

relates to sail vs. steam,

Report on the

Conduct of Maritime Meteorology in Germany

and the agreements reached between the Royal Netherlands Meteorological Institute in Utrecht and the German Marine Observatory regarding the publication of the results of maritime meteorology

delivered to the

Second International Meteorological Congress in Rome

by Dr. G. Neumayer

Hamburg, 1879

1. Brief historical survey

It is certainly not too much to claim if I say here, immediately at the beginning, that the stimulus given by the conference held in August and September 1853 in Brussels was not followed by the success which was expected and which it was very reasonable to expect. To be sure, in some countries, such as North America, Great Britain and Holland, renewed energy was applied to the organisation of maritime meteorology, and some highly important publications appeared, but the participation of other countries which should have established documentation activity by setting up central institutes for maritime meteorology was very meagre and sporadic. Neither in France, Russia, Sweden, Denmark nor even in Germany was the example of the above-named States followed immediately after that conference by appropriate organisation of meteorological observation at sea and systematic processing of the results. The way in which the foundation of central establishments and the classification of the observations gradually took place has been described in detail in the report written by Mr R Scott for delivery to this Congress, so that it is not necessary here to go back to the first years of the conduct of maritime meteorological research in order to emphasise further what was said at the beginning of this paragraph.

Among those institutes which came into being in other parts of the world at a very early stage, that is immediately after the results of the Brussels Conference had been published, the *Flagstaff Observatory* in Melbourne should be mentioned, because in some respects it was as much as 20 years earlier setting out on paths which were similar to those followed today. Details about the organisation of that institute and the work plan it applied are not widely known (only in Holland was it taken note of and fully recognised) and for this reason some information about it should be of interest.

The Flagstaff Observatory, which was opened on 1st January 1858, was mainly intended to serve research in the field of meteorology and terrestrial magnetism. But right from the beginning, particular attention was also paid to advancing the interests of maritime meteorology. Not only were the journals, containing usable meteorological information, of many ships visiting Port Philip during five years collected, extracted and the data included in the records, but a start was also made with simultaneous meteorological work by investigating the log books received at the observatory for simultaneity of atmospheric phenomena.

The results of this work and the classification and entry of the observations taken from the journals appear in the volume published in 1864:

"George Neumayer. Results of Meteorological and Nautical Observations, collected and discussed at the Flagstaff Observatory, Melbourne, during the years 1858-1862" and also in the book "Results of the Magnetical, Nautical and Meteorological Observations made and collected at the Flagstaff Observatory, Melbourne, 1858-1862", pages 208 & 209".

In addition, the Observatory organised meteorological work on board many coastal vessels; a journal specially designed for this purpose was issued to the masters of the vessels. Vessels plying to New Zealand, Mauritius and India also took part in completing these journals with useful meteorological observations. Close attention was paid to the routes and durations of these voyages, and particular note was taken of journeys from Europe to the Australian colonies and the return journeys to Europe.

For the journeys from Europe to Australia alone there were 300 journals, used as a basis for discussion, the results of which are recorded in the above-named. The instruments used for the measurements were tested when this was possible and the corrections determined were applied; the inspection also extended to sextants, barometers and compasses. The deviation on iron ships was subjected to practical processing by the Observatory.

Attempts to
organise met.
observations
on German
ships

In Germany it had not been possible to achieve anything of value as regards the organisation of meteorological observations on board the numerous ships sailing all seas, as long as no political unity existed. Certainly the efforts to extend meteorological research to the high seas by means of systematic observations on board ships had begun at a fairly early date, for in 1833, only a year after Dove had founded the network of Prussian meteorological stations and through his pioneering work, which also had a profound effect on navigation, had directed attention to the importance of meteorological research, a start was made at Beuth's suggestion on equipping Prussian ships with instruments and journals to act as floating meteorological observatories, and in 1842 Heinrich Berghaus published for the first time in a special, little known work "Six Journeys round the World etc." a series of ship's meteorological observations which had been carried out for the Prussian merchant marine and collected and summarised by Berghaus. Before beginning the discussion of the development of systematic marine meteorological observations in Germany, we should further mention the work of a man who, though his activities were not begun in Germany, rendered outstanding services to our science, as to many others. This was Dr A. Erman, who in 1829 and 1830 made a sea voyage round the world in the Russian corvette "Krotkoi" for scientific purposes. Mainly it is two nautical-meteorological and hydrographic papers in German which claim our attention but are hitherto unknown to most, even to the experts, as they appeared in a periodical which was not widely distributed, namely the *Russian Archive for Scientific Knowledge*, published by Erman himself. We must here restrict ourselves to referring to the papers by their titles, in order at least to make up for what has been neglected so far because of the periodical chosen for their publication, by bringing them to the attention of the experts. The papers in question are:

- 1) "Meteorological Observations on Russian Ships in the Russian Archive for Scientific Knowledge", 1843, part III, pages 365-438.
- 2) "Determination of Positions during a Journey through the Pacific and the Atlantic Ocean in the Corvette "Krotkoi" and an Investigation based on this of the Currents in these Seas", Russian Archive for Scientific Knowledge, vol. 10, part III, pages 473-506.

Participation
of German cap-
tains in mari-
time met. work
of Washington
Observatory

Foundation of
North German
Marine Obser-
vatory

Efforts to
expand work
of N. German
Marine, Obs.

Met. Conference
Leipzig 1872

Vienna Met.
Congress 1873

Attempts like those mentioned above were sporadic in Germany and on the part of German scholars; they did not receive the appropriate support from those concerned with shipping, probably mostly because no institute existed which could exploit the results for the benefit of the shipping community. Interest in M a u r y's results, of great practical importance in the field of maritime meteorology, had undoubtedly spread to wide circles in Germany, and many German captains became keen collaborators, but the solution then adopted was to send the abstract logs through the German governments to Washington and thus gain the benefit of possessing Maury's publications. Even after, with the outbreak of the American Civil War, the relevant work at the National Observatory in Washington had come to an end, a proposal [1] made in 1865 by Dr Neumayer, who had given up his post at the Observatory in Melbourne and returned to Europe, that a nautical-meteorological institute for North Germany be set up in Hamburg, remained without response. It was not until 1866 that the political reshaping of German State relationships brought about the greater unification of the North German States and thereby created suitable conditions for the existence of a foundation for furthering maritime meteorological and general nautical-scientific interests. In these more favourable conditions W. von Freeden succeeded on 1 January 1868 in founding the North German Marine Observatory in Hamburg. The intention in the first phase, as planned by the Director, was to form two departments, the first for maritime matters and the second for meteorology, but the lack of funds (only a meagre amount of State support came to the foundation) made it necessary to confine activities to forming the first only. However, the energetic leadership soon won the cooperation of numerous capable captains, and with the original target of "Safety and Shortening of Sea Routes" in view, the weather diaries handed in were analysed for the purpose of issuing sailing instructions for individual journeys and for discussing various sea routes across the Atlantic Ocean.

Soon after the foundation of the German Empire another attempt was made to extend the North German Marine Observatory, which until then had only received an annual subsidy, and develop it to the full extent of the working plan as an Imperial Institute. A plan for this was worked out in 1871 by v o n F r e e d e n and Dr Neumayer and made known to the Imperial authorities. The submission [2] met with no success, however; influential official circles seemed to be unwilling to try to create a larger institute on the basis of the existing beginnings. In the meantime the Hydrographic Office of the Imperial Admiralty had been reorganised, and attention had been paid to ensuring that the preparatory work for unified organisation of maritime meteorology for the German Empire could be carried out in the Office's Physical Section.

In August 1872, during the Conference of Scientific Researchers in Leipzig, an International Meteorological Conference was held and the preparatory work for the Meteorological Congress, which was to take place in Vienna in 1873, was discussed or arranged. On this occasion too, as is known from the above-mentioned published report, some decisions important for the further conduct of maritime meteorology were taken, among which particular mention should be made of those relating to dividing the work of discussion and publication of the observations and the participation of the various Navies in the work [3].

In September 1873 the Meteorology Congress for which the preparatory work had been done in Leipzig met in Vienna. The decisions of the Leipzig Conference relating to the organisation of maritime meteorological research were also accepted by the Congress [4], as a consequence of which the Hydrographic Office in Berlin proceeded with the reorganisation of meteorological observations on board German warships.

London
Conference
1874

In Vienna the necessity of a conference which would base its deliberations on the Brussels Conference, in order to obtain a generally better reception for maritime meteorology activities, had been emphasised [5], and accordingly a Conference of this nature took place in London in September 1874 at the instigation of the Permanent Committee of the First Meteorological Congress. Germany too was represented there; the Imperial Admiralty sent the Hydrographer, Dr Neumayer, and the Head of the Physics Section of the Hydrographic Office, Lieutenant Stempel, to London for this purpose. The Head of the North German Observatory, Herr von Freeden, also made an appearance. Particular attention was devoted to the pronouncements of the Vienna Congress, which proposed that in all countries in which the interests required it and centres for the conduct of maritime meteorology did not yet exist, such institutes should be set up.

Submission of
German Vienna
Congr. dele-
gates to Impe-
rial Chancel-
lor's Office

In the Autumn of 1873 and immediately after the Vienna Congress the German delegates to the congress were inclined to make their objective, by means of directing a collective submission to the Imperial Chancellor's Office, the setting up of a central establishment for maritime meteorology on the German coast in cooperation with the Organisation for Weather Research.

Establish-
ment of
German Mar.
Observatory

The consequence of this submission, along with the various decisions of the Conference, as far as we are here concerned only with reporting the progress made in Germany, was that finally on 1 January 1875 the German Marine Observatory in Hamburg came into existence, its foundation conforming in almost every respect to the international stipulations, standards and agreements.

The German Imperial authorities, in particular the Imperial Admiralty, also accepted and executed the decisions made by the London Conference relevant to the organisation of meteorological work on board His Majesty's warships and the coordination of this work with the general national system, of which the Marine Observatory is to be regarded as the representative.

Material &
inventory of
N. German Mar.
Observatory
taken over

The meteorological material collected by the North German Marine Observatory during the years 1868-1874 was purchased by the new Imperial Observatory and with this material and the organisation of maritime meteorological work existing within the German merchant marine was able to continue maritime meteorological research immediately and without interruption.

II. Organisation and state of progress of maritime meteorological work at the German Marine Observatory *

Organisation
of the Mar.
Observatory

Meteorological work relating to the ocean is the responsibility of Department I of the Observatory. In this it is supported by Department II, which has the task of testing meteorological instruments, compasses and sextants, and by the Chronometer Test Institute (Department IV). The synoptic work of Department III, which is responsible for conducting weather telegraphy, is closely related to the relevant research in maritime meteorology, therefore these two departments, which are combined in this institute, as the decisions of the Vienna Congress recommended, are able to complement and support each other in many ways in their respective research [6].

Obtaining
collaboration
of ships'
captains

The Marine Observatory, which has to function in its Department I as the centre for maritime meteorology in the narrower sense, has need for a sufficient number of staff to collect the necessary observation data at sea in order to make possible efficient operation, and when the institute was being organised, consideration was immediately given to the need to obtain the

* referred to hereafter as "the Observatory or "the Marine Observatory" or "the institute" - Translator

cooperation of as many persons as possible, as competent as possible, from among those who had already worked for the North German Marine Observatory. To assess the latter point one must remember that at the present state of progress of meteorological research only really reliable observations are valuable, so that particular emphasis is placed on finding conscientious observers through personal contact of the Institute's officers with ships' masters.

Apart from the Central Office in Hamburg, contact with the members of the public involved in shipping activities is maintained by the Observatory's agencies; 3 main agencies and 14 class II agencies have been appointed in the German coastal ports. The former are distinguished from the class II agencies in that apart from the necessary equipment for comparing barometers and other meteorological instruments, they also possess a complete range of instruments necessary for determining deviation, are fully supplied with maps and nautical literature and are managed by the officials of the observatory. The 3 main agencies are in Neufahrwasser, Swinemünde and Bremerhaven; class II agencies are situated in Memel, Pillau, Stralsund, Barth, Wustrow, Rostock, Lübeck, Flensburg, Apenrade, Brake, Elsfleth, Papenburg, Leer and Emden. Neufahrwasser and Swinemünde are also equipped as normal observation stations of the coastal meteorology system.

The ships' masters who express willingness to collaborate are granted the use of all the Observatory's facilities without charge. Their chronometers, compasses, sextants and meteorological instruments are tested without charge, they are permitted to make use of the institute's library and map collection, and they are readily given written and oral advice on carrying out the journeys they have to make or other nautical matters.

Participation
in the work

As a consequence of these arrangements the participation of ships' masters in the Observatory's work is increasing from year to year. This can be seen from the number of meteorological journals given to ships to keep. The numbers were:

1875	146
1876	157
1877	181
1878	<u>192</u>
Total	676 journals

Distribution
of journals
to German
ports and
abroad

These 676 journals were divided among the Observatory's individual points of issue as follows:

Hamburg central office	313	Class II agency at Papenburg	4
Main agency, Bremerhaven	246	" " Brake	4
" Neufahrwasser	19	" " Apenrade	3
" Swinemünde	34	" " Lübeck	3
Class II agency at Elsfleth	13	" " Rostock	3
" " Emden	8	" " Barth	2
" " Stralsund	7	" " Wustrow	1
" " Pillau	5		

Distribution of the remaining 37 journals took place through the consulates at Rotterdam, Antwerp, London, Newcastle, Cardiff, Liverpool, Singapore, Hong Kong and Shanghai. Through the good offices of the External Affairs Department it was arranged that these consulates should always be provided with an adequate number of meteorological journals and the necessary copies of the instructions for keeping them, for distribution to ships' masters.

Completion
of the met.
journal

The completion of the meteorological journals on the ships of the Imperial Navy is governed by a special order of the Head of the Admiralty, so that uninterrupted observation, entry of the results and reliability of the data seems to be assured. For the ships of the merchant fleet, participation in the work of the Maritime Observatory is entirely voluntary. Here it is usually the captain himself who sees to the execution of the observations and writing up the journal. It must however be remarked that the German Marine Observatory also accepts the masters of ships of foreign flag as collaborators, guaranteeing them the same advantages of use of the Observatory's facilities as the masters of German ships enjoy.

Arrangement
of the met.
journal

The arrangement of the meteorological journals conforms to the decisions taken at the Maritime [meteorological] Conference in London [7], and also coincides with the arrangement of the Meteorological Log of the London Meteorological Office. In the 25 columns which it contains, entries are made as follows:

Column(s)

1 & 2	times
3 & 4	latitude
5 & 6	longitude
7 & 8	course set and distance sailed
9	total magnetic variation of the compass
10	adjacent compass point
11 & 12	wind direction and force (Beaufort scale)
13 & 14	readings of barometer and attached thermometer
15 & 16	readings of thermometers with dry and wet bulbs
17, 18, 19	cloud formation and appearance of sky
20	description of the weather by the Beaufort designation
21-24	observations on the sea surface, such as direction and size of waves, temperature and specific gravity of the water
25	remarks, especially on currents observed

The observation times are 4, 8 and 12 o'clock of the day and night. The wind observations, however, are wanted for every two hours; the wind direction and strength should be given as they are at the time of observation, not as the average of what they have been since the previous record was made.

Conditions
for ships
keeping the
met. journal

According to the requirements of the Observatory, the ships on which the meteorological journal is to be kept must be equipped with at least 1 chronometer, 1 sextant, 1 mercury barometer and 3 thermometers. The existence of a wet bulb thermometer and an areometer and the corresponding completion of columns 16 and 24 of the journal is only of secondary importance.

Meteorolog.
instruments

As regards the instruments used for the meteorological observations, there is a plan, which the observatory is trying systematically to realise, to supply all collaborators with the instruments on loan. At present, however, some of the instruments are the private property of the ship and some are on loan from the Observatory. In accordance with the plan mentioned, the number of loaned instruments has increased constantly since the founding of the Observatory, so that by the beginning of 1879 there were already on board ships 79 marine barometers, 32 marine psychrometers, 192 marine thermometers and 9 areometers which are the property of the Observatory. In addition there are 20 barometers, 18 psychrometers, 15 thermometers and 1 areometer in stock at the central establishment and agencies of the Observatory for testing and to cover future requirements.

Checking
of the
instruments

It is regarded as important that if possible the instruments be tested for errors before and after each voyage. At the agencies this is done simply by comparison with standard instruments; at the central establishment, where, as already mentioned, Department II is responsible for testing instruments, each barometer is also tested by means of the vacuum gauge. The test made and the corrections found for the instrument for the various readings are noted on pages 1 and 2 of the journal. In order further to improve the reliability of the instrument readings it is intended to make constant improvements in the checking of the instruments, which in future will be easier to do when all ships making observations are equipped with instruments which belong to the Observatory itself.

Attempts
to improve
quality of
work by
instructing
the observers

For the value of the observation results not only the reliability of the instruments, but also the reliability of the observer and the method of observation must be taken into into account. In order to make sure of obtaining good, comparable material in this respect too, the officials of Department I and the Directors of the Agencies are instructed by the rules to make the ships' masters acquainted, at the time when they take custody of the journals, with the arrangement of the latter and with the method of carrying out the observations and filling in the individual columns. In addition, each collaborator is given a printed instruction on how to fill in the journal. This is modelled on the Meteorological Office's Instruction presented to the London Conference of 1874 and contains, apart from the very detailed instructions on how to fill in the journal and how to install and use the instruments, a pictorial representation of the cloud forms, several tables for the conversion of the various measurements and the reduction of the observations, and a specimen completed page of the journal form. Finally, it is earnestly requested that no inaccurate entries be made, but that it should be kept in mind that it is better to leave an empty space than enter a doubtful observation. An explanation of the symbols to be used for completing columns 12, 20 and 22 is printed at the front of the journal.

Participation in maritime meteorological work is, as was previously mentioned, entirely voluntary for the officers of the merchant fleet. This means that the great majority of the captains who declare their readiness to keep the journal have, if not complete expert knowledge, at least particular interest in the work asked of them. In assessing the quality of the material which the Observatory receives from its observers, it must be remembered that use of the barometer and thermometer and knowledge of air and sea currents and storms are subjects covered by the national examination for German ship masters and for this reason are part of the instruction course at the Merchant Navy Officers' Schools; all the younger observers have passed out from these schools.

All these circumstances combined justify the belief that the observation material delivered to the Observatory deserves the same reliance in respect of reliability as that of any other maritime meteorological institute.

Number of
journals
sent in

The number of meteorological journals kept on board ships of the merchant marine which have been returned to the central establishment direct or through the agencies named or the consulates in foreign ports, more or less fully completed with observation material was:

1875:	for sailing ships:	85	for steamers:	26	total:	111
1876:	" "	74	"	9	"	83
1877:	" "	107	"	13	"	120
1878	" "	139	"	10	"	149
1875-78	" "	405	"	58	"	463

Decrease in
number of
steamship
journals

The reason for the decrease in the number of journals sent in by steamers is that the Observatory no longer thought it necessary to ask the steamers, most of which ply between the North Sea ports and the East Coast of North America, to complete the whole journal. A new, simpler journal of observations for them was introduced in 1877; the purpose and form of this will be described in more detail below.

The met.
journals
of the
Navy

The meteorological journals which are kept on the ships of the Navy are collected by the Hydrographic Office and handed over by this authority to the Observatory for use. 247 journals have been sent in through this channel in the last four years. Some of these, however, are from the period before 1875, and it is only since that year that the meteorological journal for the Navy has had the same form as the one described above for the merchant fleet.

Examination
of the
journals

As soon as possible after the receipt of the journals their contents are subjected to careful examination in order to ascertain whether the entries made deserve to be relied on sufficiently to be included in the extract books for later use or whether the contents of certain columns must be rejected as unusable. The examination is based on a printed form modelled on the one used by the London Meteorological Office. It contains a number of questions regarding the following subjects:

1. ship's position 2. currents 3. total magnetic variation 4. adjacent compass point and heeling error 5. winds 6. barometer 7. psychrometer 8. cloud formation 9. weather 10. sea surface 11. remarks,
the answers to which should indicate the quality of the instrument, the reliability of the observer and particularly the value of the material in the various columns of the journal. According to the results of the test, each heading, then the whole journal, is given a quality code expressed by the numbers 1 to 5, where 1 = excellent, 2 = very good, 3 = good, 4 = moderate, 5 = unusable.

Results of
examination
of journals

As an example of the result of the test, we show the quality codes of the 405 sailing ship journals delivered to the Observatory since 1 January 1875. Of these

3.7 %	received the quality code	1
26.0 %	- " -	2
51.6 %	- " -	3
17.4 %	- " -	4 and
1.3 %	- " -	5.

With regard to some particularly important series of investigations, the test on the same journals showed that the barometer readings in 344 journals were good and those in 61 journals (15 %) unusable, the air temperature readings in 386 journals were good and those in 19 journals (5 %) unusable, the water temperature readings in 381 journals were good and those in 24 (6 %) unusable, and the wind readings in 385 journals were good and those in 20 (5 %) unusable.

The most frequent cause of unsatisfactory quality of the instrument readings is that they come from untested instruments, but this shortcoming has become less frequent since so many ships have been equipped with instruments on loan from the Observatory. The advantage of this arrangement shows up clearly when the above journals are compared with those collected by the North German Marine Observatory before 1875, the observation data in which were obtained entirely with instruments which were the private property of the ships.

The examination of such data carried out immediately after the establishment of the German Marine Observatory on the journals received showed that in the 543 journals of the North German Marine Observatory the barometer readings in

337 journals were good and in 206 journals (38 %) unusable, the air temperature figures in 472 journals were good and those in 71 (13 %) unusable, the readings of water temperature in 459 journals were good and those in 84 (16 %) unusable, and the information on wind direction and strength in 488 journals was good and that in 55 (10 %) unusable.

Comparison of the two groups of journals as regards general character shows the following:

Journals in the quality category	Delivered before 1875	Delivered after 1875
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good	57.6 %	81.3 %
moderate	37.4 %	17.4 %
unusable	5.0 %	1.3 %

(The quality codes 1, 2 and 3 are put together under the category "good").

Testing baro-
meters by
means of
synoptic
maps

It must be noted here that a check on the barometer readings is made by comparing the ship observations made near the coast of Europe with the observations of the nearest land meteorological stations, using synoptic maps. In the case of examination of the journal column for barometer readings, these are of course only observations made with the mercury barometer. Readings on the aneroid barometer are always regarded as unusable.

Prizes for
collaborators

Since the year 1878/79 the Observatory's budget has provided for a sum of money which is devoted to recognising captains who distinguish themselves by particular zeal in promoting the aims of the Observatory by awarding them a prize. At the end of last year some 20 captains gained this distinction. The prizes awarded were watches, atlases, books etc.

Utilisation
of the
journals

The utilisation of the meteorological journals takes various forms according to the purpose visualised. First, a short voyage report is extracted from the journals submitted, giving information on the route followed, the wind and current conditions met and other matters of importance. All extracts made from the journals received at the Observatory during a month are as soon as possible combined in a special article published in the *Annalen der Hydrographie und Maritimen Meteorologie*, so that each issue of this periodical contains an overall report of this kind. The great usefulness of these reports, which are written in a very simple style, is that they give captains the opportunity of comparing the route chosen for their journey with those of other ships which made the same journey in the same season or even at the same time, and that they can therefore be instructive because the reason for delay or unusually fast progress comes to light. For obvious reasons, there is no critical discussion in these reports of the journeys made. In this form the journey reports are welcomed by the captains, and this encourages their interest in the Observatory's work.

Voyage
reports

In the two years' issues of the *Annals* 1877 and 1878 a total of 200 reports were published. Separate extracts of these, bound into 2 volumes and provided with an index, were presented to the Observatory's collaborators. It is the intention that in future each annual series of these journey reports will terminate with a summary report describing in a practical and generally understandable way the conclusions drawn from them.

Articles for
the "Annalen
der Hydrog..."

Mention should also be made here of the less extensive, but nevertheless no less fruitful work of Department I, the articles written for and published in the *Annalen der Hydrographie und Maritimen Meteorologie* on maritime

meteorology, hydrography and general nautical subjects. Their main purpose is as far as possible to fill the gap felt because of the lack of special monographs on ocean voyages, sailing handbooks and general nautical subjects for German seafarers, until the publication of such works.

In this way the staff of the institute (not only of Department I, of course) have prepared and published in the course of the last 4 years 40 to 50 articles of various lengths, some accompanied by maps and diagrams. For these articles too, the practice is to collect them in indexed volumes and send them without charge to the captains working for the Observatory, for their use.

Sailing
instructions

The production of sailing instructions for special voyages, which are not issued regularly, but only in written form at the special request of captains, is also part of the Maritime Meteorology Department's work. The sailing instructions always bear the character of general instructions for carrying out a voyage and suggest interesting questions for observation purposes, rather as if they were parts of a sailing manual.

Sailing
manuals

Also part of the Marine Observatory's mandate is the writing and publication of sailing manuals for the various seas and various voyages for the benefit of worldwide sea communications. Works of this nature have not previously appeared in German. In addition to a discussion of the various routes, the manuals are going to give a description of the physical, meteorological and magnetic conditions of the sea concerned and in particular will also contain tabular representations of the voyages made by collaborators of the Observatory and their durations from one intersection point to the next, with the necessary charts and diagrams. The Atlantic Ocean has been tackled first, and the manuscript has reached the stage where the publication of this work can confidently be expected in the near future.

Support of
synoptic
work

The ship observations from the Atlantic Ocean are used immediately after the receipt of the journals, when preparing the "Monthly Review of Weather", which is published by the Observatory, for obtaining the necessary information on the weather conditions and the distribution of air pressure over this part of the sea in the month concerned and in order to obtain clues on the formation and development of the depressions observed over Europe. In this preparation the ships' observations made at 8 a.m. ship's or local time are first entered in a table which since July 1877 has also been published in the monthly reviews and contains the data for each day of the month taken from the journals. These cover the ship's position (latitude and longitude) at 8 a.m., the reduced barometer reading, wind direction and strength on the Beaufort scale, air temperature and sea state on the Beaufort scale. For the sake of improved clarity, synoptic charts for 8 a.m. on each day of the month are then compiled from this table, and on the basis of these particulars the section "Atmospheric processes over the Atlantic Ocean" of the Monthly Reports is prepared. In this the important practical aspects for navigation are specially pointed out and an attempt is made to apply the principles and ideas of modern meteorology for the benefit of practical navigation.

In a similar way the ship observations from the Atlantic Ocean for the year 1875 in the possession of the Observatory were communicated to the Meteorological Institute in Copenhagen for use by that Institute for Captain Hoffmeyer's synoptic charts.

As it was clear that synoptic work would be of great importance for research on meteorological processes if taken across the whole of the Atlantic Ocean, and in view of the comparatively small number of observations from the journals kept regularly for the Observatory, our aim was, as soon as synoptic work

Arranging met.
service on
steamships

on a larger scale could be considered, to divert to this kind of activity the work time freed when the ships of the large German steamship lines stopped keeping the meteorological journals. The transatlantic steamship companies Norddeutscher Lloyd in Bremen and Hamburg-Amerikanische Packetfahrt-Aktien-Gesellschaft in Hamburg responded to this objective in the most gratifying way. They were asked to have the meteorological observations necessary for synoptic work made on their ships twice a day, at 8 a.m. and 8 p.m., and to have them entered on forms issued for the purpose; this request was agreed to gladly by the managements and captains of the companies. In the short time since this arrangement was made (October 1876), 179 extract journals (as this abbreviated form for meteorological records is called), completed with good observations, covering outward and return journeys to North America, the West Indies and South America, have been delivered to the Observatory, and in this way the usable material has increased so much that for example for preparing the review of weather for June 1878 the journals of 46 sailing ships and 30 steamships were available. Because of the short duration of the journeys mostly considered for this purpose, it is also possible to have this valuable material available at the Observatory very quickly.

Processing
met. & hydro-
graphic condi-
tions within
1-deg. zones

Part of Department I's regular major work is the discussion of the material obtained from that part of the Ocean which the German Marine Observatory has agreed with the maritime meteorological institutes in Holland and Great Britain to process. The sea area concerned is the North Atlantic between the 20th and 50th parallels of latitude.

The operation starting the discussion of the material is the correction, reduction and examination of the observations; then they are arranged according to place and time and entered in the books. The method is as follows:

In the method now used by the Observatory, modelled on that in use in Great Britain, the individual measurements are entered in bound "extraction books". One book contains the observations made in the same month (even if in different years) and in the same 10 degree zone, and the content of each extraction book is further divided into one degree zones, so that the observations of the same one-degree zone appear clearly arranged together on the same pages.

Squares
completed

In this way the extraction of the material for the 10 degree zones 145, 146, 147, 148, 110, 111, 112, 75 and 76 situated to the east of 40° W longitude which was received up to 1 April 1878 by the Observatory has been started and partly completed. The material already extracted by the Observatory according to the Dutch method using strips on which the observations are entered arranged in boxes, had to be completely converted again; this was all the more necessary when the new extended requirements for this work demanded stricter examination of the material.

The number of sets of observations which were actually used ("sets" means all the details recorded in one journal about the individual meteorological and physical elements relating to the same instant) was, after simple rounding off:

square		square	
145	17 500	110	16 500
146	37 000	111	7 500
147	28 000	75	113 500
		Total	120 000

sets of observations for that part of the Atlantic Ocean lying to the east of longitude 30° W and between 50° and 20° latitude.

International
sharing of
met. work on
the squares

At the Conference in August 1872, the Congress of 1873 in Vienna and the Maritime Conference in September 1874, the importance of international division of the work of processing meteorological material was recognised by special resolutions.^[87] As it was now desirable, during the analysis of the field it had offered to cover, to have as large a quantity of observations as possible available for processing, the Observatory endeavoured to obtain in addition the material gathered by other institutes, and it succeeded in reaching an agreement with the Royal Netherlands [Met.] Institute in Utrecht that a free interchange of material between the two institutes should take place. As a consequence of this agreement, the material accumulated by the German Marine Observatory from Chinese waters (0° to 30° N, 100° to 150° E) - the sea area which the Utrecht Institute had undertaken to process - was sent to that institute, and in return the Observatory received all the material at the Netherlands Institute relating to that part of the Atlantic which was to be processed by Germany.

! An attempt to reach a similar agreement with the Meteorological Office in London achieved no result. That Office expressed willingness to transfer the material in its possession to other institutes or private persons, but remarked that this could be done only if the extraction and copying costs were met. In reply to a more particular enquiry at the beginning of 1877 the cost for the approximately 177 000 sets of observations relating to the part of the Atlantic Ocean eastwards of 30° W longitude was stated as £1800. At the same time it was suggested that it would be more appropriate to carry out such an important international transaction through more formal channels, by the agency of the two governments, than by means of a simple agreement between the institutes concerned. Since, however, it appears from the comments of the London Meteorological Office that that institute attaches no particular value to acquiring the material of other centres, it will be understood why up to now it has not been possible to achieve any exchange or acquisition of the British material.

Graphical
representa-
tion not
recommended
for internat.
processing
of the squares

As it has thus been impossible to amass a quantity of material in any way commensurate with the magnitude of the field to be investigated and produce a finished publication on the subject, the management of the Observatory has come to the conclusion that the graphical form of representation which has hitherto been preferred for publishing the results of the analyses is not suitable, and that publication must take place in tabular form, in such a way that the data from other institutes and later times can always easily be added.

Furthermore, the governing body of the Observatory cannot forbear to express its view that it is really not suitable to undertake any kind of graphical representation in publications of an international character giving the results of comparison of the material, so long as the principle of work sharing is not put into practice. However large, even comparatively, the total quantity of material available to an institute, it can be said with certainty that the addition of a substantial amount of good material will affect the summarised results to a considerable extent. Graphical representation always has the character of a definite conclusion in which one believes final results have been arrived at. If it is remembered how many of the observations evaluated, because of the method of their ascertainment, refer to one time and one place, which circumstance therefore ought to be allowed for by a particular method of reduction - but up to now has not been allowed for - one cannot help concluding that since the material is inevitably inadequate, the effort expended on producing the reduced diagrams is hardly justified.

Graphical representations which are the result of all available material and appear in publications of a more national character, such as sailing instructions, sailing manuals etc., will certainly be able to improve the clarity of the phenomena, but for this purpose one element only or at the most two closely related elements should be represented on the same page. The aggregation of elements in condensed form is neither valuable for theoretical work nor helpful for the seafarer's study for practical purposes.

The methods of graphical illustration customary up to now have not achieved their aim, that much is certain. This does not rule out the possibility that a suitable means may eventually be thought of, but so long as none exists the tabular form must be regarded as the most appropriate in all circumstances for the publication of maritime meteorological observations.

Being convinced that if it was to meet the above-mentioned purpose, the form of the publication must be international, the Observatory endeavoured to reach agreement with other institutes to this end. This was successful with the Institute at Utrecht. A plan drafted by the Observatory was approved by Professor Buys-Ballot, and in further pursuance of this an agreement was signed at Rheine on 6 February 1878 between Professor Buys-Ballot and Dr Neumayer.

Square 146 was processed in accordance with the plan and made ready for publication. In respect of the details of the negotiations on the form etc. of the publication, please refer to section III of this report, which deals with this subject.

Finally, in order to provide a basis for assessing the material in the possession of the Observatory, we now give a summary of the contents of the meteorological journals collected by the Observatory. In the first instance we show only the material usable for the work described above and obtained by systematic observations on consistently good, tested instruments. This material is contained in

- 1) the weather books of the North German Marine Observatory, kept on merchant ships during the period 1 January 1868 to 1 January 1875,
- 2) the meteorological journals of the German Marine Observatory, sent in by merchant ships during the period from 1 January 1875 to 1 January 1879, and
- 3) the meteorological journals kept by the ships of the Imperial Navy before and after 1 January 1875.

Group

- 1) comprises 543 sailing ship journals and 137 steamship journals,
- 2) comprises 405 sailing ship and 58 steamship journals, and 179 steamship journals in abbreviated form (extract journals)
- 3) comprises 247 journals.

Number of observation days contained in:

- a) the 948 sailing ship journals in groups 1) and 2) 171 254
- b) the 195 complete and 179 abbreviated
steamship journals in those 2 groups 29 012
- c) the 247 journals of the Imperial Navy 41 795

Total observation days ... 242 061

Distribution
over indivi-
dual routes
and seas

An observation day can be assumed to comprise in the case of a) an average of 5 sets of observations, in b) 4 sets and in c) 10 sets. On the basis of this estimate the contents of the journals would comprise the following numbers of sets of observations:

sailing ships	856 270
steamships	116 050
Naval ships	417 950

Total 1 390 270 sets of observations

The material is divided among the main routes and individual seas as follows.

The largest proportion relates to the Atlantic Ocean, specifically the routes from the Channel to North America and back
from the Channel to the West Indies and back
from the Channel to the equator and the equator to the Channel.

After this comes the South Atlantic with the routes:

from the equator to Cape Horn
from the equator to the Cape of Good Hope
and the corresponding return routes

The next is the Indian Ocean. There the main routes on which observations were collected were:

from the Cape of Good Hope to the Bay of Bengal and the East Indies
from the Bay of Bengal and the Sunda Islands back to the Cape of Good Hope
from the Cape of Good Hope to Australia.

In the western part of the Pacific Ocean the main areas in which observations were collected were the east Asian coastal waters, and second to these were the routes between the Polynesian island groups and from these to Cape Horn.

The contribution made by the eastern part of the Pacific Ocean, which is the smallest, consists of material on the routes leading from Cape Horn to the ports on the west coast of America and the Sandwich Islands, and from these ports back to Cape Horn.

In general the material is distributed fairly uniformly along the main routes. There is however an agglomeration of readings:

- 1) where areas of weak and changeable air currents have to be crossed, e.g. at the edges of the trade winds;
- 2) where the wind direction is predominantly opposite to the ship's course, as for instance on the route to North America, round Cape Horn in the westerly direction, leaving the Indian rice ports during the SW monsoon, at the Cape of Good Hope during the return journey, etc.;
- 3) where various routes approach one another or cross, e.g. near the English Channel and in the Atlantic Ocean area between 5° N and 5° S and between 25° and 30° W.

The following summary shows even more clearly how the observation material is distributed over the individual seas. Detailed examination of the 242 061 observation days of the meteorological journals show the following distribution:

	From sailing vessels	From steamships	From Navy ships	Total
Arctic Ocean	760			760
North Sea, Baltic & English Channel	2331	206	21422	23959
Mediterranean	166	111	5634	5911
North Atlantic Ocean	73 743	26 807	8 102	108 652
South Atlantic Ocean	32 911	868	1 791	35 570
Indian Ocean and Malacca Strait	23 363	370	994	24 727
China and Java Seas incl. the Amur district from the inlet to the passages of the East Indies archipelago northwards	15 874	370	2 453	18 697
Pacific Ocean, western part	7 731	-	817	8 548
Pacific Ocean, eastern part	14 375	280	582	15 237
<hr/>				
Observation days:	171 254	28 901	41 795	242 061

The Observatory also possesses the following older material:

- a) 166 volumes of Maury's Abstract Logs. These contain the meteorological observations from about 700 voyages, were compiled in the years 1852 to 1864 on German, British, American and some Spanish ships, and after they had already been used in Washington were handed over to the Observatory.
- b) 107 ordinary ships' logs, of interest insofar as some of them contain observations on wind and weather in the rarely visited regions of the Arctic Ocean during the period from 1795 to 1818.
- c) 47 journals of the merchant fleet of Messrs Wm. O'Swald & Co., Hamburg. These journals also contain data on air pressure and temperature, but the data are only of relative value, as the observations were not made with tested and calibrated instruments. This fact is the more regrettable as the journeys of the ships were made to places rarely visited in the Indian Ocean, Zanzibar and Madagascar.
- d) 33 journals and journal extracts collected by the Director of the Flagstaff Observatory, Melbourne. In addition to the usual readings with barometers and thermometers, which were mostly calibrated, they contain valuable notes on journeys between Europe and Australia and China and Australia, and have previously been used in the "Results of the Meteorological and Nautical Observations, collected and discussed at the Flagstaff Observatory, Melbourne, during the years 1858-1862". As the maritime meteorological activities of this Observatory were not continued after Dr Neumayer's departure, the material collected was given to him to use as he saw fit.

III Documents relating to the agreement on the nature of publication of the results of maritime meteorological research

Reference has already been made to the agreement reached with the Director of the Royal Netherlands Meteorological Institute relating to the form and extent of publication of the results of the meteorological work of the Observatory, which had to be of an international character because of their nature and importance. In view of the undoubted great importance of the subject and in the hope of thereby encouraging the extremely desirable agreement of the other European institutes devoted to maritime meteorology on a common, internationally accepted method of publication, the most important relevant documents etc are published in detail in this section.

Memorandum of Professor Buys-Ballot,

Director of the Royal Netherlands Meteorological Institute in Utrecht

on the plan submitted by him to the German Marine Observatory,
Sent to Dr Neumayer, Director of the Observatory,

dated 24 December 1877

Method of
representing
observation
material

Even though it may be desirable to retain for certain purposes the graphical representation of the results of observations - only to a lesser extent than used hitherto, of course - there is no doubt that tabular representation is preferable, and we have to thank Dr Neumayer not only for insisting that in our centres the observation material be collected in tabular form - we all agree on that - but also for endeavouring to ensure that a tabular form of publication, and furthermore an international and universal one, is adopted.

Under his guidance, the German Marine Observatory has now introduced a form which would also be very suitable for the classification of the Dutch observations, although we are not in a position to fill in all the columns. The British institute copies all journals in the same way, arranging their contents carefully in accordance with the position of the ships; the Netherlands one believes it can achieve the objective more certainly and more quickly by merely taking copies of the journals, cutting these copies up into strips, sorting the strips according to the geographic latitude and longitude of the ship's position and then sticking the strips belonging together on a sheet of paper. Thus in both London and Utrecht the same compilation of observations is obtained as in Hamburg, though in a different way.

The first question is, in what form we should publish the results to make sure that they are comprehensive and generally understandable, and at the same time observation results obtained subsequently can easily be combined with the earlier material.

In order to shorten the discussion of this question I will endorse the excellent scheme which Dr Neumayer has suggested to us.

On page 1 of this scheme we find: number of winds and strength of these. In connection with this I should like to suggest that the mean strength be given, not for each one-degree zone but all together for all 25 one-degree zones entered on one page; a line should be allotted for this purpose at the foot of the page or a special page should be set aside for it. The number of readings will in my opinion too small to give enough weight to the mean wind strength values found for the small zones. A few strong winds from the same direction can change the mean values too much quite by chance, and apart from this, the observers' estimates are so inaccurate that the mean wind strength can be learned only in a totally inadequate manner. We could quote examples of three ships sailing in the same squadron estimating the strength of the same wind three numbers different; in addition, the influence of the speed of the ship is not taken into account appropriately. The four columns: storms from the N to E, E to S, S to W, W to N indicate sufficiently accurately the direction the strongest winds come from, and if according to my suggestion a line is provided for this at the foot of the page, we obtain a rough estimate there too of the wind strength.

I could nevertheless agree to having a vertical column for mean wind strength, but I would certainly not agree to putting the wind strength in horizontal rows between the rows of wind numbers. This would lead to great confusion.

I would prefer to have the actually observed wind figures for N, NNE etc. given instead of the percentages. The percentages are numbers obtained by division. If only a few later wind measurements are going to be included, and if they all come in the same sector, not only does the percentage for this sector change, but so do all the others. It takes time to calculate the numbers in terms of percentages, and more time to recover the original figures from the percentages, while the proportion can be found immediately from the stated number of observations used. The only advantage of percentages is that only two figures are needed for them, and for the original figures perhaps three; however, in order to allow for this greater space requirement, I should like the column (row?) for storms and the barometer readings to be on the second or third page.

Originally I intended to propose putting the winds opposite each other according to Dr Prestel's method, i.e. N and S, NNE and SSW etc on page 2, but this arrangement would also have had drawbacks. I think that we meet all requirements if page 1 gives the position, then the number of observations, perhaps also the mean wind strength, but then only the sixteen sectors and two for the variables and calms.

I now come to page 3 (this page no. refers to the original proposal, which differs in some respects from the attached scheme). Here I have 3 columns for the storms and two for the barometer, or four if desired. I do not believe, however, that the maximum and minimum need be entered. These figures can only become true after many years. And if the barometer could on one occasion read 700 mm in the region of the Azores, it might not happen again inside a century. Extraordinarily high and low readings must be included in the remarks; as average figures they have no meaning. Now come the four columns for the thermometer readings. Here too I am opposed to including the maximum and minimum. In particular the maximum will not command much reliance; I would not at present give any credence to a very high thermometer level observed on board a ship.

But how shall we obtain usable averages? Should we combine morning, midday and evening readings, taken on different days, in different years, on different ships?

It would meet my wishes better if the mean thermometer readings at 8 a.m., 12 noon and 8 p.m. were put in the first 3 columns. Instead of these, different observation times could be chosen, e.g. 6 a.m., 2 p.m. and 8 p.m., and the most suitable of all would be the American times 7.35, 3.35 and 11.35. I want to see 3.35 introduced instead of 4.35, because then the twenty-four hours are divided into equal periods. Then if observation results obtained at times a whole hour earlier or later than the appointed times were entered, this would be only slightly detrimental - less than if one had calculated the mean temperature of the day from arbitrarily collected observations. I have in fact already made the arrangement recommended above, and entered the thermometer readings for the morning, noon and evening observations separately.

We should therefore have on page 3 four columns for the storms, two for the barometer reading and four for the thermometer reading. As regards the completion of the remaining columns I am in full agreement with you, with the exception only of that (those) for the current.

The currents at sea do belong in a certain sense to the meteorological elements, but their determination is so unreliable that I should prefer to leave them out of the table altogether. The sailor often says current when he is really referring to inaccuracy in the determination of his position or in the determination of course and speed. I believe it is valuable to have this column in the journal to make the sailor aware of the displacements due to current. We also refer closely to the columns in every journal containing position, course and distance, and current. But if we then look at the adjacent information on the wind direction and strength, it seems to us that the determination of current is seldom reliable.

Many measurements would be rejected, and a new column would have to be created for the number of observations made. Further, the number of observations for each individual direction would have to be given, e.g. 3 observations, current ENE, 4 current SE, 5 current ESE etc, for in what other way could the various readings be put together and at the same time give the individual observers credit? But then two columns would not be sufficient; a whole page would be necessary for recording the observations of current.

I must admit that the use of the information on page 3 of the proposal is not sufficiently clear to me for me to be able to recommend their inclusion. What am I to understand by t,l,q,g under "stormy" and h,r,s,d under "humidity" in the details under "Sky" and "Air" ? Who has ever made anything of cirri, strati etc. ? I do not say this in relation to the information for a particular place and a particular time, if these cloud formations arise from one another and follow one another, but in relation to the figures in the table, where everything is mixed up together in averages.

If page 3 is also accepted by others, I will fit in with the decision as well as possible, but I am convinced that you will already have achieved a great deal if you succeed in getting Mr Scott (or rather the Meteorological Council) to answer the questions about pages 1 and 2. If after our discussion, which I conducted quite frankly in the conviction that you wanted to hear my real opinion, you agree with my proposed amendments, I could, to give an example, begin with the publication of the observation material for the China Sea.

For the oceans, however, it will probably be necessary to provide further special summary charts, of the sort I can compile with my strips. These charts will not need to contain the details, because the details will be published in the tabular form discussed.

However, on rereading this and considering it further, it appears to me desirable to mention the Prestel method in the table in order to make it somewhat easier for the reader to make sense of the sixteen wind numbers, and so that he does not have to compare the numbers in N and in S, in W and in E before he can see whether the number of N and W winds is greater than that of S and E winds or not. If he finds only N 50, he does not know whether this is high or low until he has seen that under S 30 is shown; but if under N he finds the 50 emphasised by underlining, he does not need to look any further. It will then be found that in adjacent one-degree fields the predominant wind numbers come in approximately the same columns; if this is not the case, it can be seen that the figures are still uncertain.

Have you noticed the way in which Brault puts the wind strength under four headings ? It seems to me that we must also try to recruit this gentleman.

In my opinion the following points should be agreed:

- 1) Certain columns should be decided on which must be completed uniformly by everybody. If any individual lacks the information for the other columns, they are left empty; observations which are not allocated particular columns can be given new ones on a free page.
- 2) The information must be given in such a way that everyone can easily connect it with other corresponding information.
- 3) Everyone will enter the material collected by him in this form and publish it in this form.
- 4) From these German, Dutch, British and French tables for the Atlantic Ocean, Indian Ocean etc. you, Mr Scott and I will then later each choose a part and compile a paper for one individual sea.
- 5) Each institute is of course free to investigate and process the tables in other ways.

I hope the above makes quite clear my views on your proposals, and look forward to receiving your comments.

Buys-Ballot

The Conference
in Rheine

On the basis of the above comments on the original scheme for the publication and on the basis of the proposed changes, the scheme was subjected to revision and reworking, so early agreement could be expected, as some of the points of difference were of a minor nature. However, it did seem advisable to subject the whole matter to a further thorough examination at a conference for this purpose which Dr Neumayer suggested holding at a place on the Dutch frontier.

As a consequence of this, the Directors of the two meteorological institutes concerned met on 5 - 7 February 1878 in Rheine. There follows a resume of the agreements reached at this meeting.

Negotiations on the method of publication of the results
of maritime meteorology

between Prof. Buys-Ballot and Dr Neumayer

Firstly the question of closer relations was discussed, and whether the institutes in Utrecht and Hamburg should make further tests, and also include material other than the German and Dutch in the processing. In view of the fact that it would probably be impossible to persuade the British institute to adopt different standards in respect of making its material available, and that hardly any of the French material collected by Lieutenant Brault would be usable for the one-degree zones, it was decided to abstain from further efforts in these directions and to proceed with publication. The combined Dutch and German material, published in accordance with a unified scheme, would be suitable for guiding further investigations in the field of maritime meteorology on to the right lines. Further, in order to pave the way for contact with Britain the agreed scheme of publication should be sent to the Meteorological Office in London for information (see the preceding memorandum). This would make the experts concerned aware from the beginning of the fact and form of the agreement.

Both the Directors acknowledged the principle that the main part of the publication of the work on the one-degree zones must take place in tabular form; their representation in diagrams, maps and curves is not excluded, but it is subsidiary and not absolutely essential for satisfying the requirements that are being introduced. The diagrammatic form is not convenient enough for seafaring people, while scientists can only with difficulty and reduced accuracy find the values they are interested in from representations in curves, diagrams or maps.

There followed a discussion, on the basis of the memorandum received by the Governing Body on 26 December 1877 from Prof. Buys-Ballot, of the scheme proposed by the Observatory for publication of the material. The points agreed are briefly as follows:

- 1) A somewhat different arrangement of the tables is necessary because of the various pages, particularly because more space must be allowed for the wind figure; the barometer reading must be put on page 2, and so must the storm column. In addition, the currents must be moved to page 3, as enough room is still left for remarks. Otherwise the arrangement proposed is to be retained, unless mentioned specially below.
- 2) The wind number is not to be given as a percentage, but in the form in which it is found, because the percentage method causes difficulties later in the use of the tables, whereas the direct numbers can be used easily in all circumstances for further connections. The marking of the windward side by the Prestel method is not considered helpful, but in the tables the figures are to be differentiated by fine and bold letters in the way already used by the Observatory in Table Vb of the monthly reports.
- 3) The mean wind strength for a sub-degree zone will be dropped and the mean wind strengths for each wind direction and the sub-degree zones will be omitted; on the other hand, it is a good idea to give the mean wind strength for each wind direction and each 5-degree zone. The column necessary could be accommodated at the bottom on page 1 of the scheme. Then the overall view and the interrelationship in the wind number column will not be spoiled.

- 4) It is irrelevant and not quite correct to give the extreme barometer readings for each one-degree zone. The mean extremes would be more suitable for such a purpose, but it is thought that this can be avoided by entering the extreme readings in the "Remarks" column.
- 5) In the thermometer observations it is recommended that the coarse average of the six readings of the day be given, and also the temperature at 8 a.m., 4 p.m. and midnight.
- 6) The currents are mostly of such doubtful value that it is very uncertain what to do with them in the publication. First, a most critical attitude must be taken towards the individual records - only good ones are to be included. Considerable doubt is exercised as regards calculating the average current direction from a number of observations. Only what is essential about the current must be given in the table; the details must be given in the accompanying text, which will be discussed shortly.
- 7) The subdivision of the designations according to the Beaufort scale must be re-examined thoroughly. In particular some of the headings of the four groups must be changed; for instance, Hydrometer instead of Humidity.
- 8) For cloud cover and sea state it is preferable to give the number of observations in all cases, and the actual records belonging to the individual classes in the one case, and in the other case, those belonging to the individual directions. The division into percentages is abandoned.
- 9) The last page 4 is reserved exclusively for remarks, but observations to be entered here should be kept general; ones which could just as well be given in tabular form are particularly suitable for this purpose.
- 10) It is very desirable that each of the 5-degree zones be accompanied by a short description, which should be put in a special part after all the tables. Much of what is stated in the remarks column can be repeated in this description. Further, the result of the 25 squares which belong together can successfully be found here, and a summary can be given at least in respect of wind number and strength observations arranged by 5-degree zones. A comparison and resume of these is very useful. It is also possible to give here practical hints on navigation like those in the British publication on *Square no. 3*, and a short physical geographical summary. Curves and diagrams can be successfully used for this.
- 11) Wind roses or other pictorial representations can be used as required to illustrate the results. The subdivision into one-degree zones should however always be retained.
- 12) Dr Neumayer is requested to draft a new scheme in accordance with the above comments and send it to Prof. Buys-Ballot for final approval. After its acceptance we will proceed immediately to making up the scheme for entries.

To close the proceedings, the work of Lieutenant Brault was considered. It was agreed that he should be encouraged. But it was also emphasised equally definitely that we could only proceed according to the standards laid down by the London Conference. It is not possible to approve of Brault's reversion to 5-degree zones; his graphical representation of the wind frequency is considered good, while his designation of the wind intensities is not particularly approved of, although the importance of taking the wind intensity into account in maritime meteorology work is recognised. His tabular summaries are good, apart from the shortcomings mentioned, but here too, we must beware of spoiling the overall view.

Rheine, 7 February 1878

We agree to the above statements and rules

(signed) Buys-Ballot. Neumayer.

Utrecht, 2nd March 1878

To the Governing Body of the German Marine Observatory

I have the honour to acknowledge receipt of the Negotiations on the Method of Publication of the Results of Maritime Meteorology and on the Summaries of the German Marine Observatory.

As I previously anticipated, I believe that the personal consultations which Dr Neumayer was kind enough to hold with me have led to a favourable conclusion.

Subsequently I also received the [tabular] scheme in which the observations are to be entered.

I have no remarks to make about this except to say that I have not extracted all the events from the journals of the earlier journeys, therefore my information with regard to humidity, temperature and cloud formation will be very incomplete. But for the subsequent journals I will have these attended to if the Governing Body insists on all the points.

I think the relative humidity will be 90 % or more everywhere at sea, and will therefore show little variation, except in the east of the Mediterranean and the west coast of Africa when the east wind comes, therefore near the coasts will depend very much on the wind direction. Perhaps it would be a good idea to mention the relative humidity according to land and sea winds.

Unfortunately we have previously extracted the temperatures for different times, namely 4 a.m., noon and 8 p.m. In future, however, I can just as easily give them for 8 a.m., 4 p.m. and midnight. I leave the choice of times to the Governing Body; I only need to know them beforehand. I myself suggested 8 a.m., 4 p.m. and midnight, but at that time I did not remember that we had done it differently, and as I believe, just as well; since the maximum at about 2 p.m. is no further from 12 noon than from 4 p.m., and the minimum is just as near to 8 a.m. in the winter months as it is to 4 a.m. in the summer months.

However, I will wait for the Governing Body's decision before I have my scheme printed.

Our ship observers did not mention ground swell. I will have this column completed as well as possible. Cloud formation is, I think, quite unnecessary.

In the simultaneous observations it might be useful to know where there was cirrus and where cumulus, etc. It is more interesting in the journals themselves, where these effects can be related to what follows. Today cirrus, tomorrow somewhat more, and cumuli too, the third day rain or storm. In this way one learns the meaning of these cloud patterns at the various places on the ocean. But one can deduce absolutely nothing from the percentage relationships of cirrus, stratus etc. put together arbitrarily for various times.

In any case I will comply with the final proposals of the Governing Body, but as I mentioned, I wait to learn these before having the scheme printed.

I permit myself one further question:

Square 146 denotes the the same space as in Great Britain ? But the British squares are four time as large. Should the squares therefore be called 146a, 146b, 146c, 146d ? The Governing Body will surely agree with me that each nation must denote the same section of the ocean in the same way ?

Will the Governing Body please inform me in what way they have divided up the oceans, and what numbers the squares in the China Sea have. I have much completed material relating to the China Sea and am only waiting to find out how I shall number these sections of ocean.

Respectfully yours,

(signed) Buys-Ballot

The scheme for publication was finally accepted in the form shown in the Annex.

Despatch of
the agreed
scheme to
other
institutes

In accordance with the agreements reached, the scheme for publication of the results of maritime meteorology agreed in the manner described were sent by the Director of the Marine Observatory on 10th May 1878 to Mr Scott, Secretary of the Meteorological Council in London, with a request for his comments on the scheme.

On 20th May Mr Scott replied that he had received the scheme and would put it before the Meteorological Council.

The Director of the Marine Observatory has not received any communication regarding the result of presentation of the scheme to the Council.

It should finally be mentioned that the scheme agreed, together with an explanatory letter, was sent on 6th August 1878 to M. Brault in Paris. No reply to this communication has yet been received.

Hamburg, 1st February 1879

Dr Neumayer
Director of the Marine Observatory

References

- [1] A Proposal for the Establishment of a Nautical-Meteorological Institute for North Germany, by G Neumayer. Hamburg 1865
- [2] Draft of an organisation plan for the Nautical-Meteorological and Hydrographic Institute the German Marine Observatory etc by W von Freeden and G Neumayer, Berlin 1871
- [3] Report on the Proceedings of the Meteorological Conference in Leipzig, Vienna 1872, p. 30
- [4] Report on the Proceedings of the International Meteorological Congress in Vienna. Vienna 1873, p. 69
- [5] *ibid.*, p. 70
- [6] *ibid.*, p. 71
- [7] In discussing this important matter, it is necessary to mention the influence of the various publications of Professor Buys-Ballot on these decisions. We here name only the two most important of these: "Suggestions on a uniform system of meteorological observations", Utrecht 1872, and "A sequel to the suggestions on a uniform system of meteorological observations", Utrecht 1873
- [8] See also Buys-Ballot: *A sequel etc.*, page 48 et seq. (and ref.[7])

Translator's Notes

Author' footnotes:

Because of the different sizes of the pages in the original and the translation it is not convenient to put the footnotes on the relevant page. They have therefore been rearranged; shorter notes are incorporated in the text, and references to literature are numbered in the text in square brackets and collected together in a References section on page 25.

Notes on some terms in the text

As the text is 19th century "learned", in general the terms have been rendered by equivalent formal English words rather than ones which might be used in a modern scientific paper.

"Column"

The word "Spalte" normally means "column" in modern German. It became evident from the text that it can there mean either a column (vertical) or row (horizontal). In the description of the journal layout on p.6 and the discussion of how results are to be presented (in the Buys-Ballot letter, pp. 16-19) it is not possible, without having the original journals or tables to refer to, to know which is meant in each case. I have therefore used the word column throughout unless the writer appends "vertical" or "horizontal".

"Governing Body"

Towards the end of the exchange of views Buys-Ballot uses the term "Direktion" instead of naming Dr Neumayer. In modern terminology this is "the Management", but whether other persons than Dr N are included does not come to light.

0 — 0 N

[illegible]

Monat:

[illegible]

SQUARE
Quadrat:

° — ° N

Position Zone		BEAUFORT'S WEATHER TYPE Wetter nach Beaufort's Bezeichnung		CLOUD TYPE Wolken- bildung	CURRENT Seegang und Dünung	REMARKS Bemerkungen	
° N. Br. ° — °	° W. L. ° — °	NUMBER OF OBSERVATIONS Summe d. Beobacht.:					
		SQUALLS Böen		TYPE OF SKY Himmelsansicht	cirr.	N	
		t		b	cirr. c	NE	
		l		c	cirr. s	E	
		q		o	Str.	SE	
		u		g	W-c	S	
		PRECIPITATION Hydrometeore		CONDITION OF AIR Zustand der Luft	Cum.	SW	
		h		v	Cum. st	W	
		r		w	Nimb.	NW	
		s		m		Kreuzsee	
		d		f		glatt	
						cross-sea glatt	
		° N. Br. ° — °	° W. L. ° — °	Summe d. Beobacht.:			
Böen				Himmelsansicht	cirr.	N	
t				b	cirr. c	NE	
l				c	cirr. s	E	
q				o	Str.	SE	
u				g	W-c	S	
Hydrometeore				Zustand der Luft	Cum.	SW	
h				v	Cum. st	W	
r				w	Nimb.	NW	
s				m		Kreuzsee	
d				f		glatt	
° N. Br. ° — °	° W. L. ° — °			Summe d. Beobacht.:			
		Böen		Himmelsansicht	cirr.	N	
		t		b	cirr. c	NE	
		l		c	cirr. s	E	
		q		o	Str.	SE	
		u		g	W-c	S	
		Hydrometeore		Zustand der Luft	Cum.	SW	
		h		v	Cum. st	W	
		r		w	Nimb.	NW	
		s		m		Kreuzsee	
		d		f		glatt	
		° N. Br. ° — °	° W. L. ° — °	Summe d. Beobacht.:			
Böen				Himmelsansicht	cirr.	N	
t				b	cirr. c	NE	
l				c	cirr. s	E	
q				o	Str.	SE	
u				g	W-c	S	
Hydrometeore				Zustand der Luft	Cum.	SW	
h				v	Cum. st	W	
r				w	Nimb.	NW	
s				m		Kreuzsee	
d				f		glatt	
° N. Br. ° — °	° W. L. ° — °			Summe d. Beobacht.:			
		Böen		Himmelsansicht	cirr.	N	
		t		b	cirr. c	NE	
		l		c	cirr. s	E	
		q		o	Str.	SE	
		u		g	W-c	S	
		Hydrometeore		Zustand der Luft	Cum.	SW	
		h		v	Cum. st	W	
		r		w	Nimb.	NW	
		s		m		Kreuzsee	
		d		f		glatt	