DETERMINATION OF WIND FORCE AND PRESENT WEATHER TERMS: THE DUTCH CASE

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Abstract. The Dutch wind force terms in the CLIWOC period (1750–1854) consist for 59% of descriptors and for 41% of regular Beaufort numbers. In total, over 1600 different descriptors are encountered. An attempt is made to transform the wind force descriptors into wind speed via the Beaufort scale of wind force. Nearly two-third of the descriptors refer to the use of sails. Despite the huge amount of descriptors, it was possible to condense 99% of the wind force reports into the 13-point Beaufort scale. Quality checks against ICOADS indicate that the quality of the post-1800 Dutch CLIWOC wind data surpasses that of the pre-1800 Dutch data, while for the pre-1800 data the quality seems comparable with that from the other countries within CLIWOC. Weather terms other than wind are denoted in 15% of the reports by special symbols, of which the meaning was lost. A key to these symbols is reconstructed.

1. Introduction

In all ships' logbooks of the CLIWOC period (1750–1854) weather information and navigational information is present on a daily or sub-daily basis. This information is often given in a pre-designed tabular layout. The tables include positions, course, speed, etc. in numerical form, as well as wind, weather and sea states. The wind forces are given in a systematic, but non-standardized terminology, as the international agreement on standardization of meteorological observations on board ships (Quetelet, 1854) took place just after the CLIWOC period. The non-standardized nature of CLIWOC wind forces expresses itself in the use of many descriptive terms. The main goal within CLIWOC was to convert all descriptive wind force terms into speed in order to allow the database to be used for quantitative studies. This conversion is not a trivial task. In the 105-year CLIWOC data, the succession of generations of sailors and the development in the ship's technology and ship's size caused a gradual change in the meaning of the wind force terms. This results in shifts in vocabulary and terminology (see e.g. Wheeler and Wilkinson, 2005). The challenge within the CLIWOC project was to make the wind force terms homogeneous in time and between countries, so that this century-long backward extension (see García-Herrera et al., 2005; Können and Koek, 2005) of the current meteorological databases over the world's oceans can be used in quantitative studies of climate variability and change for the entire period 1750–present.

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Wind force terms used on board the Dutch ships differ fundamentally from those in use in other countries (see Wheeler and Wilkinson, 2005; Prieto et al., 2005) that worked in the CLIWOC project. The Dutch terms stand out in being closely related to sailing practices, i.e. to the maximum amount of sail that a vessel could carry under the given wind conditions. Nearly two-third of the many hundreds of Dutch wind force expressions make this explicit by directly referring to specific sails. No clues about when and where these terms exactly emerged could be found in the eighteenth century sailing instructions (De Vries, 1736, 1752, 1777; De Boer, 1769, 1775; Pietersz, 1791). In contrast to the Dutch terminology, the non-Dutch constituents of the CLIWOC database contains only five expressions that are sail related: one in English (topgallant gale), one in French (a basses voiles) and three in Spanish (de alta vela, de vela larga and de toda vela). As the Dutch wind force terminology is so closely intertwined with ship design and ship operations, close scrutiny of nautical practice is needed to reach a consistent and time-independent translation of Dutch wind force terms of 1750–1854 into modern units. The effort to get absolute wind speed information out of the ∼1600 Dutch CLIWOC wind force terms is the main subject of this paper. The second subject refers to the decoding of weather symbols in these pre-1854 Dutch logbooks.

2. Sailing Practices and Ship Design

The objective of most Dutch ship owners and corporate shipping companies (e.g. 'Verenigde Oostindische Compagnie' (VOC), 'Westindische Compagnie' (WIC) and the 'Middelburgse Commercie Compagnie' (MMC)), was to sail their ships as fast as possible in order to raise their profits. More sail meant higher boat speed, but there are two limiting factors. The first is the existence of a theoretical maximum boat speed, being proportional to the square root of the length of the ships' waterline (Van Manen and van Oossanen, 1988). Too much sail causes the ship to roll and pitch more, rather than to increase its speed. As this made the ship less controllable, nautical practice was to use not more sail than needed to reach the boat's maximum speed. The second limiting factor is the maximum wind stress that a ship was able to absorb. Too high wind speeds cause a great stress on the ship's sails, masts and rigging. In order to avoid damage, the number and area of sails had to be reduced below the level required for maximum speed.

If the wind increases and the ship is at top speed, sails were removed. The process started with the uppermost and smallest sails, then progressing to lower, larger sails. Hence Dutch wind terms refer to the uppermost sails that could still be operated at the observed wind speed. Around 1750, sail technology had already progressed far enough that sails did not need to be taken in completely, but could, by the process of 'reefing', be gradually reduced in area. Another development, which took place towards the end of the eighteenth century, involved splitting up the sails near the top of the mast into two separate sails, which made it easier and

safer for the crew to change the sail area. Later still, other sails were divided into two separate sails. In the subsequent years the reefing technique was refined to the degree that by the end of the CLIWOC period – around 1850 – mainsails could carry as many as four rows of reefs. At the time, sails were described as single, double, triple or close reefed depending on how many rows of reefs were taken up; close reefing would reduce the sail area the most, leaving only a small part of the sail exposed to the wind. Detailed information on reefing and sail management is described by Harland and Myers (1984).

From the early seventeenth century until the end of the eighteenth century most of the ocean-going vessels were square-rigged sailing ships, equipped with three sails standing above each other. In Dutch the highest sail was called the 'bramzeil' (topgallant sail in English), the middle was the 'marszeil' (topsail; B in Figure 1)

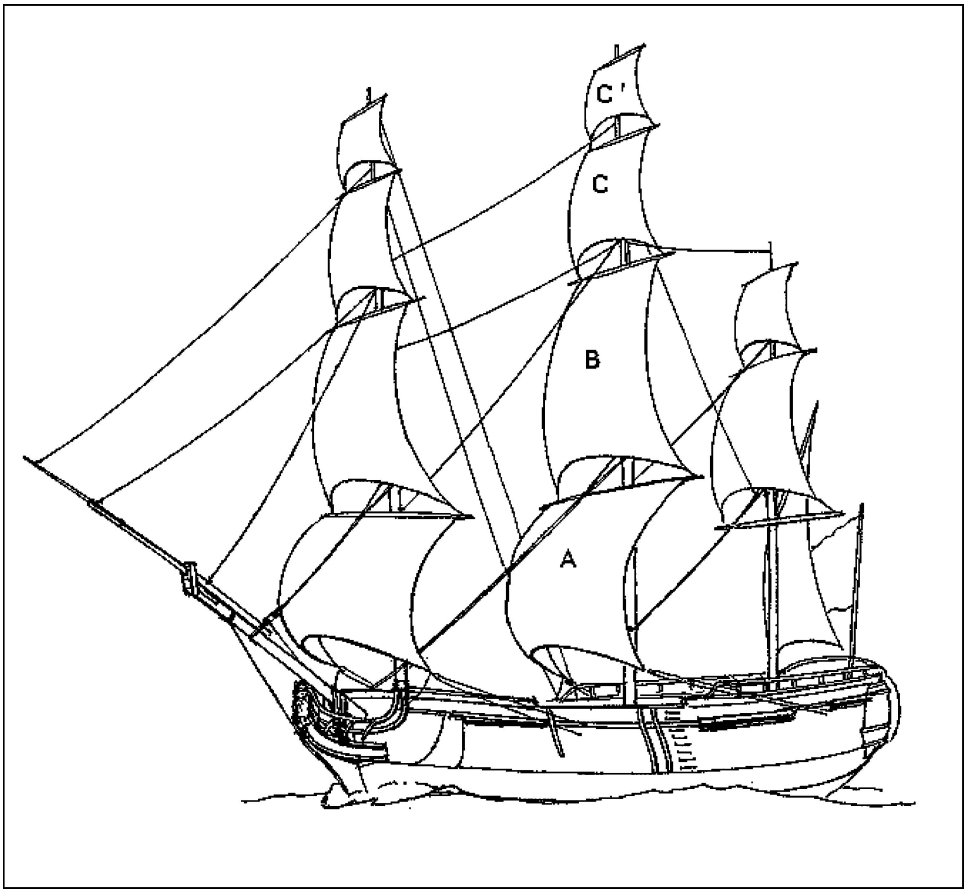


Figure 1. Sail plan of a typical late eighteenth century ship-of-the-line. Most of the ships in the CLIWOC period were built according to this, or a very similar, design. The sails that are used in the archaic Dutch wind force descriptions are marked by A–C′. Table I gives their names in four languages.

TABLE I
Names of the sails marked in Figure 1

	Dutch	English	French	Spanish
A	Grootzeil	Course or mainsail	Grand voile	Vela mayor
B	Marszeil	Topsail	Hunier	Gavia
C	Onderbramzeil	Topgallant sail	Perroquet	Vela penguito
C′	Bovenbramzeil	Royal sail	Cacatois	Sobrejuanete

and the lower one the 'onderzeil' (course or mainsail; A in Figure 1). Around 1800 the 'bramzeil' was split into the 'bovenbramzeil' (royal sail; C′ in Figure 1), and the 'onderbramzeil' (topgallant; C in Figure 1). This resulted in four sails standing above each other. Figure 1 and Table I depict this situation. Shortly after this development, also the 'marszeil' was split in the same fashion giving the 'bovenmarszeil' and the 'ondermarszeil' (upper and lower topsails). The terminology of the wind forces progressed parallel to these developments.

The ship design did not change much in the CLIWOC period, although the ships were built larger during the years. With longer waterlines, taller masts and better rigging, the ships could carry more sail in a given wind situation than before. Wheeler (2005), however, concludes that developments like this have no detectable effect on the relation between a given sail-based wind term and the actual wind speed.

3. Wind Force Terms

Around 1600, the first information about wind force began to appear routinely in ships' logbooks. At first, the information had a highly qualitative character, but by the middle of the seventeenth century the wind force terminology had evolved into a more or less common system (see Wallbrink and Koek, 2001). Towards the end of the seventeenth century almost all of the ship logbooks of the Dutch United East India Company (VOC) contain daily or sub-daily information regarding wind direction and wind force.

The way in which the wind forces were characterized after the names of the sails was the same for the Dutch merchant and Navy ships throughout the CLIWOC period. In the Dutch CLIWOC data, 1606 different wind force terms are encountered, of which Table II gives the most frequently used ones of the late-CLIWOC period. The close link of the Dutch wind force terminology to the sailing practice provides an explicit means to determine the order of the many Dutch wind force terms. This allows for a refinement in the Dutch translation to the now popular Beaufort scale that is not possible for the other CLIWOC countries.

From the description of the sails set on the ship one can make a reasonable estimate of the wind force, as the crew used uniform sail settings for square-rigged ships.

TABLE II
Nineteenth century conversion tables from old wind force terminology into Beaufort numbers, found in Dutch extract logbooks

Beaufort	Conversion 1	Conversion 2
0	Stilte (still)	Stilte (still)
1	Flaauwe koelte (faint wind)	Schip heeft stuur (ship steers)
2	Labberkoelte (weak wind)	1–2 mijls vaart (1–2 knots speed)
3	Bramzeilskoelte (topgallant wind)	3–4 mijls vaart (3–4 knots speed)
4	Stijve bramzeilskoelte (stiff topgallant wind)	5–6 mijls vaart (5–6 knots speed)
5	Marszeilskoelte (topsail wind)	Bovenbramzeilen (royal sails)
6	Stijve marszeilskoelte (stiff topsail wind)	Bramzeilen en 1 rif in de marszeilen (topgallant sails and 1 reef in the topsails)
7	Gereefde marszeilskoelte (reefed topsail wind)	Twee reven in de marszeilen (2 reefs in the topsails)
8	Dubbelgereefde marszeilskoelte (double reefed topsail wind)	Drie reven in de marszeilen (3 reefs in the topsails)
9	Digtgereefde marszeilskoelte (close reefed topsailwind)	Digtgereefde marszeilen en onderzeilen (close reefed topsails and mainsails)
10	Stijve digtgereefde marszeilskoelte (stiff close reefed topsail wind)	Digtgereefd grootmarszeil en gereefde fok (close reefed main topsail and reefed foresail)
11	Storm (storm)	Stormstagzeilen (storm staysails)
12	Orkaan (hurricane)	

Note. Between brackets: the literal translation into English.

Regardless of the fact that one sailed with one large topsail (seventeenth/eighteenth century) or a topsail and a topgallant sail (nineteenth century), one would start reefing or taking in the sails at Beaufort force 4 to 5. With lower wind forces one would have employed full sail. If the topgallant sails were close-reefed and the topsails were double reefed, the wind force had increased to Beaufort values between 6 and 9. At times of storms, Beaufort force 10, one would sail with hardly any sail hoisted and usually used some staysails to ride the storm (De Booij, 1888).

4. The Development of Wind Force Terms to a Uniform Scale

From the late seventeenth century onward, several countries attempted to design a system of objective wind force descriptors. Around 1700, practical scales of wind force terms at sea emerged, among them one developed by the Englishman Daniel Defoe. It already contained terms like *stark calm*, *calm weather*, *little wind*, *fine breeze*, *small gale*, *topsail gale*, *blows fresh*, *hard gale*, *a fret of wind*, *storm* and

a tempest. This scale ultimately evolved into the international Beaufort scale of wind force (Wheeler and Wilkinson, 2005), which is still in use. It is interesting to observe that parallel to the early developments, the Danish and Dutch undertook a first attempt to develop a terminology suitable for international exchange of wind information (Frydendahl et al., 1992).

In the Dutch part of CLIWOC a large number of so-called extract logbooks were used. These extract logbooks were hand-made nineteenth century meteorological summaries of original ship logbooks from 1826 onward. The extraction of the meteorological data from the original ship logbooks took place in the 1860s (KNMI, 1954). Since the Beaufort scale was already officially adopted in the Netherlands in 1853, just after the International Conference in Brussels (Quetelet, 1854), the archaic wind force terms in the originals were often directly transformed accordingly by the nineteenth century extractors. From all the Dutch wind force reports in CLIWOC, 41% are directly expressed in Beaufort numbers because of this nineteenth century extraction practice. This 41% of the total Dutch set corresponds to no less than 57% of all post-1800 data (see Können and Koek, 2005).

Although one published concordance table of wind force descriptions and Beaufort numbers was found (Groeneijk, 1848), the exact procedure at the time for the conversion has not survived. This is unfortunate, since otherwise a direct clue would be available for the conversion of the older observations. Two handwritten conversion tables were found in the extract logbooks (see Table II), but it is not documented if one of those were copied from any official standard. However, a few extract logbooks denote both the Beaufort numbers and the original descriptive wind force terms. This allows for a direct comparison of 338 wind reports (out of a total of 53 898 in all extract logbooks). Comparing these Beaufort numbers with their coupled descriptors, we found the best agreement with the table shown in Conversion 1 of Table II. As an illustration: the term 'bramzeilskoelte' (topgallant breeze), which was mentioned in 98 of the 338 reports was assigned in 69 cases to Beaufort number 3, where it according to Conversion 2 should correspond to Beaufort 5–6. This correspondence encouraged us to apply Conversion 1 from Table II as the basis for the translation of the Dutch wind force terms in the entire CLIWOC period. Where appropriate, Conversion 1 is refined according to the development of reefing and sail usage, described in Section 3.

It should be noted that not all terms of Conversion 1 appear during the full CLIWOC period because of the expanding terminology. For instance, a term like 'dichtgereefde marszeilskoelte' (close reefed topsail breeze) – according to Table II equivalent to Beaufort 9 – was not used before 1816. Similarly, the term 'bovenbramzeilskoelte' (royal sail breeze) – a refinement of 'bramzeilskoelte' (topgallant breeze), not included in Conversion 1 – did not appear in the logbooks before 1830. So far, we found no evidence that the introduction of these new terms affected the homogeneity of the wind data.

In many cases, the reported wind forces of the Dutch ships show a choice of words around the actual wind force term. The description usually starts with

an expression that gives information about the relative strength of the wind, i.e. whether it is a strong or a weak form. The subsequent phrase describes whether the wind is decreasing, increasing or remains constant. The use of these adjectives in the description of the wind force makes it possible to make an even finer resolution of the Beaufort scale. If 'bramzeilskoelte' (topgallant breeze) corresponds with 3 Beaufort, the adjective 'flauw' (or weak) means that it is comparable with a 'low' 3. The expression 'stijve' (stiff, strong) puts the wind force in the upper half of the wind force 3 class. See further Können and Koek (2005), Table V.

At the moment we are left with 299 (19%) out of the 1606 terms that we could not relate to a Beaufort number. Among them, 76 terms were only used once or twice during the whole CLIWOC period. The 299 non-convertible descriptors refer to only 1.2% of all wind reports (i.e. to 1209 out of a total of 1 14 715 Dutch wind reports in CLIWOC). Note that a similar situation emerges in the English data (Wheeler and Wilkinson, 2005).

5. Quality Checks of Wind Force

Figure 2 shows a histogram of the Dutch Beaufort numbers in CLIWOC, for the N-Atlantic south of 45°N. Distinction is made between the pre-1800 and post-1800 data. For comparison, the distribution of the observations (also known as Deck 193)

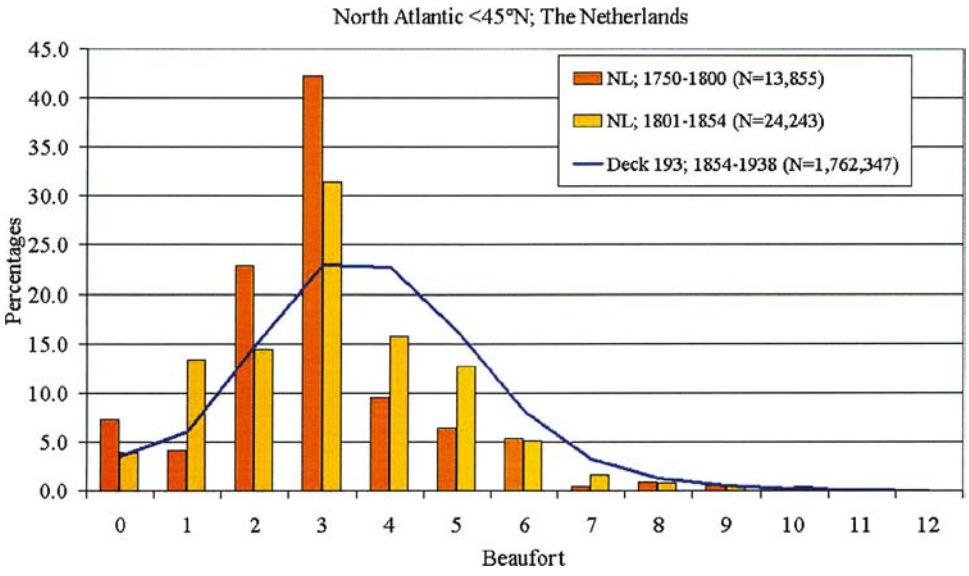


Figure 2. Histogram of Dutch Beaufort numbers in CLIWOC for the eighteenth and nineteenth century observations. The line represent the distribution of the Dutch observations 1854–1938 in ICOADS, referred too as Deck 193 (Wallbrink et al., 2003). The area considered is the N-Atlantic south of 45°N. The symbol *N* in the insert refers to the number of observations.

1854–1938 in ICOADS (Wallbrink et al., 2003) is included. The figure indicates a best match between ICOADS and CLIWOC for the post-1800 data, although there seems to be an overrepresentation in Beaufort 3 and an under representation in Beaufort 4. The pre-1800 data also show an overrepresentation in Beaufort 3, but of a larger magnitude, and a strong under representation in Beaufort forces 4 and 5. Figure 2 leads us to the surprising conclusion that the translation of the descriptive terms into Beaufort numbers, as done in the 1860s by the compilers of the extract logbooks, is of a better quality than the translation done by us during the CLIWOC project. This means that there may be room for improving the translation of the Dutch descriptive wind terms (Table II) into Beaufort numbers.

Figure 3 shows the histograms of the Beaufort numbers by country for the same oceanic region. The figure is made for the pre-1800 period, being the period where all countries contributed substantially. The area (N-Atlantic south of 45°N) is chosen because it was sailed by all the CLIWOC countries (Können and Koek, 2005). The figure shows similar features between all countries: overrepresentation with respect to ICOADS in certain classes (Beaufort forces 4 and 8 for ES; Beaufort 7 for FR; Beaufort forces 4 and 8 for UK), and underrepresentation in other classes (e.g. Beaufort 3 for ES; Beaufort 2 for FR; Beaufort 3 for UK). Our general conclusion from Figures 2 and 3 is that the quality of the pre-1800 data does not differ much between the CLIWOC countries, although the French data seem to have performed

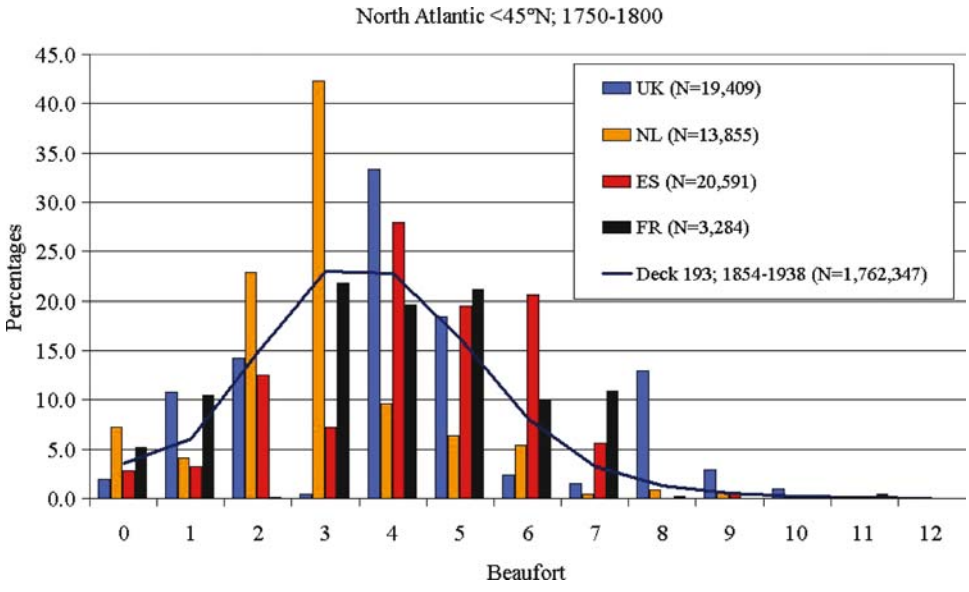


Figure 3. Histogram of eighteenth century Beaufort numbers in CLIWOC by country. The line represents the distribution of the Dutch observations 1854–1938 in ICOADS (see also Figure 2). The area considered is the N-Atlantic south of 45°N. The symbol *N* in the insert refers to the number of observations.

TABLE III
Noppen's (∼1730) windmill scale of wind force and its transformation into Beaufort (Van Engelen and Geurts, 1992)

Beaufort	Noppen	Effect on the arms of the windmill
0	0	Mills do not work
1	1	Arms move occasionally, but very slowly
2	2	Arms move steady, but slowly
3	3–4	Arms move moderately or vividly
4	5–6	Arms move powerful, but still hold all sail
5	7–8	A quarter to a third of the sail area is removed, arms still move powerful
6	9–10	Half to two-third of the sail area is removed
7	11–12	Three quarter of the sail area is detached
8	13–14	No sails used, but arms still move very strong
9–10	15–16	Milling is too dangerous
11–12	>16	Milling is too dangerous

best. Of the Dutch data, the quality of the post-1800 data is clearly best. Note that so far the wind scale determinations were performed per country. The differences between the countries in the 3–5 Beaufort range, as apparent in Figure 3, indicates that there is room for improvement of the wind force calibrations in the combined CLIWOC dataset.

A different, though somewhat qualitative way to check the reality of the Dutch wind force conversion into Beaufort numbers (Table II), is to compare the operational descriptions of the sail-based terms with those underlying the eighteenth century Noppen's windmill scale of wind forces (Van Engelen and Geurts, 1992). Noppen's windmill scale descriptions (see Table III) indicate that the millers started to decrease the sail area on the arms of the mill at Noppen by wind force 7 (hence Beaufort 5). Practice on board ships showed similar behaviour: reefing started around Beaufort wind force 4–5. At high wind speeds (Noppen force 15, Beaufort 9), when the millers found it too dangerous to continue, sailors used only their reefed main sails (Sail A in Figure 1) of the thickest canvas to minimize the damage.

6. Weather Symbols

After the establishment of the various national meteorological centres in Europe around the middle of the nineteenth century, Dutch researchers were collecting ship's observation for their studies and copied the meteorological contents in extract logbooks. Twenty of these extract logbooks, covering 1826–1854, are still kept in the archive of the Royal Netherlands Meteorological Institute (KNMI). This is fortunate, as the 273 original logbooks of which that data are extracted are all lost,

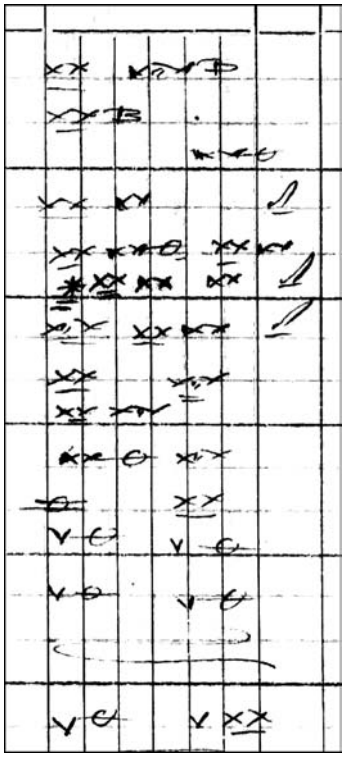


Figure 4. Sample of an extract logbook, showing symbols, used for the description of the weather. This example is from Extract T, H.M. Brig 'Panter' in March 1839. See Tables IV–VII for the meaning of the symbols used in this logbook.

together with virtually all 20 000 original logbooks covering the period 1854–1940 (Wallbrink and Koek, 2000). All 20 extract logbooks were used in CLIWOC. The disadvantage of the extracted logbook data is that the meteorological information is generally reported in a condensed form, often combined with codes and/or symbolic characters. To save time, the extractors – who were paid per record – used a kind of shorthand writing. In this, the weather description was often represented by symbols (see Figure 4). The coded reports make up 15% of all the weather reports in the Dutch part of CLIWOC. Altogether, there are 74 different symbols in use. Although a general key to the symbols is missing and no single suitable original book was found, we were lucky enough to find some explanation of the symbols in the margins of the extracts and from that we were able to deduce a plausible interpretation for 67 out of the 74 symbols. To be able to approach these symbols in the database, it was necessary to devise a dedicated code. This code gives a pointer to a conversion table with the symbols for weather (Table IV), shape of clouds (Table V), clearness (Table VI), sea state (Table VII), and sea current (Table VIII).

TABLE IV

Symbols in the column 'weather' in Dutch extract logbooks and their coding in the CLIWOC database

Symbol	Explanation(s)	Code	Symbol	Explanation(s)	Code
	Light showers	W00	D	Light hail	W26
	Showers; moderate showers	W01	D	Hail	W27
	Heavy showers	W02	D	Heavy hail	W28
–	?	W03		Light lightning	W30
\	?	W04		Moderate lightning	W31
	Showers increasing	W05		Heavy lightning	W32
	Showers continuous	W06		Increasing lightning	W33
	Showers decreasing	W07		Lightning continuous	W34
A	Foggy	W10		Decreasing lightning	W35
A	Thick fog	W11		Light thunder, thunder and lightning	W40
A	Very thick fog	W12		Light thunderstorm, thunder and lightning	W41
B	Drizzle	W20		Light thunderstorm, thunder and lightning	W42
B	Rain	W21		Moderate thunderstorm, thunder and lightning	W43
B	Heavy rain	W22		Heavy thunderstorm, thunder and lightning	W44
C	Light snow	W23		Increasing thunderstorm, thunder and lightning	W45
C	Snow; moderate snow	W24		Thunderstorm, thunder and lightning continuous	W46
C	Heavy snow	W25		Decreasing thunderstorm, thunder and lightning	W47

In some of the youngest CLIWOC extract logbooks (1854) a special mystery surfaced that persisted in a number of later extract logbooks. In the column titled 'Aard en rigting der wolken' (nature and direction of the clouds) the following codes appeared: 'vv9 vvvvv13' or 'vvv4 vvvv9'. The meaning of the numbers was

TABLE V
Symbols in the column 'shape of clouds' in Dutch extract logbooks and their coding in the CLIWOC database

Symbol	Explanation(s)	Code
	'Floating' clouds	V00
	Slightly changing amount of cloud	V01
	Moderately changing amount of cloud	V02
	Strongly changing amount of cloud	V03
	Clouded	V04
	Overcast	V05
	Completely overcast and 'dark' clouds	V06
	Slightly changing amount of cloud and showery sky	V07
	Moderately changing amount of cloud and showery sky	V08
	Light showery sky; appearance of a thunderstorm; increasing amount of clouds	V10
	Moderate showery sky; appearance of a thunderstorm; increasing amount of clouds	V11
	Heavy/strong showery sky; appearance of a thunderstorm; increasing amount of clouds	V12
	Light 'densely' sky; 'dirty' air	V13
	Moderate 'densely' sky; 'dirty' air	V14
	Heavy/strong 'densely' sky; 'dirty' air	V15
	Thickly/densely sky	V16
	?	V17
	?	V18

easily found, being the direction of the movement of the clouds, given in tens of degrees: $9 = 90^\circ$ (east), $13 = 130^\circ$ (southeast). However, an explanation for the v-marks could not be given until, by accident, a drawing was found in the back of an instruction manual (Jansen, 1853). The drawing showed a landscape (see Figure 5)

TABLE VI
Symbols in the column 'clearness' in Dutch extract logbooks and their coding in the CLIWOC database

Symbol	Explanation(s)	Code
	Clear sky	H00
	Damp air; 'Dewy' weather	H01
	Dew	H02
	Heavy dew	H03
	Light hazy air; Mist	H10
	Moderate hazy air; Mist	H11
	Strong hazy air; Mist	H12
	'Dewy' weather with clouded sky	H13
	?	H20
	?	H21
	?	H22

with some cloud formations and some v-shaped 'birds'. The birds, however, appeared to be referencing to the names that were given to the clouds, written below the drawing. As a result, we could develop the explanation as shown in Table IX.

7. Conclusion

We have described an attempt to translate CLIWOC wind and weather terms into modern equivalents. Despite the huge number of wind terms it turns out that most of them can be transformed meaningfully into a Beaufort force and consequently in wind speed. The present outcome seems suitable for first quantitative studies of the wind climate in the period 1750–1854 (Jones and Salmon, 2005), although there remains room for improvement. The dynamical character of the CLIWOC database (Können and Koek, 2005) allows effortlessly for updating of the wind

TABLE VII
Symbols in the column ‘sea state’ in Dutch extract logbooks and their coding in the CLIWOC database

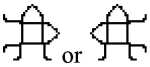
Symbol	Explanation(s)	Code
	Sea	Z00
	High sea	Z01
	Wild sea	Z02
	Swell	Z03
	High swell	Z04
	Heavy swell	Z05
	Continuous heavy swell	Z06
 or	Crossing swells	Z07

TABLE VIII
Symbols in the column ‘sea current’ in Dutch extract logbooks and their coding in the CLIWOC database

Symbol	Explanation(s)	Code
	Light tide rips	S00
	Moderate tide rips	S01
	Strong tide rips	S02

TABLE IX
Symbols, used in the column ‘nature and direction of the clouds’ in Dutch extract logbooks and their coding in the CLIWOC database

Symbol	Cloud type
v	Cirrus; Cirro Stratus
vv	Cumulus; Cumulostratus
vvv	Stratus
vvvv	Cirro Cumulus
vvvvv	Nimbus

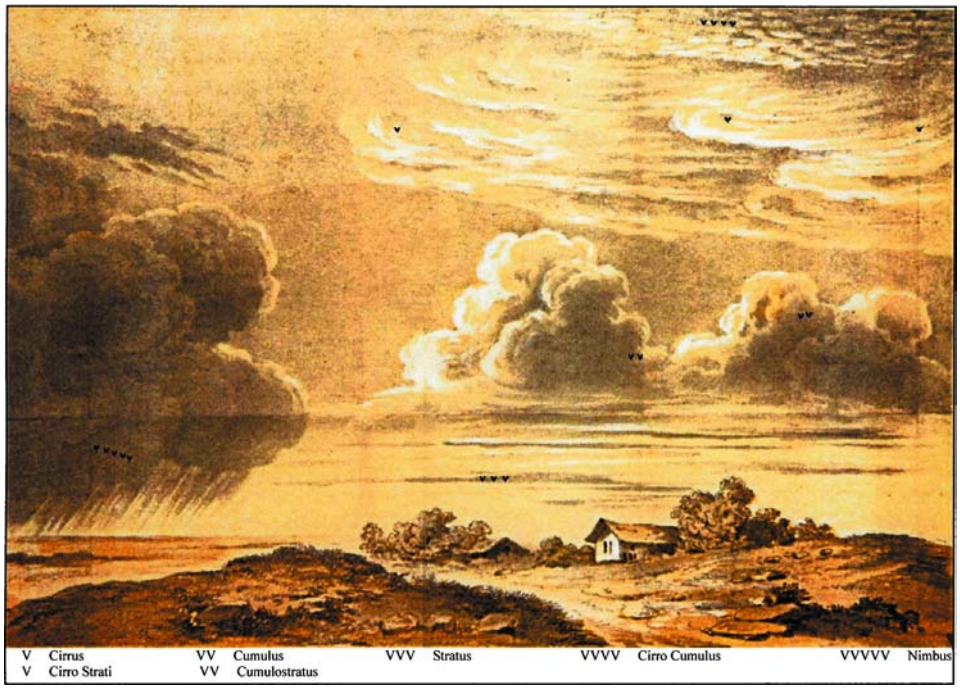


Figure 5. Drawing of cloud shapes and their explanation, found in the instruction manual (Jansen, 1853) for the use of the Universal Extract Logbook. The v-marks indicating the various cloud types in the drawing turn out to be accidentally evolved into regular cloud symbols in some extract logbooks (Table IX).

tables. Additional to the wind studies, a successful attempt has been undertaken to find the lost keys to weather symbols encountered in the logbooks. Although so far the analyses of the CLIWOC database did not go beyond considering wind, future studies will inevitably go into elements like precipitation, sea ice and present weather reports. All of them are in principle available from CLIWOC.

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