Official No. 23.

REPORT

OF

THE PROCEEDINGS

OF THE

CONFERENCE ON MARITIME METEOROLOGY

HELD IN

LONDON, 1874.

PROTOCOLS AND APPENDICES.

Published by the Authority of the Meteorological Committee.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE,
AND SOLD BY
J. D. POTTER, 31 POULTRY, AND 11 KING STREET TOWER HILL;
AND
E. STANFORD, CHARING CROSS.

1875.

Price Two Shillings.

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LETTER OF INVITATION.

Meteorological Office,
116, Victoria Street, London,
25th June 1874.

SIR, Maritime Conference.

I HAVE the honour to inform you, that it has been decided by the Sub-Committee (consisting of MM. Buys Ballot, Mohn, Mouchez, Neumayer, and myself), appointed by the Permanent Committee of the Vienna Congress, that it is desirable to hold a private conference for the discussion of the subject of Maritime Meteorology in London, in the course of this year.

I have received authority from the Meteorological Committee of the Royal Society, to place this Office at the service of the Conference, for its Meetings.

The Conference will assemble on the 31st August, at noon, and will probably last three or four days.

I have the honour to invite you to attend the Conference personally, or to authorize some Meteorologist conversant with the subject of Maritime Meteorology to represent you.

Copies of the programme proposed by the Sub-Committee for the deliberations of the Conference are enclosed for yourself, and for presentation to other gentlemen in your country interested in the subject.

I have already issued copies of this Circular to the gentlemen specified below,* and I hope to receive a reply as to your intention to attend, or the contrary, previous to the 1st of August at latest.

The Sub-Committee will feel themselves deeply indebted to you if you can procure for them written opinions from men of experience in your country who may not attend the Conference, on any, or all of the several subjects embraced by the programme, and send them to me at this Office.

I have the honour to be, &c.
ROBERT H. SCOTT,
Secretary to the Sub-Committee.

* The names of gentlemen in the same country as the recipients of the Circular, to whom invitations had been issued, were here given.

PROGRAMME

OF THE

CONFERENCE ON MARITIME METEOROLOGY.

A general wish has of late been expressed that the measures for the prosecution of Maritime Meteorology proposed at the International Conference at Brussels, in 1853, should be reconsidered, now that the experience of more than 20 years of the operation of these measures has enabled Meteorologists to form opinions as to their utility.

At the Meteorological Conference at Leipzig in 1872, and again at the International Congress at Vienna, in 1873, preliminary discussions took place on the subject of the more successful prosecution of Ocean Meteorology. Certain resolutions were adopted at Leipzig and confirmed at Vienna, and accordingly it seems proper to embody them in the present Programme. They run as follows:—

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

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

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

"4th. With reference to the utilisation of the results, the Committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith is the carrying out of the division of labour of the Central Stations of the individual states. This principle must be recognized as of the greatest importance for the further development of Marine Meteorology. The repetition of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development."

It was further resolved—"That the convening of a Maritime Meteorological Conference is desirable."

While accepting the above resolutions as a general expression of the principles which should form the basis of an agreement as to future operations in the field of Ocean Meteorology, the Sub-Committee to whom the negotiations preparatory to the assembling of a Conference have been entrusted, consider that it is advisable to enter more minutely into the details, and have accordingly agreed on the following series of questions:—

In the case of a nation which sent any representative to the Brussels Conference, in 1853, a circular should be addressed to the chief of the Office for Maritime Meteorology, if such exist, or to the chief of the Meteorological Organization of the country, requesting him to state:—

1. To what extent the resolutions adopted at Brussels have been carried out in that country;
2. What have been the grounds for departure from them, if such departure has taken place;

and to send his reply to the Secretary to the Sub-Committee, Mr. Robert H. Scott, 116, Victoria Street, London, S.W., before the 1st of June 1874, in order to allow ample time to draw up a report on the replies for consideration at the Conference.

It seems advisable that, as above stated, the action taken at Vienna should be carefully reconsidered under the several heads which will now be recapitulated.

I.—*Observations.* In respect of this subject it will be most convenient to take the "Abstract Log" of the Brussels Conference, and to discuss the several subjects of observation noted therein in the order of sequence of the columns.

Cols. 1—6. *Date and Position of the Observations.*
Is it your opinion that a fresh column should be added, headed "Course and Distance by the Log in every Watch of 4 hours"?

„ 7 and 8. *Currents.*

„ 9. *Magnetic Variation.*
Is it desirable to give an additional column for the "Direction of Ship's Head"?

Cols. 10 and 11. *Wind, Direction and Force.*
Is it possible to employ an anemometer at sea so as to give trustworthy results?
Can the use of the Beaufort Scale be made universal?

„ 12 and 13. *Barometer.*
To what degree of minuteness is it necessary to observe this instrument?

„ 14 and 15. *Thermometer.—Dry Bulb and Wet Bulb.*
Should these observations be required from all ships?

„ 16. *Forms and Direction of Clouds.*
Is this column sufficient, or should any notice be taken of more than one stratum of clouds?

„ 17. *Proportion of Sky Clear.*
Is it not advisable to substitute for this heading "Proportion of sky clouded"?

„ 18. *Hours of Rain, Fog, Snow, &c.*
Is it desirable to retain this heading, or to substitute for it and No. 23 a column headed—"Weather by Beaufort Notation"?

„ 19. *State of the Sea.*
Should this be given according to a Numerical Scale?

„ 20. *Temperature of Sea Surface.*

„ 21. *Specific Gravity* „ „

„ 22. *Temperature at Depths.*
Is it desirable to retain these two last columns, or can the observations when taken be inserted in the column for "Remarks"?

„ 23. *Weather.* See No. 18.

„ 24. *Remarks.*

II. *Instruments.*—What patterns of instruments should be employed for any observations which may require them?

Is there a reasonable possibility of introducing the Metric and Centigrade systems for general use at sea?

III. *Instructions.*—Is it possible to devise a general form of Instructions to ensure uniformity in regard of methods of observation and registration?

IV. *Observers.*—What control should be exercised over the Observers as to their instruments and registers?

Is it desirable that all instruments employed should be the property of the Central establishment, and *lent* to the Observers?

V. *Co-operation of the Royal Navy.*—To what extent can ships of war assist in forwarding the ends of Meteorological Inquiry?

VI. *Discussion.*—Can general suggestions be thrown out as to the most profitable mode of discussion of the observations?

VII. *Subjects of Inquiry.*—To what extent can a division of labour as regards subjects of inquiry be carried out in a spirit of fairness to the collecting and discussing establishments respectively?

VIII. *Sailing Directions.*—In how far are purely practical investigations, such as the preparation of Sailing Directions, admissible for a Scientific Institution?

Any gentleman into whose hands this Programme may come, and who is himself not likely to attend the Conference, is requested to forward any remarks he may wish to make, on any of the subjects mentioned herein, to Mr. Scott, at the above address, before the 1st of July 1874.

LIST OF PERSONS PRESENT AT THE CONFERENCE.

Austria - -	R. Müller - -	Director of the Imperial Royal Hydrographic Office at Pola.
Belgium - -	F. van Rysselberghe	Navigation School, Ostend.
Bengal - -	H. F. Blanford -	Secretary, Meteorological Committee, Calcutta.
China - -	J. D. Campbell -	Inspectorate General of Chinese Maritime Customs, London.
Denmark - -	Capt. N. Hoffmeyer -	Director of the Royal Danish Meteorological Institute at Copenhagen.
France - -	A. Delamarche -	Ingénieur Hydrographique, Ministry of Marine, Paris.
,, - -	C. Sainte Claire Deville	Inspector of French Meteorological Stations, Paris.
Germany - -	W. H. v. Freeden -	Director of the "Deutsche Seewarte" at Hamburg.
,, - -	H. A. Meyer -	Commissioner for investigating the German Seas, Kiel.
,, - -	G. Neumayer -	Hydrographer, Berlin.
,, - -	Capt. Stempel -	Imperial Navy.
Great Britain -	R. J. Mann, M.D. -	President of the Meteorological Society, London.
,, - -	R. Admiral M.F. Nolloth.	Representative of the Admiralty.
,, - -	R. H. Scott, F.R.S.	Director of the Meteorological Office, London, Hon. Sec. to the Sub-Committee.
,, - -	Capt. H. Toynbee -	Marine Superintendent, Meteorological Office (Representative of the Board of Trade).
Holland - -	H. Buys Ballot -	Director of the Royal Meteorological Institute of the Netherlands, Utrecht.
,, - -	Lieut. J.E. Cornelissen	Marine Superintendent, do. (R. Dutch Navy.)
Italy - -	Capt. N. Canevaro -	Naval Attaché to the Royal Italian Legation, London. (R. Italian Navy.)
Norway - -	H. Mohn - -	Director of the Royal Norwegian Meteorological Institute at Christiania.
Portugal - -	J. C. de Brito-Capello	Director of Nautical and Meteorological Observations, Observatory of the Polytechnic School, Lisbon.
Russia - -	A. Moritz - -	Director of the Observatory at Tiflis.
,, - -	Capt. M. Rikatcheff -	Central Physical Observatory, St. Petersburg. (Imp. Navy.)
Spain - -	Capt. H. Montojo -	Spanish Navy.
,, - -	Capt. C. Pujazon -	Director of the Marine Observatory, San Fernando. (Spanish Navy.)

PROCEEDINGS

OF THE

MARITIME CONFERENCE AT LONDON,

1874.

Meeting of the 31st August, at Noon.

PRESENT:

MM. Blanford.	MM. Meyer.
Buys Ballot.	Mohn.
Campbell.	Montojo.
Canevaro.	Müller.
Capello.	Neumayer.
Cornelissen.	Pujazon.
Delamarche.	Rikatcheff.
Deville.	Scott.
v. Freeden.	Stempel.
Hoffmeyer.	Toynbee.
Mann.	

Mr. SCOTT opened the Conference and said that, in the name of the Meteorological Committee, he felt most highly honoured in welcoming all the gentlemen to the Meteorological Office.

The present Conference, like that of Leipzig, had been called together by a Sub-Committee, appointed by the Permanent Committee of the Vienna Congress of 1873, and it had been thought desirable by a majority of that Sub-Committee to have the Conference *private*, in order to ascertain whether or not there existed a serious difference of opinion on the various questions connected with Maritime Meteorology, and whether or not they could be settled without a Government Congress.

He thought the best plan would be to read out the names, and introduce the members present to each other, and afterwards to proceed to elect the President and Secretaries. Having read the names, he stated that he had received a letter from M. A. Moritz, asking permission for M. van Rysselberghe and himself to attend the Conference, and that he had invited them by telegraph to do so. This action was approved by the Meeting.

On Mr. Scott's proposal, the Meeting chose M. Buys Ballot as President.

M. BUYS-BALLOT said he was very sensible of the honour done him, but his task was a difficult one, and he would have liked a better chairman. He hoped the Meeting would excuse his imperfect knowledge of English.

Mr. Scott was elected a Secretary, and he proposed that M. Hoffmeyer should act with him, and undertake the French portion of the proceedings, a proposal which was approved by the Conference.

Mr. Scott said it was unnecessary to read the letters which had been received from gentlemen who accepted the invitation to attend, but he would read those received from gentlemen unable to be present, viz. (vide Appendix A.) :—

MM. Buchan.	MM. Rothe.
Davis.	Rubenson.
Findlay.	v. Wrangel.
Marié-Davy.	v. Wüllerstorf.
Myer.	Wyman.

and he regretted that neither Sweden nor the United States would be represented at the Conference.

The President said the first thing to be done was to learn the opinions about the working of the Brussels Conference, and he called on the Secretaries to read the several written communications which had been received on the subject.

Mr. Scott said that letters had been issued to every nation that had sent a representative to Brussels, and stated that replies had been received from every one. The answers had been sent by the following gentlemen ; it would not, however, be necessary to read them all here in full, as they would be referred to the several Sub-Committees to be hereafter appointed. (Vide Appendix B.) The names were :—

MM. Buys Ballot.	MM. Myer.
Capello.	Quetelet.
Hoffmeyer.	Rikatcheff.
Mohn.	Rubenson.
Mouchez.	Wyman.

The President proposed that the meeting should divide itself into two Sub-Committees, viz., one treating of that portion of the Programme which had special reference to *Observations*, and the other to *Discussions*, with power to sub-divide themselves further, if necessary.

This proposal was put to the meeting, and agreed to unanimously.

The first Sub-Committee (Observations) should take into consideration Questions I.–III. of the programme, and the following gentlemen were elected to act on it :—

MM. Capello.	MM. Müller.
Canevaro.	Neumayer.
Cornelissen.	Pujazon.
Deville.	Rikatcheff.
Meyer.	Toynbee.
Montojo.	

The second Sub-Committee (Discussions) should take into consideration Questions IV.–VIII. of the Programme, and the following gentlemen were elected to act on it :—

MM. Blanford.	MM. Mohn.
Buys Ballot.	Moritz.
Delamarche.	Nolloth.
v. Freeden.	van Rysselberghe.
Hoffmeyer.	Scott.

The other Members of the Conference would have the option of joining one or other of the Committees at their pleasure.

It was arranged that the Sub-Committees should bring up their Reports for discussion as soon as ready, and the President then called on the Meeting to make any general remarks which might assist the Sub-Committees in their deliberations.

M. Hoffmeyer expressed the hope that the logs of merchant ships of each nation should be arranged as much as possible on the same model as those for ships of war, viz., that approved by the Conference.

M. Deville asked if the first Sub-Committee would be charged both with the questions of "observations to be taken," and "the hours of taking the same," and was answered in the affirmative.

M. v. Freeden wished the Weather-Book to contain all the absolutely necessary columns together, and to have extra columns for such things as were not actually necessary for seamen.

Mr. Scott said it was intended that the first Sub-Committee should undertake all practical questions as to the Observations and Instruments, and the hours of taking the Observations, and it would be composed, as far as possible, of sailors ; the other Sub-Committee would take charge of matters which would be discussed in the Offices. As soon as every gentleman had had an opportunity of offering any remarks which he chose, the Conference should formally either accept or reject this Programme which had been proposed by the Sub-Committee.

M. Buys Ballot agreed with M. v. Freeden that we should divide the journal into columns of primary and of secondary importance.

M. Rikatcheff handed in some remarks, for the consideration of the Sub-Committee, and drew attention to the necessity of special observations on the velocity of the wind, and on the rainfall on shipboard.

The President referred the proposed Programme to the Meeting, and asked whether or not they accepted it as it stood ?

Mr. Scott drew attention to a proposal by General Myer, as to Synchronous Observations, which was not mentioned in the Programme, and asked if the Conference thought that the question of Synchronous Observations should be included in the Programme.

He himself thought that it should not be so included. We

must get such Observations from ships' logs, if we can, but it was not possible to treat the matter as one of Maritime Meteorology.

M. NEUMAYER concurred in this view, in so far that at the present stage of the proceedings of the Conference, it had nothing to do with Synchronous Observations, which might, however, be got from the ordinary logs.

CAPT. TOYNBEE said that Synchronous Observations should be made the subject of a special request, and could hardly be included in the form of a ship's log. Those Captains who took them might enter them in the column for Remarks. It might be well if General Myer had circulars printed asking for them. The circulars could be issued to those Captains who observe for the various Maritime Meteorological Offices.

M. BUYS BALLOT said the Captains could have their attention called to it, but it could not be imposed on them.

The Conference then definitely accepted the Programme.

Mr. SCOTT explained the arrangements for the Conference. The Sub-Committees should meet at 11 o'clock, and sit till 1h., and again from 2 to 4 o'clock. On Wednesday afternoon, or Thursday, the Conference in full would receive and discuss the Reports of the Sub-Committees.

BUYS BALLOT.

Meeting of the 2nd September, at 2.30 p.m.

PRESENT :

MM. Blanford.	MM. Mohn.
Buys Ballot (President).	Montojo.
Canevaro.	Moritz.
Capello.	Müller.
Cornelissen.	Neumayer.
Delamarche.	Nolloth.
Deville.	Pujazon.
v. Freeden.	Rikatcheff.
Hoffmeyer.	van Rysselberghe.
Mann.	Scott.
Meyer.	Stempel.
	Toynbee.

The PRESIDENT said that the Resolutions of both the Sub-Committees had been printed and were in the hands of the Members. They would be brought before the General Meeting as soon as the Proceedings of the last Meeting had been read.

The Proceedings of the previous Meeting were read and confirmed.

The PRESIDENT reported that MM. Moritz, Nolloth, and van Rysselberghe, who were not present at the first Meeting, had

since arrived and had taken part in the labours of the second Sub-Committee and he thanked them for their assistance.

He then requested Mr. Scott to proceed with the reading of the several questions enumerated in the Programme, and the Resolutions of the respective Sub-Committees upon them. At the same time he requested the Members of the Conference to make remarks upon the Resolutions to be brought forward, suggesting that, owing to the short time available for discussion, any observations they might wish to make ought to be well considered, and of weight, since the different Committees had already considered the Resolutions in detail.

The Conference then passed to the consideration of the Resolutions of the First Sub-Committee. The "Abstract Log" of the Brussels Conference was taken, and the several subjects of observation noted therein were discussed in the order of sequence of the columns.

Resolutions passed by the First Sub-Committee.—

"Observations."

1°.* "That there should be but one form of Meteorological Register for the Navies and Merchant Services, and that those that cannot fill the log should keep part of it."

The Second Sub-Committee stated that they had resolved to recommend that there should be two kinds of Register.

M. v. FREEDEN said it would be better to have a log which did not require so much education in the observers. He would give an opportunity of keeping some columns, and would introduce other columns to be filled at pleasure, but there should be only one kind of log.

CAPT. TOYNBEE thought that the logs of the Meteorological Office were sufficient for all practical purposes ; in them the four-hourly periods were printed in large type.

M. NEUMAYER also said that he should prefer only one form of log.

The Conference then divided on the question, and it was decided by 14 votes against 9 that there should be but one form of Register.

The PRESIDENT remarked in announcing the majority, that as regards the columns in this general log, and as to the question, which of them were the most important, each Institute would select columns according to the country and to its own requirements.

---

* The figures marked thus 1° are the several Resolutions.

Question I.: *Observations.*

Cols. 1—6.* *Date and Position of the Observations.*

Is it your opinion that a fresh column should be added, headed "Course and Distance by the Log in every Watch of four hours"?

2°. "That an additional column should be given in the log for 'Course and Distance.'

3°. "That the course should be expressed in degrees and not in points."

4°. "That the question of hours, 4-hourly periods, as proposed by Captain Toynbee (Appendix C.), and in general use by Dutch and German Captains since 1865, should be adopted."

It was here decided, on the motion of the PRESIDENT, that Capt. Toynbee's Report on the Programme, which had been laid before the Sub-Committees should be printed in full, and embodied in the Report of the Proceedings of the Conference, as Appendix C.

CAPT. TOYNBEE referred to the importance of 4-hourly periods in calculating the Diurnal Range, and said that the work would suffer by the introduction of intermediate hours.

M. v. FREEDEN proposed as an amendment that the course should be expressed in points and parts of points.

On a division the Amendment was negatived by 17 votes against 6.

The Resolutions were then adopted.

Cols. 7 and 8. *Currents.*

5°. "That observations on the 'Direction' and 'Rate' of currents be transferred to the column for Remarks."

Adopted.

Col. 9. *Magnetic Variation.*

Is it desirable to give an additional column for the "Direction of Ship's Head"?

6°. "That an additional column be given in the log for the direction of the Ship's Head and the amount of Heel to Port or Starboard."

Adopted.

7°. "That the Total Compass Error, and not Variation only, should be given."

Adopted.

8°. "That the Conference expresses its opinion that the lettering on the English compass should be adopted by all nations for Meteorological purposes."

Adopted.

* The numbers of the columns refer to the Brussels Abstract Log.

Cols. 10 and 11. *Wind, Direction and Force.*

Is it possible to employ an anemometer at sea so as to give trustworthy results?

9°. "That a decided answer to this question cannot at present be given, but it is desirable that various anemometers should be tested by special ships, and that a special form of four extra columns should be prepared for the purpose of recording such observations."

Adopted.

Can the use of the Beaufort scale be made universal?

10°. "That the use of Beaufort's scale should be continued, with the addition of the amount of sail which Beaufort's ship would have carried, had she been rigged with double topsails. Also that the Direction and Force of the wind should be recorded *at the time of observation* and *not estimated for a certain number of previous hours.* Also that it should be recorded every two hours."

Adopted.

Cols. 12 and 13. *Barometer.*

To what degree of minuteness is it necessary to observe this instrument at sea?

11°. "To one hundredth of an inch, or its equivalent in the metric scale."

Adopted.

Cols. 14 and 15. *Thermometer. Dry Bulb and Wet Bulb.*

Should these observations be required from all ships?

12°. "That wet and dry bulb observations are desirable, and should be obtained whenever possible."

Adopted.

Col. 16. *Forms and Direction of Clouds.*

Is this column sufficient or should any notice be taken of more than one stratum of clouds?

13°. "That the upper and lower clouds should be recorded in separate columns, and that the direction from which *upper* clouds come should be recorded when possible."

Adopted.

Col. 17. *Proportion of Sky Clear.*

Is it not advisable to substitute for this heading, "Proportion of Sky Clouded"?

14°. "That it is preferable to give the proportion of sky clouded, instead of the entry of 'proportion of sky clear' as recommended by the Brussels Conference."

Adopted.

This regulation is identical with that recommended by the Vienna Congress.

Col. 18. *Hours of Rain, Fog, Snow, &c.*

Is it desirable to retain this heading, or to substitute for it and No. 23 a column headed "Weather by Beaufort Notation"?

15°. "That it is desirable to retain this heading, but that the use of Beaufort's Notation may be continued by those accustomed to it."

Adopted.

Col. 19. *State of the Sea.*

Should this be given according to a numerical scale?

16°. "That a numerical scale (0–9) be adopted, and that an extra column should be given to the Observation. The direction of the sea, swell, or the different swells to be given in the original column."

Adopted.

Cols. 20 to 22. *Temperature of Sea Surface. Specific Gravity. Temperature at Depths.*

Is it desirable to retain these columns, or can the Observations, when taken, be inserted in the column for "Remarks"?

17°. "That the first two of these columns be retained."

Adopted.

18°. "That sea temperatures at depths should not be required from all ships, and that they should be recorded among the Remarks."

Adopted.

Col. 23. *Weather.*

19°. *Vide* the Resolution on column 18.

Col. 24. *Remarks.*

20°. "That the 'Remarks' as asked for by the Brussels Conference should be adopted, with the exception of the Observations of temperature with coloured bulbs at sea."

Adopted.

Question II. *Instruments.*

What patterns of Instruments should be employed for any Observations which may require them?

21°. "That the question of the precise pattern of Instruments is not of very great importance, so long as they satisfy the tests applied at the several Central Institutions, and are compared with Standard Instruments, but it is recommended that they shall be of a pattern as easy as possible for reading."

Mr. BLANFORD proposed as an amendment, that it should be specially stated that all barometers should be so constructed that the light could be let in behind the tube. Some old-fashioned barometers, still used at sea, were opaque behind. Sometimes the mercury is read, not at the top of the meniscus, but where it touches the glass. Mr. Blanford wished to urge this addition to stop the construction of barometers of the kind he above referred to.

M. BUYS BALLOT also pointed out that it was desirable that the top of the glass tube should be visible.

M. NEUMAYER pointed out that these questions had been dealt with, and settled by the first Sub-Committee.

After some remarks in the same sense by Admiral NOLLOTH, Mr. SCOTT and Captain TOYNBEE, the Resolution was adopted.

A discussion then arose as to the use of the rotatory thermometer (thermomètre fronde).

Mr. SCOTT proposed, that it be recommended that some experiments should be made with this thermometer, which had been found to give very good results, and he thought it might be used with advantage at sea.

M. DEVILLE stated that he supported this view warmly.

It was then explained that the first Sub-Committee had determined to abstain from referring to any special Instruments, but that there would be no objection to such observations as those referred to being made as well as other experiments.

Is there any reasonable possibility of introducing the Metric and Centigrade systems for general use at sea?

22°. The recommendation respecting the use of the Metric and Centigrade systems, as expressed at the Vienna Congress, is approved, and it is recommended that a table of conversion should be entered in each log, to enable Captains to compare barometers which have different scales.

Adopted.

M. DEVILLE here remarked that he thought the first Sub-Committee had paid too much attention to mere forms, and had not entered sufficiently into the details of the subject of Instruments, which he considered of paramount importance.

Question III. *Instructions.*

Is it possible to devise a general form of Instructions to ensure uniformity in regard of methods of observation and registration?

23°. "That the Instructions should be suited to the log now proposed by the Conference, but modified to meet the various requirements of different Nations."

Adopted.

24°. "The Conference requested that Captain Toynbee's proposed form of log should be printed, and the English 'Instructions' printed for circulation amongst its members."

Adopted.

The Conference then proceeded to the Consideration of the Resolutions of the Second Sub-Committee.—"Discussions."

Question IV. *Observers.*

What control should be exercised over the Observers, as to their Instruments and Registers?

25°. "That it is necessary that all instruments used should be compared with standard instruments, either at the central or the filial Institutions (if such exist), before and after the voyage, and that the corrections and date, &c. of the comparisons should be entered in the log."

Adopted.

Is it desirable that all instruments employed should be the property of the Central Establishment, and *lent* to the Observers?

26°. "That it is desirable that the Instruments should be the property of the Central Office."

Adopted.

27°. "That it is necessary that a careful examination should be made into the quality of the Observations recorded, and that the attention of the Observers should be specially directed to any errors which may have been detected."

Adopted.

Question V. *Co-operation of the Royal Navy.*

To what extent can ships of war assist in forwarding the ends of Meteorological Inquiry?

28°. "The Royal Navy can furnish more complete Observations than are possible on board Merchant Ships, *e.g.*:—

Deep-sea soundings and temperatures.

Observations in unfrequented parts of the sea.

Special experiments.

"It is most desirable that the duty of observing should be entrusted to some responsible Officer.

"It is therefore resolved, that the Authorities of the Navies shall be requested to continue to give such assistance to the prosecution of Meteorological Science as circumstances shall permit."

A Report was handed in which had been drawn up by a number of the members, who were in the Naval Services of some of the countries represented, in regard of the co-operation between the Navies and the Merchant Services.

This Report led to a discussion, in which MM. BLANFORD, v. FREEDEN, MANN, NEUMAYER, NOLLOTH, RIKATCHEFF, SCOTT, and TOYNBEE took part.

It was finally decided by the Conference that the following Resolutions, contained in the Report, should be adopted in lieu of that given above, and entered on the Protocol of the Meeting, as follows:—

A. "It is very important that the organization of Meteorological Inquiry, as regards the Navies of all countries, should be arranged in accordance with the principles and stipulations laid down by the Conference for Marine Meteorology generally, and it is further important that the results of all Observations made on board ships of war in any country should be rendered accessible for discussion by the Central Station for Maritime Meteorology in that country, without prejudice to any subsequent publication by the respective Naval Authorities."

B. "The Conference, while admitting that the introduction of measures calculated to improve the condition of Meteorological Inquiry in the Navy must be left to the Authorities of the respective Navies, is nevertheless of opinion that all care should be taken to secure uniformity as to mode of Observation, and especially to provide for the comparison of all instruments used with the respective standard Instruments of the Central Institutions."

C. "The Conference considers it to be its duty to request that those entrusted with the management of scientific affairs on board men-of-war will lend their strenuous support in securing from the Naval Authorities in each country, such regulations as will place Meteorological Inquiry on board such ships in as favourable a position as may be deemed consistent with the execution of the ordinary duties of the service, and will also induce the Commanders to render to such Inquiries all the assistance and furtherance in their power. The Conference knowing that such regulations must be framed according to the requirements of each

Country, expresses, nevertheless, its opinion that, inasmuch as Meteorological Investigations require considerable experience, they should be entrusted to experienced Officers on board suitable vessels."

D. "Although the Conference is of opinion that, as far as the general scope of Meteorological Inquiry goes, the same form of Register should be supplied to Merchant Ships as to Men-of-War, it declares it will be most desirable that, besides the regular observations, a more extended scale for scientific inquiry should be adopted on board ships-of-war; as in such cases there is a larger number of suitable Officers, as well as more means for carrying on the service. As examples of observations which are of importance for the development of Maritime Meteorology, over and above the regulations embodied in the scientific instructions given to Naval Expeditions for the special purpose of advancement of science, the following suggestions may be enumerated:—

1. Possibility of carrying out accurate observations on the velocity of the wind by anemometers at sea.

2. Possibility of employing rain-gauges satisfactorily at sea.

3. Observations with Regnault's or other hygrometers, and experiments on the best mode of observing wet and dry thermometers, and the best position for them on board ship.

4. Currents at the surface and at depths to be observed with great minuteness with the special object of defining their limits.

5. The comparison of various instruments among which are expressly mentioned that of aneroids with mercurial barometers. It is further deemed very desirable that frequent comparisons should be instituted between instruments used at sea and those of Meteorological Stations on shore in various Countries.

6. Deep sea soundings and temperatures, with specimens of water.

7. The collecting of information on Ocean Meteorology at outlying stations.

9. The furnishing of Synchronous Observations at 0h. 43m. Greenwich Mean Time, in accordance with the suggestion and request of the United States Signal Office."

Question VI. *Discussion.*

Can general suggestions be thrown out as to the most profitable mode of discussing the observations?

29°. "That it is desirable that every Institution should publish the observations and results in such a manner that every foreign Institute can incorporate them with its own observations and results in the easiest way possible, that is, by preserving the *number* of observations, together with any means derived from them, for single degrees square."

Adopted.

30°. "That it is further desirable that whatever Charts be published, the results for single degrees square should be published in a tabular form."

Adopted.

31°. "That it seems desirable for the use of the Sailor, that each Chart should have reference to only one element, or at least only to elements closely related to each other."

Adopted.

Question VII. *Subjects of Inquiry.*

To what extent can a division of labour, as regards Subjects of Inquiry, be carried out in a spirit of fairness to the Collecting and Discussing Establishments respectively?

32°. "That the division of labour, as regards investigations, can only be carried out by mutual agreement between the several Institutions, and each Institution should announce to other Institutions what investigations it proposes to undertake.

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

Mr. SCOTT stated that the second Sub-Committee had carefully considered the question of requiring payment for copying observations as mentioned by himself both at Leipzig and Vienna, but without deeming it advisable to pass a Resolution respecting it.

The CHAIRMAN said that there could be no doubt that every nation had the right to require such payment.

The Resolution was then adopted.

Question VIII. *Sailing Directions.*

In how far are purely practical investigations, such as the preparation of Sailing Directions, admissible for a Scientific Institution?

33°. That the sailor wants the results of experience alone, and he must receive assurance that his observations have been turned to use. When these results of experience have been given, the theorist may point out the reason why certain routes are the best.

Adopted.

The discussion of the Programme being concluded—

Mr. SCOTT stated that he wished to take the opinion of the Conference as to what communications should be printed in the Official Report of the Proceedings of the Conference.

He proposed—

1. That letters from gentlemen accepting the Invitation to attend should not be printed.

2. That the information respecting the working of the Brussels Conference in each Country should be printed.

3. That replies from gentlemen who were unable to attend should be printed in full.

4. That only the Remarks of Capt. Toynbee which had been discussed by the first Sub-Committee should be printed.

These proposals were agreed to by the Conference with the following exceptions:—

M. RIKATCHEFF wished a selection from his own and other gentlemen's communications regarding the Programme, to be printed, in addition to those of Capt. Toynbee, if they were found to contain any new ideas.

Mr. SCOTT promised compliance with this request and stated that he hoped to have the Report ready by the end of November.

The PRESIDENT said that before bringing the Meeting to a close, he would be glad to hear any further suggestions which any gentleman might wish to make.

After a few remarks by Capt. HOFFMEYER, the PRESIDENT congratulated the Conference on having completed their labours in a most satisfactory manner, and said he considered that the important Resolutions which had been arrived at would have the greatest influence on the future prosecution of Maritime Meteorology in all Countries. He appreciated highly the fact that all the deliberations have been conducted in such a liberal spirit, and without laying down too many written rules, so that much liberty was left to each Member, according to his own responsibilities.

He spoke in flattering terms of the effective manner in which the Office, which he and the other gentlemen had had the opportunity of seeing, was managed, and thanked the Meteorological Committee for their great kindness in allowing the Conference to meet in their Office, and for the excellent arrangements made for convenience and comfort of the Members.

On the motion of Mr. BLANFORD a vote of thanks was given to the Secretaries of both Sub-Committees.

Mr. SCOTT, in replying, thanked the Members collectively for their attendance at the Conference, and said that when he was at Vienna, in 1873, one of the gentlemen present had assured him that if invitations were issued for a Maritime Conference in London, every one would attend. The result, as they saw, had more than justified his friend's anticipations.

He ventured to express his own opinion that the fact that the Conference had conducted its deliberations so speedily and satisfactorily had been mainly due to the decision arrived at by a majority of the Sub-Committee to the effect that the Conference should be of a private and not of an official character.

The Report would be submitted to the Permanent Committee at their Meeting at Utrecht on the 10th September, and prior to that date the Resolutions would not be published.

He expressed the hope that the present deliberations would render another Maritime Congress unnecessary for at least another 20 years.

In conclusion he could not permit the Conference to separate without alluding to the serious losses which Meteorology had sustained. Since the Congress at Vienna last year, one had been taken from among the Delegates to that Meeting, and also, still more recently, a veteran Meteorologist had passed away, whose labours in the science had extended over a period of 40 years, and who had presided over the first Maritime Conference at Brussels in 1853.

He (Mr. Scott) did not presume to speak of the loss which Astronomy had sustained in the death of two of its ablest followers, but on the part of all Meteorologists he wished to offer a tribute of respect to the memory of MM. Donati and Quetelet.

Dr. MANN proposed a vote of thanks to the President for the able manner in which he had conducted the business entailed upon him.

M. BUYS BALLOT, in acknowledging this compliment, which was passed by acclamation, declared that the second Maritime Conference was now closed.

BUYS BALLOT.

APPENDIX.

Appendix A.

LETTERS RECEIVED FROM GENTLEMEN UNABLE TO ATTEND THE CONFERENCE.

A. Buchan, Secretary, Scottish Meteorological Society, Edinburgh.

Your letter to the Marquis of Tweeddale, dated June 1874, inviting his Lordship or a representative to attend the private Conference on the subject of Maritime Meteorology which is to meet on the 31 prox°., has been remitted by his Lordship to the Council.

I am directed by the Council to inform you that his Lordship is, owing to the state of his health, obliged to decline the invitation, and that, with reference to a representative, the Council are, owing to want of funds, not in a position to send one.

I am further directed to say that in connexion with this subject, the Council will be happy to give any information in their power, and that they have instructed Mr. Stevenson and myself to forward to the Sub-Committee their opinions regarding some of the subjects embraced by the Programme.

Rear-Admiral C. H. Davis, Superintendent, U.S. Naval Observatory, Washington.

The Hydrographical Office having been created several years ago, by removing from the Observatory all charge of the subject of Meteorology, Maritime or Continental, I have been unable to serve the objects set forth in your communications in any way so well as by the reference which has been made.*

Wishing the largest success to the able Meteorologists who are to prosecute further this most interesting and, practically, most useful branch of Science.

A. G. Findlay, F.R.G.S., London.

I regret to say that long-continued bad health will prevent me from being present at the Maritime Conference to-day as I had hoped, until this morning, to be able to do.

I should have been gratified if I could aid in any way the topics which have been of great interest to me for many years and more especially those included in cols. 7 and 8, 20, 21, 22, and § VIII.

H. Marié-Davy, Central Meteorological Observatory of Montsouris, Paris.

I am, it is true, directed by the Minister, to study your Meteorological materials in London, Greenwich, Kew, and Oxford; but I am a member each year of the Council of Professors of Physics of our Lyceums, and the Session which commences about the 14th August generally lasts till the 5th or 6th September. I should, therefore, arrive too late to take an active part in your interesting meetings, which I much regret. I shall be happy, however, to find some of the *savans* who are to attend the Conference still in London.

Brigadier-General A. J. Myer, Chief Signal Officer, U.S.A., Washington.

It will not be practicable for this Office to be represented at the meeting of the Sub-Committee. We are oppressed with work this summer.

The only point I would urge, if present, would be an arrangement for an International Exchange of a simultaneous report. This, indeed, is in effect, already provided by the action of the Vienna Congress, the proposition adopted by that Congress, embracing in its view as well observations taken at sea as on the land.

* Letters referred to General A. J. Myer, Chief Signal Officer, U.S.A., and Commodore Wyman, Hydrographer, U.S.N.

The ship's chronometer will enable the simultaneous observations to be easily made at the proper time. The latitude and longitude in which each is taken can be readily determined sufficiently well later, by computation of the "Dead Reckoning," in the very numerous instances in which Astronomical Observations cannot be had.

A series of simultaneous reports will be, for the work of this Office, of the greatest advantage.

In any form of blank, provision ought to be made for the record of, at least, one simultaneous report, with latitude and longitude of place of observation, the report to be co-incident with those now taken on land. The number of continental and insular stations simultaneously reporting has reached 281.

Commodore H. P. Rothe, Hydrographer, Copenhagen.

I have the honour to acknowledge the receipt of your agreeable invitation to attend the Maritime Conference assembling on the 31st August in London, and I beg you to excuse the delay of my answer, on account of a long absence from Copenhagen.

I regret sincerely, on account of official business, not to be able to be in London at the time fixed, and partake in the discussion on the many and highly interesting subjects put forth in the Programme, but I beg to assure you of my greatest interest in all matters relating to Maritime Meteorology, and that I will do everything to introduce in Denmark the measures which may be adopted after the deliberations of the Conference.

Dr. R. Rubenson, Central Meteorological Institute, Stockholm.

I have the honour to acknowledge the receipt of your invitation to the Maritime Conference in London. As I am just now on the point of starting on a tour of inspection of our northern stations, I must give up the idea of taking part in this Conference. I hope, however, that the decisions which will be taken will advance Maritime Meteorology and will do all in my power to give effect to these decisions in this country.

I have communicated the invitation to some persons interested in the subject, but I have not yet heard whether they intend to forward any written replies to the Conference.

I refer you to my previous letter as to arrangements made here since the year 1853.

Baron v. Wrangel, Hydrographer, Nicolaief.

Your letter of the 25th June with enclosed Programme of the Conference for Maritime Meteorology arrived at Nicolaief during my absence. Having just now returned from an official tour in the Black Sea, I hasten to let you know that pressing business prevents me from making use of your kind invitation for the Conference. However, I enclose the expression of my views on the questions mentioned in the Programme.*

Vice-Admiral Baron v. Wüllerstorf-Urbair, Gratz, late Commander of the Austrian Circum-Navigation Frigate "Novara."

Although I have already written to Dr. Jelinek that it is not possible for me to accept your invitation this year, and especially at the end of August, I consider myself bound to give you notice of the same, not because my presence at the Conference appears to me necessary, but because I wish to express my regret at being unable to make your acquaintance personally and meeting men whom I respect and esteem, and whose excellent contributions to the domain of Meteorology I acknowledge with admiration.

*** This letter was accompanied by remarks which were laid before the Conference and carefully considered.

Commodore R. H. Wyman, U.S.N., Hydrographer, Washington.

I have the honour to acknowledge the receipt of your letter of the 25th June containing an invitation to attend the private Maritime Conference in London, with the request that I forward to the Conference my opinion in answer to the

* Printed in Appendix C.

questions contained in the Programme accompanying your letter. After consulting with Commodore Daniel Ammen, U.S.N., the Chief of the Bureau of Navigation, this Office being under that Bureau, I have the honour to inform you that the Navy Department do not consider it expedient at the present moment to send an officer to the Conference, and that I am authorized to forward for your consideration the opinions enclosed.*

Appendix B.

REMARKS ON THE RESULTS OF THE BRUSSELS CONFERENCE IN VARIOUS COUNTRIES REPRESENTED AT THAT CONFERENCE.

Meteorological Office, 116, Victoria Street,
London, 7th May, 1874.

SIR,

Maritime Meteorology.

The Sub-Committee appointed by the Permanent Committee of the Vienna Congress, propose to hold a Meeting in the course of the present year, to discuss the subject of Maritime Meteorology, with especial reference to the decisions taken thereon at the Brussels Conference in 1853, in order to ascertain whether or not it will be advisable to hold an official Conference on the subject in 1875, or later.

As ——— was represented at Brussels by ——— , I am to request you to be so good as to furnish to me, before the 1st of June, or as soon after as convenient, replies to the following questions, in order that I may prepare an abstract of the replies for submission to the proposed Meeting.

1. To what extent the resolutions adopted at Brussels have been carried out in your country?

2. What have been the grounds for departure from them, if such departure has taken place?

If this matter does not fall within your own Department, I shall be obliged if you will kindly forward the communication to the proper quarter.

I am, &c.

To each country Represented at Brussels.

ROBT. H. SCOTT,
Director.

Professor Buys-Ballot, Royal Meteorological Institute, Utrecht.

I have from the beginning thoroughly opposed the Resolutions of the Brussels Conference. I was, however, bound to observe those regulations because of the American publications which were carried on in accordance with them. But as soon as the Dutch Institute had its own publications, I adopted another form of log.

The Brussels Conference asked for too many observations, *e.g.* psychrometer, specific gravity, &c., which we could not expect to be made accurately by Merchant Ships, and which are of no use to them. Moreover, the hours 3 and 9 were not convenient. The true course and distance which are of practical use for Sailors and Directors of Institutes were not required.

I beg to refer you, for further particulars, to the following extracts from my printed papers :—

1°. "Suggestions on a Uniform System of Meteorological Observations."

"The Congress held at Brussels aimed at accomplishing too much, and thence many were discouraged.

"Or how else shall we account for it, that especially in the Netherlands, which soon declined to observe these directions, most observations have been sent in.

"In all probability it would have been sufficient to confine the observations to the end of the watch kept on board a ship, and not to ask for too much information. If I may be allowed to state, what has in this country attracted most attention, and with respect to which we have been supplied with the most and the best observations, it will be this :—

* Printed in Appendix C.

"1. We require at the beginning of the log book a statement of the corrections of the instrument, after they have been examined by persons appointed for that purpose by the Central Observatory.

"2. The number of days the ship was at sea.

"3. The conjectured and observed position of the ship.

"4. The heights of the barometer by the mercurial barometer.

"5. The direction and force of the wind.

"6. The temperature of the surface of the sea.

"No one will deny to these observations their high practical and theoretical value.

"7. Deviations of the compass.

"On entering a port, or whenever there is an opportunity at sea to veer the ship, the deviations are verified. The safety of the ship depends too much on the local deviations, that time may well be sacrificed.

"8. The Temperature observations, if there be any place on board fit for taking them.

"Psychrometrical observations; how much rain fell in one day; deep sea soundings, etc., may be safely left to the interest of captains themselves and to such opportunities as are afforded.

"What is of most importance to navigation must have the greatest weight with us."

2°. "A Sequel to the Suggestions on a Uniform System of Meteorological Observations."

"I do not see any safer means of knowing the average indication of the instruments, for every time of the year and every place, than to note in our registers every observation on a different page according to the place in the ocean, and separately for every day of the year, that we may be able to make a graphic table of these observations, and to see if any districts of the sea have some phenomena in common, and what are the boundaries of these districts.

"Unhappily it is not sufficient to form squares of five degrees *á priori* for it will often be the case that one half of such a square shows a digression from the mean opposite to that of the other half. For instance, if we seek the limits of the Trade Winds, shall we find them by studying only large squares, viz. from 15° to 20° lat., and from 20° to 25° long., &c.? Are they at the same latitude in different longitudes? It is impossible to determine them, if we do not know what passes at every square degree, at every square minute of a degree. Sooner or later, therefore, some one will come to the system of giving separately what has been observed at separate points of space and time.

"This is possible, as I will show by describing at some length one of the methods to obtain it, which is followed at the Dutch Institute. We shall be happy if other Directors describe their own methods that we may compare and judge.

"Every Meteorological Journal, sent in to the Institute, is copied on sheets of paper, with printed lines and columns all of the same model on one side, blank on the other.

"Every line of this copy bears the number of the Journal, in order that every questionable entry may be checked by the original; further, the date and the place when and where the observations, put down in the following columns, were taken.

"Then by scissors the paper is cut into horizontal slips, so that each slip contains no other observation than that taken at the same degree of latitude and longitude.

"These separate slips are put in different covers, each containing the observations of a fifth or tenth degree square; they are lightly bound together in 12 different bundles corresponding to the 12 months.

"When we think we have a quantity sufficient to make a study of them, these slips are arranged according to time and place, and since they strictly correspond to the breadths of the columns, we can easily follow their indications, draw up a chart of large size for such a portion of the ocean as we are then treating of.

"If it be objected that we might have done so from the first, we answer that so doing takes too much time and requires much more attention; that it is much more fatiguing and wearisome to extract observations from the Journal—now here, now there—than to do twice the work, but each time without fatigue.

"Moreover, by this method we get a means of checking which otherwise is possible only by doing it over again from the beginning.

"If now we have recorded the observations of one instrument on one chart, the observations of the other on another chart, we are able to publish either for a single degree square, or even for smaller parts, if there is a fair number of observations, or to join several such degrees into a larger space, and to give its average value."

J. C. De Brito Capello, Observatory, Lisbon.

In reply to your letter of the 7th instant, I will answer the two questions respecting Maritime Meteorological Observations.

Portugal has adopted all the Resolutions of the Brussels Conference. Consequently the Government ordered, in 1854, that all men-of-war should be furnished with Meteorological Instruments as recommended by the Conference, with blank "Abstract Logs," and Instructions of the same Conference, very carefully translated by M. Pegado, Director of Nautical Observations at the time mentioned.

Since 1854, most of the men-of-war have taken Meteorological Observations, and some have obtained rewards from Lieutenant Maury.

The merchant ships have also made Meteorological Observations, and one received a gold medal from the French Government. You have some of the Abstract Logs of both services in the Meteorological Office.

Generally speaking, we have conformed to all the regulations of the Conference; we have only departed from them in some points of detail.

The Two-hourly Observations seemed to us too much for our sailors, who were commencing the work.

Thus we have adopted for men-of-war the hours proposed by the Conference for merchant ships, but we have retained all the vertical columns of the Abstract Log of the men-of-war.

The headings of these columns are retained in the English language.

All the men-of-war carry at least a barometer by Adie with metric scale, and an aneroid for comparison, or, in case of accident to the barometer; two or three thermometers by the same maker, with centigrade scales, one being used as a wet bulb; and two hydrometers. All these instruments are compared with Standards at this Observatory. They also carry a metal bucket with two valves for getting water from a depth.

The merchant ships have taken observations with the same Abstract Log, and some have increased the hours of observation.

We have never employed self-registering thermometers for temperatures at depths; the depth has never exceeded 5 or 10 fathoms except in a few special cases.

Most of the ships of war have also taken observations while lying at anchor.

Capt. N. Hoffmeyer, Royal Meteorological Institute, Copenhagen.

The question having been discussed by a Commission, consisting of Members of the Royal Society of Copenhagen and others, the Ministry of War decreed, on the 23rd of April 1853, that in future, on board the Danish men-of-war which are thought fit for it, according to their destination, Meteorological Observations are to be undertaken and noted down conformably to the scheme adopted at the Conference of Brussels, but with the following restrictions:—

That the specific gravity of the water is not necessarily to be examined daily, but only when there is a fit opportunity to do so.

That it is not made a duty daily to examine the temperature of the water below the surface, but that such is to be done whenever place and opportunity are fit and convenient, and if possible in different depths; and,

That the aneroid barometer is to be used on board the smaller vessels, and where a mercurial barometer cannot appropriately be placed.

The Director of the Hydrographic Office has been ordered to take care of the execution of the above decrees, and, as far as might it be thought appropriate

to communicate with Lieut. Maury at Washington. Respecting the participation of merchant ships in the aforesaid Observations nothing was decreed, only it was left to the Director of the Hydrographic Office also in this respect to enter into communication with Lieut. Maury.

From this gentleman the Hydrographic Office has at different times received large collections of his Current and Wind Charts, as well as Sailing Directions, to be distributed both to men-of-war and to merchant vessels. The men-of-war have been furnished with these Charts, and they have been distributed to merchant vessels, Danish as well as to a few foreign, on their undertaking to deliver the Meteorological Journals after having been filled up. When the Master of the ship could express himself in English, the journal was written in this language; when it was written in Danish it has been translated into English at the Hydrographic Office. The journals received from the vessels have gradually been transmitted to Lieut. Maury. The last collection sent by this gentleman was received by the Hydrographic Office on the 17th December 1861.

The war in North America, and the interruption occasioned thereby of all the communications which had been brought about by Lieut. Maury with foreign countries for the promotion of Maritime Meteorology, has caused a cessation of the interchange of the objects concerned also with regard to Denmark.

Professor H. Mohn, Royal Meteorological Institute, Christiania.

In reply to your letter of the 7th of May, I have the honour to offer the following remarks:—

The Resolutions adopted at Brussels have been carried out in the Norwegian Navy, by both the men-of-war and merchantmen. The logs have been sent to Washington. The "Abstract Log" has been used on board the men-of-war; the Merchant Service Log on board the merchantmen. A number of Maury's Wind and Current Charts, as well as of Maury's "Physical Geography of the Sea" have been distributed to Norwegian Captains making observations and forwarding their logs to Washington. In our country there has not been any official provision for securing the corrections of the instruments used for the above-named observations. It will not be possible to ascertain the number of the logs sent to Washington. The observations contained in the merchantmen's logs embrace almost all navigated parts of the sea.

The observations have been continued, as I can see from logs now in the possession of the Meteorological Institute at Christiania, up to 1865. In the year 1867 the Norwegian Meteorological Institute issued an invitation to Norwegian Sea Captains to make Meteorological Observations on board their ships. Through the different Shipping Offices in the country the Captains could receive schedules with instructions for making the observations. Since that time there have come into the Institute yearly about 60 logs. From that time the logs issued by Maury have not been in use in our navy.

The grounds for departure from the Brussels Resolutions are therefore chiefly the establishment of the Meteorological Institute. Meanwhile there may also have been other grounds.

In the Royal Navy the observations grew scarce, as the instruments originally purchased grew older and unsuitable, and the observations came to a close at the beginning of the war in America. In the Merchant Navy it was difficult to keep up the observing spirit among the Captains as they did not get any encouragement or instruction from any Scientific Institution at home.

Capt. E. Mouchez, Ministry of Marine, Paris.

I regret to inform you that the Regulations laid down by the Brussels Conference have not been regularly carried out either by our Navy or Merchant Service. Log books were printed nearly similar to the one adopted, and were distributed on board the ships; but the want of success in taking the observations has been principally due to the following causes:—

1. Too much was asked for, instead of limiting the requirements to what was strictly necessary.

2. The use to which the observations would be put, or how they would be employed after the voyage was not made sufficiently apparent.

And, further, no Observatory or Central Establishment was specially charged with the duty of keeping and studying the Registers.

It appears to me, therefore, that what is wanted is, 1°. a simpler form of Register, and, 2°. the establishment in each Country of a Central Office, whose duty would be to receive all the Registers, and extract their data according to rules to be settled upon, and to give advice as to the manner in which they have been kept.

As soon as it is known that these documents are studied and utilized, no doubt all the Navigators will be eager to take the observations with greater care than is done at present.

Brigadier-General A. J. Myer, Chief Signal Officer, U.S.A., Washington.

I have the honour to acknowledge the receipt on May 20th, 1874, of a communication referring to the action of a Sub-Committee appointed by a Permanent Committee of the Vienna Congress upon the subject of Meteorological Observations taken at Sea. This communication was addressed by you to Rear-Admiral C. H. Davis, Superintendent of the United States Naval Observatory at Washington, with the request that it might be forwarded to the proper quarter, and has been transmitted by that Officer to this Office for reply. The interruptions caused by the war and the changes which have taken place, both in the *personnel* and the duties of the different services since the date of the Brussels Conference, have rendered some delay necessary in order to ascertain as definitely as possible, what had been done in the different Departments up to the present time.

I am able to give you briefly the following facts :—

(1.) The United States at once undertook to carry out the propositions adopted at Brussels. The "Abstract Log" was approved by the Navy Department, adopted, and ordered for use in the Navy, and is at this time used in all naval vessels. Navigators generally were invited to keep the log, and transmit copies at the end of each cruise to the Chief of the Bureau of Ordnance and Hydrography.

(2.) To encourage all Navigators in so doing, copies of the Sailing Directions and of all published results based upon data furnished by them were offered them.

Agreeably with this arrangement of a proposed exchange, a large number of navigators of various flags furnished freely the observations taken by them at sea. These observations were compared, employed in perfecting the work already begun, and in prosecuting researches in Maritime Meteorology. A large number of copies of Maury's Sailing Directions and kindred publications were distributed among the contributors of different nations according to this arrangement.

(3.) In conformity with the Brussels plan, the United States received the co-operation of foreign Powers, who were not ready to discuss the observations of their own vessels, but who were willing to collect and forward them to Washington. Among these were France and the Netherlands; and the vessels of all such co-operative Powers were put on the same footing with American vessels in receiving the Wind and Current Charts, the Sailing Directions, &c., issued by Commodore Maury, many of which are based in part upon such data. This continued up to the commencement of the war in 1860.

(4.) After 1861, though with occasional protracted interruptions, the United States continued to collect maritime data according to the suggestions made at Brussels. The Abstract Logs, filled up upon the vessels of the United States' Navy, are filed in the Bureau of Navigation, whence they are transmitted to the Hydrographic Office of the Navy Department, for such use as may be made of them.

Since the establishment of the Signal Service Bureau charged by law with the observation and report of storms, the duty of displaying cautionary signals at the different ports and upon the sea coasts, and also of furnishing such reports as may be necessary for the benefit of Agricultural and Commercial Interests, it has been one of the duties of this Office to collect from all vessels

arriving in the ports of the United States extracts from their logs, or other useful data, and also to request assistance from any vessel or officer in collecting such data. The enclosed form * issued in 1871, is one prepared for this purpose. A circular is also enclosed.* The Observers of this Office located at the different Branch Offices established at the different ports have also been instructed to visit vessels in the ports and procure useful information. The Office has also furnished instruments for use upon vessels furnishing reports to this Office.

In exchange for such courtesies the facilities of the Signal Service Offices in the different cities for comparison of instruments, obtaining specific information in reference to the weather past or present, the use of their daily telegraphic record, &c., are extended to the Officers of any vessels of any nationality that desire to avail themselves of them, and upon request of any Officer corresponding with the Office, any publications of the Office are furnished to him free of charge.

In its exchange with other Offices this Office is always ready to furnish upon their request, data in its possession relating to particular storms occurring either upon the land or sea, or to enter upon wider exchange in pursuance of the suggestions of the Vienna Congress.

The system of Simultaneous Observations adopted at that Congress requires, to complement it, a system of coincident observations extended as widely as possible at sea.

E. Quetelet, Royal Observatory, Brussels.

With respect to Maritime Meteorology, I have seen the Director of this Department, at the Ministry of Public Works, and he thinks that only a few results exist. To make the necessary inquiries, he requested me to apply to the Ministry of the Interior. I have not yet received an official reply, but I believe you can only reckon on very little. We have no Navy, and the captains of the Merchant Service generally care very little about scientific questions, especially when anything would thereby be added to their work. A reform must be introduced if useful results are wanted.

Capt. M. Rikatcheff, Imperial Russian Navy, Central Physical Observatory, St. Petersburg.

Mr. Wild asked me to answer the questions contained in your letter of the 7th May 1874.

Our Navy is provided with Meteorological Journals, Instructions, and Instruments by the Hydrographic Department. The journals containing observations are returned to the same Department.

To be able to answer you with sufficient authority I have seen some of the last Meteorological Ship Journals, and I had an interview with Vice-Admiral Zelenoy, who has been 15 years the Director of the Hydrographic Department, and left this duty only a few days ago. I divided your questions into six points, and in the name of Mr. Zelenoy, I am authorized to answer as follows :—

1. The thermometers on board ship have not been provided with another scale in addition to Reaumur's, as required by the Resolutions of Brussels Conference, because (*a*) if a thermometer were to have two such similar scales as Centigrade and Reaumur, one would be often read instead of the other; (*b*) the conversion of degrees Reaumur into Centigrade is so easy, that it is not judged necessary to have two scales together, only in order to accustom observers to the use of the Centigrade; (*c*) to avoid a considerable and useless expense.

2. The barometers have not been compared since 1853, and corrections of instruments generally are not determined, because there is no Office or official person who has the charge of all maritime observations.

3. Anemometers are not in use on board ships, because no experiments have been made with them, and there was no Office, as mentioned above.

4. Ships for long voyages are provided with hydrometers, and occasionally observations are made with them.

5. The meteorological observations have hitherto been made exactly in the form recommended by the Brussels Conference, because the opinion of the Director

* Not printed here.

of the Hydrographic Department was, that nothing should be changed without another Resolution of a second Maritime Conference, and because there was no Office which had to discuss the Journals and propose any change.

6. Some of the Ship Meteorological Journals have been sent to Lieut. Maury, in Washington, and afterwards to the Office of Admiral FitzRoy. The Maritime Meteorological Observations are not discussed and utilised in our country, and Journals are not even sent regularly to any office abroad, because we have no Office for Maritime Meteorology, and because, after the death of Admiral FitzRoy, nobody asked the Department for Journals.

You ought not to be astonished, Sir, if from these answers you see that the greater part of our Maritime Meteorological Observations lie dormant till now. The Director of the Hydrographic Department is so much charged with other business, that it is not possible for him to undertake the direction of the whole question of Maritime Meteorology.

Many times, and especially in the year 1862, he asked the Government to institute an Office for Maritime Meteorology, but it was never done, and only in this year, on the recommendation of the Imperial Academy of Science, a Commission has been appointed to prepare a project for such an Office.

Dr. R. Rubenson, Royal Meteorological Institute, Stockholm.

After the receipt of your last letter of the 7th May I made inquiries into the questions contained in it, and can, unfortunately, give but very little information about the state of Maritime Meteorology with us. From what I have been able to learn from persons acquainted with these matters (Peterson died long since), so-called "Abstract Logs," were distributed just after the Brussels Conference, both to Captains in the Navy and Masters of Merchant Ships. These log-books were, by the care of the Royal Academy of Science, translated into English (some Captains kept their Registers in English) and sent to Maury, at Washington. At the outbreak of the American war these transmissions ceased spontaneously, nevertheless the observations have been continued to the present time on the same plan in our Navy, and these Meteorological Registers are deposited in the archives of the Central Meteorological Institute. Their number, however, is not sufficient to allow of their being worked up there.

I have been unable to get any further information about the Observations in the Merchant Service. I presume, therefore, that the whole system in that Service has ceased to exist.

Although this matter belongs to my Department, I have not yet been in a position to arrange the system of observations, but I should consider the Resolutions of a future Congress for Maritime Meteorology as a welcome opportunity for directing attention to this subject here, and shall endeavour as far as in me lies to contribute our share to the common work at sea.

Commodore R. H. Wyman, U.S.N., Hydrographer, Washington.

Replying to your letter of the 7th instant referred to this Office, I have the honour to state that the Resolutions adopted at the Brussels Conference were carried out in this Country up to the commencement of the late war.

The Abstract Logs were printed and issued both to naval and merchant vessels, but are not now issued to either. The Log now in use in the Navy of the United States is substantially the same as far as its Meteorological Records are concerned, as the Log recommended at Brussels—we employ the Howard Cloud nomenclature and a scale for wind-forces differing not materially from the Beaufort scale.

I send you herewith a copy of the Meteorological Journal recently introduced from this Office.

Appendix C.

Remarks by Capt. Toynbee, in answer to Questions I. to VIII. of the Programme; followed by Extracts from the Written Opinions of other Correspondents.

Captain H. Toynbee, F.R.A.S., Marine Superintendent, Meteorological Office.

I. Observations.—We in this office have thought it necessary to depart slightly from the form of the Brussels Log, and I have drawn up a form which is the result of my experience of eleven years as an Observer at sea, and of seven as Marine Superintendent of this Office.

For convenience of reference, I shall give in the margin the numbers of the Columns of the Brussels Log, stating the changes proposed, and my reasons for them.

Date and Positions by Observation and Dead Reckoning.—These remain the same, only we have made it clear at the head of Column 1 that we wish for Civil Time, and we have rejected the 9 a.m. and 3 p.m. entries, which give undue weight to the day hours. These entries would also prevent our getting observations at four-hourly periods, for few men will observe at 8 *and* 9 a.m. or at 3 *and* 4 p.m. — Columns of Brussels Log. Cols. 1 to 6.*

Current.—This has been transferred to the Remarks, as the direction and rate of Current is generally only found once in 24 hours. When opportunity offers for finding the current more frequently, the result should also be given in the Remarks. In the space previously occupied by "current," we have introduced "*true* course and distance by Log every four hours," as suggested by Professor Buys Ballot. This is very useful work to the Navigator, who should know his ship's position each four hours, and it helps the Meteorologist to find the latitude and longitude of the position in which each observation was taken. It is not, however, considered absolutely necessary, as explained in the new Instructions. — Cols. 7 and 8.

Magnetic Variation Observed.—Instead of this we have "Total Compass Error," or variation and deviation combined. These are the data which Navigators usually enter in this column, therefore it should be so headed. Next to the compass error we give a column 10 for "ship's head," and degrees of Heel to Port or Starboard. From the compass error and direction of ship's head, together with the deviation from one of the forms at the commencement of the Log, which it is supposed will be filled up, the *Variation* may be deduced if required (always remembering that the deviation is liable to change with geographical position), and even though the total compass error may not be recorded, it can be found if we have the direction of the ship's head, and the deviation recorded in the tables, always supposing that each ship has a variation chart or table. By this means the *observed* direction of the wind can be converted into *true*, which latter result is the chief use of compass error to Meteorologists. — Col. 9.

Direction of Wind.—(This comes in our column No. 11.) We have added "at the time of observation" which we prefer to an estimate of what has prevailed for the last eight or even four hours; and we ask for it every two hours. It is believed that, as a rule, seamen only record the wind which was blowing at the time of actual *observation*, and a fact is preferred to a doubtful estimate. In synoptic chart work *the estimation* of wind for a certain number of hours is very objectionable; for instance, in our discussion of the Meteorology of the part of the Atlantic, north of 30° N., we frequently found that ordinary ships' logs which give the direction and force of wind for each hour, were much better than our own logs for fixing the time at which a certain change of wind reached a ship. — Col. 10.

The proposed method of giving the direction and force of wind at the time of actual observation, every two hours, and also any important changes which may intervene between the two-hourly observations, as well as the direction and force

* See the corresponding columns in the reduction of the proposed form of Log at the end of Appendix D.

Columns of the Brussels Log.

of squalls, seems to meet the present requirements of Maritime Meteorology. If a squall is blowing at an ordinary time of observation, the direction and force of wind between the squalls should be recorded, and the direction, force,

Col. 11. and duration of squalls should be given in the Remark Column.

Wind Force.—(See our column No. 12.) This is by Beaufort's scale, and is also asked for each two hours, *at the time of observation*, a record which (as in the case of direction) is considered much more satisfactory than a rough estimate for eight or even four hours. Here it may be well to repeat that if the weather is squally, the direction and force between the squalls should be given, and the duration, direction, and force of squalls should be entered in the Remark Column. When squalls are frequent their general character should be given.

I do not think that a cup anemometer can be successfully used at sea, having tried one for a voyage, but should like to have a small fan wheel tried by an experienced Captain.

I think that Beaufort's Scale, which expresses the force of wind by figures, words, and the speed of his standard ship (a well-conditioned man of war), or the amount of sail which she could carry, is the best at present devised. As the "double topsail yard" rig is now very common, I propose to give also the equivalent amount of sail which Beaufort's ship would carry if she were so rigged, all other qualities being the same. This only affects the forces 6 to 10,

Cols. 12 and 13. inclusive.

Barometer height and attached Thermometer.—(Our Nos. 13 and 14.) We have slightly altered the headings and asked for the height of the cistern above the sea. For the use of seamen I would certainly return to reading barometers to hundredths of an inch, and would make the vernier as distinct as possible. Many officers cannot read to thousandths, and others twist the barometers about so as to get them into a position for easy reading (as it is difficult to bring both sides of the circular vernier and the surface of the quicksilver in a line), thus causing the quicksilver to rise in the tube.

Thermometers, Dry and Wet Bulbs.—(Our Nos. 15 and 16.) I think all ships which carry our instruments should be asked for these observations. Our

Col. 16. Square 3 work shows their value. The thermometers should be read to tenths of a degree, the division being easily done by the eye.

Forms and Direction of Clouds.—(Our Nos. 17 and 18.) We have divided these data and give them in two columns. In No. 17 we give the names of Lower Clouds; in No. 18 the names of Upper Clouds, and direction *from* which they move over the sun, moon, or stars. If the direction from which *Lower* Clouds move differs from that of the wind, we ask that that fact may be recorded in the Remarks.

In our Square 3 work the eastern and western strips of the charts, as well

Col. 17. as Tables 6, 7 and 8 for each month, and the Remarks following them, show the use that we have made of Cloud data.

Proportion of Sky Clear.—(Our No. 19. *Proportion of Sky clouded.*) It

Col. 18. matters little whether we give proportion of Sky or Clouds, but as we have the Amount of Cloud in full use, I think it well to continue it.

Hours of Fog (A), *Rain* (B), *Snow* (C), *Hail* (D).—(Included in our No. 20, Beaufort's Weather Notation.) Beaufort's letters which represent these states of weather should be preceded by a figure showing the number of hours they

Col. 19. had existed since the last observation.*

State of the Sea.—(This column we have expanded into two columns, Nos. 21 and 22.) These give the direction from which the sea comes at the time of observation, recording when it is confused, and when it is only a swell or swells. No. 22 shows the disturbance of the sea by figures, which are explained on the same page with Beaufort's Notation. They are adopted by the land

Cols. 20 and 21. branch of this Office in its Telegraphy.

Temperature and Specific Gravity of Sea Surface.—(See our Nos. 23 and 24.) They both give interesting results in our Square 3 work. I think the degrees

* The London Conference decided that it is desirable to retain Column 18 of the Brussels Log, but that the use of Beaufort's Notation in one column may be continued by those countries accustomed to it. The latter method has been continued in the English Log, and it is the only case in which there is a difference between the Log adopted by the London Conference and that given with this Report, which is the one proposed by Capt. Toynbee.

of the thermometer, and the divisions of the hydrometer are easily divided into tenths by the eye, which makes their readings more exact. Columns of the Brussels Log.

Temperature at Depths.—This observation should, it seems to me, be left Col. 22. to men-of-war, or ships specially fitted for the work. We supply a self-recording thermometer, and copper case with a valve at each end, to observers who offer such work, with the object of trying the temperature at small depths, as they may sometimes show that cold water of lower density, may overlie warm water of higher density, &c. &c. Such observations are only occasional, and do not need a special column, but should be entered in the Remarks.

State of the Weather.—(See our No. 20.) The contents of this Column Col. 23. together with those of No. 18 are combined in our No. 20.

Remarks.—(See our No. 25.) A few suggestions as to the most important Col. 24. Remarks are given at the head of the Column, and they are more thoroughly explained in our Instructions.

Experience has proved that it is most important for each Log to be carefully examined as soon as it is received, so that any questions found necessary may be asked of the Captain who kept it, before he sails again. See the "Form for testing Logs" in each filled-up Log, of which the following is a reduced blank copy :—

FORM FOR TESTING LOGS.

No. of Log. Date. Nature of Voyage. Character. Captain. Observer's Rank (hours he observed). Ship.	Commencing From For whole of Log	Ending To Keeper of Log Wood or Iron	Steam or Sailing
		Instruments.	
Barometer.	No. Height of Cistern feet.		
Thermometers.	Sea surface No.	Dry Bulb No.	Damp Bulb No.
Hydrometer.	No.		
Entries. Character.	Hours when observations are given? Hours taken for extraction? Did ship pass to eastward of Cape Verd Islands on outward passage? Are there too many entries of "Do." instead of observations?		
Ship's Positions. Character.	Are observed and Dead-Reckoning positions given throughout? Is there any evidence of positions being good or bad? Is Dead-Reckoning longitude carried on from last land seen?		
Currents. Character.	Given by Captain? Are data regularly given?	Are they correctly calculated? Do results seem probable?	
Sea Temperatures. Character.	Average number of observations daily? Name tests. Obs. read to degrees or tenths.		
Specific Gravity. Character.	Average number of observations daily? Do they range lower in Doldrums?		
Compass Errors. Character.	Are there data for obtaining the actual compass errors? Does the variation agree with Admiralty chart?		
Ship's Head. Character.	Is it generally given?		
Winds. Character.	Direction: Is it given to 32 points of the compass? „ Are changes and their times carefully given? Force: Are changes and their times carefully given? „ Does it agree with distance run? „ Are the direction, force, duration, and veering of squalls given?		

Form for Testing Logs—*cont.*

BAROMETER. Character.	Is daily range regularly shown in tropics? Does pressure decrease when approaching Equatorial Doldrums? Does pressure increase when leaving Equatorial Doldrums? Does the barometer rise or fall in accordance with Buys Ballot's law? Is there evidence of repetition or interpolation? Is attached thermometer always given? Does barometer "pump" much?
DRY AND DAMP BULBS. Character.	Are they in the open air, showing diurnal range? Any signs of being in sun? Is there a fair difference ranging with weather? Obs. read to degrees or tenths.
CLOUD. Character.	FORM: Well given? Regularly given? Simple and compound well separated? AMOUNT: Cloud or clear sky? Scale 0 to 10? DIRECTION OF UPPER: From or to?
WEATHER. Character.	Is it fairly represented? Is the entry "Do." used frequently? Can it be got from remarks?
REMARKS. Character.	Is state of sea given? Are any interesting facts given? Are they full or scanty?
HYDROGRAPHICAL NOTICES.	Give their dates?
DIAGRAMS.	Are they neatly drawn?

The character of each style of observation is recorded under the word "Character," and the general character of the whole log is deduced from these and recorded on the upper part of the testing form. The greatest weight being given to wind, barometer, and thermometer observations.

On the back of the testing form are the following tabular forms for testing the calculation of current, and for comparing the recorded force of the wind with the speed of the ship, so as to show whether the force seems to have been under- or over- rated.*

OUTWARD PASSAGE.						
Date	CURRENTS.		WIND FORCE.			
	Dif. Lat.	Dep.	Distance in. Lat.	Distance in. Long.	Distance run.	Knots per hour.

HOMEWARD PASSAGE.						
Date.	CURRENTS.		WIND FORCE.			
	Dif. Lat.	Dep.	Distance in Lat.	Distance in Long.	Distance run.	Knots per hour.

II. INSTRUMENTS.—I think the instruments used by this Office are very good. So long as they *are* good, and properly compared with standards, it does not seem to matter much what system of scales is used, and I should prefer those to which the observers are well accustomed, so as to avoid errors as much as possible. I think that there would be great difficulty if we attempted to change the scales to which our Captains have become accustomed, in fact my chief desire is to make the work more easy if possible, with the object of getting a larger number of observers.

* It is easy to discover when the force is *under-rated*, as few merchant ships would sail faster than Beaufort's typical man-of-war; but the question as to *over-rating* requires very great judgment, as we cannot know the individual qualities of each ship, and the speed of a ship frequently decreases as the sea rises, although this is generally in consequence of the wind freshening.

III. INSTRUCTIONS.—Instructions must be modified so as to meet the customs of various countries, but they should so far agree as that the results of Observations in different countries may be compared and combined if requisite. I have recently revised our Instructions to adapt them to the form of log now proposed.*

IV. OBSERVERS.—Our present plan of supplying instruments and logs is good, but some Captains cannot undertake so much work, and as we need a large number of Synchronous Observations for daily charts, I am inclined to propose that we offer to compare the instruments belonging to certain ships, to supply their Captains with Rough Books, and to get them to record a few more instrumental observations than they have been in the habit of doing: then at the end of the voyage to ask for their ships' logs, or even for the Rough Books properly filled up. By this means we should be brought into direct communication with a larger number of Captains, and might increase the number of first-class observers, who take our instruments and keep a separate log for us. We might try this method for second class observers with all ships that trade in the North Atlantic, with the object of connecting the American and European daily land observations.

V. CO-OPERATION OF THE ROYAL NAVY.—This Office does not receive many Meteorological Logs from the Royal Navy, and in some cases they are not so good as might be hoped for. In cases where the Captains and Navigating Officers take special interest in the work, first-rate registers are produced. It is hoped that means may be devised by which every ship in the Service will record first-rate meteorological observations, for at least the four-hourly periods, and in logs which may be deposited in this Office, as we wish to perform part of the discussion of the observations in the logs themselves, a practice for which the Royal Navy logs are not adapted, and if they were, such disfigurements could not be permitted.

VI. DISCUSSION.—Discussion naturally divides itself into two branches:—

1st. Meteorology requires the monthly, or other, means of various data for certain parts of the sea. These are deduced from observations spread over a large number of years, and can be discussed after the method of our extracting books if the data are required in 1° squares. This method is explained in the Report for 1867, and in the introduction to our Square 3 work.

2nd. Synoptic work, or daily charts at a given hour; for this the method followed in drawing the charts for our "Discussion of the Meteorology of the part of the Atlantic lying North of 30° N., &c.," seems to be the most suitable, though probably the stereographic projection would be better for the charts than that of Mercator.

VII. SUBJECTS OF INQUIRY.—DIVISION OF LABOUR.—If division of labour means breaking up the meteorological subjects of a district and dividing them amongst different nations, I do not approve of it, as one part of the data throws light on another: for instance pressure and temperature are related; also winds, currents, and sea temperature (see our Square 3 work). But if division of labour means that one nation has a large mass of observations for a certain district, and wishes to make them more complete by combining with them those of another nation, then I think it is good; and, as in this case one nation might be called upon to supply much more data than another, it seems well to keep to the custom of this Office, and to let each nation pay for the copying of the data it asks for.

The methods of dealing with meteorological data are so varied and progressive, that we can hardly hope to bind all countries to the same; but if the best method could be devised for dealing with monthly or other means, and another for synoptic data, it would be well that all countries should follow them. In all cases it might be well to give the data in such a form as that they may be easily combined with other observations. It would also be well for the Heads of Departments to communicate with each other before commencing new work, and to ask what available data each has on the special subject or district.

VIII. SAILING DIRECTIONS,—or "best routes," seem to be the natural result of Marine Meteorology, though I should be inclined to give not merely the best routes, but also the data from which they are deduced. Our Square 3 work enables the Navigator to form an independent judgment, which he could not do if

* See Appendix D.

we merely worked out the best routes by averaging the number of days employed by different ships in passing through the different routes. It seems necessary that Meteorology should give the *reasons* for a certain route as well as the fact that it is the best. This is what has been aimed at in our Square 3 work.

In dealing with the data of Square 3, it was felt that as seamen had been asked to record certain facts, some of which were not Meteorological, those facts ought to be dealt with, otherwise it would be fair for them to say,—Why ask for such facts?

A. Buchan, Secretary, Scottish Meteorological Society, Edinburgh.

I.—*Observations.*

Cols. 10 & 11. A simple pressure anemometer, registering the maximum force of the wind is recommended for the purpose of arriving at some rough approximation to the force of the wind at sea, and the pressure exerted on sails. An anemometer on board ship will not give results sufficiently trustworthy for strictly meteorological purposes.

Beaufort's scale should not in its present form be made universal; but the pressures represented by the figures might be altered so as to represent a regularly graduated series of pressures when it could be recommended for general adoption. It is perhaps unnecessary to add, that the strength of the wind at sea should be referred not to velocity but pressure.

Cols. 12 & 13. If the barometric readings are carried to two decimal places, such observations should be declared to be satisfactory, but three decimal places might be recommended.

Cols. 14 & 15. The dry-bulb should be declared to be satisfactory, but both dry and wet bulbs should be strongly recommended, and particular directions given as to a good position for these instruments.

NOTE.—The errors of the thermometers should not exceed 0°·3.

Col. 16. There should certainly be two columns for clouds, one for the Lower and another for the Upper Clouds.

NOTE.—Observations of the Upper Clouds at sea are of the utmost importance, particularly in view of their connexion with the question of the advance of storms on Western Europe from the Ocean.

Col. 17. Yes, by all means.

Cols. 18, 19, & 23. Retain in separate columns.

NOTE.—Should state smooth, rough, ground swell, with approximate height of waves; and in cases of ground swell without wind, the direction in which the waves come should be stated.

Cols. 20, 21, & 22. Retain these also as separate columns.

Notes on Observations:—

1. The force and direction of the wind should be entered as at the hour of observation, and not the force and direction which has been most prevalent during the four (or eight) preceding hours. The latter should go into "REMARKS" column together with the times when storms came on and took off.

2. All barometers and thermometers should have one scale only, and not two scales as recommended. Two scales engraved on one instrument lead to errors of observation.

3. It is assumed that such nice questions as the relation of wind-force to the barometric gradient do not fall within the scope of Ocean Meteorology.

II.—*Instruments.*

In addition to the ordinary marine barometer there should be an aneroid which could be used as an interpolation instrument.

Particular directions should be issued as to the protection of the thermometers with the view of securing, so far as attainable, uniformity among air-temperature observations at sea.

Since the introduction of Metric and Centigrade systems for general use at sea is not reasonably possible, the English barometer and Fahrenheit's thermometer should be retained.

III.—*Instructions.*

Yes, and all steps should be taken by extended experiments and observations where required to prepare a general form of Instructions, which will secure uniformity in methods of observation.

IV.—*Observers.*

It should be seen that the instruments are of patterns which are recommended, that their errors at different points are known, and that they are periodically compared with standard instruments.

Whilst it is desirable that the Central Establishment *lend* in the most liberal manner to observers the instruments which are required, it is for various reasons most desirable that owners of ships, Captains, and others who may be observers, be invited and encouraged to procure instruments for their own use, it being in all cases clearly understood that such instruments must previously and thereafter periodically be compared with standard instruments.

V.—*Co-operation of the Royal Navy.*

Generally, as indicated under the third Resolution adopted at Leipzig and confirmed at Vienna. In certain cases the services of the Royal Navy might be made available in collecting meteorological data from the less frequently traversed parts of the ocean, the Meteorology of which it is most desirable to know.

VI.—*Discussion.*

In the discussion of the observations two objects should be aimed at:—(1) That the results of, say, the barometric observations represent as approximately as possible the *mean* atmospheric pressure of the Square or Sub-Square discussed, or furnish the data for arriving at it; and (2) that the results be printed in a form so that the results of future observations could be readily incorporated with them without the necessity of again discussing the old observations. Towards securing these objects it is proposed that the results of each Square's observations be printed in full as follows:—

MEANS OF SQUARE No.

Hour.	Mean Barom. at 32° and Sea level.	No. of Obs.	
2 a.m.			Similarly the means of Temperature of Air and Sea-Surface.
4 „			
6 „			
8 „			
9 „			
10 „			
Noon			
2 p.m.			
3 „			
4 „			
6 „			
8 „			
10 „			
Midt.			

In addition to the above, unusually low and unusually high readings should be detailed.

In squares and sub-squares, where numerous observations have been made, this degree of fulness in the published results is less imperative, though it is very desirable in point of scientific accuracy that it be adopted in all cases. But in squares and sub-squares, where comparatively few observations have been made, it is absolutely indispensable that the observations be grouped and arranged and the results published as above, it being obvious that *means* deduced from such observations, uncorrected for daily range, will give results which are not comparable with each other, and which, being misleading, will prove worse than useless.

It is scarcely necessary to add that it is yet premature to deduce daily range tables for pressure and temperature, the requisite number of observations not having been yet collected. Till this be done it is wise to publish the results uncorrected for daily range.

VII.—*Subjects of Inquiry.*

Obviously the division of labour as regards Subject of Inquiry can only be brought about by mutual arrangements entered into among the Collecting and Discussing Establishments themselves. A strong hope is hereby expressed that these Establishments will effect some such arrangements, the repetition of work over definite regions with reference to the area to be investigated having been already declared by the Congress at Leipzig and Vienna to be indefensible.

J. C. de Brito Capello, Observatory, Lisbon.

I.—*Observations.*

Cols. 10 and 11. I think that it is possible to construct an anemometer suitable to observe the velocity of the wind, but much attention must be given,—

1. To the placing of the instrument so as to be free from the influence of the sails, &c.
2. That the axle of the instrument keeps the most advantageous position to give trustworthy indications.
3. To the manner of discriminating the absolute velocity of the wind from the total velocity indicated by the instrument.

I think that it is possible to construct anemometers of the system of the *air meter* of Casella, with a weathercock to keep the plane of the movement of the paddle wheel normal to the direction of the wind.

The use of the Beaufort scale can hardly be made universal, as two ships according to their construction bear the same wind in a very different manner. And how can one employ this scale in a steam ship?

I would prefer the establishment of an universal numerical scale, similar to the scale employed to denote the force of the wind in the Continental Meteorological offices.

I present the following table only as an example :—

0. Calm.
1. Very light.
2. Light.
3. Moderate.
4. Fresh.
5. Strong.
6. Very strong. Heavy.
7. Violent. Storm.

The intermediate gradiations may be denoted with the two next numbers, as : 1.2, 4.5, &c.

II.—*Instruments.*

In order to accustom the English Observers to the Metric scale, I propose that in the barometer the two scales (inch and metrical) should be side by side. With this precaution and some years of practice it would be possible to adopt universally the Metric scale for the barometer and the Centigrade scale for the thermometer.

III.—*Instructions.*

I think that very detailed Instructions must be given to the Observers, especially with regard to the placing of thermometer, in order to give the most approximate temperature of the air.

VI.—*Discussion.*

The mode of discussing the observations used in the London Meteorological Office is the most sure and methodical, but it is very troublesome.

There are some more easy methods, but they are not free from inconvenience; one of these, very ingenious for the classification of the observations according to the latitude and longitude, in use (I think) in the Meteorological Institute of the Netherlands, consists in cutting the *abstract log* in strips, and placing every strip in the compartment corresponding to its latitude and longitude;

with this method the work is much facilitated, but the *abstract logs* are lost.*

There is yet the graphic method which has many advantages, mixed however with some inconvenience.

This method consists in writing on two large sheets of paper, where a degree is 0.1 or 0.15 metre long, the observations of a month denoted by conventional symbols. In one of the sheets we inscribe, at the latitude and longitude of the observation, an arrow denoting the force and direction of the wind, another different arrow denotes the direction and rate of the current, and the principal accidental phenomena, such as rain, lightning, thunder, the proportion of the sky clouded, fog, &c., are denoted by symbols. In the other sheet and at the same place we write the readings of the barometer, temperature of the air, temperature of the water, magnetic variation, specific gravity, &c.

When all the observations are inscribed, those in a square degree are combined, except the currents, and a mean obtained which is the only entry on the final map. This map in a smaller sheet contains many of the original sheets. To complete the monthly map we inscribe in every square the number of the variable winds, calms, barometrical and thermometrical observations, percentages, &c.

VII.—*Subjects of Inquiry.*

There must be a Central Office charged with continuing the construction of the Charts according to the system of the Meteorological Office, with the modifications that experience will suggest, and the Conference think necessary to introduce.

To this Central Office, which will be surely the London Meteorological Office, all the Directors of Meteorological Maritime Observatories will send summaries of their observations, already classified as to the geographical positions, and arranged according to the plan now adopted. The Central Office can even furnish the blank forms so as to have more uniformity in the summaries. These summaries must not prejudice any other study or publications that every Observer will make.

The Offices which send their summaries should receive in exchange some of the general charts published by the Central Office.

C. Meldrum, M.A., Secretary, Meteorological Society, Mauritius.

Previously to the Conference held at Brussels the Meteorological Society of Mauritius had adopted a form of "Abstract Log," which has been adhered to since.

The main ground for not adopting the Brussels "Abstract Log," has been the difficulty of getting shipmasters to take the required observations. Only a small number have kept that Log for the Society.

I.—*Observations.*

Cols. 10 and 11. It may be possible, but I do not think that any means now exist for obtaining accurate observations of the pressure or velocity of the wind at sea.

The Beaufort scale is, I think, objectionable, on the ground that the numbers do not express the relative velocities or pressures of wind, a strong breeze being 6 and a hurricane only 12. It is, I think, possible to adopt a scale, the numbers of which, while referring to the amount of canvas a vessel can carry, would give a nearer approximation to the relative force.

Cols. 14 and 15. No. I think that any observations carefully made on board ship should be received, even if they were only the positions of the vessels and the directions of the wind, with remarks on weather.

Col. 16. The *same* nomenclature of clouds should be adopted. Particular notice should be taken of all the strata seen.

Col. 19. The state of the sea might be represented by symbols.

IV.—*Observers.*

Officers of the Mercantile Marine should have to undergo an examination as to their knowledge of the construction and use of the barometer and thermo-

* I have since found that this is an error. It is a copy of the observations in the Log which is cut up, so that the Log itself is not lost.—J. C. DE B. CAPELLO.

meter at least. It would probably be considered a hardship to compel the use of a certain class of barometers and registers on board ships making distant voyages, but recommendations might be made and circulated. It is in my opinion very important that *all* observations carefully made on the winds and weather at sea should be received at the Central Establishment.

VIII.—*Sailing Directions.*

I think that a Scientific Institution for advancing Meteorology should confine itself to obtaining reliable observations and to discussing them, leaving the practical application of the results to those most interested.

Captain M. Rikatcheff, Imperial Russian Navy, Central Physical Observatory St. Petersburg.

I.—*Observations.*

Cols. 10 and 11. The column for direction of wind by compass should be retained, because this value is given by direct observation, and is therefore less liable to error. We are also accustomed to give the direction by compass, therefore this must be given as well as the true direction, to remove the doubt as to whether the direction of wind has been corrected for compass error. We propose also to retain the column for force of wind by Beaufort's scale. Hitherto it is the only scale used for noting the force of wind, and, besides, it is necessary to have the means of comparing this scale with the velocity of the wind, which I propose to measure with an anemometer, and to enter in the next column. In my article on this subject in the Austrian Journal for Meteorology I have given my reasons for thinking that this element is one of the most important in practice as well as in theory. I think that it is not difficult to set up an anemometer on board a ship. In any case the result thus obtained would be more certain than estimation by Beaufort's scale. I agree, however, that before the introduction of this method, some experiments should be made. We erected an anemometer on board the ship "Wsadnik" last autumn, but, unfortunately, we have not yet received the result of these observations.

I propose to introduce two more columns for the *true direction* and the *true velocity* of the wind. This direction and velocity should be corrected for the magnetic variation and the deviation of the compass as well as for the ship's way, *i.e.*, we propose to give the absolute direction and velocity of the wind and not the apparent direction and velocity which depend on the progress of the ship. It is almost useless to say that the correction due to the variation and deviation of the compass is indispensable, for the deviation is an element peculiar to each ship, and varies with the direction of the ship and with the change of latitude, and the magnetic variation is not only very different in different latitudes and longitudes, but also varies at the same place with the time.

As to the correction due to the progress of the ship, it is also very important and I think indispensable, if we wish for an exact idea of the distribution of the atmospheric currents. A wind whose velocity is 30 to 40 kilomètres an hour is strong enough to give to a ship, having the wind abeam, a velocity of 15 to 20 kilomètres, which gives a difference between the true direction of the wind and the direction observed on the ship a very considerable value.

I think that if a well adjusted and verified anemometer were given to the Captain of a ship he would very soon accustom himself to this instrument, and would very soon find it as useful and interesting to observe as the other meteorological instruments. It is improbable that after an experiment of some months there would be any opposition on the part of the Captain to make the anemometrical observations.

I am of opinion that it would be better to give the observations at the moment of making them than to estimate the prevailing wind during the past eight hours.

Col. 18. A column giving the amount of rainfall should be added. I see no impediment to erecting a rain-gauge on board ship, and the data will be most important for Meteorology. We are completely ignorant of the amount of rain which falls over the ocean in the zones of the Trade Winds and in the zone of Calms.

Col. 19. This column may be retained. I propose to denote the state of the sea by the words "calm," "swell," "rough."

The figures 1–2 by the side of "swell," and 1–4 by the side of "rough," will indicate the degree of sea disturbance.

Captain A. Schück, Hamburg.

The suggestions contained in this letter have been carefully considered, but it is not thought necessary to print them. The suggestion that Beaufort's scale should be extended so as to suit the modern rig of vessels has been carried out in Resolution 10.

Baron von Wrangel, Hydrographer, Nicolaief.

The Resolutions of the Brussels Conference have been carried out in Russia so far, that every man-of-war on a long commission, and every merchant vessel desiring it has been supplied with the "Abstract Log" and the instruments necessary for observations. As to the observations, they have been made in an adequate manner only on board a few of those ships, whilst on board other ships many of the columns were left blank, or what is worse, have been filled with imaginary figures.

The chief reason of this fact is, that too many observations were required and the bad choice of the hours. In our Imperial Navy as well as Merchant Service, the best hours are those of the change of watch, viz. 4 a.m., 8 a.m., Noon, 6 p.m., and Midnight.

I.—*Observations.*

Cols. 10 and 11. I do not know of any means by which an anemometer could be made trustworthy on board ship. The estimation by Beaufort's scale (or the 10 numbers of Continental Meteorologists) will give still a better, although approximate, idea of the force of the wind. Up to No. 7 of the Continental Scale sailors will seldom disagree in the estimation, whilst an anemometer may show in one part of the ship twice the velocity it shows in another, not to speak of the practical difficulties in calculating the correction for ship's way, &c. It will be very useful to make experiments in that direction, but I think it as yet impossible to introduce anemometers as instruments for general use at sea.

Cols. 14 and 15. A column for dry and wet bulbs should be left, but these observations should only be recommended, and not required, as they are of less importance than barometer, wind, and weather. Besides it is impossible to find a spot on board where the thermometer would always show the real temperature of the air. I have found that the readings of two thermometers hanging quite free and *in the shade*, one in the aft, the other in the forepart of the ship, or on the weather or the lee side may differ 7° Fahrenheit; on board a steamer, in a calm, the thermometer suspended over the forecastle will always show a great deal less than over the poop or the bridge. As Meteorologists want to know the temperature of the air and not of the ship, it is very important not to have the thermometer in a fixed position, but to suspend it, before the observations are made, at the weather side and in the shade. There is no difficulty in observing the wet bulb as well as the dry if a so-called travelling psychrometer, as made by Kappeller in Vienna, is used. It consists of two thermometers turning on a hinge. When not in use the dry bulb is protected by a copper cap, screwed on the thermometer. A similar cap on the wet bulb contains the water, and when unscrewed can be pulled down to a certain distance from the bulb. This instrument can easily be suspended at any place on the weather side and in the shade before the observation, and put away afterwards; besides it is not in constant danger of being broken.

Cols. 18 and 23. Instead of the two columns, one headed "Weather by Beaufort Notation," should be substituted.

Col. 19. State of the sea should be given at the utmost in five gradations, whether by numbers or by conventional signs, seems indifferent.

Cols. 21 and 22. Specific gravity and temperature at depths cannot be observed on board of all ships; if it is done it can be put in the column for "Remarks." The use of the hydrometer adopted by the Brussels Conference is rather difficult, particularly with a rolling ship, when the small weights will easily

fall into the water, &c.; of all the hydrometers I have seen, by far the best are those furnished by the "Ministerial-Commission zur Untersuchung der deutschen Meere," Kiel. The pattern called "Normal Gebrauchs-Areometer" is handy and, although made of glass, does not break very easily. The error amounts only to $\pm 0{\cdot}0002$ of specific gravity.

II.—*Instruments.*

It seems to me by far the easier thing to introduce even now everywhere on the Continent the inch scale, than to introduce the Metric system for general use at sea, not only because the number of observers in every part of the world using the English scale is so very much larger than the number of observers using the Metric scale, but also on account of the great and daily importance which the barometer has for the seaman, who is accustomed to attach a certain meaning to the readings of his inch instrument, and will less easily be induced to part with it than the majority of observers at land stations.

IV.—*Observers.*

All the instruments should be verified at the Central Establishment, but I do not think it necessary that they should all be its property. Many observers prefer using their own instruments, and if these are good there seems no reason to increase the expenses of the Establishment.

V.—*Co-operation of Royal Navy.*

In order to secure the valuable assistance of ships of war in collecting meteorological data, it seems advisable not to enforce the making of observations, but to make it a voluntary service as it is with the merchant ships; on board of every ship there will be Officers (amongst them the doctor), willing to undertake the task, and able to make even the more difficult observations *e.g.*, the hydrometrical and psychrometrical.

VI.—*Discussion.*

Those occupied with the discussions of the observations will find suggestions for the best mode in the respective works of others, and occasionally modify the plan according to abilities and the end in view. It seems difficult to imagine general rules for such work.

VII.—*Subjects of Inquiry.*

The division of labour does exist, in fact, to a certain extent. The Maritime Department of the Meteorological Office in London, the Institutions of Utrecht, Christiania, and Hamburg have each their respective field of investigation. But the distribution of scientific material collected, is not yet organized, and that should be the case, because else a great part of the observations is wasted, not coming into the right hands. This could be attained if every Institution (or scientific man) would let the Sub-Committee know which part of the ocean it (or he) is working out, and what kind of data are wanted. Then the Sub-Committee could organize a fair interchange of observations, addressing itself to all those Central Institutions which supply ships with journals and instruments.

VIII.—*Sailing Directions.*

I consider it the greatest benefit to the interest of science as well as to the material welfare of the nations, if practical investigations, such as preparation of Sailing Directions, are carried out by Scientific Institutions, although that ought never to be considered their direct duty.

Commodore R.H. Wyman, Hydrographer, U.S.N., Washington.

I.—*Observations.*

Replying to the questions under the head of Observations, I would state:—

Cols. 1 to 6. That in the construction of the Meteorological Journal (by Lieutenant-Commander George W. Sumner, U.S.N.), lately issued by this

Office, a copy of which has been forwarded to you, it was not considered necessary to introduce the columns of Course and Distance by Log for every four hours, but observers have been requested to record the ship's position not less than three times daily, and the hours of 4 a.m., Noon, and 8 p.m., are specified as those most desirable for these records, more frequent records being made on all special occasions, such as the approach to or departure from a Trade Wind, Stream, Current, or Calm Belt.

Col. 9. It was deemed sufficient to request that the Variation as recorded should be divested of the local deviation.

Cols. 10 & 11. It would seem possible, and certainly is desirable, to introduce some mechanical means for measuring the force of the wind at sea, that the results may be reliable and comparable with each other as also with those of observations on shore. Should the Beaufort scale be universally used, without the means of measuring mechanically the force of the wind, the results would be far from comparable; generally the estimate will be much higher in small than in large vessels, and different individuals on board the same vessel will frequently estimate the force of the wind widely apart.

Cols. 12 & 13. The barometer should be recorded to hundredths of an inch.

Cols. 14 & 15. The record of the thermometer attached to the barometer and the temperature of the air and water should be required from all ships making these observations, the wet-bulb only from national vessels.

Col. 16. It would seem desirable that the form and direction of both the upper and lower stratum of clouds be noted.

Col. 17. It would hardly seem material whether the column were headed "Proportion of Sky Clear" or "Proportion of Sky Clouded," as long as it is distinctly understood what is the signification of 0 and what the signification of 10 in the column noting the proportion of sky clear or clouded.

Col. 18. It seems desirable that the state of the weather should be recorded, first in considerable detail, even to the hours of continuance of any particular incident of the weather, and secondly, the general state of the weather by symbols, this latter being solely a confirmation of the accuracy of the former.

Col. 19. As a numerical scale is used for the wind force, and a second for recording the proportion of clear sky, it is thought desirable to record the state of the sea by means of a set of symbols, the letters used for which in the Journal offered by this Office, are in a measure suggestive of the state of the sea which they are intended to represent.

Cols. 20–22. It is considered desirable, for the facility of reference and calculation, to provide columns for the notation of all surface observations and for the occasional observations for temperature and specific gravity at depths; any observations on either, of a serial nature, must necessarily come under the head of Remarks.

II.—*Instruments.*

The objection to the adoption of the Metric and Centigrade systems is, that the present considerable supply of instruments are graduated on the English system, and the large amount of data on hand has been recorded in accordance with that system; the facility with which one system is converted to the other, can make little difference in the labour of collation.

Uniformity is desirable in the deep-sea sounding apparatus and in the method of sounding. For deep sea temperatures the "Miller-Casella" thermometer is used by our naval vessels; for the purpose of obtaining the specific gravities, the hydrometer recommended in the instructions in the original Abstract Log is used.

III.—*Instructions.*

It would seem possible, and is certainly desirable, that a general form of Instructions to secure uniformity in regard of methods of observation and registration, be devised.

IV.—*Observers.*

It would appear to be desirable that all the meteorological instruments to be used in making observations for record in the journals should be the property of the Central Establishment employing the Observer, not only from the

increased number of Observers thus obtained, but because in no other manner can records, having a fair degree of reliability, be secured.

V.—*Co-operation of the Royal Navy.*

All Naval vessels of the United States are required by the Navy Department to fill up and return the Meteorological Journals issued from this Office.

VI. and VII.—*Discussion and Subjects of Inquiry.*

The United States Hydrographic Office (in its Meteorological Department) under the Bureau of Navigation, will be always ready to consider any general suggestions as to the most profitable mode of discussion of observations, but while it regards with much interest the proceedings of the various Meteorological Conferences, and the growing popularity and importance of the science of Meteorology, it is not prepared to enter into any arrangement for a division of labour as regards Subjects of Inquiry.

The Journal issued is for the collection of data for a specific purpose, the revision of our present Wind and Current Charts, this being the only subject of inquiry in this science in which it is at present engaged. To the end that our Journals may be of the highest order required for the collection of meteorological data for this purpose, we are ready to receive any suggestions which may be made.

VIII.—*Sailing Directions.*

The preparation of general Sailing Directions describing the winds, currents, and phenomena of the Ocean would appear to be a subject, admissible for a Scientific Institute. Sailing Directions for coasts and harbours, can only be prepared by Hydrographic Surveyors and Experts.

Appendix D.

Proposed English Instructions for keeping the Meteorological Log.

Pages of Meteorological Log.

It may be well to commence these Instructions with the all-important remark that regular *honest* observations, in *fine* as well as bad weather, are what Meteorologists require, and that a blank space is very much preferred to a doubtful entry, because one bad observation vitiates many good ones.

To make the Instructions as clear as possible they commence with the introductory pages of the Meteorological Log in the order of their numbers,* and then deal in the same way with the columns of the Form of Log, which columns are numbered from left to right at the bottom of each page. It will be seen that the columns of the Rough Book bear the numbers of those in the Meteorological Log which contain the same observations.

1. Names of Ship, Captain, and Keeper of log. Corrections for Instruments.

The upper part of this page needs no explanation.

All instruments belonging to the Meteorological Office are compared with standards before they are issued, so that this form should be left blank, except in cases where other instruments than those of the Office are in use; these should be compared with instruments issued by the Office, or other Standards when opportunity offers.

When a ship has private instruments as well as those belonging to this Office it is very important that they should be recorded at the same time as those belonging to the Office for several days at the commencement of the voyage, so that if the Office instruments get broken the ship's may be taken into use, and a fair error found for them. *The comparisons should extend over as great a change of pressure and temperature as possible*, so as to test the different parts of the scales. As we only supply one barometer, it is much more important that it should be compared with the ship's than in the case of thermometers, &c. The readings of both barometers should be given in the Log during different parts of the voyage, and in fine, as well as stormy, weather.

* With this Appendix it has only been considered requisite to give pages 15 and 16, which are a printed specimen of the log proposed, but much reduced in size. See the end of this Appendix.

Pages of the Meteorological Log. 2. Wind and Weather notations. Sea Disturbance.

Beaufort's Notations of Wind and Weather explain themselves; they are alluded to again on pages 50 and 56 of these Instructions, when speaking of columns 11, 12, and 20 of the Log. It may be well to remind the Navigator that the speed of Beaufort's ship is what she would make in a *smooth* sea; therefore, to estimate the force of a wind, he must consider what speed a well-conditioned man-of-war of Admiral Beaufort's time (1800 to 1850) would be driven by it in a smooth sea when "on a wind."

The best authorities have decided that with force 5 Beaufort's ship would have sailed 9 knots an hour when "on a wind," "full and by," in a *smooth* sea. To assist the Navigator the following comparison is given of Beaufort's scale of wind force up to 5, with the speed of his ship.

Beaufort's scale of wind force	1	1·5	2	2·3	2·8	3	3·3	3·8	4	4·1	4·4	4·7	5
Miles per hour which Beaufort's ship would sail when "clean full" in smooth water	½	1	1½	2	3	3½	4	5	5½	6	7	8	9

Since Admiral Beaufort's time there has been a great change in the rig of merchant ships by the introduction of double topsail yards; it has therefore been thought advisable to add to Beaufort's scale the amount of sail which his ship would have been able to carry, had she been rigged with double topsail yards, but all other circumstances the same. The change would only affect Beaufort's wind forces 6, 7, 8, 9, and 10.

The equivalents are :—

Force 6.* Top gallant sails.
" 7. Topsails, jib, &c.
" 8. Reefed upper topsails and courses.
" 9. Lower topsails and courses.
" 10. Lower main topsail and reefed foresail.

The figures indicating the *Disturbance of the Sea* are those in use at our telegraph stations, and save a certain amount of writing.

Barometer and Thermometer Range.

3 to 6 Diagrams.

The inches and tenths of the barometer and degrees of the thermometer are given on the upper part of the page. Each vertical line represents a tenth of an inch of the Barometer, and 2° Fahr. of the thermometer; the eye easily divides the space between the lines into hundredths of an inch of the barometer, and into single degrees, halves, or even quarters of a degree of the thermometer.

The horizontal lines represent four-hourly periods of time.

These Diagrams are filled in by making dots on each time line to represent the readings of the barometer and thermometer at that time; these dots are joined by lines of different thicknesses or colours; or, if preferred, by plain and dotted lines. Instrumental records for each hour can be recorded, if necessary, as the eye easily divides the four-hourly space into quarters.

It is better to record on the Diagram the open air thermometer instead of that attached to the barometer. Some observers also add the sea temperature, direction, and force of wind, weather, sea, clouds, &c.; they make a very interesting picture of what has been, and in some cases help the Navigator to judge of what is coming.

The Diagrams are not required for use in the Meteorological Office, and are chiefly intended to help the Navigator. Very interesting facts have, however, been learnt from them, as will be seen in the Non-Official Report, No. 2, published by the Meteorological Office, in which it is shown that the barometer is much more disturbed on board a steamer going from England to America than during her return passage. Also that the barometer frequently rises during a southerly wind on board a steamer coming to the eastward, from America, but seldom or never during a southerly wind on board one steaming fast to the westward.

* Here it may be well to remark that the reason why a ship having double topsails can carry them unreefed longer than she could the old single ones, is because the pressure of the whole of single topsails is on the top-mast head and rigging, whilst in the case of double topsails, the topmast head and rigging only get the pressure of half or at most two-thirds of the whole sail.

Pages of the Meteorological Log.

Those Observers who have but little spare time should devote it to recording honest and good observations, as it is *their* quality, and not the neatness of the Diagrams which decides the value and character of a Log.

7 to 14. Deviation of Compass.

These pages are devoted to various methods for finding and recording the Deviation of the Compass, they need no explanation. The use of iron in the construction of ships has rendered the question of compass errors so important and so complicated that it cannot be dealt with here. The following works on the subject will be found useful:—

Admiralty Manual for the Deviations of the Compass.

Elementary Manual for the Deviations of the Compass in Iron Ships. By Capt. Evans, C.B., F.R.S., Hydrographer to the Admiralty. Published by J. D. Potter, 31, Poultry, London.

Practical Information on the Deviation of the Compass, by J. T. Towson, F.R.G.S. Printed for the Board of Trade by H.M. Stationery Office.

Magnetism and Deviation of the Compass, by J. Merrifield, LL.D., F.R.G.S.. Published by Longmans & Co., Paternoster Row, London.

Sun's True Bearing, or Azimuth Tables, by Capt. J. Burdwood, R.N. Printed for the Admiralty by H.M. Stationery Office.

To those who wish to go more deeply into the subject the following work will be found useful:—

A Treatise on Magnetism by Sir. G. B. Airy, K.C.B. Published by Macmillan & Co., London.

The Navigator must remember that for the purposes of Meteorology the *true* direction of the wind, clouds, &c. is required, so that if it is not recorded at once in the Log (which is the best plan), he must give the total compass error, or the data for finding it, for every change of course, so that the true direction of each observation can be deduced.

15 and 16. Specimen sheet of Log.

(*See the reduced printed specimen at the end of this Appendix.*) These pages contain a form of Log showing four days correctly filled up; it is given to guide new Observers. The heading of each column in the specimen is more full than that in the rest of the Log, the same has been done in the case of the Rough Book; the intention is to make as clear as possible to the new Observer, what it is we wish to have recorded in each column.

Form of Log.—The columns are numbered at the bottom from left to right, and will be remarked upon in the order of their numbers. The columns numbered 1, 2, and 7 to 25 will also be found in the Rough Book, so that the remarks on them will refer to either book. The Navigator is advised to take the space of the first day in each log for remarks on the correction to be applied to the direction of the wind, cloud, sea, &c. &c., the position of the barometer and thermometers, &c. &c. See the specimen columns of the Meteorological Log at the end of this Appendix.

Columns of the Meteorological Log.

1 and 2. Date.

Date.—The name of the month may be written, or its number given in Roman letters, as shown in specimen Log, where VI. means June.

Civil time is required, the same as that used on shore, where the day commences at midnight. The day of the month should be entered to the left of 2 a.m. in the Log and 4 a.m. in the Rough Book. The Log Book is ruled for two-hourly periods, and it is hoped that the direction and force of the wind will be given every two hours, but on all ordinary voyages it is sufficient to give other data for four-hourly periods, except during hurricanes or other exceptional weather, when the space of two or more days may be taken for one if required.*

For distinction the figures showing every fourth hour in the Log are in larger type than the others. The Rough Books are only ruled for four-hourly observations so as to keep them handy, but lines are given for the two-hourly winds. If the observer finds that he can observe *thoroughly good* observations every two hours, then he must take two days of the Rough Book for one day's observations, and alter the hours accordingly.

* It is very desirable that observations should be entered for all the four-hourly periods, since the *constant* omission of any one such period renders it impossible to utilize the others for diurnal range and similar work, though an *occasional* omission is of little importance.

Columns of the Meteorological Log.

When observations are only taken each four hours, copying from the Rough Book into the Log will be made easier, if the four days from one opening of the Rough Book be copied into one opening of the Log.

3, 4, 5, and 6. Position.

Latitude and Longitude.—The ship's positions by both Observation and Dead Reckoning are required at Noon when possible, and oftener when convenient. Their difference is required for calculating the "Current in last 24 hours," which is recorded on the Noon line of the Remark Column, No. 25. It is hoped that the Captain will himself calculate the Current each day, as nobody can decide so well as he whether the positions are sufficiently trustworthy; if they are not trustworthy, the fact should be recorded in the space where the current would otherwise be entered. If he can get it more frequently than each 24 hours, it should be recorded in the Remarks.

7 and 8. Course and Distance.

True Course and Distance by Log each Four Hours.—As the latitude and longitude of each observation is required, the course and distance between each set of Meteorological observations will give much more correct results than can be arrived at by interpolating between the noon positions, for they will show the effects of changes of wind, tacking, &c. The true course and distance each four hours are also very useful data for the Navigator when near land, and it is a good practice to have them always carefully worked out. They are not, however, considered to be absolutely necessary to constitute an "Excellent Log."

9. Total Compass error.

Total Compass Error.—This column contains the Variation and Deviation combined. The compass error required is that of the compass by which the directions of wind, clouds, &c., are recorded. Without it the *true* direction of wind cannot be discovered, and the wind observations of ships in which the compasses have much deviation are rendered comparatively useless. Some Captains record the *true* direction of the wind, which is preferred. It must, however, be remembered that to get the true direction of wind, &c. from an uncorrected compass reading, this Office requires the total compass error or variation and deviation for each change in the direction of the ship's head.

Whatever plan is followed, it should be clearly stated in the Log at the commencement of each voyage. A good letter on the compasses of iron ships, by Mr. W. W. Rundell, is given on the second page of the Rough Book. For further remarks on the deviation of the compass, see p. 48 of these Instructions, where pp. 7 to 14 of the Log are alluded to; these pages contain various forms for recording the deviation, and the best works on the subject are mentioned.

10. Ship's head and degrees of heel.

Ship's Head by the same Compass as the Wind.—Also Degrees of Heel to Port or Starboard (P. or S.).—The direction of the ship's head is especially needed with each record of the wind in those ships which do not give its *true* direction. Without it the requisite deviation cannot be taken from the Table of Deviations which all ships are supposed to have recorded on pages 7 to 14, and which, combined with the variation, gives the compass error. The direction of ship's head is also useful in cases where a Deviation Table is not filled up, for with it, together with the compass error and variation, an approximate Deviation Table can be constructed. Of course it is known that a ship's deviation often changes with her geographical position, so that it should be observed as frequently as possible. The amount of heel is required, as it frequently affects the amount of deviation, and its influence should be known. These facts are well explained in the works alluded to on page 48.

11. Direction of wind.

Direction of Wind.—The direction of the wind should be given to the nearest point, and, if possible, every two hours. It should be clearly stated at the commencement of the Log whether this direction is true or subject to total compass error, or only to variation. The course and speed of the ship make the *apparent* direction of the wind by a vane differ from the *true*, especially in fast steamers; but experienced seamen can generally estimate it by the direction from which the tops of the waves or the *lowest* clouds come. This observation is asked for *at the time of observing*, and not an estimate of the direction since the last observation. If a squall is blowing at the time of observing, the direction and force which existed before the squall should be entered in the Direction and Force columns, and the direction, force, and duration of the squall should be entered in the Remark Column (No. 25), with any other important remark respecting it, such as how the wind changed during the squall, &c. &c. It is particularly requested that the direction, force, and duration of squalls be entered in the Remarks, and if they are too numerous, then their general character. It is also most important that the exact time of any important change in direction

Columns of the Meteorological Log.
12. Force of wind.

or force of wind should be recorded in the Remarks; this becomes more and more important now that it is frequently found requisite to draw daily charts of the wind, weather, &c., over certain parts of the sea, for by means of such observations the track and rate of motion of certain changes can be made out.

Force of Wind.—The force of the wind is estimated by Beaufort's scale, see page 2 of the Log and its explanation on page 47 of these Instructions. It ranges from 0, a calm, to 12, a hurricane. Between 0 and 5 it depends upon the speed at which a well-conditioned man-of-war of Admiral Beaufort's time (1800 to 1850) could "sail on a wind," "clean full," in a smooth sea. From 5 to 9 it depends on the amount of sail which the same ship could carry when on a wind "full and by." From 10 to 12 also it depends upon the amount of sail that the same ship could carry, but she is not necessarily "on a wind," though in the case of 11 she would be so.

To use this scale correctly the Navigator must not use the speed or sail of his *own* ship as the criterion, unless he supposes that she fairly represents a well-conditioned man-of-war of Admiral Beaufort's time, but he must endeavour to estimate what Beaufort's ship would do with the existing wind, and in the first four, or, we may say, five cases, he may suppose that the sea is smooth. It has been decided by the best authorities that Beaufort's ship would have sailed 9 knots with force 5 in a *smooth* sea.

See page 47 of these Instructions for the comparison of Beaufort's scale with the speed of his ship, where it is given in the explanation of page 2 of the Log. Beaufort's scale of wind force is also given on the first page of the Rough Book, so that the Observer has it handy for reference.

13 and 14. Barometer and attached thermometer.

Barometer and its attached Thermometer.—Next to the direction and force of wind, the readings of the barometer are most important. Unfortunately they have not been always carefully taken in fine weather, though to the Meteorologist they are just as important then as when the weather is unsettled.

The number of the instrument and the height of its cistern (or lower end) above the sea level must be entered in the upper part of the column, and any change in its position or height of the cistern should be recorded in the Remarks; of course, the height of the cistern is affected by a change in the ship's draft of water. Captains are also requested to state in the column for Remarks whether their barometers "pump" much, *i.e.*, whether the quicksilver rises or falls when the ship has much motion, so as to prevent their getting a correct reading, and to state how much they do pump. Of course in such cases the reading entered in the Register should be the mean between the highest and lowest points of the oscillation. The attached thermometer must always be recorded at the same time as the barometer. This observation is especially valuable if the instrument is influenced by heat from a lamp, a fire, or the sun.

The following directions for handling the barometer should be carefully studied by a new Observer:—

Barometer.

In handling barometers it should always be remembered that they are delicate and expensive instruments. The result of rough treatment is breakage, and for scientific purposes, observations from an instrument improperly repaired and not verified are useless.

The barometer should be fixed in a good light for observing, but out of the reach of sunshine or the occasional heat of a fire or lamp. The ill effects of artificial heat are, however, nearly completely obviated by taking a careful reading of the attached thermometer at the time of observation of the barometer. It should hang where it can swing freely, and be out of the reach of passengers or others passing near it, so as to be carefully protected from injury. The height of the cistern or lower part of the barometer above the level of the sea should be ascertained and noted in the Log at the beginning of each passage.

Fixing up.

A bracket and screws for suspending the barometer are in its box. Screw up the bracket where the barometer is to hang. Then lift the instrument carefully out of its box, bend back the hinged part of the suspension arm, and slip it into the bracket. (The holding screws should not be driven quite home until the instrument is in position.) The mercury will then fall gradually, and the instrument will usually be ready for observation in about an hour; but as local temperature affects the instrument slowly, it may be well not to record observations from it for some hours after first fixing it. In a well-boiled tube, the mercury hangs adhesively sometimes, and will not quit the top of the tube. If, after an hour or so, the mercury has not descended to its proper level, tap the cistern end rather sharply with the hand, or make the instrument swing

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a little in its gimbals. This difficulty very rarely happens, and no precise mode of treatment can be laid down: the remedy lies much at the judgment of the Observer, who should use such means as his discretion may lead him to deem best to cause the mercury to fall. The box should be safely stowed away.

Taking it down.

Whenever it may be necessary to take down a barometer and stow it in its box, *the vernier should be brought down to the bottom of the scale.* Then, having lifted the instrument out of the bracket, place or hold it in an *inclined* position for a few minutes, so as to allow the mercury to flow *very gently* up to the top of the glass tube. It should then be taken lengthwise and laid in its box. It is now portable, without any other adjustment whatever; and may be carried with the *cistern end upwards* or *lying flat*, but it must not be subjected to jars or concussions.

Packing it.

Experience shows that it is advisable to give some directions as to packing barometers. The instrument having been taken down and placed in its box as directed, if it is to be sent by rail or other conveyance, and will probably have to be handled by persons unacquainted with its delicate and peculiar construction, should be placed in a packing case with two or three inches of soft elastic packing all round it, as hay, straw, shavings, tow, or paper-cuttings. The lid of the case should *never be nailed down*, but always fastened with screws, The address label should be *pasted* (not nailed) on the end of the case which is next the cistern, or lower end of the barometer, and it should be marked "Glass and fragile instruments. Keep this box lying flat, or carry it this end upwards." Of course, if two or more barometers are packed together, the cisterns should all be placed at this marked end of the case. Barometers should be transmitted by passenger train, and, in short, always by whatever route or conveyance affords the most safe transit. Transhipment or change of conveyance should be avoided if possible.

Barometer Vernier.

Principle of the vernier.

In order to facilitate the taking of accurate readings of the height of the barometer, a small moveable scale, called a vernier, is attached to the instrument.

The general principle of this moveable dividing scale is that the total number of the smallest spaces or sub-divisions of the vernier are made equal, taken together, to one less or more than that number of the smallest spaces in an equal length of the fixed scale. In standard barometers the twenty-five spaces in the vernier are equal to any twenty-four spaces of the scale, which are each half a tenth or five hundredths of an inch; therefore a space on the scale is larger than a space on the vernier by the twenty-fifth part of ·05, which is ·002 inch, consequently the vernier exhibits differences of ·002 of an inch.

Setting the vernier.

The vernier is moved by a rack and pinion. Turn the milled-head of the pinion so as to bring the *lower* edge of the vernier exactly on a level with the top of the mercurial column. When set properly, the front edge of the vernier, the top of the mercury, and the back edge of the vernier should be in the line of sight, which line will thus just touch the *middle* and *uppermost* point of the column. Great care should be taken to acquire the habit of reading with the eye exactly on a level with the top of the mercury, that is with the line of sight at right angles to the scale.

A piece of white paper placed behind the tube, so as to reflect the light, assists in setting the vernier accurately. A small bull's-eye lamp held behind the instrument enables the observer to get a correct setting at night. When observing the barometer, it should hang *freely*, not being inclined by holding, or even by a touch; because any inclination will cause the mercury to rise in the tube.

Every long line	cut on the barometer scale corresponds to - -	a tenth	(·100) of an inch.
„ short „	„ „	five hundredths	(·050) „
Every long line	cut on the vernier scale corresponds to - -	one hundredth	(·010) „
„ short „	„ „	two thousandths	(·002) „

Reading the barometer.

The mode of reading off may be learned from a study of the following Diagrams, in which A B represents part of the scale, and C D the vernier, the lower edge D denoting the top of the mercurial column. The scale is readily understood; B is 29·000 inches; the first line above B is 29·050; the second line 29·100, and so on. The first thing is to note the scale line just below D, and the next is to find out the line of the vernier which is in one and the same

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direction with a line of the scale. In figure (1), the lower edge of the vernier, D, is represented in exact coincidence with scale line 29·5; the barometer therefore reads 29·500 inches. Studying it attentively in this position it will be perceived that the vernier line *a* is ·002 inch below the next line of the scale. If, therefore, the vernier be moved so as to place *a* in a line with *z*, the edge D would read 29·502. In like manner it is seen that *b* is ·004 inch away from the line next above it *on the scale*; *c*, ·006 inch from that next above it; *d*, ·008 inch from that next above it; and 1, on the vernier, is ·010 below *y*. Hence, if 1 be moved into line with *y*, D will read 29·510. Thus the numbers 1, 2, 3, 4, 5, on the vernier, indicate hundredths, and the intermediate lines the even thousandths of an inch. Referring now to figure (2) the scale line just

Fig. 1.

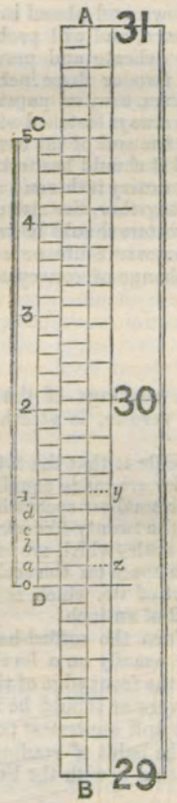
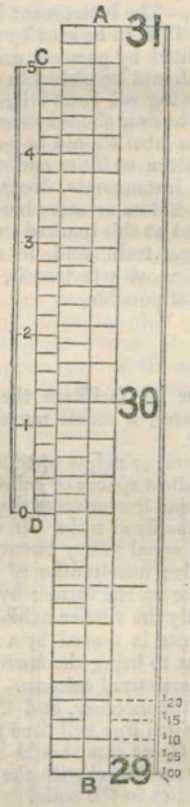


Fig. 2.



below D is 29·650. Looking carefully up the vernier, the third line above the figure 3 is seen to lie evenly with a line on the scale. The number 3 indicates ·030, and the third subdivision ·006; and thus we get—

Reading on scale - - -		29·650
Reading on vernier - - -	·030	
	·006	
Actual reading - - -		29·686 inches.

Sometimes two pairs of lines will appear to be coincident; in which case the intermediate thousandth of an inch should be set down as the reading. Thus, suppose the reading appears to be 29·684 or 29·686, the mean 29·685 should be adopted.

Thermometers.—The numbers of the Instruments in use should be entered at the heads of the columns, and every change during the voyage should be

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recorded in the Remarks. At the commencement of the voyage the position of the screen containing the thermometers should be plainly stated, and any changes recorded. The thermometers should be read to tenths of a degree, which are easily estimated by the eye. Readings below zero should be preceded by the minus sign thus,—15°, the minus sign must be repeated with each observation that is below zero.

The following Instructions should be carefully studied:—

Dry and Damp Bulb Thermometers.

Thermometer screen.

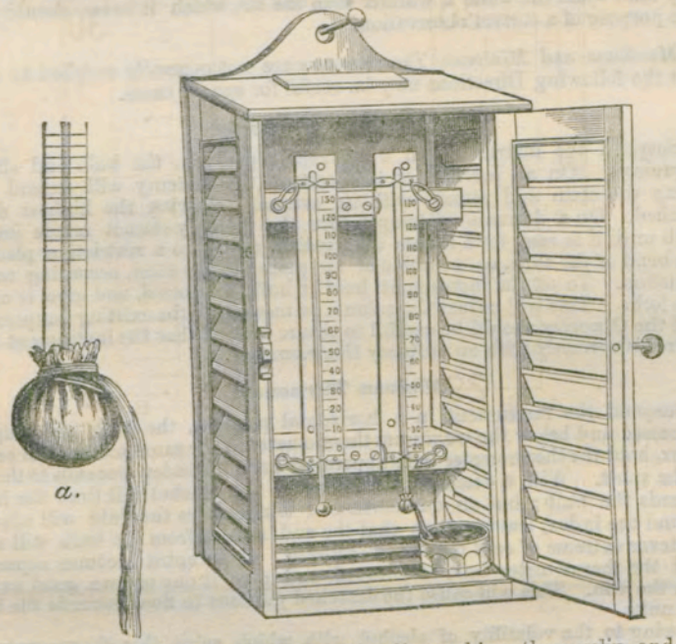
It is not at all an easy matter to obtain a record of temperature which shall be altogether unexceptionable. If an open exposure is available, a louvre-boarded case, or screen should be set up to contain the thermometers. There is a great difference of opinion among Meteorologists as to the best form and size for such a screen. It would be suitable for its purpose if it afforded perfect shelter from the sun's rays falling directly upon the instruments and allowed free circulation of the air about them, keeping them at least three or four inches from the sides and front of the screen itself.

The annexed engraving shows the form of screen used for mounting the dry bulb and wet bulb thermometers on board ship, where it should be fixed in any available position on the upper deck, so as to be freely exposed to the external air, but protected from sun, rain, or spray, and about four feet from the deck.

Two thermometers should be fitted up in the vertical position in the screen, one to give the temperature of the air, and the other that of evaporation. They should be without cases or guards, near each other, but not within a less distance than two or three inches, and as free as possible from radiation from cabins and engine rooms, and from draughts near windows of warm rooms.

One thickness of the finest muslin or cambric should be tied round the bulb of one thermometer, and a few threads of cotton wick passed round the

Fig. 3.



glass stem close to the bulb* (see *a*, fig. 3), touching the muslin, and long enough to reach two or three inches below the lowest part of the bulb, should

*8 or 10 threads formed into a loop or "bight" in their middle, having their ends passed round, above the bulb, and through the bight.

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be carried down so as to dip into and remain in a small vessel of water. By this arrangement the water is slowly conducted, by capillary attraction, to the bulb and evaporated there. See fig. 3.

The cup, glass, or other small holder of water ought not to be under or too near the dry thermometer. This little reservoir should be on the off side of the wet thermometer, that is, as far as possible from the dry thermometer, which of course should not receive any moisture either from rain, spray, or otherwise. The water should be either distilled or rain water, or, if this be not procurable, the softest pure water which can be had, to avoid the inconvenience of the deposit of lime, &c. on the bulb. The water vessel should be replenished *after*, or some little time *before* observing; because observations are incorrect if made while the temperature of the water differs from that of the air.

The muslin and wick should be well washed before being applied, and occasionally while in use. They should be changed once or twice a month or even oftener, according to the quality of the muslin, &c., and the exposure to *dust* or *blacks*. Accuracy depends much on the care taken for cleanliness, and for a proper supply of fresh water. The temperature of evaporation is a very important observation, and therefore especial care should be taken to make it correctly.

In our climate the usual difference between the readings of the dry and wet bulb thermometers ranges from 0 to 12 degrees in *outer* air on land, but at sea the difference seldom exceeds 6 or 8 degrees.

When the wet bulb is frozen it should be wetted by means of a camel-hair brush or feather with some cold water taken from under ice, care being taken to raise its temperature as little as possible. After waiting a few minutes, the moisture will first freeze, then cool down to the temperature of the air, and finally the thermometer will fall a trifle lower than the dry one, and then the temperature of evaporation may be noted. It is only when there is absolutely no water, either fluid or frozen, upon the bulb, that it fails in cold weather; and allowing for the error of the instrument, it can only read higher than the dry bulb when the water is warmer than the air, which it never should be for the purpose of a correct observation.

Maximum and Minimum Thermometers are not generally supplied to ships, but the following Directions may be useful for special cases.

Maximum Thermometer.

Suspend the instrument in a horizontal position, the bulb end slightly depressed. On an increase of temperature the mercury will extend itself along the stem and remain with its extremity showing the highest degree reached. On a decrease of temperature the mercury cannot recede into the bulb until it is reset for a future observation, owing to a restriction placed in the bend of the tube, or a bubble of air placed in the stem, according to construction. To set the instrument hold it bulb *downward*, and give it one or two jerks. This will adjust the column of mercury to the existing temperature, and the Observer should be careful to assure himself that the instrument when set reads correctly with an ordinary thermometer.

Minimum Thermometer.

Suspend the instrument in a horizontal position, the bulb end slightly depressed and below the maximum thermometer in the same screen. To set the index, hold the thermometer bulb uppermost until the index descends to the end of the spirit. With a decrease of temperature the alcohol will draw the index towards the bulb; but on an increase of temperature the fluid will advance beyond the index, leaving it so that the end remote from the bulb will show whatever extreme of cold may have occurred. If the spirit becomes separated hold the thermometer bulb downward, and give it one or two good swings with the arm. This will cause the detached portions to flow towards the bulb and unite.

Owing to the volatility of alcohol with which spirit this thermometer is made, a little will in course of time be carried away from the column and condensed at the sealed end of the tube. Hence it is necessary to compare a spirit thermometer from time to time with a mercurial thermometer of known accuracy. Should they not read alike, the upper end of the spirit thermometer

FORMS OF VARIOUS CLOUDS.



Fig. 5. Roll-Cumulus. (Roll_c.)



Fig. 1. Cirrus. (Cir.)



Fig. 6. Cumulus. (Cum.)



Fig. 2. Cirro-cumulus. (Cir_c.)



Fig. 7. Cumulo-stratus. (Cum_s.)



Fig. 3. Cirro-stratus. (Cir_s.)



Fig. 8. Nimbus. (Nim.)



Fig. 4. Stratus. (Str.)
a. Detached Stratus. (Det_s.)

Vincent Brooks Day & Son Lith.

should be examined closely, and if any spirit be apparent there, it should be shaken down. Columns of the Meteorological Log.

When observing, neither the maximum nor the minimum thermometer should be touched by hand until the readings of the indices have been recorded.

Clouds.—The following plates and explanation of clouds are repeated at the end of the Rough Book for easy reference by the Observer when recording them. Each cloud entry should be what exists at the time of observing. 17, 18, and 19, Clouds.

Explanation of the Forms of Clouds.

The following explanation of the different forms represented on the Plate has been prepared principally from the works of Luke Howard.

Upper Clouds.

Fig. 1. Cirrus. (Cir.) This is the very lofty cloud which looks like hair, thread, or feathers, and is often called "Mare's tails." It frequently moves in a direction different to that of the wind at the earth's surface.

Fig. 2. Cirro-cumulus. (Cir.-c.*) This is also a high cloud; it differs from the *cirrus* in being more globular in form, as it consists generally of small detached rounded masses, like a flock of sheep lying down, or like the markings on a mackerel, whence the name "Mackerel sky." They are sometimes seen at lower levels, when it may be difficult to distinguish them from small *cumuli*. (See the remark about cir.-s.)

Fig. 3. Cirro-stratus. (Cir.-s.) This resembles the *stratus* in being a sheet or layer of uniform thickness, but it belongs to the higher regions of the atmosphere.

Whenever there is a doubt the Observer had best enter the cloud either as "high str." or "low cir.-s." It often happens that the Observer looks upon the edge of a layer of *stratus* or *cirro-stratus*, which appears like a straight line, as in the case of the horizontal bands across the *cumulo-stratus*.

The distinction between *stratus* and *cirro-stratus* seems to depend on the relative levels above the earth's surface, at which they are observed. Clouds are seen at all levels between the highest *cirrus* and the lowest *stratus*, so that it is often difficult to determine whether a particular sheet or layer of cloud is a high *stratus* or a low *cirro-stratus*.

The same remark is applicable to *cir.-c.* and the smaller forms of *cumulus*, for there is a stage in which they seem, as it were, to run into each other.

Lower Clouds.

Fig. 4. Stratus. (Str.) This is a sheet or layer of cloud, of uniform thickness. It has but little variety of light and shade, and belongs to the lower regions of the atmosphere, so much so that Luke Howard speaks of it as "Ground Fog," the cloudy formation which spreads over low grounds in the evening. All low detached clouds, which look like a piece of lifted fog, and are not in any way consolidated into a definite form, are *strati*, and may be called "detached" *stratus*. When a *stratus* is at a high level, it may pass into a *cirro-stratus*, which see.

Figs. 5 and 6. Cumulus. (Cum.) This class of clouds comprises all those which have a globular or rounded form, from the small white cloud represented in Fig. 5, to the heavy mass represented in Fig. 6, which is almost a *cumulo-stratus*. The *cumulus* sometimes takes a cylindrical shape, forming itself into long horizontal rolls, between which gleams of light are seen, but which are often so closely packed as to hide the blue sky. These are called by us *Roll-cumulus* (*Roll-c.*) † See Fig. 5.

Fig. 7. Cumulo-stratus. (Cum.-s.) This is the *cumulus* as it were changing into a *nimbus*. It is dark and flat at its base, and is traversed by horizontal lines of dark cloud.

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* NOTE.—The second part of the contraction has been reduced to one letter, because it is found that in practice the hyphen has frequently been left out, so that cir.-cum. was understood as *cirrus* and *cumulus* instead of *cirro-cumulus*. This error has been common to all the contractions.

† This variety of *cumulus* is an addition to Howard's nomenclature.

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Fig. 8. Nimbus. (Nim.) This is a Rain-cloud. Whilst on the horizon, or as it advances towards the Observer, its front frequently presents a marked outline like that of a very heavy *cumulo-stratus* with rain falling from it, and with some *cirrus* above, so that Howard has called it the *cumulo-cirro-stratus*. When it has overspread the whole sky, it is usually so mixed up or concealed by the falling rain, that it generally assumes an uniform dark appearance.

Fig. 8, represents a *Nimbus* before it has overspread the sky; there are also smaller clouds of the same kind which only produce a passing shower. They are easily distinguished by the fact that rain or snow, &c., is falling from them.

It is believed that the foregoing description is sufficient to explain the ordinary forms of clouds, but the appearances are much intermixed. Thus, before rain we often see a dirty background of *cirro-stratus*, over which black patches of *cirro-cumulus* are travelling. Such combinations may be noted in the column for "Remarks."

17. Lower clouds.

Column 17 is devoted to the *names of the lower clouds*. The direction from which they come is not needed, unless it differs much from that of the wind, in which case a special entry should be made in the remark Column, No. 25.

18. Upper Clouds.

Column 18 is for the *names of upper clouds, and the direction from which they are passing over the sun, moon, or stars*. The direction from which *upper* clouds move should be recorded whether they are moving with the wind or not, and it is an observation which is much prized. The relative motion of clouds past other clouds, or any moveable object, is so deceptive that it should never be recorded. If the upper clouds move very quickly a remark should be made to that effect. It is particularly requested that the contractions Cir., Cir-c., Cir-s., Str., Cum., Cum-s., Roll-c., and Nim., which are given on the plates, be used in columns 17 and 18, as any other contractions are liable to mislead.

19. Amount of cloud.

Column 19. *Proportion of sky clouded*, or Amount of Cloud. It is represented by figures, 0 meaning "No clouds," and 10 "Completely clouded."

20. Weather.

Weather is recorded according to Beaufort's Notation, which is given on p. 2 of the Log, and p. 1 of the Rough Book.

The weather reported should be that which exists at the time of observation, and not an estimate of what has been since the last observation; except in the case of fog, rain, snow, or hail, when their initial letters should be preceded by a figure showing the number of hours that they have lasted during the time elapsed since the previous observation.

Any important facts respecting the weather, which cannot be shown in Col. 20 should appear in the Remark Column No. 25, such as the kind of lightning, with the direction in which it is seen, or thunder heard; and especially the direction, duration, and force of squalls, with the veering of the wind in them. When squalls are numerous, their general character should be explained in the Remarks.

A dash under a letter means increased intensity, thus :—

r	means	heavy rain.
w	,,	very heavy dew.
q	,,	an extremely heavy squall.

As some observers have been led into the mistake of using

d	instead of	w	for	dew;
h	,,	m	,,	haze or mist;
s	,,	p	,,	showers, and
s	,,	q	,,	squalls,

it seems well to remark that when the first letter of a word has already been appropriated, another has been taken. In the case of showers "p" alludes to the word passing, as showers are supposed to be passing.

21. Sea or swell direction.

Direction from which sea or swell comes.—This should be given by the same compass as the direction of the wind. If, besides the sea produced by the existing wind, there are swells from other quarters, they should also be given in this Column, stating that they are swells. In cases where the Column will not contain the important facts relating to the sea, they should be entered in

the Remark Column, No. 25. Although the direction of the sea is usually only given in general terms, such as westerly, south-westerly, &c., it is important to know whether or not the compass error has to be applied, as in some parts it amounts to several points. Columns of the Meteorological Log.

Disturbance of Sea.—This is expressed by figures 0 to 9, and is explained on page 2 of the Log and 1 of the Rough Book, where it follows the Beaufort Notation. The same scale is in use at the land telegraph stations along our coasts. 22. Sea disturbance.

Surface Temperature of the Sea.—The thermometer used for surface temperature should be protected by a metal case having a water-tight space at the bottom, which will hold sufficient water to surround the bulb; the number of the thermometer in use must be entered at the head of the Column, and any change during the voyage should also be recorded in the Remark Column, No. 25. The water must not be pumped but drawn by a bucket direct from the sea, and in steamers drawn before the ejection pipe. A canvas bucket is generally used, and the thermometer should remain in the bucket for a couple of minutes, it should then be read quickly whilst the bulb is surrounded with water in its metal case. The reading should be taken to tenths of a degree, which is easily done by the eye. 23. Surface temperature.

When water can be brought direct from the sea from a certain depth, either by letting a sea-tap run for some time or by working a pump so long that it brings water direct from the sea, it is interesting to know the temperature and specific gravity of such water, stating the depth at which it was obtained. This observation is especially valuable in the neighbourhood of great changes in the surface temperature, and the temperature and specific gravity of the surface water should be given at the same time. If any great difference is found it should be confirmed by a second observation. The temperature and specific gravity of the sea at great depths is not alluded to here, as it can only be properly done by ships specially fitted for the purpose. Three spare thermometers are supplied, in case those in use as dry and damp bulbs and for surface temperature get broken.

Specific Gravity of Sea Surface. — This observation shows the relative saltness of different parts of the sea. The readings of the scale of the hydrometer increase *downwards;* it sinks to 0 in pure fresh water at a temperature of 60°, and floats at 40 or even higher in some parts of the Suez Canal, where the water is exceedingly salt. It is a rather difficult observation when the ship has much motion, or the surface of the water in the bucket is exposed to much wind. A large well-filled bucket seems to answer the purpose best, and the hydrometer should be slightly spun in the centre; after a minute or two it loses all up-and-down motion, and the scale can be read as it is brought to face the eye by the slight remaining turning motion. The water for trying the specific gravity should also be drawn over the side by a bucket, and its temperature is required at the same time as the specific gravity is obtained. 24. Specific gravity of sea.

The hydrometers supplied by the Meteorological Office are of glass; they should be perfectly clean and dry when used. The number of the instrument in use should be recorded at the head of the Column, and any change during the voyage should be noticed in the Remark Column, No. 25. Metal hydrometers must not be used, as they are liable to oxidize or to get dented, which renders them useless.

Few observers give the specific gravity of the sea more than once a day (at noon) except when in the neighbourhood of current ripples, on each side of lines of foam, &c. &c. In cases of extreme motion it is better to omit than to give a doubtful observation.

Remarks.—On the noon line of each day is given *Current in last 24 hours.* If the Navigator has other opportunities of observing the current they should be carefully recorded in the Remarks, with an explanation of the method used. 25. Remarks. Currents.

If the observations are not sufficiently good for calculating the Current the fact should be stated in the space for currents. Captains are specially requested to calculate the current themselves. See p. 49 for the Instructions on Columns 3, 4, 5 and 6, which allude to currents.

As it is impossible to confine each remark to the line of the hour at which it took place; the hour relating to each remark should be *written* before it. This is very important in the case of a change of wind in direction or force, also in entering the hour when a ship arrives in or leaves port, both of which entries add much to the value of a Log.

Columns of the Meteorological Log. 25—*continued*

The remarks should contain any important facts, even though they may not at first sight appear related to Meteorology.

They should include the direction *from* which *lower* clouds come *when they do not move with the wind*, stating whether they move fast or slow, also anything very remarkable in the position or appearance of clouds.

Exceptional weather.

Extra observations of the barometer, wind, &c. during cyclones, or other exceptional weather, carefully stating the hour. In such cases the space of several days may be taken for one, and, if thought requisite, the remarks may extend across the whole Log.

Lightning. Corposants. Aurora. Zodiacal light. Falling stars.

The name and bearing of Lightning. The appearance of Corposants, their position and duration, whether they flit about or remain steady, Aurora, Zodiacal Light, Falling Stars, stating in what constellation the last appear, the direction and speed of their falling, the number in a given time, how long they last, how they disappear, and whether they leave tracks.

Waterspouts. Temperature of Rain.

Waterspouts and any facts connected with their formation, rotation, track as related to the wind, and disappearance. Temperature of rain *just fallen*, and that of the air by the *dry* bulb at the same time, seeing that it is dry.

Various.

Halos, Red Fog, Showers of Dust, Earthquakes.

Sea.

Current or Tide Ripples, Discoloured or Luminous parts of the sea, Ice, Seaweed, Drift Wood, Current Bottles, Wreck, &c. &c.

Natural history.

Land or Sea Birds, Insects, or other creatures of land or sea, and the direction in which they are travelling. For instance, Whales, Black Fish, Porpoises, &c.; also fish, such as Albicores, Bonitos, Dolphins (*Coryphæna*), Flying Fish, Sharks, and especially shoals of Herrings, Mackerel, Pilchards, &c., giving the temperature of the sea they are in, and the direction towards which they are going.

Hydrography.

Well-confirmed Hydrographical Notes, such as bearings, soundings, &c., which do not agree with the best charts. The times of high water on full and change days, and amount of rise and fall, direction of tides and currents, &c., when they are not already known.

Nautical experience.

Navigators who have much experience of particular routes are requested to devote a few pages at the end of the Log to remarks on wind, weather, currents, tides, best routes at the various seasons of the year, &c. &c.

Specimen log.

A specimen page of Log precedes the blank form in each Log Book, which, together with the above Instructions, will, it is hoped, render the keeping of a Meteorological Log easy and interesting.

Conclusion.

In conclusion, it is most earnestly requested that no doubtful entries be made, for Meteorology has suffered most seriously from careless observations, and it should always be remembered that a blank space is *very much better* than a doubtful observation.

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Meteorological Log kept on Board the Screw Steamship "Siberia,"

Captain John A. Martyn, from Queenstown to Boston, U.S.

Date, 1869. Month.	Day of Civil Time.	Hour.	Latitude. Observed.	Latitude. D. R.	Longitude. Observed.	Longitude. D. R.	True Course and Distance by Log each four hours. Course.	Distance.	Total Compass Error, of Compass used for Wind, being Variation and Deviation combined. State whether by Az., Amp., or otherwise.	Ship's Head. By same Compass as Wind; and Degrees of Heel to Port or Starboard. (P. or S.)	Wind. Every two hours, at the time of Observation. Give the times of changes in direction and force in the Remark Column. Direction. State if true or subject to Compass Error or only to Variation.	Wind. Force. Beaufort Scale, 0-12. See p. 2 of Log.	Barometer, No. 269. Height of Cistern above the Sea 21 Feet. Uncorrected Reading.	Barometer. Att. Ther.	Thermometers. Dry Bulb. No. 854.	Thermometers. Damp Bulb. No. 851.
VI.	2	2 a.m.														
		4														
		6									Subject		The Barometer		The Dry and Damp	
		8									to		is in the Chart		Bulbs are in the case	
		10									Compass		Room where		supplied for them,	
		NOON.									Error.		there is a fire		which is fixed abaft the	
		2 p.m.											at times.		Chart Room in the open	
		4													air, but screened from	
		6													sun, rain, and spray.	
		8														
		10														
		MIDT.					S. 89 W.	22		N.W. by W.½W.	N.W.	5	30·284	67	56·2	53·3
	3	2 a.m.									N.W.	5				
		4					S. 89 W.	40		N.W. by W.½W.	„	4	30·245	63	59·1	54·1
		6									„	4				
		8					S. 89 W.	42	33° 10′ W. Azimuth.	N.W. by W.½W. Upright	„	4	30·247	66	64·0	55·8
		10									„	3				
		NOON.	51° 22′ N.	51° 21′ N.	13° 28′ W.	13° 30′ W.	S. 89 W.	43		„	„	2	30·186	70	66·4	59·8
		2 p.m.									„	1				
		4					S. 88 W.	46		„	Calm	0	30·142	73	66·2	58·7
		6									„	0				
		8					S. 88 W.	46		„	S.W.	1	30·072	69	60·3	55·8
		10									„	3				
		MIDT.					S. 88 W.	46		„	„	5	29·972	73	55·1	55·1
	4	2 a.m.									S.W.	5				
		4					S. 88 W.	46		N.W. by W.½W.	W.S.W.	5	29·833	66	59·6	57·2
		6									„	5				
		8					S. 88 W.	45	34° 18′ W. Azimuth.	N.W. by W.½W. 5° S.	„	5	29·796	66	61·3	59·7
		10									„	4				
		NOON.	51° 10′ N.	51° 12′ N.	—	20° 45′ W.	S. 88 W.	46		W.N.W.	„	3	29·752	67	64·4	59·1
		2 p.m.									„	3				
		4					S. 76 W.	46		„	S.W. by W.	3	29·672	70	59·2	57·6
		6									„	3				
		8					S. 76 W.	46		„	West	4	29·669	67	62·6	57·5
		10									„	4				
		MIDT.					S. 76 W.	46		„	S.W. by W.	5	29·642	69	59·0	55·0
	5	2 a.m.									S.W. by W.	5				
		4					S. 76 W.	46		W.N.W.	„	5	29·562	64	56·2	54·1
		6									„	5				
		8					S. 76 W.	46	37° 24′ W. Azimuth.	W.N.W. 8° S.	W. by S.	5	29·570	67	64·7	56·5
		10									„	5				
		NOON.	50° 11′ N.	50° 5′ N.	27° 35′ W.	27° 49′ W.	S. 76 W.	45		„	W.S.W.	6	29·607	67	65·2	56·3
		2 p.m.									„	6				
		4					S. 74 W.	45		„	West	7	29·610	69	65·2	57·6
		6									„	6				
		8					S. 74 W.	46		„	„	5	29·636	69	59·5	54·4
		10									„	5				
		MIDT.					S. 74 W.	46		„	„	6	29·635	68	55·4	51·1
1		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Hour.	Clouds. When Lower Clouds do not move with the Wind, give the Direction they come from in the Remarks. (For Plates see p. 55 of Instructions.) Lower: Names.	Clouds. Upper: Names and Direction from.	Clouds. Prop. of Sky clouded 0-10.	Weather. According to Beaufort Notation. See p. 2 of Log.	Sea Surface. Direction from. Record when Confused, also when only Swell or Swells.	Sea Surface. Disturbance. 0-9, see p. 2 of Log.	Sea Surface. Temp. by No. 182.	Sea Surface. Specific Gravity by No. 303.	Remarks. Here give any important Remarks with the times of their occurrence: especially the times of Changes in Direction and Force of Wind, as well as the Direction, Force, and Duration of Squalls. Also note the hour at which the Ship arrives in or leaves Port. (See Instructions for further Particulars.)
2 a.m.									
4		Subject to			Subject to				
6		Compass			Compass Error.				
8		Error.							
10									
NOON.									Current in last 24 hours. DIRECTION. None. RATE.
2 p.m.									
4									At 4h. 54m. Slipped from moorings in Cork Harbour and proceeded. At 5h. 21m. discharged Pilot off Roche's Point and proceeded S.S.W. ½ W. At 10h. 48m. Passed
6									Fastnet and set course N.W. by W. ½ W.
8									
10									
MIDT.	Str.		1	b.			53·4		
2 a.m.									
4	Cum.	Cir-s. N.W.	8	c.	N.W½	2	53·2		
6									
8	Str.		1	b.	„	„	55 5		Steaming only.
10									
NOON.	Cum-s.		3	bc.	„	„	56·2	28	Current in last $\frac{19}{24}$ hours. DIRECTION. None. RATE. Specific Gravity 19 feet below surface, 28·2. Temp. 56° by Surface Ther.
2 p.m.									
4	Str.	Cir-c.	7	cb.	S½. swell	1	56 2		
6									Ship passing through streaks of pale green water, the sea being generally darker; this phenomenon *not* caused by cloud shadows. At 8 p.m. set fore-and-aft sails.
8	Str. Cum.		10	o.	S.W½	3	57·3		
10									
MIDT.	Nim.		10	o3r.	S.W½	4	57·0		
2 a.m.									
4	Nim.		10	od.	S.W½	4	56·1		
6									
8				f.	„	„	57·8		
10									
NOON.	Str.		10	om.	„	„	57·8	28	Current in last 24 hours DIRECTION. Insufficient data. RATE. Specific Gravity 19 feet below surface 28·5 Temp. 56°.
2 p.m.									
4	Str. Cum.		10	om.	W½. swell	3	57·5		Colour of sea, pale green.
6									
8	Cum-s.	Cir-c. N.W.	7	cb.		3	56·7		7 p.m. Wind veered to west in a squall, force 6, which lasted a quarter of an hour.
10									
MIDT.	Cum. Cum-s.		10	o.	S.W½ W½ swell	4 3	56·9		At 3 a.m. Heavy rain.
2 a.m.									
4	Cum-s. Nim.		10	o2r.	S.W½ W½ swell	4 3	55·3		
6									
8	Cum-s.	Cir. East.	4	bc.	„	„	54·1		Numbers of whales going to the westward.
10									Colour of sea, pale green.
NOON.	Cum-s.		4	bc.	„	„	56·1	28·5	Current in last $\frac{48}{24}$ hours N. by E. RATE. 10 miles. Specific Gravity 19 feet below surface, 29. Temp. 55° q. N.W. 8 lasted ½ an hour, wind then backed to West.
2 p.m.									
4	Cum-s.		6	qcb.	N½ and W½. swells.	5	56·4		
6									
8	Cum-s.	Cir-s.	4	bc.	„	„	55·2		Clouds packed near horizon, except cir-s.
10									
MIDT.	Cum-s. Nim.		8	c.	„	4	55·8		
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