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SADCO

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A step into oceanographic history

SADCO has just added the CLIWOC set of oceanographic observations (1750-1850). This extends the holdings of data from voluntary observing ships (previously to 1850) back by another century.

Introduction

Over a 3-year period 2001 – 2003, staff from the

- Universidad Complutense de Madrid (Spain);
- University of Vigo (Spain)
- University of Sunderland (UK);
- Royal Netherlands Meteorological Institute (KNMI) (Netherlands);
- University of Leiden (Netherlands)
- University of East Anglia (UK)
- University of Mendoza (Argentina)

painstakingly acquired, inspected and digitised log books from vessels that plied the oceans between 1750 and 1850. CLIWOC, **the Climatological Database of the World Oceans, 1750-1850**, was funded by the European Union.

The principal objective of the project was to mobilise the scientific potential of marine climatic data enclosed in the logbooks from the period 1750 to 1850 (García-Herrera *et al.*, 2001, 2006).

SADCO was kindly provided with a copy of the data, and the loading was recently completed. The brief summary provided in this Newsletter has been gleaned from the various publications in the Reference list. The aim of the Newsletter is not only to indicate the complexity of the task undertaken by the compilers, and to acknowledge the extent and interest of the outcome, but also to touch on many of the fascinating aspects associated with the marime environment of the time. The interested reader is referred to the web site of the compilers (http://www.knmi.nl/cliwoc/), which contains a host of information on the process and the participants.

Ships

For many people not calling themselves sailors, and most likely never having been on a sailing ship, the concepts of wind, weather and sailing vessels of 300 years ago may conjure up images of pirates, foreign ports and hidden treasure. However, CLIWOC was about old sailing ships as observational platforms and not about what they actually were, namely transport and military vessels.

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In the days before steamships the mariner needed to be very sensitive to the wind, its power, direction and variability. The typical sea-going sailing ship of the period around 1800 (see Fig. 1) had about 25 different sails, some with peculiar names (the main course was not part of the menu, and the *flying jib* was never meant to get airborne). Apart from considerable experience and dexterity on the part of the crew, the deployment of these sails required a keen insight into the prevailing wind conditions in terms of speed and direction as well as the direction in which the skipper wanted the vessel to go. To set the right course the skipper needed to find an optimal solution to an equation in which the 25 sails, the draft and tonnage of the vessel, and the rudder acted as independent variables.

Logbooks

The log books were gleaned from various archives in England, Spain and the Netherlands. Log books in Portugal, an obvious choice because of the voyages undertaken by this country and its colonial past, could not be located. A few logbooks were obtained from USA, Germany, Denmark and Sweden (García-Herrera *et al.*, 2005a,b; Können and Koek, 2005).

Logbooks were used to record navigational records (position, time, bearings, etc), but other entries included aspects of the sails, weather, distance covered over the past 24 hours, encounters with other vessels, arrival in port, the status of provisions, the discipline and health of the crew, etc. There could even be different log books, the prime one kept by the skipper, while other officers also had log books. British log books were a legal requirement and had to be handed in for the officer to be paid (García-Herrero, 2005b; Wilkinson, 2005).

As far as observing and interpreting weather (wind) is concerned, the officers had considerable experience. Many of them joined the maritime world as young lads, and lived and breathed the marine environment of a ship. The performance of the sails provided good insight into the wind speed and direction, and can be considered meteorological "sensors". The noon entry in the logbook was the one where the weather was noted along with the position, and the CLIWOC project considered only those records.

The CLIWOC logbooks originated from the Netherlands (611), England (585) and Spain (452). Twenty were located in France and 6 from other sources (e.g. Sweden) (Können and Koek, 2005). These 1674 logbooks were only a subset of the useful books. The 280 195 observations are similarly distributed (Fig. 1).

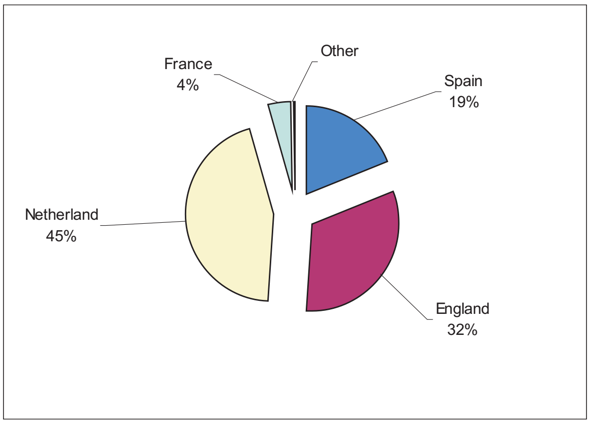

Fig 1. Distribution of observations by country of the logbook origins.

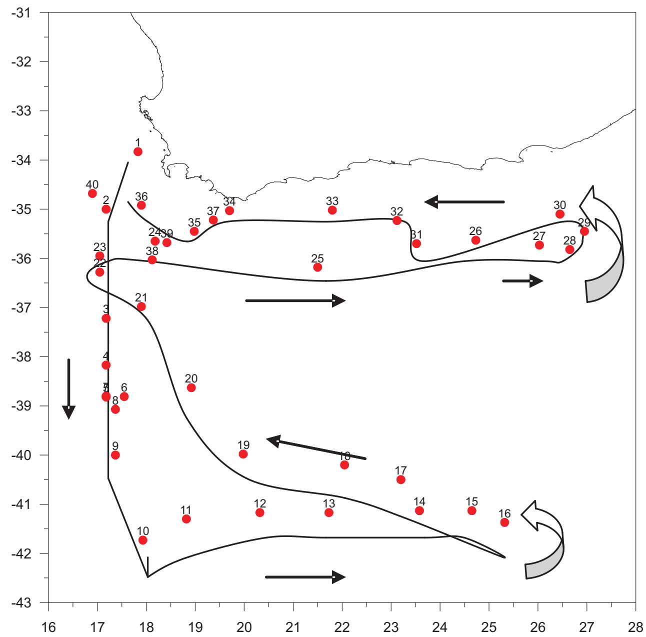

Fig.2 Track of the Dutch vessel Wesel off South Africa from 31 March (day 1) to 11 May (day 40) 1699. The direction of the track has been added. For unknown reasons the vessel ended on day 40 more or less where it started on day 1

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Quality control

The quality control exercised by the compilers of the data set is impressive. The description below does not give justice to the extensive deciphering, checking and cross checking that was undertaken.

a. Position

The latitude was derived from the sun or stellar sightings with a sextant and almanac, and expressed relative to the zero latitude (equator). On the other hand, the longitude often did not refer to the Greenwich meridian, since the latter was only adopted as the universal zero meridian late in the 1800s. About 50 % of the 4816 cruises digitised during CLIWOC referred to altogether 646 different zero-meridians (Können and Koek, 2005).

The effect of a single non-Greenwich meridian on a cruise is that the whole cruise track is displaced zonally east- or westwards (depending on the actual meridian) when plotted on a map.

If this wasn't bad enough, it seems that some skippers adopted a new zero-meridian whenever the ship went into port or passed a known landmark (García-Herrera *et al*., 2005b), and only half of these changes in the navigational reference frame was reported in the logbooks. Plotting the digitised cruise tracks revealed time-space discontinuities at these points, causing the track as a whole to appear fragmented (see García-Herrera *et al*., 2006; Können and Koek, 2005). The CLIWOC team used GIS to visualise and correct these errors.

It is noted by Wilkinson (2005) that there were definite improvements in the journey time of the vessels from Europe to India and China, decreasing by 25% over a period of about 30 years. It is surmised that these may be associated with the systematic use of log books.

The sailing routes also changed: before 1780 the forward journey to India passed through the Mozambique Channel but later followed a wider, ant-clockwise, southerly passage (see Fig. 2). There was also a definite seasonal character to the sailing routes. E.g. towards the end of a year Dutch and British shipping avoided the South Atlantic, largely due to the circulation patterns in the Indian Ocean (monsoon). Many other interesting historic facts, based on log books, on life at sea can be found in Wilkinson (2005).

Examples of tracks of individual ships are given in Fig. 2 - 5. The Spanish vessels were largely sailing between Europe, the West Indies and South America; the Dutch between Europe, the northern South America, the Gulf of Guinea and Indonesia, and the British between Europe, the West Indies and eastern India.

Figures 2, 3, 4 /.....

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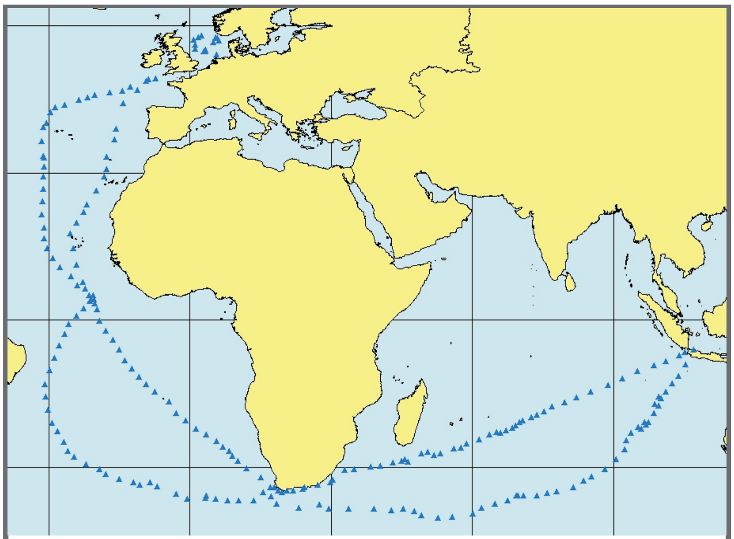

Fig. 3 Tracks of the Dutch vessel ARGO, 1840-1 and 1843-4 (from http://www.knmi.nl/cliwoc/cliwocmeta_nl.htm)

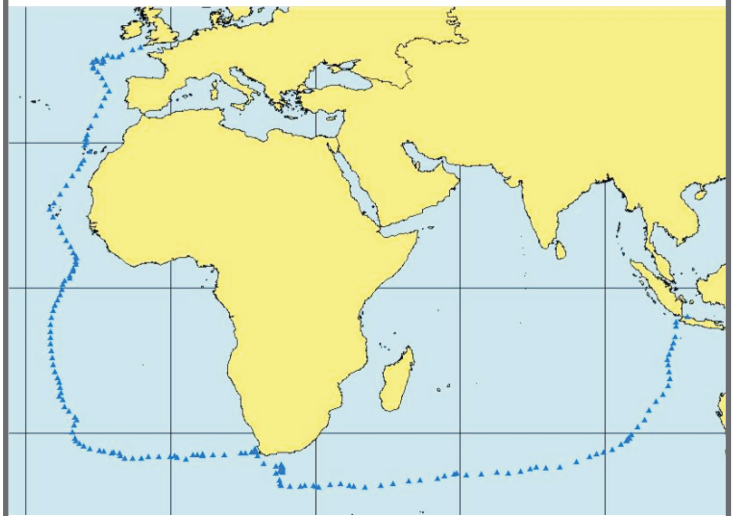

Fig. 4 Track of the Dutch vessel Maarseven, 1662-3 (from http://www.knmi.nl/cliwoc/cliwocmeta_nl.htm)

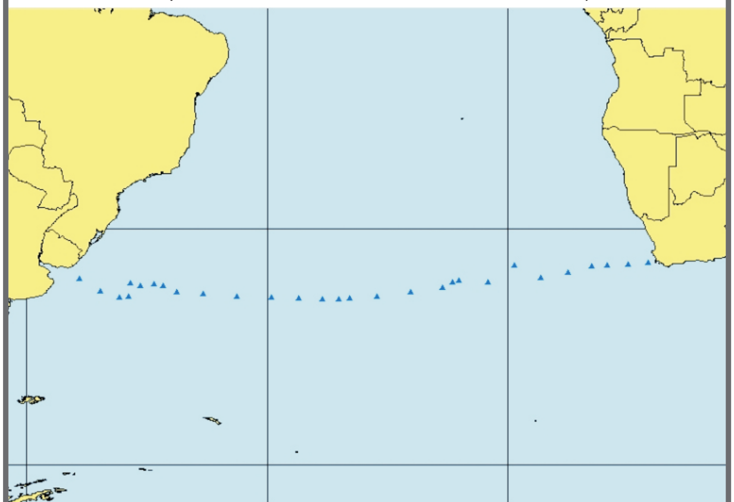

Fig. 5 Track of the English vessel Hermes, 1807-8 (from http://www.knmi.nl/cliwoc/cliwocmeta_uk.htm)

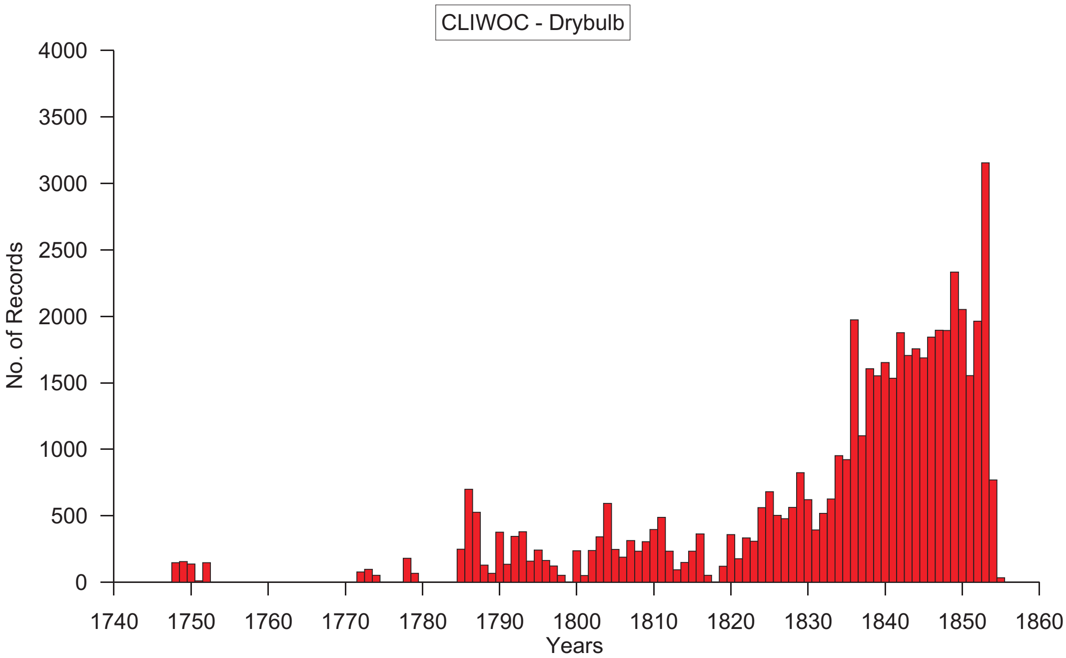

Fig.6 Amount of records containing air temperature observations (from García-Herrera et al., 2005a)

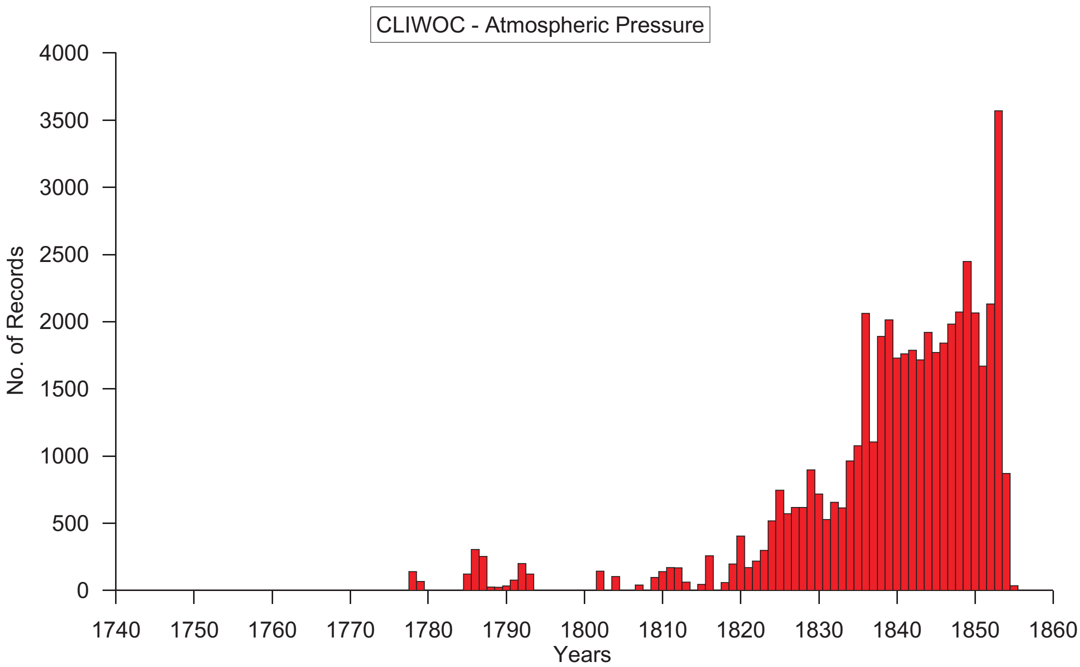

Fig.7 mount of records containing atmospheric pressure observations (from García-Herrera et al., 2005a)

b. Date and time

In Britain there was a difference between a nautical day and a civil day. The nautical day started at 12 noon, while the civil day started at midnight. In the log books this meant that "am" and "pm" were reversed. In addition, English logbooks used the Julian calendar until 1752 (García-Herrera *et al.*, 2005b).

The marine chronometer was invented by Harrison in 1759, but before that ½ hour sand glasses and stellar positions were used. It was the duty of a crew member to ensure that the sand glass was rotated timeously and the bell sounded.

c. Wind speed

The essence of the CLIWOC digitisation process was around the environmental information contained in the log books and daily records, mostly wind speed and direction. It is also in this domain where the greatest effort was required to qualify and quantify the observations (see Prieto, *et al.*, 2005; Wheeler and Wilkinson, 2005; Koek and Können, 2005; Wheeler, 2005; and Wallbrink and Koek, 2001a; 2001b).

In the period under discussion there were no "instruments" to measure the wind speed. Nevertheless, the authors of CLIWOC consider that the sails of a ship, as well as the effect of the wind on the water, represented similar "instruments" with which to gauge the wind force. This, coupled with the experience of the officers, augured well for the quality of the wind observations.

A systematic wind force scale was only defined by Beaufort in 1806 and more widely adopted thirty years later. Before then, wind speed was noted in anecdotal form and included words like "much wind", "more wind", "pretty breeze", "fine gale", "gentle gale", and "baffling". It seems that more than 100 different expressions were used to express wind force in each of the four language groups that were handled during CLIWOC (English, Dutch, Spanish and French). Fortunately, 12 of these expressions represented 90% of al the wind speed descriptors. A consistency check was also done between the denoted wind force and the reported distance covered (Wilkinson, 2005). The Beaufort scale was officially introduced in Britain In 1938, in the Netherlands in 1854 and more universally in 1874.

d. Wind direction

In terms of wind direction Dutch speaking readers may not have difficulty in distinguishing between "**Op** de wind", "**In** de wind", "**Bij** de wind", "**Aan** de wind", "**Van** de wind", "**Voor** de wind", but for others it may be confusing. Each of these expressions indicates a different wind direction (Koek and Können, 2005).

Compasses were mostly of a 32-point type (spaced 11.3 degrees apart) or a 16-point type (spaced 22.5 degrees apart). There is also evidence that until half way through the 19th century the wind direction was not corrected for the speed of the vessel.

If this complexity was not enough there was the issue of magnetic north vs. true north, or whether the magnetic variation was correctly applied.

e. Summary of QC process for wind speed and direction

The quality control involved four steps (García-Herrera *et al.*, 2005a):

- Dealing with the wind force terms, and translating these to the Beaufort scale. Translations were done in the country of origin of the specific log books.
- The reliability of the wind force and directions were checked where ships travelled in convoy, or where ships of different nationalities met.
- Comparison of the data with other global but more recent data sets (such as COADS)
- Investigation whether directions referred to magnetic north or true north.

Other parameters

Some records contained air temperature, starting in the late 1700s (García-Herrera *et al.*, 2005a) (see Fig. 6) (the Fahrenheit thermometer was invented in 1714 and the Celsius thermometer in 1742). The mercury barometer was invented in the middle 1600s and the aneroid barometer 200 years later in 1843). The CLIWOC air pressure records started in the early 1800s (Fig. 7), and given that the aneroid barometer only became useful in the mid 1800s, the CLIWOC pressures are mostly from mercury barometers.

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Nomenclature

One of the important exercises of the compilers was to establish a set of nomenclature regarding the quantitative meaning of the observations (CLIWOC Team, 2003). A straightforward example would be the use of terminology, such as "leagues" in stead of nautical miles. Not only did the CLIWOC compilers need to quantify the anecdotal descriptors but they also had to ensure agreement among the languages of the log books, namely English, Spanish, Dutch, and French).

It would be quite interesting for the uninitiated reader to guess what sort of wind force is meant by the following Dutch expressions in the 17th century: "de wind is wiew"; "de wind is waauw"; "labberkoelte"; "huiken en guiten"; "kaak"; "de zeilen waaien uit de lijken". What wind speed is a "Bramzeilskoelte"? [It is a gentle breeze of Force 3]. Or what is the difference between a "fresh gale" and a "fret of wind" [The prior, in today's terms, would be Strong breeze of Force 6, the latter a Storm of about Force 10.].

Data loaded in SADCO

The overall amount of data loaded in SADCO is indicated in Table 1, while information of the environmental parameters in given in Table 2. A temporal distribution of the loaded data is indicated in Fig. 8. Note that there was also a small amount of data in the 1600s!

Table 1 CLIWOC data loaded in SADCO.

Load ID	#1661	#1769	#1780	#1794	#1825	#1847	Total	Percentage
Number of records	50000	50000	50000	50000	50000	30280	**280280**	100.00%
Records in SADCO target area	13427	10774	12810	18072	20811	11907	**87801**	31.33%
Records rejected	0	0	0	1	7	28	**36**	0.01%
Records overland	171	99	139	157	388	216	**1170**	0.42%
Records with PK error	7007	5926	6868	2133	2852	2569	**27355**	9.76%
Duplicates	144	440	225	114	492	379	**1794**	0.64%
Fatal errors	7322	6465	7232	2404	3732	3164	**30319**	10.82%
Records loaded	42678	43535	42768	47596	46268	27116	**249961**	89.18%

Note: Data was loaded in 6 batches, identified by the first year in the batch (e.g. #1780 started in 1780). Only 31% of the data fell within SADCO's target area (but all the data was loaded). 10.8% of the data could not be loaded, because of key errors, most notably errors in the Principal Keys (data, time, and position).

Table 2 Parameters of the CLIWOC data loaded in SADCO.

Totals	Loaded	Percent
Drybulb	52325	20.93%
Surface Temperature	108	0.04%
Atmospheric Pressure	48891	19.56%
Wind Direction	231026	92.42%
Wind Speed	216262	86.52%

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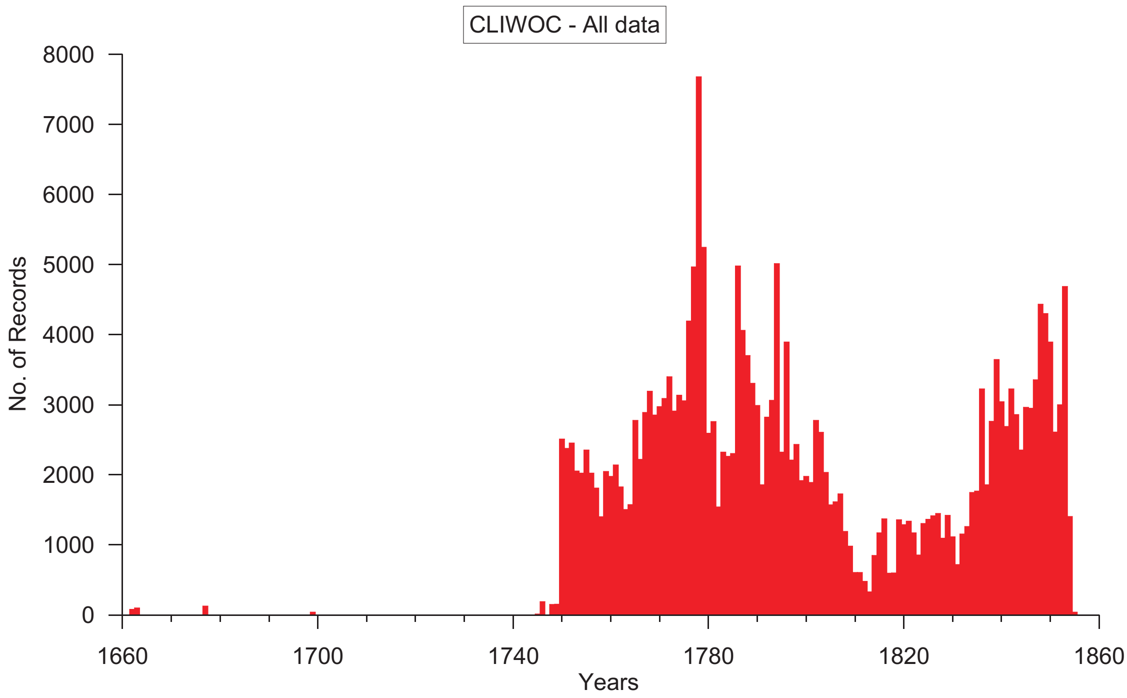

Fig. 8 Year-by-year variation of the amount of CLIWOC data loaded in SADCO.

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