ECMWF COPERNICUS REPORT

Copernicus Climate Change Service

Best Practice Guidelines for Keying Data from Historic Marine Documents

C3S_311a_Lot1_Met Office – Collection and Processing of In Situ Observations - Data Rescue

Issued by: CSW Associates/Wilkinson

Date: 30/11/2021

Ref: C3S_DC3S311a_Lot1.3.4.2_2021_BestPracticeGuidelines_Part3_v1.docx

Official reference number service contract: 2020/C3S_311a_Lot1_Met Office/SC3

IMPLEMENTED BY ECMWF

To cite this report:
Wilkinson, Clive; Freeman Eric, 2021: Best Practice Guidelines for Keying Data from Historic Marine Documents. Copernicus Climate Change Service Data Rescue Service [Ref C3S 311a Lot 1].
DOI: 10.24381/68FY-2307, https://doi.org/10.24381/68fy-2307

Contributors

CSW ASSOCIATES

1. Clive Wilkinson

NOAA NATIONAL CENTER FOR ENVIRONMENTAL INFORMATION

1. Eric Freeman

Table of Contents

1. Introduction

These best practice guidelines (BPG) are part of a series documenting the retrieval of historical weather observations for use in climate research. The first step in this data retrieval involves working in archives and document imaging. Guidelines for this have been published previously:

https://climate.copernicus.eu/sites/default/files/2020-02/BestPracticeGuidelines_ClimateDataRescue_0.pdf

This BPG describes the second step – the transcription of weather records in document images into computer readable form (henceforth, "keying"), but exclusively for keying *marine* observations (observations from ships, buoys and other marine platforms), which differ from terrestrial observations in many ways. First and most obviously, marine observations are not fixed to one location. Additionally, there are observations such as sea surface temperature (SST) and others that are unique to the marine environment. Marine documents such as the deck or navigation logbook vary considerably over time and between nations, but do consistently record the same basic information. This basic minimum information to be keyed is date and time, position of the vessel or other platform, wind direction, wind force, and weather. Depending on the type of logbook or other document, and the time period, additional information might include air pressure, air temperature, sea temperature and various other parameters. Keying these records means inputting the numbers written in the document into a computer-readable format (typically some kind of spreadsheet) in a way that allows the keyed numbers to be further processed into databases of observations. Keying can be time consuming and expensive, so it is vital to do it efficiently – to make it as easy and as fast as possible to key a document, while still providing an output format adequate to support further processing.

The objective of this BPG is to assist both project managers and those keying marine observations from original documents (or images of them). It is assumed that prior experience with ships' logbooks and related documents is limited or entirely absent, and the aim here is for keyers and managers to quickly become expert in all types of logbooks, journals and other marine data documents. This BPG will act as a reference guide. Some of the information provided here would usually be needed in the post-keying processing of data. However, it is also important that those managing and performing the data keying stages are aware of the needs of those working downstream from their tasks, as they will then be able to flag potential issues.

It is important to understand the context under which historic observations of the marine environment were made, and to understand the meaning and reason for the many ancillary observations and remarks concerning the navigation and conduct of the vessel, as these may affect the nature and quality of the observations.

Much of the material discussed in these guidelines is taken from British or English language marine documents. Many of the details of navigation and marine observing were common across all nationalities and languages, with only minor differences. Nevertheless, wherever possible we have also used some non-English material to demonstrate some of the subtle differences in recording practice, or in the format and content of the logbooks. The choice of these additional examples has relied heavily on material that has recently been imaged and was available to the authors at the time of writing and the choice does not reflect the importance of any particular national collection, type of document or observational methodology. Other marine data practitioners may wish to add to or amend these guidelines with additional information on nationally specific observational practices and recording scales as that information comes to be known through the digitisation of more global marine records. These guidelines should therefore be considered as a work in progress rather than the final word on the subject.

2. Types of Keying

Data can be keyed directly from the original documents, a printed facsimile or images of the document. We recommend that where possible all original documents are imaged before being keyed. This will allow the image to be consulted whenever required without a return to the archive holding the original document and also preserves all of the information contained in degrading hard copy documents.

Small keying projects can be undertaken by a group that should consist of a manager or supervisor and a team of individuals performing the data entry - this is called direct data transcription. The keyers should be provided with a spreadsheet with a predetermined format, or data transcription (or keying) template, that has been created by the project supervisor. This format should reflect the range of data recorded in the original document, with provision for further cells to record any additional comment, issues or uncommon observations noticed by the keyers. The same spreadsheet format should be used consistently for a project, so care is needed to get the format correct from the very start. This is discussed in more detail below.

Larger projects should key data using crowd-sourcing, usually referred to as citizen science. This type of keying involves placing images of original documents on the web and using an interface that allows volunteers to key the data. This has proven to be an effective and efficient method of data transcription. Recent projects such as Old Weather, Southern Weather Discovery, and others have been very successful, and have been established and developed using the Zooniverse platform, a web portal for citizen science projects with over 1.6 million registered volunteers (https://www.zooniverse.org). Setting up and managing a citizen science project will not be discussed here as the Zooniverse projects page will provide this information. Citizen science is the recommended method of data transcription for all but very small projects, where direct data transcription might be more suitable.

A third method of data transcription is the use of AI or machine learning. Advances in machine learning technology and accuracy of transcription are improving, but to date (2021) accuracy is not sufficiently advanced for use on hand-written documents. This will eventually change, and AI will at some future date be a preferred method of data capture.

The sections below apply to both direct data transcription and citizen science projects. With both types of transcription, the different data types need to be examined and organised into a structured keying format. Apart from the observations themselves, managers must consider the capture of relevant metadata (e.g. ship names, nationality, types of meteorological instruments, etc.) We would recommend that metadata transcription be considered as a sub-project and keyed separately.

3. Data Keying - General

3.1. Pre-planning and screening of documents prior to keying

Before keying data, a manager or supervisor should examine the documents and produce a structured and detailed plan of how the keying of the data will be undertaken. This should be done for both direct transcription and for the preparation of documents for citizen science projects. Build flexibility into the plan. By flexibility, we mean that keying formats and planning should have provision for dealing with unexpected situations and unusual observations. The plan should include training for those undertaking the keying, and this training should enable the keyers to familiarise themselves with the documents. Those performing these tasks should not be considered simply as data-entry staff. They can make a valuable contribution to the data recovery process by alerting managers and colleagues to potential data issues and thereby assist those working downstream from the data entry, for instance in quality control.

It follows therefore, that managers should pre-screen or examine as many of the documents as possible. This must be done in order to:

- Document the form, type and layout of the observations
- Define the data transcription template
- Prepare materials for training sessions
- Alert the data keyers to potential issues with specific logs/observers
- Awareness of unexpected items so that when the keyers come across them, they are ready with instructions provided through the pre-screening process
- Efficiency

There are instances where pre-screening might not be required such as highly standardised forms, or pre-printed or published observations.

3.2. Data keying formats

The output from a keying project should be a set of computer-readable files in a single consistent table format – usually spreadsheet files in in comma-separated or tab-separated format.

Marine documents are diverse in format and content, therefore it is not possible to recommend a one-size-fits-all format for a data transcription template. However, especially with small projects where direct transcription is desired, the format of your spreadsheet should mimic as far as possible the order of the data in the original document or image. This will permit data entry to be carried out more efficiently with less likelihood of errors. Once keyed, the columns of data on the template can be rearranged easily, if required. However, it is vital to key strictly to a consistent format. The format can change between projects, but there should be only one format per project. See also, the Best Practice Guidelines on Formatting, Metadata and Quality Control:

http://climate.copernicus.eu/sites/default/files/2021-05/C3S_DC3S311a_Lot1.3.4.2_2020_BestPracticeGuidelines_Part2.pdf

3.3. File formats

By whichever method the data is transcribed, whether directly onto a spreadsheet or through a web based citizen science project, the keyed output will not be in a suitable format for further processing or inclusion in international archives. At present, all keyed marine data needs to be converted to the International Marine Meteorological Archive (IMMA) format. The conversion of keyed data to IMMA format is not a keying task. However, a member of the project team could undertake this additional work, if that is possible. IMMA formatting tools for Python can be found on the C3S Data Rescue Service portal:

https://datarescue.climate.copernicus.eu/st_formatting-marine-data

Converting the data to IMMA format is outside of the scope of this BPG, but it is important to understand that the converted output, not the keyed data, will be used as the input for future processing, so the keyed files must be entirely machine readable – consistent in structure and format.

3.4. Data Entry Checks

To ensure the accuracy of data entry, some form of check needs to be made. In general, all documents should be double keyed, by two different people, to check for consistency. This is expensive, so in small keying projects, with expert keyers, it may be sufficient to transcribe each document only once and have a supervisor carry out checks on randomly chosen documents and the associated output. This worked well for the CLIWOC Project (2000-2003) where very few errors were detected, (probably due to the high quality of staff employed and good training). Note, that double keying does not just catch keyer errors – it also identifies illegible or incomprehensible records in the original documents.

Multiple keying works very well with citizen science projects. By this process, every document is keyed two, three, or more times, and software is used to compare the output and thus detect keying errors. Again, errors need not indicate carelessness. Handwritten documents, with varying writing styles and quality of penmanship, may be difficult to read and interpret. With a citizen science project, double keying is recommended as a minimum, with treble keying preferred. Keying more than three times might be needed, depending on the difficulty of the documents and the expertise of the keyers.

3.5 Data Corrections

The original documents will sometimes contain mistakes that are obvious to the keyers reading them. An obvious error might include an incorrect date, numbers transposed, a wrong hemisphere recorded, or the wrong side of a meridian, or air temperatures recorded in the sea temperature column of the logbook. These are all real examples, and keyers will rapidly acquire the skills to notice these problems and it is necessary to specify what they should do when these errors are noticed.

There are two schools of thought on whether corrections should be made at the keying stage. One school would advocate keying exactly what is on the page, including any errors in the original document. There is merit in this, but we must ask what is the objective in keying the data? Is the objective to produce an exact copy of the original document when we should already have an image of the original document to refer back to, or is the objective to extract data for research and climate services? The *verbatim keying* of incorrect information will only produce poor data that will be rejected during processing and QC, and require additional work to correct at that stage.

The second school of thought advocates using the keyers to make corrections. Having keyers make corrections adds value to their effort. Experience from previous citizen science projects, has helped to inform us as to how the keying process might be better developed and managed in the future. One thing that these projects lacked was a facility for volunteers to provide value-added input, whether that was corrections to the original documents or other comments. Getting involved in the research process, interacting with the science, and contributing to the success of the project is what attracts volunteers to citizen science, so the facility for volunteers to make these added contributions is important.

Based on the experience of current and past citizen science projects, it is recommended that data transcription projects should allow keyers the discretion to correct obvious errors in the original document and to provide input and comments where appropriate. The keying stage is often the last point where individual observations are looked at by a person. Subsequent stages mostly process observations in bulk, so a problem not fixed by a keyer might never be resolved.

4. Marine Data Documents

4.1. Introduction to the Types of Marine Documents

Historic marine documents come in various sizes, shapes and formats but can be broadly categorised into logbooks and journals, dedicated meteorological logbooks and met forms, whale and other fishery catch books, remark books, hydrographic reports, and ice reports, along with other documents specifically concerned with extreme weather events, such as typhoon reports.

4.1.1. The Marine Logbook or Journal

The marine logbook can also be called a journal, and this older term is often carried into more recent times in some countries, and the term will often be evident in archival collections. There are several different types, with distinct functions. First, there is the personal log or journal, kept by the captain, the master or navigating officer, other ships' officers, such as mates, lieutenants, midshipmen, apprentices and others. These are the usual types of logbook or journal up until the early part of the 19th century. From the early 19th century, you will begin to find the ship's logbook or the deck or navigation logbook. This is usually a fair copy. Infrequently you will find a rough logbook, from which the fair copy was made. There are also abstract logs and engineering or engine room logbooks after the introduction of steam power. None of the above documents recorded information specifically for scientific purposes, although it is clear that some writers had an interest in science and many were careful and methodical in their observations and recording. The logbook or journal was completed to fulfil legal obligations, to keep an account of proceedings for the ship's owner, whether that was a naval service or a merchant ship owner, and to record observations for the purposes of safe navigation.

4.1.2. Marine Meteorological Logbooks and Met Forms

The meteorological logbook or met log, was used to record data of scientific interest, and would have been kept in addition to an officer's journal or a ship's logbook. The earliest met logs were associated with scientific expeditions, especially to the polar regions, and on voyages of discovery. By the middle of the 19th century and especially after the 1853 Brussels International Meteorological Conference, these types of logbook were standardised by the participating countries into a format for recording sub-daily observations over a wide range of atmospheric, oceanographic and biological parameters. In the United Kingdom, in the 20th century, and about the 1920s, a shortened version of the met log, called a met form, was introduced, and this form went through several changes in format and content before it reverted into a different type of logbook that was smaller in dimensions and therefore more easily handled.

4.1.3. Documents from Whaling and Fisheries

Early whaling logbooks are similar to officers' journals, although many are in narrative form rather than the more typical tabular logbook layout. During the early 20th century, and especially after the establishment of the International Convention for the Regulation of Whaling (1937), the whaling companies produced documentation in addition to the usual ship's logbook. These documents include whale catch books, detailing the specifics of daily catches but also including daily barometric pressure, air temperature, winds, weather and ice conditions. There are also Døgn-Rapport, or Day-Reports, from Norwegian ships, inspectors' logbooks, notebooks, diaries and field notes, all containing some elements of meteorological and oceanographic data. There are also books entitled *Record of Whales Captured*, which have separate pages for each capture along with weather and ice conditions. The earliest of these (found so far) date from 1925.

4.1.4. Remark Books and Hydrographic Reports

Remark books and similar documents were used by some navies (mostly in the 19th century) to record hydrographic information for charts and pilot books or sailing directions. They frequently contain meteorological data, either on pre-printed pages, or in blank books, meaning the presentation of the data can vary considerably. In many instances, remark books can be considered as an early form of unofficial meteorological logbook. Meteorological and oceanographic data is also found in other documents such as survey data books, soundings and serial temperature books, and other documents connected with surveying and hydrography.

4.1.5. Ice Reports

Ice reports begin from the early 20th century as official pre-printed documents, usually from whaling vessels and merchant shipping. They report both icebergs and sea ice (i.e., pack ice, etc.) with a date and position. They sometimes detail weather conditions as well as the ice. Ice will also be recorded in logbooks and journals.

4.1.6. Other

There are a host of miscellaneous documents that contain useful data in both original and printed form. These include reports of hazards to navigation (which will include ice), cyclone reports, providing details of particular events, surveying reports and workbooks containing astronomical observations and meridian distances for charts, sailing directions and pilot books, printed periodic journals that often contain extracts from ship logs, and other publications. Good use has been made of these publications in the past, especially printed expedition reports. However, these expedition reports can often be edited, with for instance, detailed ice sightings reduced to the single word ice, so if you have the original document as well, always compare it to the printed version before opting to key the publication.

Although the documents to be keyed vary substantially, the process of keying them is very similar. In each case, the essential parameters (date, time, position, temperature, etc.) must be identified on each page of every document, and typed into a spreadsheet or similar file. The keyer will read each page and ask: "Where is the ship?", "What is the date?", "What is the sea surface temperature?" etc., and type in the answers, in the same format for each page.

4.2 Essential Parameters to be Keyed – non environmental

There are non-environmental parameters that must be keyed and must be included in your keying template. Every observation must be fixed by a date, time and location for it to be of use. However, if any of this essential information is missing from the original document, the meteorological and oceanographic data should still be keyed. This is because the missing information may be found in another document or from another source.

4.2.1. Determining the Date and Time

Dates

Countries adopted a variety of dating formats and this will be reflected in the original documents. For instance, the 4th July 1921 might be written as 4/7/1921 in British documents and 7/4/1921 in the United States. In older documents, the month will be written out in full or a Roman numeral might be used, such as 4 VII 1921. Dates must be keyed from the original document in a consistent and unambiguous format. A keying template must have a separate cell for the year, month and day on the spreadsheet or on the web interface. The format (YYYY, MM, DD) in separate columns is consistent with the format used for terrestrial data and avoids ambiguities.

Care is required with dates, especially prior to the mid-eighteenth century. In Catholic, but not Protestant, countries, the Gregorian Calendar was adopted in preference to the Julian Calendar in October 1582, at which time 10 days were removed. Therefore, there are national differences in dates recorded in ships' logbooks until the Gregorian calendar was universally adopted. Great Britain and its American colonies did not adopt the new calendar until September 1752, when eleven days were removed. September 2 was followed by September 14. Until the change was made, the new year began on 25 March, not 1 January. This means that when working with documents from this period, care is needed to ensure that the correct year is keyed. This is only an issue for the period January to March, on documents prior to the change in 1752, at least in the case of English logbooks. Many logbooks from this period are double dated, meaning for instance that 20 February 1733/34, is 1734 in the modern style. Always use the second, year number. In this instance, what would be keyed is 1734, 02, 20, in separate columns. The adjustment to the modern calendar by removing eleven days will be made at a later stage of data processing, so the adjustment must not be made at the keying stage. If there is no double-dating, in a time period where double dating would be expected, then the issue needs to be flagged and brought to the attention of a supervisor. When comparing marine records with terrestrial records this difference in dating should also be borne in mind. For instance, Japan did not adopt the Gregorian calendar until 1872. Furthermore, when comparing data from vessels of Catholic countries and vessels of Protestant countries prior to September 1752, it is certain that the data will not match or be consistent with logbook entries made on the same dates *as written* because different calendars were kept.

A further issue with keying dates concerns the International Date Line, when a vessel crosses that line in either direction. If you are keying 20th century logbooks or met forms, you will notice that the date will change when the line is crossed. Either a day will be missing or a day will be duplicated depending on the direction of travel. However, the date change may not have been implemented immediately by the logbook writer, and this will need to be corrected at the keying stage. In the 19th century and earlier, the date in the logbook was not changed to account for the International Date Line, as the line had not been formally established. Dating in the logbook continued as usual, and the date change took place once the vessel reached a port. This means of course, that between the Date Line and the port, the date recorded in the logbook is wrong. When this situation is encountered, the date should be corrected from the time of crossing the Date Line, and then checked carefully against the dates entered on the document when the vessel reaches port, to ensure that there is a continuous run of correct dates.

The Structure of the Ship's Day

Determining the day and time of day within logbooks as late as the 19th century can be bewildering if you are not familiar with the structure of the ship's day or nautical day. It may be necessary to make adjustments to your keying format to better accommodate this structure. The ship's day revolved entirely around noon, as this was the time of day that the ship's position would be determined, and a revised course calculated. In effect, the ship's day ended at noon, and a new day began, meaning that the ship's day was twelve hours ahead of the civil day. In many 18th century English logbooks, the date changed at noon, not at midnight. This at least was the English practice, and if you are keying for instance, American, French, Dutch or Spanish logbooks before the mid-19th century, you need to check carefully how the logbook and the ship's day is structured. If this is overlooked, then sub-daily observations will be assigned to the wrong day and date.

The practice of logging entries according to the nautical day ceased in the British Royal Navy in the first decade of the 19th century (Admiralty order of 11 October 1805), when the civil day was adopted but not implemented with immediate effect and the old nautical day structure would have continued with merchant shipping. It should also be noted that whenever a vessel was in port, the ship's time would revert to the civil day and would then revert to the nautical day when the ship sailed. The transition from one to the other can be especially confusing. The logbook should note something like 'This log contains 12 hours' on entering port and 'This log contains 36 hours' on the day of departure.

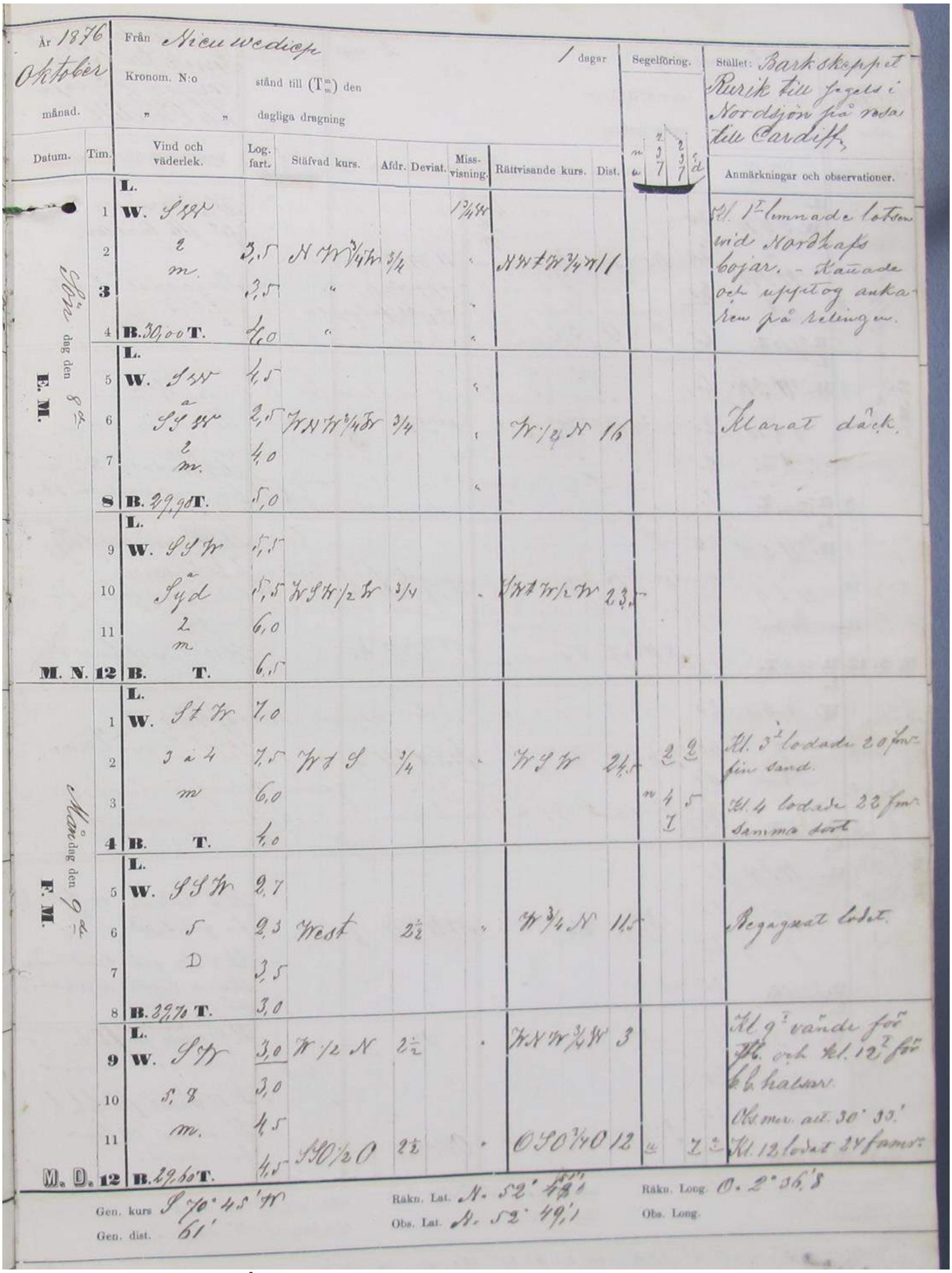

Fig. 1. Maritime Institute of the Åbo Akademi, Turku Finland - Barque Rurik, 8-9 October 1876

The format of the logbook page can sometimes alert you to the daily structure in use. In the nautical day, and assuming the format is one day per page, the noon observations will be at the bottom of the page as these are the last sets of observation of the day, and here you will find the ship's noon position, course over the last 24 hours, etc. If the daily noon position, and course made good are in the centre of the page, this is a clear indication that the civil day structure is in use. However, there are many examples in the 19th century where the structure of the nautical day is preserved in the format of the logbook, but the civil day is followed.

In the example of the Finnish barque, *Rurik* (Fig. 1), you will see that the format is one day to a page. The first set of observations are at 1pm in the afternoon of 8th October 1876 and follow through to the noon observations on the 9th October towards the bottom of the page. The civil day is accounted for by having two different dates on the same page, and helpfully the midnight and noon observations are marked as MN and MD. In this example, the notation EM and FM are the equivalent of PM and AM in English. Times of observations are in **bold**: 3pm, 8pm, midnight, 4am, 9am and noon. The weather observations recorded here are wind direction (cardinal points), wind force (a number but not necessarily the Beaufort scale), weather (a letter), barometric pressure (in inches). There are no temperature observations in this example, but they would be recorded where the bold **T.** is located. The keying template for this type of logbook would be no different to a template for a logbook with a single date to a page. Therefore, keyers need to be alert and take notice of the date changing halfway down the page, ensuring that the keyed observations are assigned to the correct day.

Time of Day

The notation used to specify the time of day can vary but is usually the hour, as in the example of the barque *Rurik* above. In some much older logs and journals, the day might be divided into three parts (first, middle and third/last) denoting the times between noon-8pm, 8pm-4am, and 4am-noon. Each of these three divisions would contain two four-hour watches, but you will find that this is not indicated, the day only being divided into three parts. Assigning a time to these observations is necessary. The noon observation, which from the point of view of the ship's officers is the most important observation of the day, is clearly at the end of the third part of the day, and therefore the two other observations should be assigned to 8pm and 4am, which is the corresponding endpoint to the first and second parts of the day. In this older type of logbook, observations are descriptive, usually just of wind and weather and describe the general conditions over the preceding eight hour period. If there is an instrumental observation, it is usually only a single observation and written down at noon. In other logbooks, there may be two sub-daily sets of observations noted as AM and PM, or in the case of the nautical day PM and AM. In this case, logbook entries describe conditions over the previous twelve hour period. One of those periods will end at noon, meaning the other period will end at midnight. Any single instrumental observation will be at noon.

In the logbook of the Danish frigate *Docquen* of 1750 (Fig. 2), the numbers 1 to 8 signify the number of bells rung on the half hour within each watch, with eight bells being at 4am, 8am, noon, 4pm, 8pm and midnight. In this instance, the pre-screening of the log and the setup of the keying template would need to account for potential sub-hourly data, not just hourly data.

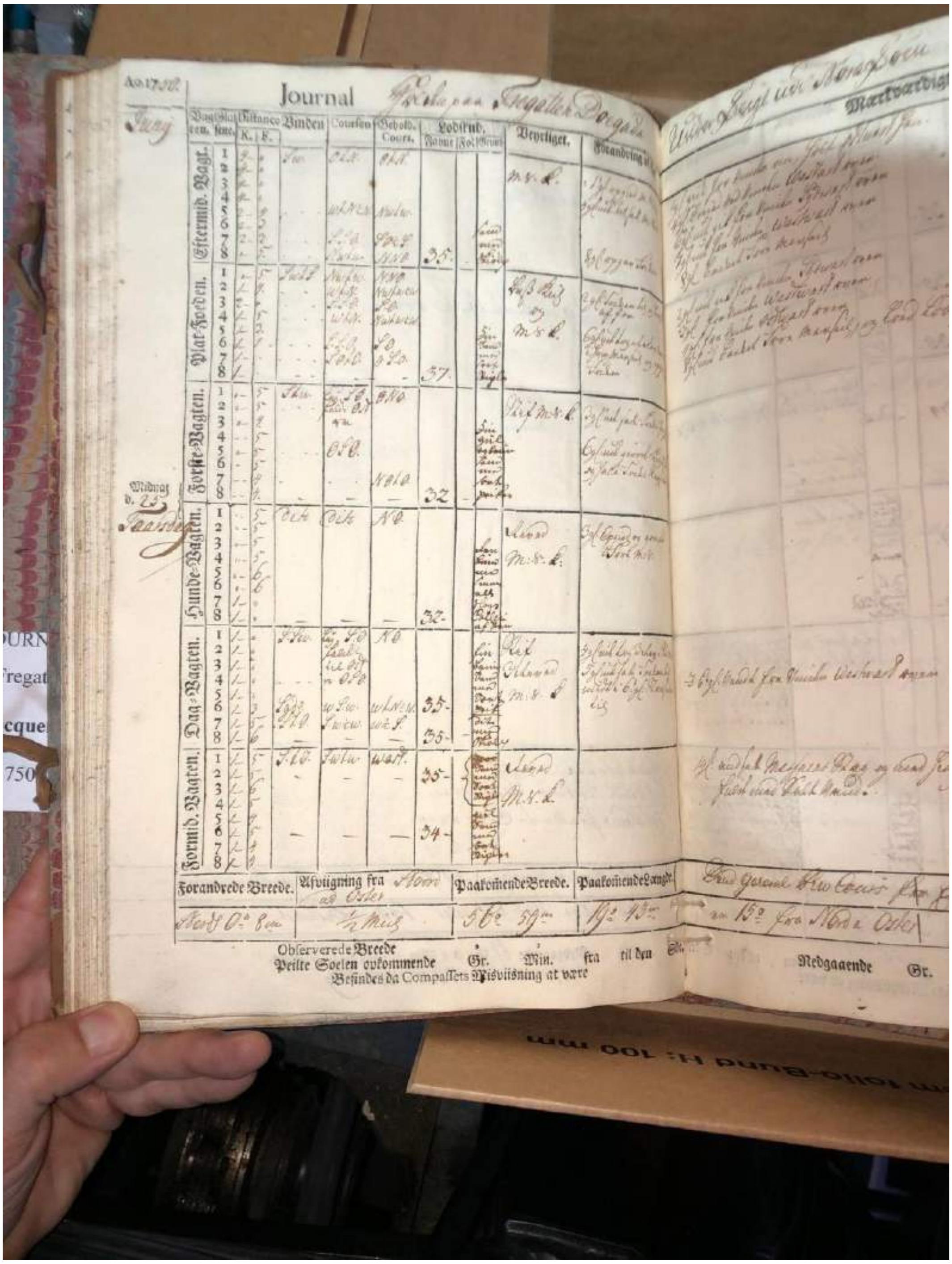

Fig. 2. National Archives of Denmark, ref. 452B-4 – 453-4 - Danish Frigate Docquen 24/25 June 1750. The time of day within each four-hour watch is designated by the number of bells struck (1 to 8) on the half-hour. (photo by Adam Jon Kronegh)

There will be many older logbooks (18th century and earlier) where there is a single daily set of observations with no time assigned to them. This is invariably a set of noon observations. However, there are more modern instances where the single daily observation is not a noon observation, and these are likely to be found in documents that are not navigation or deck logbooks.

Dagbokens anvendelse.

Rubrikk 3. Her opføres middagsposisjonen så nøie som mulig.

— 4. Her opføres lufttemperaturen kl. 8 samt barometerstand til samme tid. Vind, vær, sjø og isforhold føres som det har artet sig i store trekk for hele ettmålet.

— 5. Her føres innbragt hval. Med innbragt hval forståes hval som er levert til kokeriet eller til bøiebåt, eller hval der holdes av hvalbåt som er kommet til kokeriets posisjon, og som altså bare venter på å få sine hval avlevert.

— 6. Her føres den olje som er utkokt i de forskjellige kieler eller

Fig. 3. St. Andrews University, Archive of the Sea Mammal Research Unit: MS38600/1/5/FH/1/3, Catch Book, Whale Factory Ship Hektoria, 1938. The instructions show that the single set of observations of temperature and barometric pressure are at 8am (kl. 8), along with observations of the wind, weather and sea. The daily position recorded is at noon (middagsposisjonen).

In the case of Antarctic whale catch books in the first half of the 20th century, those issued by the British Board of Trade specify that all the daily meteorological observations should be noon observations. However, the corresponding documents issued by Norwegian authorities (Fig. 3) have a mid-day position recorded but with the meteorological observations made at 8am. It is, therefore, important for a supervisor to also examine the printed instructions to be found at the front of the book during the pre-screening stage, and this should be done with most documents as the instructions may be amended or have changed over time. Keyers can then be alerted to the fact that the meteorological observations are at a different time to the noon position. In this instance, the data to be keyed would be 8am meteorological observations (with no position entered) and then on the next line, noon (with no meteorological observations) and the vessel's position.

Time Zones

When keying meteorological observations from 20th century deck logbooks, managers should consider how to deal with ships that adjust their clocks to the time zone they are passing through. The time zone was recorded in Royal Navy logbooks from about 1920 onwards and it is likely that other national navies and merchant vessels recorded this information from about the same period. The US Navy was using time zones in WWII and probably much earlier (Logbook CL58 USS *Denver,* 1941). Time zones were a departure from earlier logbooks that kept 'local time', which was reset at noon every day. The local ship's time will normally differ from Greenwich Mean Time (GMT) according to the distance of the ship's noon position from the Greenwich meridian and this would equate to one hour for every 15 degrees of longitude. Logbooks using a time zone recorded a figure plus or minus GMT, either as a whole figure or a fractional part. Time zones to the west of the Greenwich meridian are plus and those to the east are minus. Note, that this is the opposite of modern practice, where time zones to the east of the Greenwich meridian are UTC +, and west of Greenwich UTC -. When the 'zone kept' is recorded in the logbook, it frequently does not adhere to strict boundaries, and many vessels recorded a minus figure when west of the Greenwich meridian, as did, for example, HMS *Alcantara* in December 1942 (Table 1).

Table 1. HMS Alcantara Dec 1942 – Time Zones

Day	Time Zone Kept	Longitude
24	-2	5.44E
25	-1	1.53E
26	-1	2.07W
27	-1	6.12W
28	GMT	10.41W
29	GMT	13.43W
30	GMT	Freetown

There are practical explanations for this. Each ship effectively carried around its own time and if sailing due east or west would need to adjust its internal time as it crossed into different time zones. However, it was sometimes inconvenient for a ship to constantly adjust its clocks. If a ship's port of departure and destination were both in time zone –1 and the route carried the vessel from zone –1 to –2 and then back to –1, it made no sense to alter the ship's clocks and consequently the vessel's domestic routine. Therefore, the ship's time does not strictly coincide with local time, the only exception being of course, that precise local noon was required to determine the ship's longitude. It is also possible that two ships, having commenced their voyage in different time zones might meet or record the same event in their logbooks but at different hours. This need not be an error and merely reflects the nature of their movements across the ocean. It should be assumed therefore that when the noon position is recorded in the logbook this is with reference to local noon. The question then arises as to whether the other hourly logbook entries and four-hourly met observations are made according to time reckoned from the noon observation or the time zone kept (ie +/- GMT or a fractional part). The instructions issued by the (British) Naval Meteorological Branch, and printed in the front of the logbook, clearly states that 'Observations should be logged at 0000, 0800,1200,1600 and 2000 *time zone*' (HMS *Newcastle* 1941).

This complicated issue is dealt with at the data processing stage, nevertheless keyers will need to know how to enter information where a time zone is indicated, so that the data processing can be undertaken efficiently. Where adjustments to the ship's clocks are noted in the logbook or where a ship records the time zone kept, provision must be made in the keying template to record this information. Keyers should record the time zone as stated in the logbook (e.g. GMT, +3, -8, etc.), regardless of the actual position of the vessel, and ensure that each time zone other than GMT has +/- to avoid ambiguity. Keyers must also record (in the same time zone column or set of cells) when the ship's clocks are advanced or retarded, and by how much. With this information, all necessary adjustments can then be made during data processing.

4.2.2. Determining Position

The second essential parameter to key is the ship's position. Position is the most complex and potentially problematic parameter that needs to be keyed. At sea, a ship's position will be expressed as a latitude and a longitude, in degrees and minutes, and either prefixed with or followed by a letter denoting the hemisphere. In the example of the *Rurik* illustrated above (Fig.1), near the bottom of the page, the observed Latitude (obs. Lat.) is 52° 49'N or north latitude. In this example there is no observed longitude, but there is an estimated or calculated longitude of 2° 36'E or east. The 'O' before the number is the abbreviation for East in Finnish and Swedish logbooks. In English language logbooks it would be 'E'. Note, that there is also an estimated latitude. Estimates of daily noon position, called 'dead reckoning' (abbreviated as DR, or in this example the Swedish Räkn), were always recorded, and observed positions were included when a noon sighting of the sun was possible. Where there is no observed position recorded, then the estimated position should be keyed. Where both are recorded, then both should be keyed. Significant differences between the observed and estimated positions can indicate that a strong ocean current has been encountered over the previous 24 hours, and this difference was one of the traditional ways of calculating the speed and direction of a current.

Latitude is always north or south of the equator and denoted by N or S, either before or after the position. Longitude was not expressed in such a simple way until the late 19th century or early 20th century. Today we express longitude as being either east of west of the Greenwich meridian, and scientifically by using a notation whereby west longitude is a negative number and east longitude is a positive number. Longitude is always expressed as being either east or west of a meridian, but that meridian can be assigned to any point on the Earth. Before the 1850s and in some cases much later, do not assume that the longitude recorded is based on the Greenwich meridian. Provision should be made for keyers to record which meridian is being used.

In early English logbooks, the meridian used was the last sighting of a major landmark and under this system all longitudes were estimated. A voyage from England to Bombay would have a different meridian for separate passages, beginning with Start Point in the English Channel, then Madeira, one of the Canary Islands, one of the Cape Verde Islands, Cape Agulhas, at the southern tip of Africa, and then one of the Comoro Islands at the northern end of the Mozambique Channel. At each of these sightings of land, the ship's position would be verified and the longitude reset to zero**.** During the course of the CLIWOC Project, it was determined that over 600 different meridians had been found in the logbooks used by the project (CLIWOC, 2006). **When keying data, the keyer must be alert to changes in meridian, and provision in the spreadsheet should be made for noting the name of the meridian being used.** The data to be keyed will be the name of the meridian/landmark, not the actual longitude of the meridian. If a change of meridian is missed, or if it is not clear which meridian is being used, it is a simple task to go back through the log until the longitude approaches, or is very close to, zero. At this point, there will be a bearing to a landmark close by the ship, and usually in sight from the deck. This landmark will be the new meridian. In most cases the keyer should be able to work out which meridian is being used.

European nations adopted a prime meridian before Britain, and the English began to do so by c. 1780s, including in particular, the vessels of the English East India Company (EIC). The meridian used by English EIC ships was London, and this was a line that passed through St. Paul's Cathedral, and therefore slightly west of the present Greenwich meridian. Other European nations in the 17th and 18th centuries used El Hierro, the westernmost of the Canary Islands as a prime meridian. This prime meridian continued in use on many Norwegian, Swedish and Russian charts into the 19th century (*Horsburgh, 1852, p.11*). In the 19th century, prime meridians were often based on the longitude of observatories at Greenwich, Paris, and Cadiz. If in doubt as to whether the Greenwich meridian is being used, check the longitude recorded by the ship against the longitude (as per Greenwich) of a landmark once the vessel is close to that landmark. Google Earth is especially useful for this exercise. The result will not be precise but certainly close enough to remove doubt. A practical example of how to do this, using longitudes recorded on board HMS *Starling* in 1837, is provided in the appendix. (6.3)

There are infrequent examples of vessels calculating their longitude beyond the anti-meridian (180°) or International Date Line. So, a longitude of 210°W of Greenwich would equate to the modern 150°E. It was simply a different way of expressing the same thing. Keyers *should not* change the longitude to the modern equivalent, as what is recorded here is not an error. A calculation is required and the conversion is a data processing task. In this example the longitude recorded also alerts the data processing team to the fact that the vessel has crossed the International Date Line, and should prompt a check of the dates recorded.

Sometimes there is no position recorded in the logbook, and this is always the case when a ship is in port. In sight of land, and usually in coastal waters that the ship's captain was familiar with, the latitude and longitude was not recorded, simply because there was no need to, a reminder again that ships' logs and journals were kept for practical purposes and not for the recording of scientific data. This was common practice close to a port, in enclosed seas such as parts of the Baltic, narrow straits such as Malacca, or Magellan, amongst island groups, especially Indonesia, and on large navigable rivers such as the Yangtse.

An approximate position can still be keyed if there is an observation giving the bearing and distance to a landmark. If the landmark is close by and visible from the ship, the bearing will be magnetic (except Dutch ships). If the bearing is taken from a chart (ie the landmark is not in sight from the ship), then the bearing will be true. For the purposes of estimating the ship's position, it is sufficient for keyers to record just the name of the landmark, which would normally be close by. Provision should already have been made in the keying template to record the name of a port or place if the ship is at anchor and that would be a suitable place to record the landmark. It is important for keyers to record places such as ports in an unambiguous fashion. A place called Devonport can be found at Plymouth in England and at Auckland in New Zealand. Plymouth itself can be found in England, in Massachusetts USA, Tobago and Montserrat. Whoever is keying the data will know where the ship is, somebody processing the data will not, so the general location of ports and landmarks must be clear. There will be instances where the landmark to be keyed is some considerable distance away from the vessel and it would be best to record the bearing and distance as well. In the absence of an observed or estimated latitude and longitude, keyers should provide as much information as they can. They should key the name of a port or landmark if it is close by, or approximate the position as much as possible. Keyers will always know where the ship is, so even an approximate latitude and longitude can be processed, whereas an unstructured comment, or no information cannot.

Some of the notation used to record bearings will be unfamiliar and may not be recognised as such by keyers. The bearing will either be a compass point or a combination of letters and numbers, but seldom a bearing in degrees until the 20th century. The letter/number combination will be unfamiliar to many but is very simple. Typically, it will combine two cardinal directions such as South and East with a number. In the example S15E, the prime cardinal direction is South, adjusted eastwards by 15°. South in degrees is 180, meaning an adjustment eastward of 15 is to subtract that number (180-15=165). S15E is therefore a bearing of 165°. Likewise, N60W would be 300°. When keying a bearing, the original notation should be entered but it is worthwhile if both managers and those performing the keying have some familiarity with what was being recorded.

The distance to a landmark may also use unfamiliar terms. Older logbooks and journals recorded distances in leagues. A league is three nautical miles. Conversion to nautical miles could be performed at the keying stage by including a cell with a simple formula where the number of leagues can be automatically multiplied by three. As stated before, the bearing and distance to a landmark, or just a landmark if close by, should be keyed if no other positional data is available, or a close estimate of position cannot be made.

In polar regions, omission of positional data was common even in the 20th century. The reason for this is simple. If a whaling ship was drifting along the edge of the ice pack, the ship's position was irrelevant for the purposes of navigation, so it was not recorded, at least in the navigation log. A position was only needed in order to set a course to another place, so the whaling ship would not need to record its position until it decided to leave the ice pack and head out into open ocean. Even in these circumstances, where no position is recorded, any weather data should be keyed as the necessary positional information may be found in another document, such as the logbook of another vessel arriving in the vicinity, or a corresponding fisheries catch book, where the ship's position has relevance. **Managers should note that in certain circumstances, such as this, it is worth keying the names of other vessels sighted or in company.** Make sure that the keying template has provision for this additional information. The point here also, is that although position is an essential parameter, when it is missing, the weather observations should still be keyed.

Sometimes things will go wrong or not look right. If the position you have keyed is clearly wrong, the keyer or a supervisor needs to determine if something has been overlooked such as a change of meridian, or if the problem is to do with the document and the way the information was recorded. We might have an example where the position of the ship is over land, so what went wrong? There are several things that must be checked.

1. Has the position in the logbook been keyed correctly?
2. Is the correct meridian being used?

Once you determine that the above have been performed correctly, it only remains to flag the issue or correct the error if this is feasible. To assist with these sorts of decisions it is worthwhile reviewing why these apparent errors occur.

The writer may have written the position incorrectly, such as transposing numbers. Sometimes the wrong hemisphere is noted, or the wrong side of the meridian is recorded. These errors are easy to see and to correct.

In older logbooks, a common reason for a vessel to apparently be over the land towards the end of a voyage is to do with early navigation, especially before the widespread use of chronometers and accurate charts. When navigating by estimated position or dead reckoning, it was common practice to keep the estimated position slightly ahead of the ship. If on the other hand the ship was ahead of the estimated position (due to an undetected strong favouring current, for instance), there was danger of the vessel running into the land, especially at night or in poor visibility. This 'safety cushion' would be one reason for the ship appearing to be over the land towards the very end of a voyage, but in reality the vessel was safely behind its dead reckoning position. This deliberate error in recording an estimated position is not so significant as to invalidate the location of the observations, unless the difference is clearly a large one. A second reason for this apparent error, and possibly the most common reason in early logbooks is that the positions of landmarks, ports, islands etc. and therefore the meridian being used, were themselves 'best estimates'. This meant that the ship's estimated position was relative to another estimated position. This situation only improved after new surveys and improved charts became widely available in the 19th century. In this instance, there is little that the keyer can do other than enter what is recorded in the logbook. Provided that the name of the meridian is also keyed, the ship's position can be adjusted at the data processing stage.

A set of incorrect positions can also arise when a vessel makes an unexpected landfall, for example, arriving at an island such as Barbados sooner than expected. In this example, you find that on the last day before sighting Barbados the ship has covered 350 miles, whereas on all previous days it was never more than 120 miles and often less than this. The 'distance made' of 350 miles is wrong, and an experienced keyer will pick this up and know that an 18th century vessel cannot cover 350 miles over a period of 24 hours. This is a real example from the CLIWOC Project and what has happened here is that the ship had been subjected to a strong favourable equatorial current for days and possibly weeks after leaving West Africa, and was ahead of the captain's reckoning until Barbados was sighted at least two or possibly three days before it was expected. As a consequence, the estimated daily positions before the vessel arrived at Barbados are incorrect. The question that now arises is what can the keyer or a supervisor do to correct this error, or assist the data processing team to correct the error. Should they even attempt to do so?

The answer is yes, they should. With this example and in many other similar situations, the keyer is best placed to know that the information recorded in the log is in error. Somebody processing the data might simply assume that 350 miles covered in a single day by an 18th century vessel was not only possible but not at all unusual. The keyer and supervisor would need to flag this error so that it is brought the attention of the data processing and QC teams. QC might then use the course and speed recorded in the original document to re-calculate the ship's position backwards in time from the landfall on Barbados. If appropriate, as much information as possible should be provided by the keyers, to assist with this process.

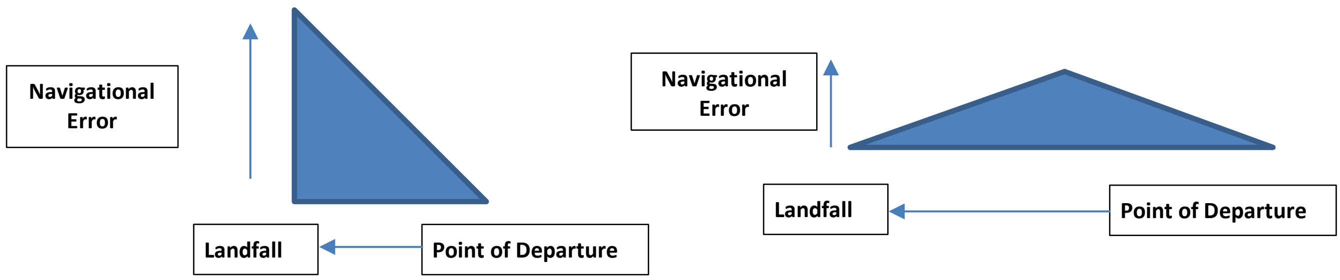

Fig. 4. Navigational error will accumulate over time when daily positions are estimated instead of being observed. In this illustration, a constant rate of error is assumed for illustrative purposes. The largest error will be recorded prior to making a landfall (observed position). By recalculating the daily position back from the landfall, the largest error will be halfway between two observed or verified positions (point of departure and landfall).

The information needed from the keyer to recalculate the daily positions back from the landfall are date, position, course made good, and distance covered over each 24 hour period. Alternatively, the data processing team can refer back to the original images. Information will be needed as far back as halfway between the landfall and the last 'observed' latitude/longitude, or some other clear reference point or point of departure. The largest amount of navigational error will then be at the halfway point instead of at the end of the voyage (Fig. 4).

In conclusion, correctly keying ship positions will prove to be the most challenging parameter. If you are keying older logbooks, especially those from the early 19th century and before, then particular attention needs to be paid to this parameter. Many of the issues that are likely to arise have been discussed above. However, it is recommended that supervisors and keyers will find it useful to read through the relevant sections of the CLIWOC Project results (CLIWOC 2006), where these situations are also discussed. The book can be downloaded at:

https://op.europa.eu/en/publication-detail/-/publication/5d39314a-89df-4059-80eb-427f5ca0e35a

4.2.3. Additional Parameters that might be keyed and why.

As outlined above, the important non-environmental parameters are date, time, and position. There are additional optional parameters that may be keyed, but managers will find that these are usually not worth keying due to time and resource constraints. Nevertheless, in certain situations, or in fulfilling particular project objectives, some of these additional parameters will prove useful. In the section immediately above, we had an example of the daily distance covered by a vessel being clearly incorrect, and this fact indicates that the vessel's positions over the previous few days were also incorrect. The example given above was a real Royal Navy ship that had been subject to strong equatorial currents on a voyage from West Africa to Barbados. Keying, or at least taking notice of the daily distance logged can, as in this case, be an indicator of such errors. An additional use of the daily distance logged can be to indicate the edges of the trade wind belts and the Inter-Tropical Convergence Zone (ITCZ). On losing the trade winds, in the Atlantic for instance, the daily distance covered by a sailing ship drops dramatically as it enters the equatorial calms and suddenly increases again when the trade winds are regained. This, therefore, provides a date and location for the edge of the ITCZ or the monsoon trough if the vessel is in the China seas or Indian Ocean. Such data might be useful to researchers interested in monsoon studies.

Furthermore, keying sub-daily courses and speeds may assist in determining a ship's position at times other than noon or help determine a daily position where this information is absent. However, keying these parameters will be time consuming if the process is not automated, and managers should weigh the benefits of the keyed data against the time and resources to hand. If the original documents have been imaged, it will always be possible for data rescuers to extract this information at a later date.

Another piece of potentially useful information can be found in the logbooks of certain ships in the mid-19th century. These are early steam vessels that employed sail as the primary motive power. The logbook will state whether the ship is under sail or under steam. This fact may have a bearing on the weather observations recorded, depending on the potential exposure of the instruments to ship heating. More importantly however, the wind direction and wind force characteristics will be altered when the vessel is steaming, rather than under sail.

During the screening of documents, managers should review the range and characteristics of any ancillary information in the documents to be keyed and design the keying templates accordingly.

4.3. Essential Parameters to be keyed – Environmental

4.3.1. Barometric Pressure

What does a barometric pressure observation look like? Most observations you are likely to encounter will be in inches, millimetres or millibars. Observations in inches will appear in the range of 27 or 28 to 31 inches of mercury. A typical example might be 29.62 inches. The equivalent in millimetres would be 752 mm and in millibars 1013 mb. Each type of measurement is distinctive and recognisable, and should not be difficult to identify. Be aware, however, that very early marine pressure observations (from the 17th-18th centuries) may make use of other scales such as French lines or French inches which are different to English inches. You will frequently find that pressure observations in inches have been truncated. This means that the initial observation might be 29.62, and subsequent observation will be written as .59, .55, .53, etc. Keyers should enter the observations in full as 29.59, 29.53, 29.53, etc.

The pressure data recorded could be a single daily observation usually at noon or a sub-daily observation at a specific time. In the example from the *Rurik* previously shown (Fig. 1), there are four sub-daily pressure observations, next to the **B** printed in bold type, and the observations are in inches. More typically there will be a column headed Barometer, Bar or some other abbreviation. A pressure observation might also be found under a column marked with an S or the abbreviation Symp. This is also a pressure observation, but from a sympiesometer (see section 5.1). Some documents may record simultaneous observations from multiple instruments, such as a mercury barometer and a sympiesometer and an aneroid barometer. The keying template will need to be adjusted to accommodate multiple observations if you intend to key data from more than one instrument. If you have a choice of instruments, but intend to key only one of them, then use the observations from the mercury barometer. Some meteorological logbooks will have separate columns for corrected and uncorrected barometric pressure readings. If you decide to key only the corrected reading, then it should be made clear that the observation is corrected.

Another observation associated with the barometer is the temperature observation from the attached or adjunct thermometer. This measures the ambient temperature near the barometer so that it can be corrected for temperature. This should always be keyed. However, in some older logbooks and especially those not specifically designated as meteorological logs, it may not be clear if the temperature observation recorded is an attached thermometer or some other thermometer. The difficulty under these circumstances is where to assign the observation when it is keyed (see section 5.3). In this instance, provision would be needed to record a generic temperature observation if it cannot be identified as an observation of the attached thermometer or an 'on deck' air temperature.

4.3.2. Air Temperature and Humidity

Most temperatures in ships' logs will be recorded in either Fahrenheit or Celsius (but see section 5.5c below for exceptions such as Reaumur). They will be often be marked F or C, but if not marked, it is usually easy to tell the difference, for instance 54F is equal to 12C.

Temperature observations may be marked **T**, or in a column headed 'Temp' or some other abbreviation. In many logbooks, the column is headed 'Air' indicating an air temperature observation. In meteorological logbooks, there will be a range of columns for temperature. One will be headed 'Att therm', or just 'Att', and this is the observation associated with the barometer (see above). Another column will be headed 'Dry Bulb' and this is the same as the air temperature. Another column will be headed 'Wet Bulb' and this is used to measure humidity. Other instruments that measure humidity might be headed Hygrometer (Hygr) or Psychrometer. The dry and wet bulb thermometers are usually housed within a screen to protect them from direct sunlight and sea spray. The screen could either be fixed or portable, but might in some instances be placed in an inappropriate position, causing a warm bias in the observations. Sometimes, therefore, the screen would be moved to a better location or the issue of faulty readings noted in the logbook. Additionally, the instruments might change due to one of them being broken, faulty or lost overboard. Provision should be made for keying this information if it is noted (see also section 5 below on metadata).

From the early to mid 1930s, some larger naval vessels began using a distant reading thermograph (DRT) to record dry and wet bulb temperatures, instead of using thermometers housed on deck in a screen. The thermometer bulbs of the DRT were attached to a mast or yard with a capillary leading down to a recording instrument. Such drastic changes in recording practices will often introduce biases into the observations, and these will require correction at a later stage. Therefore, if a DRT is being used, then the keying template should contain separate temperature columns so that these observations can be processed separately from the usual screen thermometer observations. Again, this serves to ease the data processing and quality control procedures downstream from the data keying.

Temperature observations should be keyed with great care if the vessel is in very high latitudes, especially the polar regions. Negative temperatures can be problematic. A column of negative temperatures may only have the minus sign at the head of the column. Alternatively, negative temperatures may be in red and positive temperatures in black. This can result in an observation being keyed incorrectly, and in the past this has been a problem. Managers should review the documents and make proper provision to see that any negative values are entered correctly. Whatever way negative temperatures are presented in the document, they must be keyed in a consistent and regular form (e.g. -3 or -11.56).

4.3.3. Sea Temperature

Much of what has been said above, on air temperatures, also applies to sea temperatures. Sea surface temperatures or SSTs become common in ordinary logbooks by the second half of the 19th century. This is in part to do with the issuing of dedicated meteorological logbooks by proto-meteorological agencies after the 1853 Brussels Conference on Marine Meteorology, and partly due to the advent of steam power. Sea temperature observations were needed to monitor the temperature of the water to cool the engines and supply additional water to the condensers.

Sea temperatures and even sub-surface temperatures have been found in ship's logs and other documents as far back as 1749. In early logs (pre-19thC), an SST observation might be written in the remarks section as there was not usually a designated column for SST. Where written in the remarks section, you will find the word 'sea' or 'water' or a 'W' next to it, or the equivalent in some non-English logs such as *Vatt* or *Vattnet* (Swedish) or *Vann* (Norwegian). In later logbooks, from about the 1880s, there was often a column headed 'Sea', and frequently this was next to the column marked 'Air'. Because the two columns are adjacent, some care needs to be taken with data transcription. If, for example, only the air temperature is observed, there have been instances where the logbook writer strayed into the sea temperature column to record the air temperature. The mistake is usually obvious and should be corrected at the keying stage.

If sub-surface sea temperatures are recorded and keyed, then ensure that these are keyed as sub-surface observations and not sea surface observations.

4.3.4. Wind Direction

Wind directions in all logbooks are designated according to a standard 32 point compass and describe the direction from which the wind is blowing. Rarely, a 64 point resolution was used with the addition of a half-point, for example SE by E½E (meaning midway between Southeast by East and East Southeast). Most often however, mariners would employ a coarse resolution in wind direction, using 16 or even 8 points or with entries such as SWly or south-westerly (Wheeler, 2005). Wind directions need to conform to a standard vocabulary so entries such as SWly would be keyed as SW.

In all logbooks, apart from meteorological logbooks, there will be no indication or confirmation as to whether the wind direction is true or magnetic. This is because wind directions, on British ships at least, were always magnetic. What was common practice did not need to be explicitly stated. Magnetic wind directions will be found in British logbooks from the earliest times, and in Royal Navy logbooks, until the period after the First World War.

The 1915 edition of The *Marine Observers Handbook* states:
The direction of the wind is given by the quarter from which the wind blows. For meteorological purposes, the geographical or true direction is required. It is the practice on the ships of the Navy for all directions to be logged according to the magnetic compass, but on merchant ships the true direction has come to be regarded as the most convenient, and the column in the meteorological log should accordingly be carefully headed.

Unless specifically stated as true, it is safe to assume that wind directions are magnetic. Note, however, that Dutch ships recorded true wind directions, as their officers corrected the compass for magnetic declination daily. This was remarked upon as early as 1789, by William Bligh who was taking passage on a Dutch vessel from Timor to the Cape of Good Hope. Early Dutch logbooks do not state that the wind directions are recorded as true for the same reason that English logbooks do not state the winds are magnetic. If an early logbook happens to indicate one or the other, then key this information.

During the 20th century, and post-World War I, there was a transitional period where the recorded wind directions moved from magnetic to true bearings. British Royal Navy logbook formats show that sometime in the 1920s or 1930s the wind directions recorded in Royal Navy logbooks were with reference to the geographic pole, or true north, rather than the magnetic pole. The relevant column in logbooks of the late 1930s is printed 'wind direction (true)', so there is no ambiguity over this. However, printed logbook pages of the early 1920s indicate that only the ship's course was recorded as true. This was a development from the use of the new gyro-compass. So, there is a degree of ambiguity with wind directions in the logbooks of the 1920s, at least with the British Royal Navy. It is best to be cautious and look out for 'true' being noted on the heading at the top of the winds' column. There is however, a certainty that on Royal Navy vessels, magnetic bearings were recorded for both course and wind direction up to the end of the First World War (1918). The logbook of HMS *Alcantara* in 1915 shows courses as 'standard compass course' that are magnetic, and the wind direction recorded as in earlier logbook formats. Furthermore, the front cover of the 'Convoy Orders for the Mediterranean 1918' (UK National Archive, ADM 137/2648), clearly states in a large bold type that all courses and bearings are magnetic.

4.3.5. Wind Force

All early wind force observations were descriptive. These were studied during the course of the CLIWOC Project, and English, Spanish, Dutch and French terms were converted to Beaufort equivalents (CLIWOC Multilingual Meteorological Dictionary, 2003). The dictionary can be accessed via the following link:

https://www.knmi.nl/kennis-en-datacentrum/publicatie/cliwoc-multilingual-meteorological-dictionary-an-english-spanish-dutch-french-dictionary-of-wind-force-terms-used-by-mariners-from-1750-1850

With early logbooks and journals, the wind force descriptor should be keyed. The conversion to modern equivalents is a data processing task.

The Beaufort wind force scale was coming into use by the second quarter of the 19^{th} century. It is a 13-point scale (0-12), widely used by the end of the 19^{th} century, even in non-English logbooks. It should be noted however that it was not universally adopted. What looks like a Beaufort wind force number may not be a Beaufort number. A 7-point wind force scale can be found in logbooks kept on board Norwegian ships in the 20^{th} century. If in doubt, there will often be a set of instructions on how to complete the logbook, printed on the first few pages, and the scales and notation to be used can be found there. Key the number used to record the wind force. If the number is clearly not a Beaufort number, or if you have strong reason to think that it is not a Beaufort number, then the keyer should make a comment on this.

4.3.6. Weather and Visibility

Early weather observations are descriptive and usually found in the remarks section, with some of the terms used being interchangeable with visibility (for example, clear, hazy, fog etc.). Francis Beaufort developed a letter designation for weather observations and these are commonly found by the second quarter of the 19^{th} century. Most countries adopted the Beaufort letter designation or their own version it. The designation to be used should be printed within the first few pages of the logbook. Like the wind force, the data to be keyed should be the weather descriptor or the letter designation written in the logbook.

4.3.7. Upper air Observations

Early marine upper air observations are rare. They can be found from the early 20th century, especially the World War I period onwards. They will be found in the logbooks of naval vessels that carry either a single small aircraft or in the logbooks of aircraft carriers. Data can be recorded from weather balloons or from the aircraft themselves. Some research vessels may also make upper air observations. Managers should look out for upper air observations from the logbooks of appropriate vessels and make provision for the data to be keyed. The data to be keyed will be the temperature, pressure, and the altitude at which the observations were made.

4.3.8. Oceanographic observations (other than SST)

Oceanographic observations will be found in most logbooks. In early logbooks, these entries will be in the remarks section with descriptive observations of waves, swell and ocean currents. In meteorological logbooks, you will find a more formal recording of oceanographic observations, with various scales used to record sea swell, wave height and/or sea disturbance. Managers should note which scale is in use from the printed instructions at the beginning of the logbook. As well as sea temperatures, meteorological logbooks will often record the density or salt content of the seawater, also called specific gravity. The column where this is recorded will be headed specific gravity or might be headed hydrometer. Ocean currents will be noted as the direction the current is flowing, and in a true direction (therefore the opposite of winds). The rate or speed of the current will be either a daily rate or an hourly rate, and it should not be difficult to distinguish between the two, but the interval must be noted.

Your project may not need or want these additional observations, and if they are extensive, may use valuable time and resources to key them. If these observations are not keyed, then this fact must be recorded somewhere to ensure that there is no future assumption that all the data from a particular document has been extracted. If these data are extracted, then again it is a case of keying the descriptive term or a corresponding number or letter designation. There are several sea state and/or sea disturbance scales, such as the Douglas Scale, and this information must also be keyed.

Other observations such as sea colour, sea mammals, weed, etc. will be found in the remarks section. Although these biological observations are scientifically important, time and resources and the nature of the data required will make it impractical to key all of these observations. Therefore, your project should note that the observations are present but have not been keyed. This might be done in a project report.

4.3.9. Ice Observations

Ice observations will be found in the remarks section of the logbook and are of two types, icebergs and sea ice. Icebergs can vary in size from very small to many miles in extent. They have usually calved from a glacier or an ice shelf. The smaller pieces of loose ice are called bergy bits and growlers. Sea ice is frozen sea and can range from pack-ice to pancake-ice, drift-ice, etc. These are all well-defined, descriptive terms, although their meaning and use has evolved over the centuries. These are the terms you will find in common use in the appropriate latitudes, and in polar seas. The remarks section of the logbook should be checked for ice observations if the vessel is making a high latitude transit of the ocean.

If ice observations are evident, then provision needs to be made on the spreadsheet for recording the position and description of the ice. Keying ice data may mean writing a very detailed description. Truncating the description by keying just ‘ice’, reduces the value of the observation. Is it sea ice, a single iceberg, many icebergs, are they large or small? Key the full description, along with the date and the position.

In the case of non-English logbooks, it is well worth having a note of the appropriate non-English ice terminology, and this need not be onerous. Norwegian terms such as *pakkis* (packice) and *isfjell* (iceberg) are easy to identify. *Tempano* is Spanish for iceberg, *eis* is German for ice, *glace* is the French term. Nevertheless, looking for the terms whether in English or in other languages might seem time consuming, but there is an easy technique for finding them from the sea temperature observations. Merchant sailing ships seldom recorded sea temperatures unless they were writing a dedicated meteorological log. In an ordinary deck logbook, they would only observe sea temperatures in those latitudes and places where ice might be expected. In the southern hemisphere for instance, this would be the high latitudes of the western Indian Ocean, in the region of the Cape of Good Hope (beyond 50° south), and on either side of the Drake Passage, south of Cape Horn. Low sea temperatures were an indication of ice nearby, so whenever there is an SST observation, from one of these sailing ships, there may also be an ice observation if the SST is sufficiently low. In all other cases, steam or sail and especially in a logbook where sea temperatures are regularly recorded, it is a simple task to scan through and check the SST observations at the appropriate locations and latitudes. Sea temperatures of 29°F or 30°F are a sure sign of ice nearby, and the remarks section can then be checked for observations. At present (2021), the International Comprehensive Ocean-Atmosphere Dataset (ICOADS) has mostly modern real-time ice observations and there is no provision for historic ice data, apart from supplemental attachments. Nevertheless, it is recommended that ice observations be keyed (full descriptions) on the assumption that provision for historic ice observations will improve in the future.

4.3.10. Magnetic declination

Magnetic declination was frequently recorded in older logbooks. It was usually called variation (or abbreviated as var.). This was recorded either to correct the compass (in the case of the Dutch) or to be used in the calculation of the daily position on a chart, or conversely to set a magnetic course from a direction on the chart. The observations need not be keyed as historic magnetic data is already available.

It is worth summarising here, the nature of the different types of bearings commonly recorded in ships' logs and journals. The summary is from the mid 19th century but can be applied generally to logbooks before the 20th century.

Bearings from ship

Winds – magnetic. (*Dutch excepted*)
Waves – magnetic
Currents – True
Courses – magnetic
Bearings from ship – magnetic (a landmark or object sighted from ship)
Directions of coast – True (from a chart)
Source: James Horsburgh, *The India Directory*, v1 (1852), p xxxiii

4.3.11. Greenwich mean noon observations

Greenwich mean noon observations (GMN) will be found in some meteorological logbooks, especially logs issued by national weather services or their predecessors from c. 1875. These should be keyed. The idea was to record simultaneous observations around the globe at noon GMT, and these entries are effectively a second set of observation in the logbook. These observations will be found at the back of a meteorological log and will include the local time at which the observation was made. It is important to indicate that these are GMN observations, and provision for this should be made on the keying template. The information that needs to be keyed is the local time as indicated in the log and the observations.

4.3.12. Other observations

There is a wealth of ancillary weather observations amongst the details of shipboard routine in the remarks section of almost all logbooks. Ideally some, if not all, of the additional weather observations will be keyed, but managers must decide how much time and resources should be spared for this additional data. Certain remarks and observations should be given priority. Ice observations should be a first priority, followed by sea temperatures where there is no provision for these observations in the main section of the logbook. Any remarks concerning instruments and their exposure should also be keyed or noted separately, especially if one of the instruments is broken and replaced. Remarks on uncommon weather conditions, such as unusually low temperatures will be of interest. It has already been noted that such anecdotal information, especially if observed by many different vessels, can inform and confirm anomalous computer generated, weather reconstructions. Observations of aurora are useful for reconstructions of historic space-weather. Those performing the keying should be trained to use their discretion, based on the above recommendations.

There are sometimes additional annotations, especially in meteorological logbooks. These are often made by personnel of the national weather service, who have inspected the logbook or extracted data from it in the past. Another set of annotations, often in pencil, can sometimes be seen next to some of the observations. These take the form of groups of numbers and are an indication that the observations have been encoded for radio transmission. There is no need to key these annotations.

Finally, during the keying process, if remarks have only been selectively keyed or data has been omitted during the keying process, then there should be provision to note this fact, for example in a project report. A document should not be designated as ‘keyed’, if keying is not entirely complete. Too often in the past, logbooks have been considered as ‘done’, when on later inspection only selective parameters had been keyed, and then only within a narrow set of geographic co-ordinates. It is absolutely essential that managers and supervisors feed this information back to the data rescue community so that the DR status of any document can be properly maintained.

5. Metadata – Types of Instruments used and their Exposure

Metadata on instruments and their exposure is important additional information. Project managers and supervisors should ensure that this information is captured. The information may be on a separate page at the beginning of the logbook. The information may also be recorded on the first page of observations, possibly in the remarks section, or at the head of the columns where the observations are written. Most meteorological logbooks will contain good instrument metadata, but ordinary deck and navigation logs can often be vague as to the exposure and location of the instruments. It has been found that the instrument metadata descriptions can vary considerably from logbook to logbook, in both what is recorded and the level of detail. You will find that by collating the metadata from a series of consecutive logs from one vessel, it is often possible to gain a very detailed picture of how the instruments were exposed. It is therefore important to record all details, no matter how sparse or vague they may seem, as once collated, the required level of information might be obtained. Furthermore, notes about errors, and corrections to the instruments, remarks about faulty instruments or instruments replaced or moved to a different location, are important for correcting biases or addressing problems with anomalous observations.

Given the importance of metadata, managers should arrange for keying the metadata as a separate exercise to keying the meteorological observations. This will be a more efficient way of capturing the metadata, which can then be assigned to the corresponding set of observations. If metadata is not captured and documented at the keying stage, it may be overlooked and therefore lost, on the assumption that everything in a document was keyed. There are advantages to having a separate metadata inventory as relevant details can then easily be consulted on a ship by ship basis by climate service providers. There are existing metadata inventories on the CS3 Data Rescue Service portal, so you should first check that the relevant metadata for the set of vessels you are working on has not already been keyed. A good place to search for this is under the data rescue initiative ACRE Oceans, in the C3S Data Rescue Service portal:

https://datarescue.climate.copernicus.eu/projects Click on the project ID number. This will take you to the project description. The inventories will be found as attachments at the bottom of the page.

If you are producing your own metadata inventory there is a prescribed format for this, and a keying template is available on the CS3 Data Rescue Service portal:

https://datarescue.climate.copernicus.eu/met Click on Marine observations.

Once completed, you should arrange for your metadata inventory to be uploaded to the marine section of the CS3 Data Rescue Service portal.

5.1. Barometers

There are many different types of barometer, but those most likely to be used at sea are the mercury barometer, a sympiesometer, or an aneroid barometer. Rarely, a spirit barometer might be used for some of the earliest marine pressure observations. All but the aneroid barometer require correction through an attached or adjunct thermometer. The most unusual of these instruments was the sympiesometer invented by Alexander Adie in 1819. It is more sensitive to pressure changes than a mercury barometer. It therefore enjoyed a short period of popularity as a storm prognosticator. However, the pressure observations are difficult to reconcile with a mercury barometer and are considered inferior. It is therefore important to note if the observations are from a sympiesometer. Sympiesometer observations are rarely found in logbooks after the 1840s. The aneroid barometer was invented in 1844, but observations are not common until some decades later. You will find that most pressure observations are from mercury barometers well into the 20th century.

All information concerning the barometer(s) and their exposure should be keyed. The type of barometer, the maker's name and the number should be recorded, along with any changes and the dates at which those changes were made. Changes might include a different type or make of barometer and possibly a change of position within the vessel. Typically, the position of the barometer will be described in a meteorological logbook but rarely in a deck or navigation log, which will usually only note the height of the instrument above sea level. The height of the barometer above sea level (the cistern in the case of a mercury barometer) is the most important piece of information. This is recorded in feet and sometimes very precisely in feet and inches. For the purposes of modern data analysis and instrument correction, this information is required in metres, so it will be helpful to have a separate column containing a formula that automatically converts the keyed data to metres. However, if this conversion is performed at the keying stage, then it should be clear that the conversion is not a part of the original document. As some barometers are positioned below decks, in a wardroom, saloon, companionway or parlour for instance, it is possible for the height of the barometer to be at sea level, and therefore keyers must be instructed that the value '0' is a real value and is not a designation for 'no data'. To date, no logbooks have been found with the barometer situated below sea level, but if this situation should arise, then a negative value will need to be recorded.

It should not be assumed that the height of the barometer will remain the same once this fact has been determined for a particular vessel. As noted above, the position of the instruments within the ship might change. However, it is also possible for barometer heights to change while the location of the instrument remains the same. This has been noted in merchant shipping meteorological logbooks where the height of the barometer cistern is written at the head of the pressure column on each page. The reasons for changes in barometer height are due to the loading of the vessel. A heavily laden merchant ship will sit lower in the water and, when unladen, it will sit much higher out of the water. The height differences can be significant and are often evident from photographs of the same vessel at different times. Where such changes in height are observed, provision should be made to record these changes.

5.2. Thermometers - Air

Many different types of thermometer might be carried on a vessel and each type should be documented if possible. Thermometers are usually mercury, but rarely a spirit thermometer might be used in the polar regions. Commonly, the instruments are dry and wet bulb thermometers housed in a screen or ventilated box, one recording air temperature and the other used to record humidity. The latter might also be called a hygrometer, and a device called a sling psychrometer also performs the same function as the wet and dry bulbs, by manually whirling the device to create an airflow over the bulbs. It is important to record which of these devices is in use and if several methods are used, then all observations should be recorded. In addition, if a distant reading thermograph (DRT) is being used then this must be noted (see 4.3.2 above).

Like the barometer, the metadata that needs to be recorded is the type of instrument, the make and the number. Changes in instruments should be noted with the date of change. Metadata relating to the DRT will include the make and number, the position (usually a mast or spar) and the height above sea level. Other information will be the length of the capillary leading from the bulbs to the recording instrument, and the distance of the bulbs from the ship's funnel. Where a screen for the thermometers is employed, the location of the screen should be recorded. Note should be made of whether the screen is in a fixed position or whether it is portable. Portable screens were moved to the windward side of the deck at or prior to the time of observation, to minimise the effects of ship heating. You are most likely to find portable screens in use from the 1920s onwards. The 1926 edition of the *Marine Observer's Handbook* refers to portable screens, whereas the 1921 and previous editions do not (HMSO, 1926). The height of the screen above sea level is seldom recorded, but where this information is given it should also be noted. It is possible to infer the height of the thermometer screen from its location with regard to the barometer, but only in some instances and usually on board merchant ships. Where the barometer is kept in a chart house, wheelhouse or other structure on deck, the thermometer screen is often fixed to the exterior of the same structure, and usually about four feet above the deck.

The position of the thermometer screen is important because it was intended to shelter the instruments from sun, rain and spray, while at the same time allowing free circulation of the air. If the screen is situated near a funnel or ventilation shaft, the observations can be adversely affected, depending on the wind direction and flow of air across the deck. The position of the screen was always at the discretion of the commanding officer, but commonly it was located on the bridge, outside the wheelhouse or outside the chart house, on the poop deck or at the break of the poop deck. There are infrequent instances of a fixed screen being moved because the observations were affected by something like a ventilator or an open hatch leading to the engine room. All such changes and the date must be recorded.

There are other temperature observations made by un-screened instruments. Only rarely, will the metadata record the absence of a screen. Screens, such as the Stevenson screen, were developed in the 1860s and used on board ships at some time after this. It is unlikely therefore that there will be evidence of screened instruments, meaning a modern type of screen, before about 1870. This does not invalidate pre-1870 shipboard temperature observations as it is evident that some care was taken to shelter instruments from the effects of the sun and sea spray, prior to making an observation. On HMS *Bounty,* in the late 1780s, William Bligh remarked in his journal that the thermometer was kept in the binnacle when not in use. Any such information concerning instruments and their exposure should be recorded.

5.3. Thermometers – Sea

Like the air thermometers, the sea thermometer metadata that needs to be recorded is the type of instrument, the make and the number. Changes in instruments should be noted with the date of change. The usual way of recording the sea temperature was with the designated thermometer placed in a bucket of water drawn from the sea (forward of any engine room outlets). In sailing vessels, it is likely that the bucket was drawn from the sea via the stern rail or counter of the ship, rather than over the ship's side. In strong winds, the leeward side of the deck was a dangerous place and could be awash due to the pressure of the wind on the sails causing the ship to lean to one side.

Buckets were not always uniform in size or construction and could be made from wood, canvas or much later rubber or some other material. There is rarely anything recorded in logbooks about the type of bucket in use, so any remarks concerning the type of bucket or the method of water extraction is valuable and should be recorded.

During the 20th Century (and possibly earlier), some SST observations were made at the engine-room water intake or ERI. It is essential that where observations are taken at the ERI, this fact is noted and recorded as there are known biases between bucket and ERI observations that must be accounted for. There is seldom any confirmation in the logbook that an observation is by the use of a bucket, but there should be a mention if an ERI is used. This fact might be found in the metadata section of the logbook but might also appear in a logbook entry, where this is recorded just as a comment or an aside. As this may be the only notice of the method of handling water samples, it should be flagged and brought to the attention of a supervisor. Early examples (pre-20thC) of intake readings are rare and especially important. There are instances of sea temperature observations from both buckets and ERIs recorded in parallel. Managers should make provision in the keying template for these twinned observations where they occur, and both should be keyed. Lastly it was common for most early sea temperatures (pre 20th century) to be recorded in whole degrees only. Any exceptions to this will most likely be from the logbooks of research vessels.

5.4. Additional Metadata

It is important to key the particulars of the vessel from which the observations are made, if this information is recorded. The tonnage of a vessel will indicate the relative size in relation to other vessels and will help to distinguish between different vessels with the same name. There are different ways of calculating tonnage, so it is important that comparisons are made like for like. Early tonnages were calculated from 'builder's measure' and this would differ in a small degree from one country to another. Other forms of measurement are gross tonnage, net tonnage and displacement tonnage.

The differences between the different calculations for tonnage will not be discussed here but are easily found on-line.

It is worth recording if a vessel is constructed of wood or metal. This fact is frequently noted in 19th century meteorological logbooks, so at the time was considered important. Also, note whether the vessel is powered by sail, sail with steam as auxiliary, or just steam. The logbooks of vessels employing both forms of propulsion will note whether the ship is under steam or under sail. The type of vessel or the rig (meaning the number of masts and configuration of the sails) of a vessel was often noted in logbooks and always in meteorological logbooks. Recording such information will again help to distinguish between vessels using the same name.

There is some metadata that is unique to the document itself. Some meteorological services made annotations in the logbooks and other documents returned to them. This sometimes took the form of a pre-printed document. In the case of the collection held by the United Kingdom's National Meteorological Archive in Exeter, these documents are called 'Form for Testing Logs'. They contain a wealth of metadata on instruments and their exposure, but importantly they also contain remarks on the observations themselves, therefore being an early form of quality control. They will have remarks on whether the temperatures recorded display a diurnal range and whether there is evidence of solar or local heating in the observations, as well as many other remarks of a qualitative nature. These separate documents, enclosed with almost all meteorological logbooks from the 1870s to the early 20th century, can provide an early warning of any potential issues with a set of observations. Managers should discuss and plan with those working downstream of the keying phase, how this information might be documented and utilised. Lastly, the archive name and archive reference should always be documented for every set of observations. It is important that every observation or set of observations, has a clear provenance that can be traced back to the archive and to the original document.

5.5. Potential Issues where metadata are absent and how to resolve them

In this section, some questions that are likely to arise will be presented and a range of solutions discussed. Many such questions will be resolved at the QC and data processing stage. Nevertheless, the entire procedure can be made more efficient by identifying potential problems at an early stage, and making provision for them at the point of keying. When individuals examine or key data from many logbooks and other documents, they will find they become attuned to both the documents and the data. In this way, those who perform these tasks become a valuable resource, beyond the mere tasks of data entry. They will notice things that seem unusual or anomalous. This will assist with data handling downstream of the data entry process. Furthermore, this section will alert managers to potential issues with marine data, so that they can structure keying templates accordingly.

A. How can you tell the difference between a temperature observation from the adjunct thermometer of a barometer and an air or dry bulb temperature observation, where this is not clear from the document? How should the data be keyed?

B. In the absence of metadata on the exposure of instruments, how can you tell if a temperature observation is on deck or in the cabin?

These two questions are closely related and will be treated together. The simple answer is that in these situations it is very difficult, in fact impossible, if looking at individual observations. However, where there are sub-daily observations, you will likely see a marked diurnal change of temperature if the observations are on deck. If the observations are not on deck, then the temperatures will remain more even throughout the day. The real difficulty arises where only a single daily temperature observation is recorded. These temperatures could be examined over a series of days or weeks to see if they change significantly, indicating that they are taken in the open air, and to see whether the temperatures conform to climatological norms. This is a QC process, but keyers may find clues within the remarks of the logbook that will confirm the matter. For instance, in the 18th and 19th centuries there was an interest in the influence of temperature upon health, so it was not uncommon to record the temperature below decks, especially in warm climates. If you are keying a marine medical journal, take particular attention of this. It has been noticed in some logbooks that at times two temperatures have been recorded and annotated as 'on deck' and 'in the cabin'. It might be useful to key both sets of observations but distinguish clearly between the two.

C. How can you tell the difference between a temperature observation in Centigrade/Celsius and one using the Reaumur scale? Which ship logs are most likely to have observations in Reaumur?

The Celsius scale was developed in Sweden by Anders Celsius and uses 0° as the freezing point of water and 100° as the boiling point of water. In English logbooks, the Celsius scale is usually referred to as the Centigrade scale. The corresponding values on the Reaumur scale are 0° and 80°. Therefore, it may be difficult to distinguish between the two. You are likely to encounter the Reaumur scale in French observations before 1790, and you will find it in use in German and Russian documents into the 20th century. Most 19th century Finnish logbooks (these will be from Russian flagged vessels) are written in Swedish, so it might be assumed that as Anders Celsius was Swedish, the temperatures are in Celsius. This will not necessarily be the case and Reaumur temperatures have been noted on these vessels. The Grand Duchy of Finland was ceded by Sweden to Russia in the early 19th century, so in this instance, the choice of the temperature scale has more to do with geo-politics than language. Context is important.

Some logbooks will state if the Reaumur scale is used, usually on one of the pages towards the front, but this cannot be depended upon. If the logbook you are examining originates from a country likely to use the Reaumur scale, but there is no indication as to which scale is in use, then there is a test that might be made if the vessel sails through the tropics. Differences between the two scales are more obvious at warmer temperatures. For instance, 25C is 20R and 40C is 32R. Look for the larger numbers and see what makes most sense. At colder latitudes, this will not be possible as, for instance, 5C is 4R. It is also worth mentioning that where the Reaumur scale is clearly in use, then the adjunct or attached thermometer is likely to be Reaumur and furthermore any temperature corrections to the barometric pressure may also be in Reaumur. That should not normally be a problem as the temperature reduction to 0° would be the same on both scales. However, the St. Petersburg Yearbooks for the period 1840s to the 1860s, indicate that the pressures were being reduced to 13.33R.[1] This has not been noticed in any ship logbooks or other marine documents, but to date (2021), only a very limited number of 19th century Finnish/Russian logbooks have been imaged.

[1] Prof. Tim Osborne, and Prof. Phil Jones, Climatic Research Unit, University of East Anglia – personal communication. It is not clear why a reduction to 13.33R was used.

References

CLIWOC (2003) *Multi-lingual Meteorological Dictionary* (KNMI), https://www.knmi.nl/kennis-en-datacentrum/publicatie/cliwoc-multilingual-meteorological-dictionary-an-english-spanish-dutch-french-dictionary-of-wind-force-terms-used-by-mariners-from-1750-1850

CLIWOC (2006) Climatological Database for the World's Oceans 1750 to 1850, results of a research project,

https://op.europa.eu/en/publication-detail/-/publication/5d39314a-89df-4059-80eb-427f5ca0e35a

Earl, G.E and N. Peter (1961) *Maritime Meteorology, a primer for seamen.*

HMSO (various editions 1915 to 1963) *The Marine Observer's Handbook.*

Horsburgh, J. (1852) *The India Directory.*

Jonkers, A.R.T. (2005) Parallel Meridians: Diffusion and Change in Early-Modern Oceanic Reckoning, J. Parmentier, *Noord-Zuid in OostindischPerspectif* (Hague).

Wheeler, D. (2005) An Examination of the Accuracy and Consistency of Ships' Logbook Weather Observations and Records. *Climatic Change* **73**, 97-116.

Wilkinson, C. (2009) *British Logbooks in UK Archives 17th to 19th Centuries, A survey of the range, selection and suitability of British logbooks for climatic research* (NOAA/CDMP), https://icoads.noaa.gov/reclaim/pdf/Pre-20thC_British_logbooks_report_version_2009_2.pdfWilkinson, C. (2009a) *British Logbooks in UK Archives 20th Century, A survey of the range, selection and suitability of British logbooks for climatic research* (NOAA/CDMP), https://icoads.noaa.gov/reclaim/pdf/20thC_British_logbooks_report_version_2009_2.pdf

Appendix

6.1. List of common abbreviations found in early English logbooks

Ac., Acc. or Acct.	Account or estimate. Refers to the latitude or longitude having been determined by dead reckoning or account.
am	Period from midnight to noon. In logbooks kept according to the nautical day, where the day commenced at noon, the am formed the second half of the day.
Amp.	Amplitude. An observation of a celestial body usually performed to determine the magnetic variation of the compass.
Azm.	Azimuth. An observation of a celestial body usually performed to determine the magnetic variation of the compass.
Chron., Chro.	Marine chronometer. Used to indicate that the longitude has been determined by reference to a timekeeper.
Dep.	Departure. The last sighting of a recognized landmark, usually used as a zero meridian.
Diff. Lon.	Difference in longitude from the previous day.
DR.	Dead Reckoning. An estimate of the vessel's position based on course and speed, with corrections for leeway, drift and magnetic variation.
E	Eastings. The distance a vessel has made in an easterly direction as determined from a traverse table. A traverse table was a running account of courses and speed.
F	Fathom. Refers to the vessel's speed at one-eighth part of a knot (nautical mile per hour). In the later 19th century, the term referred to one-tenth part of a knot. The term is also used in the same sense when measuring the velocity of a current.
First part	First part of the day. In logbooks kept according to the nautical day, the first part was the period from immediately after noon until 8pm.
H	Hour. Found at the head of the column where the hour of the day is noted.
K	Knot. Refers to the vessel's speed in nautical miles per hour.
Lat. Acc.	Latitude by account. An estimate of the ship's latitude by dead reckoning.
Latter part	Latter part of the day. In logbooks kept according to the nautical day, the latter part was the period from 4am to noon.
Lon. in	Longitude by the Greenwich meridian.
Lon. mde	Longitude made. Distance in degrees and minutes from the zero meridian.
Lun.	Lunar. Refers to the vessel's longitude being determined by a lunar observation.
M+D	Meridian + Distance. Longitude made. Distance in degrees and minutes from the zero meridian expressed as leagues or degrees of a fixed length irrespective of latitude.

Middle part	Middle part of the day. In logbooks kept according to the nautical day, the middle or second part was the period from 8pm to 4am.
N	Northings. The distance a vessel has made in a northerly direction as determined from a traverse table. A traverse table was a running account of courses and speed.
No obs.	No observation. Indicates that, no celestial observation was possible due to the state of the sky. The ship's position is often absent though there may be a dead reckoning estimate.
Ob.	Observed. Indicates that the vessel's position has been determined by an observation, solar or lunar, as opposed to an estimate by dead reckoning.
pm	Period from noon to midnight. In logbooks kept according to the nautical day, where the day commences at noon, pm will form the first half of the day.
S	Southings. The distance a vessel has made in a southerly direction as determined from a traverse table. A traverse table was a running account of courses and speed.
Second part	Middle part of the day. In logbooks kept according to the nautical day, the second or middle part was the period from 8pm to 4am.
TK	Marine timekeeper or chronometer. Used to indicate that the longitude has been determined by reference to a timekeeper.
Var.	Variation. A term used for the magnetic declination of the ship's compass.
W	Westings. The distance a vessel has made in a westerly direction as determined from a traverse table. A traverse table was a running account of courses and speed.
X Lat.	Difference in latitude from the previous day.
X Lon.	Difference in longitude from the previous day.

6.2. Analysis of a typical English EIC logbook from the late 18th Century

Extract from Wilkinson (2009)

In the example of the *Melville Castle*, below, the nautical day format is used with the noon observations and position at the bottom of the page. The first column 'H' is the hour of the day, commencing with 1pm and ending with 12am or noon. The second column 'course' is the course steered by magnetic compass on an hourly basis.

Table 2. Typical 18th century English East India Company Logbook (abridged)

Melville Castle from England towards Bombay					
H	Course	K	F	Winds etc.	Monday 2nd April 1787
1	NEbE	6	6	S. cloudy	
2	-	7	2		
3	-	8	-		
4	NE	8	5		
9	-	9	4	SEbS squally + small rain	Variation by Amplitude 20.32W by Azimuth 19.56W ship 13 miles to the southward of account Latitude observ'd 32°.12'S
10	-	9	5	squally	
11	-	9	-		
12	-	9	-		
209					

Course	Distance	N E	M + D	Lat. Acc.	Diff. Lon	Lon. in	Bearings & Dist.
N29E	209 ms	183 101	32°.59'E	31°.59'S		61°.36'E	Isle of Rodrique N9E 253 lgs.

Where this information is blank, the previous entry applies. Column 'K' is the vessel's speed in knots. Column 'F' records the fractional parts of a knot. Thus at 1pm, the speed of the *Melville Castle* was six knots and six fathoms or 6.75 knots in the modern decimal equivalent.
The fifth column would contain a note of the wind direction, wind force and general weather. In the example the wind direction 'S' (for south), as recorded at 1pm, would hold true until another direction was recorded, for example at 9am, 'SEbS'. This particular example has no wind force recorded but is an isolated example of this omission. EIC ships had a slightly different and more archaic vocabulary for describing wind force than the Royal Navy. For a full discussion of this see CLIWOC (2003). The sixth column would record any remarks concerning the general management of the ship along with any additional navigational information. In the example, the magnetic variation is recorded by two

different observations. The observed latitude at noon was also recorded here. This was common in earlier logbooks before a specific box for this information appeared on printed logbook pages.

The rows along the bottom of each entry recorded the summary of the day's navigational observations and calculations. In the example, the course made good between the noon position and that of the previous day is N29E. The distance is 209 miles. The next entry 'N E' refers to northings and eastings. In this example, the vessel has made 183 miles to the north and 101 miles to the east. The navigating officer determined his course and distance made good by a method called plane sailing. This involved the resolution of a right triangle in which the northings and eastings represented two of its sides, the hypotenuse of which gave the true distance and direction covered in the day. This was the simplest form of dead reckoning and was adequate for navigation using plane charts on which the distances between meridians remained constant regardless of latitude (see below).

The box 'M + D' refers to meridian + distance or meridian distance. This is the distance east or west of the zero meridian from which the vessel took its last departure as distinct from the vessel's longitude according to the Greenwich meridian. Meridian distance was stated in either leagues or degrees of a fixed length irrespective of latitude (20 leagues = 1 degree). This is because large-scale plane charts were being used to navigate rather than other charts where the distance between meridians narrows as the latitude increases. With plane charts, the distance between meridians on the chart is constant at all latitudes (Jonkers, 2005). In later logbooks, meridian distance is sometimes referred to as 'Lon mde' or longitude made.

The box 'Lat Acc' refers to the latitude by account or by dead reckoning. Comparing this with the observed latitude in the remarks column, indicates an error in the account of 13´ or 13 nautical miles and the remarks column records that the vessel is 13 miles to the south of account. Such errors in account were common and due to currents, drift, leeway or minor errors in calculations or in the observations themselves. 'Diff Lon' refers to the difference in longitude from the previous day's position. In the example, the data are not inserted. In many logbooks, 'X' is used instead of 'Diff' to denote the difference, as in 'X Lat' or 'X Lon'. 'Lon. in' states the longitude according to the Greenwich meridian. 'Bearings and distance at noon' indicates that the Island of Rodrigue is bearing N9E (9°) at a distance of 253 leagues (759 nautical miles). The bearing is true not magnetic as it is taken from a chart.

6.3. Not the Greenwich Meridian? How do you find the position?

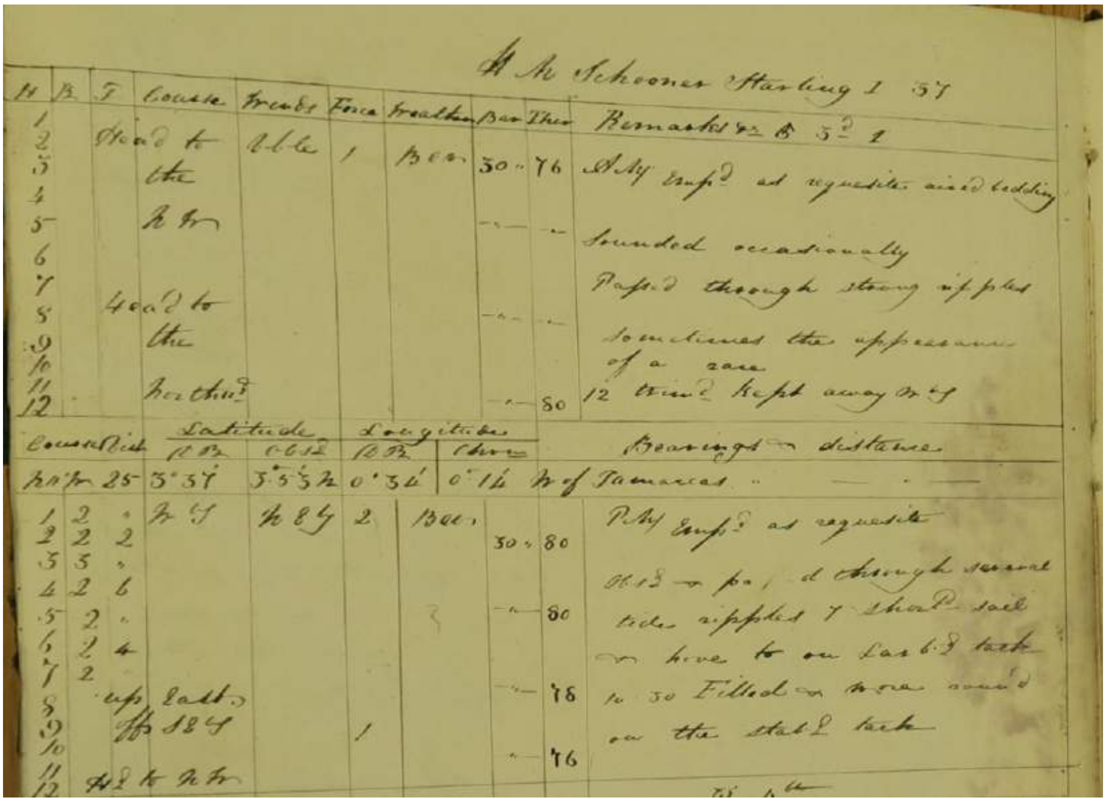

Fig. 5. UK Hydrographic Office, Misc. Papers, Logbook of Midshipman D. Gordon, HMS Starling - 1837

In the example above (Fig. 5), HMS *Starling* is in the Pacific, and the position recorded at noon on 3 January 1837 is Lat. 3°37' (DR) 3°53'N (Obs.), Lon. 0°34' (DR) 0°14'W (Obs.) of Tamacas. From the previous and following days' positions, in particular noting the latitude, and the mention of other coastal landmarks, we can narrow down the area where the vessels is sailing. Tamacas is Tumaco on the coast of Colombia about 1°50'N, 78°45'W. Co-ordinates can be found using Google Earth. By adding 14' to the longitude of Tumaco, we can determine that the *Starling's* longitude is 78°59' west of Greenwich.

As the longitudes are to be keyed **as written**, provision should be made to record the meridian being used. We would suggest the meridian name (as written) and the modern equivalent name if different. There will be alternate names and spellings of placenames. We would suggest that a separate listing of meridians and their Greenwich equivalents is also kept for reference.

Copernicus Climate Change Service

ECMWF - Shinfield Park, Reading RG2 9AX, UK

Contact: info@copernicus-climate.eu

climate.copernicus.eu copernicus.eu ecmwf.int