the atlas, each individual cloud should conserve its former number and the new clouds should be duly classified in connexion with it.

The necessity of conserving for each individual cloud its proper number is very great; in the last edition of the international atlas it was recommended to indicate the corresponding number of the cloud in that atlas, which shows the greatest likeness with the observed cloud. Such indications have a great value for the study of the forms of clouds, and for that reason it is desirable to be able not only to refer to the international atlas but to refer as well to other atlases, as in the former the number of reproductions is comparatively low.

It is absolutely necessary that these indications should be very definite and that each cloud should keep up its proper number when the atlas is re-edited.

APPENDIX VIII

On Homogeneity of Methods of Aerological Observations.

SOME RESULTS OF BASE-LINE OBSERVATIONS MADE AT THE AEROLOGICAL OBSERVATORY, PAVLOVSK.

By P. A. MOLTCHANOFF.

The base-line observations were made in the course of the two years 1923 and 1924 at morning and evening hours. The data obtained show that the departures of the rate of ascent of the balloons have a diurnal and annual course, the departures at morning hours (as well as those of the winter periods) being smaller than those of the afternoon hours, especially in summer. By the breaking up of the observations into groups according to the force of wind at the height of 500 meters it becomes evident that the departures of the rate of ascent augment with the increasing velocity of the wind at that height; this is especially to be observed during the winter period. At heights exceeding 600 metres the difference between the departures observed in summer with high and feeble winds disappears almost entirely. By grouping the cases of observed departures according to the direction of the wind, it becomes evident that the largest departures take place in the presence of winds blowing from the northern side of the horizon, the largest difference being observed in the lower layers. By grouping the cases of observed departures according to the periods of lower and higher temperatures the largest departures are observed with lower temperatures.

As a peculiarity of our observations it must be noted that the values of departures are larger than those, for instance, which are obtained from American observations.

This may be explained by the influence (which was denoted by the author in previous articles) of the rate of free lift of the balloons on the regularity of their ascent. Namely, with lower rate of free lift the rates of ascent become nearer to the theoretical values than with a higher one. In America the free lift of all the observed balloons did not exceed 150 gr. (the weight is 20–30 gr. with an average rate of ascent of 180 metres per minute), whilst in Russia the free lift of the balloons is generally more than 170 gr. Balloons of free lift lower than 170 gr. were used at morning hours in August and September, 1924—and the departure of vertical velocities proved to be in this case even lower than those shown by the data of American observations—the highest rate of approximation of rates of ascent to the theoretical values equalling not more than 400 metres. This circumstance proves the rationality of using for pilot observations from a single point the lowest free lift possible under the condition of the greatest rate of ascent which could be allowed.

In computing the observations, in cases when the balloon floated not far from the base-line and the values of vertical angles exceeded 45°, the formula obtained by the projection of the balloon on a vertical plane (instead of a horizontal one) was applied, giving for the heights of the balloons more precise results than the usual formula.

APPENDIX IX

Additional Communications from Dr. Moltchanoff.

SYSTEMATIZATION OF THE NETWORK OF AEROLOGICAL STATIONS.

By P. A. MOLTCHANOFF and B. I. ISVEKOFF.

System and method in the work of aerological observations prove to be the most important conditions of its fruitfulness and expediency. Aerological observations carried out now in different countries by special Aerological Observatories excel in characteristic peculiarities, hindering the thorough utilization of the results of these investigations. Moreover, their publication is generally also irregular, and almost always differs in scheme and programme. In order to set aside the above-mentioned deficiencies we venture to suggest the organization of an international net of aerological stations, rationally distributed and compelled to work according to a preliminary settled plan, at the basis of which the following considerations may be laid.

At first separate sections have to be selected in which the corresponding countries should undertake the establishment of the said statutory* aerological stations (one per each section). In selecting the said sections one can be guided by climatological data which would give necessary indications as to the peculiarities of the distribution of meteorological elements in such or other section. It seems that the establishment of statutory aerological stations would be desirable in the following regions: (1) at the extreme north in the region of Vardö or in that of the Murman; (2) in the centre of the black-earth's zone of Russia; (3) in the region of the Siberian anticyclone; (4) in Iceland; (5) on the Azores, etc.

The programme of work for statutory stations should be worked out by the International Commission and be in its main lines uniform for all these stations. We should like to point out that base-line observations by means of pilot-balloons ought to be included in that plan, as well as ascents of meteorographs on kites or aeroplanes and ascents of sounding-balloons.

---

* That is, stations working according to a preliminarily settled statute.

Moreover, systematical determinations (approximately every two hours) of the form of the clouds ought to be made too, defining not only the form but also the type of the cloud according to the clouds imaged in some cloud atlas.

It would be indispensable to choose one of the existing atlases to be specially adapted as a normal one for the use of the statutory stations. The observations made at the statutory stations should be made at beforehand-fixed hours and be immediately after being effected, communicated to the enregistered addresses.

All the observations should be regularly published once a month according to a determined scheme in a special international periodical. The cost of this edition should be met by the contribution of a necessary fund by the interested countries on mutual agreement.

The sums needed for the equipment of these stations (technical investigations, materials, etc.) should be, as well, in some cases, provided by the international fund. The main supervision as to the fulfilment of the established programme should be confined to the good offices of the President of the International Committee for Exploration of the Upper Air, whilst in separate countries where statutory stations will be organized the members of the Commission may be charged with this responsibility.

A meeting of the representatives of the countries having partaken in the organization of the statutory stations and upholding them should be held yearly for the purpose of discussing the subjects concerning the work of this net. Some of the stations already existing, if their situation proves to be convenient, may be included in this net: these stations will have to effect statutory observations in addition to those which constitute their former programme.

The expenses connected with statutory observations made at ordinary stations should be also covered by assignments provided by the international fund.

On changing the Methods of Organization of Aerological Observations for the purpose of increasing the number of Observations made on days when big Cyclones are passing.

By B. I. Isvekoff.

Series of synoptical investigations effected in the course of these last years are based on aerological observations. This can be said especially with regard to recent synoptical studies of the "polar front" as well as to the synoptical testing of Prof. V. Bjerknes' ideas and his new theory of the origin and development of the cyclones in the Northern Hemisphere. Stüve, Diesing, T. Bergeron and G. Swoboda and others are studying the distribution of the elements of real cyclones and anticyclones and the location and transposition of the surface of discontinuity forming the "polar front."

These studies are met by serious difficulties owing to the following circumstances:—

(*a*) The aerological network is not sufficiently complete.

(*b*) Corresponding data of aerological observations coinciding with days of big typical cyclones are generally too scarce.

(*c*) The observations prove to be not uniform enough as regards time, being effected at different hours by different stations, which renders the determinations of gradients exceedingly difficult.

We find, therefore, very desirable the inserting in the number of international days of several days more in which the passing of large pressure minima over Europe may occur, not fixing precisely these days. so that the stations could be informed by wire on the passing of the cyclone at the very moment of its appearance and would produce their observations according to a uniform plan and, if it proves to be convenient, at the same hours.

APPENDIX X

List of Members of the Commission, London, April 22nd, 1925.

Bureau :

Sir Napier Shaw, 10, Moreton Gardens, London, S.W.5. (*President*).
Director Th. Hesselberg, Det Norske Meteorologiske Institut, Oslo, Norway (*Secretary*).
Mr. R. G. K. Lempfert, Meteorological Office, Air Ministry, Kingsway, London, W.C.2 (*Secretary*).

Members :

Prof. F. Åkerblom, Meteorologiska Observatorium, Upsala, Sweden.
Dr. W. van Bemmelen, The University, Amsterdam, Holland.
Prof. V. Bjerknes, Geofysisk Institut, Bergen, Norway.
Mons. A. Moreira de Carvalho, Commandante de Centro de Aviaçao Maritima, Lisboa, Portugal.
Mons. Mario da Costa Franca, Commandante de Companie de Aerostreiros, Lisboa, Portugal.
Mr. C. J. P. Cave, Stoner Hill, Petersfield, Hants, England.
Dr. D. la Cour, Director, Det Danske Meteorologiske Institut, København, Denmark.
Le Général E. Delcambre, Director, Office National Météorologique, Rue de l'Université, 176, Paris, France.
Mr. L. H. G. Dines, Kew Observatory (Upper Air Section), Old Deer Park, Richmond, Surrey, England.
Mr. W. H. Dines, Benson Observatory, Wallingford, Berks, England.
Mons. R. Dongier, Institut de Physique du Globe de la Faculté des Sciences de l'Université de Paris, Rue de l'Université, 176, Paris, France.
Prof. E. van Everdingen, Koninklijk Nederlandsch Meteorologisch Instituut, De Bilt, Holland.
Prof. F. M. Exner, Direktor der Centralanstalt für Meteorologie und Geodynamik, Hohe Warte, 38, Wien XIX, Austria.
Mr. J. H. Field, Director-General of Indian Observatories, India Meteorological Department, Simla, India.
Dr. E. Fontséré, Jefe, Servei Meteorologic da Catalunya, Urgell, 187, Barcelona, Spain.
†Prof. A. A. Friedmann, Director, Central Geophysical Observatory, Leningrad, Russia.
Dr. S. Fujiwhara, Central Meteorological Observatory, Tokyo, Japan.
Prof. P. Gamba, R. Osservatorio Geofisico, Pavia, Italy.
Prof. W. Georgii, Vorstand des Wissenschaftlichen Abteilung, Deutsche Seewarte, Hamburg, Germany.
Lieut.-Col. E. Gold, Meteorological Office, Air Ministry, Kingsway, London, W.C.2.
Prof. Dr. B. Helland-Hansen, Geofysisk Institut, Bergen, Norway.
Prof. Dr. H. Hergesell, Preussisches Aeronautisches Observatorium, Lindenberg, Kreis-Beeskow, Germany.
Mons. P. Idrac, Chargé des études de la haute atmosphère, Office National Météorologique, Rue de l'Université, 176, Paris, France.
Mons. F. Jacobs, Président, Société Belge d'Astronomie, Bruxelles, Belgium.
Commandant J. Jaumotte, Institut Royal Météorologique de Belgique, Uccle, Belgium.
Prof. F. Linke, Direktor, Meteorologisch-Geophysikalisches Institut der Universität, Frankfurt a/Main, Germany.
Dr. C. F. Marvin, Chief U.S. Weather Bureau, Washington D.C., U.S.A.
Lieut. Colonel L. Matteuzzi, Sezione Aerologica S.S., 8, Lungo Tevere Michelangelo, Roma.

† Deceased, September, 1925.

Mons. Ch. Maurain, Directeur, Institut de Physique du Globe de l'Université, Rue de l'Université, 176, Paris, France.
Col. E. Meseguer, Jefe (*vice* Col. Cruz-Condé, resigned), Servicio Meteorológico Español, Madrid, Spain.
Dr. P. Moltchanoff, Aerological Observatory, Sloutzk (Pavlovsk), Russia.
Mons. Chr. A. C. Nell, Société Aérologique, De Perponcherstraat 49, La Haye, Holland.
Prof. L. Palazzo, R. Ufficio Centrale di Meteorologia e Geodinamica, Via del Caravita, 7, Roma, Italy.
Mr. J. Patterson, Meteorological Office, Toronto, Ontario, Canada.
Prof. Dr. A. de Quervain, Schweizerische Meteorologische Centralanstalt, Zürich, Switzerland.
Dr. G. Rempp, Institut de Physique du Globe de l'Université de Strasbourg, 38, Boulevard d'Anvers, Strasbourg, Alsace-Lorraine, France.
Mr. L. F. Richardson, 31, Bridge Lane, London, N.W.11, England.
Dr. S. Róna, Director, M. Kir. Országos Meteorologiai és Földmagnességi Intézet, Budapest, Hungary.
Mons. E. Rothé, Institut de Physique du Globe, Université de Strasbourg, 38, Boulevard d'Anvers, Strasbourg, Alsace-Lorraine.
Dr. J. W. Sandström, Statens Meteorologisk-Hydrografiska Anstalt, Stockholm, Sweden.
Mons. Ph. Schereschewsky, Office National Météorologique, Rue de l'Université, 176, Paris, France.
Dr. A. Schmauss, Director, Bayerische Landeswetterwarte, München, Bavaria.
Mr. R. Sekiguchi, Imperial Marine Observatory, Kobe, Japan.
Dr. Griffith Taylor, Professor of Geography, University of Sydney, New South Wales, Australia.
Prof. G. I. Taylor, Trinity College, Cambridge, England.
Sir Gilbert Walker, School of Meteorology, Imperial College of Science and Technology, South Kensington, London, S.W.7, England.
Dr. A. Wallén, Statens Meteorologisk-Hydrografiska Anstalt, Stockholm, Sweden.
Mons. le Capitaine P. Wehrlé, Office National Météorologique, Rue de l'Université, 176, Paris, France.

INDEX.

Printed under the authority of His Majesty's Stationery Office
By Eyre and Spottiswoode, Ltd., East Harding Street, E.C. 4,
Printers to the King's most Excellent Majesty.

Publications of Researches—*cont.*

GEOPHYSICAL MEMOIRS. Vol. III.—*cont.*

No. 22. Absolute Daily Range of Magnetic Declination at Kew Observatory, Richmond, 1858 to 1900. By C. Chree, Sc. D., LL.D., F.R.S. (No. 254*b*. 1923.) 2*s*. 6*d*. Postage 1½*d*.

No. 23. The Climatology of Glasgow. By L. Becker, Ph. D. (No. 254*c*. 1925.) 10*s*. Postage 3½*d*.

No. 24. The Distribution of Thunderstorms over the Globe. By C. E. P. Brooks, M.Sc. (No. 254*d*. 1925.) 2*s*. Postage 1*d*.

No. 25. Surface and Geostrophic Wind Components at Deerness, Holyhead, Great Yarmouth, and Scilly. By S. N. Sen, M.Sc. (No. 254*e*. 1925.) 2*s*. Postage 1*d*.

No. 26. Classification of Synoptic Charts for the North Atlantic, 1896–1910. By E. V. Newnham, B. Sc. (No. 254*f*. 1925.) 6*s*. Postage 1*d*.

PROFESSIONAL NOTES. (8vo.) :—

Vol. III. :—

No. 30. Diurnal Variation of Temperature as affected by Wind Velocity and Cloudiness. A discussion of Observations on the Eiffel Tower. By Captain J. Durward, M.A. (No. 245*j*. 1922.) 4*d*. Postage ½*d*.

No. 31. The Relation between Height reached by a Pilot Balloon and its Ascending Velocity. By J. Wadsworth, M.A. (No. 245*k*. 1923.) 3*d*. Postage ½*d*.

No. 32. A Note on the Upper Air Observations taken in North Russia in 1919. By W. H. Pick, B.Sc. (No. 245*l*. 1923.) 3*d*. Postage ½*d*.

No. 33. The Diurnal and Seasonal Variations of Fog at certain stations in England. By F. Entwistle, B.Sc. (No. 245*m*. 1923.) 6*d*. Postage ½*d*.

No. 34. How to Observe the Wind by Shooting Spheres Upward. By L. F. Richardson, B.A., F. Inst. P. (No. 245*n*. 1924.) 9*d*. Postage ½*d*.

No. 35. Report on Observations of Atmospheric Electricity and Terrestrial Magnetism made at Kew, Stonyhurst and Eskdalemuir Observatories on the occasion of the Solar Eclipse, April 8th, 1921. By C. Chree, Sc. D., LL.D., F.R.S., H.W.L. Absalom, B.Sc., and E. Taylor, M.A., B.Sc. (No. 245*o*. 1924.) 9*d*. Postage ½*d*.

No. 36. On the Inter-Relation of Wind Direction with Cloud Amount and Visibility at Cahirciveen, Co. Kerry. By L. H. G. Dines, M.A., A.M.I.C.E., and P. I. Mulholland, B.Sc. (No. 245*p*. 1924.) 1*s*. Postage ½*d*.

No. 37. Pressure Type in Relation to Fog Frequency at Scilly during Summer Months. By E. G. Bilham, B.Sc., D.I.C. (No. 245*q*. 1924.) 6*d*. Postage ½*d*.

No. 38. Measurement of Upper Wind Velocities by Observations of Artificial Clouds. By C. D. Stewart, B.Sc. (No. 245*r*. 1924.) 9*d*. Postage ½*d*.

No. 39. Upper Air Circulation of the Atlantic Ocean. By E. W. Barlow, B.Sc. (No. 245*s*. 1925.) 6*d*. Postage ½*d*.

No. 40. Ground Day Visibility at Cranwell, Lincolnshire, during the period 1st April, 1920, to 31st December, 1923. By W. H. Pick, B.Sc. (No. 245*t*.. 1925.) 3*d*. Postage ½*d*.

Publications of Researches—*cont.*

PROFESSIONAL NOTES—*cont.*

Vol. IV :—

No. 41. Upper Air Temperatures in Egypt. By E. V. Newnham, B.Sc. (No. 273*a*. 1925.) 3*d*. Postage ½*d*.

Publications of Data. (4to.)

Daily Weather Report. 1. British Section. 2. International Section. 3. Upper Air Section. Subscription 13*s*. per quarter for two or three sections, 6*s*. 6*d*. per quarter for one section. Single copies of any of the reports can be obtained from the Meteorological Office, price 1*d*. each.

Weekly Weather Report. 9*d*. Post free 9½*d*. Annual subscription, including Introduction and Guide to Tables, 40*s*. post free.

Monthly Weather Report. 9*d* Post free 10*d*. Annual subscription, including Introduction and Annual Summary, 10*s*. post free.

The Observatories' Year Book. Comprising the results obtained from autographic records and eye observations at the observatories at Aberdeen, Eskdalemuir, Cahirciveen (Valencia Observatory), Richmond (Kew Observatory), and Benson. [In continuation of the former *British Meteorological and Magnetic Year Book*, Parts III and IV.] 1922 vol. 63*s*. Postage 9*d*.

British Meteorological and Magnetic Year Book.—Part V.—*Réseau Mondial.* Monthly and Annual Summaries of Pressure, Temperature and Precipitation at Land Stations, generally two for each ten-degree square of Latitude and Longitude. Commencing 1910, Charts, 8*s*. 6*d*; Tables, 15*s*.; 1911, Charts, 3*s*. 6*d*.; Tables, 7*s*. 6*d*. 1912, 1913 Tables, 7*s*. 6*d*. each; 1914 Tables, 18*s*.; 1915, Tables, 24*s*.; 1916, 1917, Tables, 22*s*. 6*d*. each; 1918, Tables, 21*s*.

Publications of Normals.

The Book of Normals of Meteorological Elements for the British Isles for periods ending 1915. (No. 236.) (8vo.)

Section I. Monthly Normals of Temperature, Rainfall and Sunshine for Stations. 2*s*. Postage 1½*d*.

Section II. Weekly, Monthly, Quarterly and Seasonal Normals for Districts. 9*d*. Postage ½*d*.

Section III. Maps of the Normal Distribution of Temperature, Rainfall, and Sunshine for the British Isles. 1*s*. 6*d*. Postage 1*d*.

Section IV.—(*a*) Range of variation of Temperature and Rainfall; (*b*) Frequency Tables for Hail, Thunder, Snow, Snow lying and Ground Frost. 3*s*. 6*d*. Postage 1*d*.

Section V. Monthly Normals of Rainfall. 4*s*. Postage 1*d*.

With the exception of the Daily Weather Report all publications are obtainable directly from H.M. Stationery Office, in London, Cardiff, Manchester, Edinburgh, and Belfast, or through any bookseller.

** A complete list of publications of the Meteorological Office will be supplied on application to the Director, Meteorological Office, Air Ministry, Kingsway, London, W.C. 2.