CLIWOC FINAL REPORT

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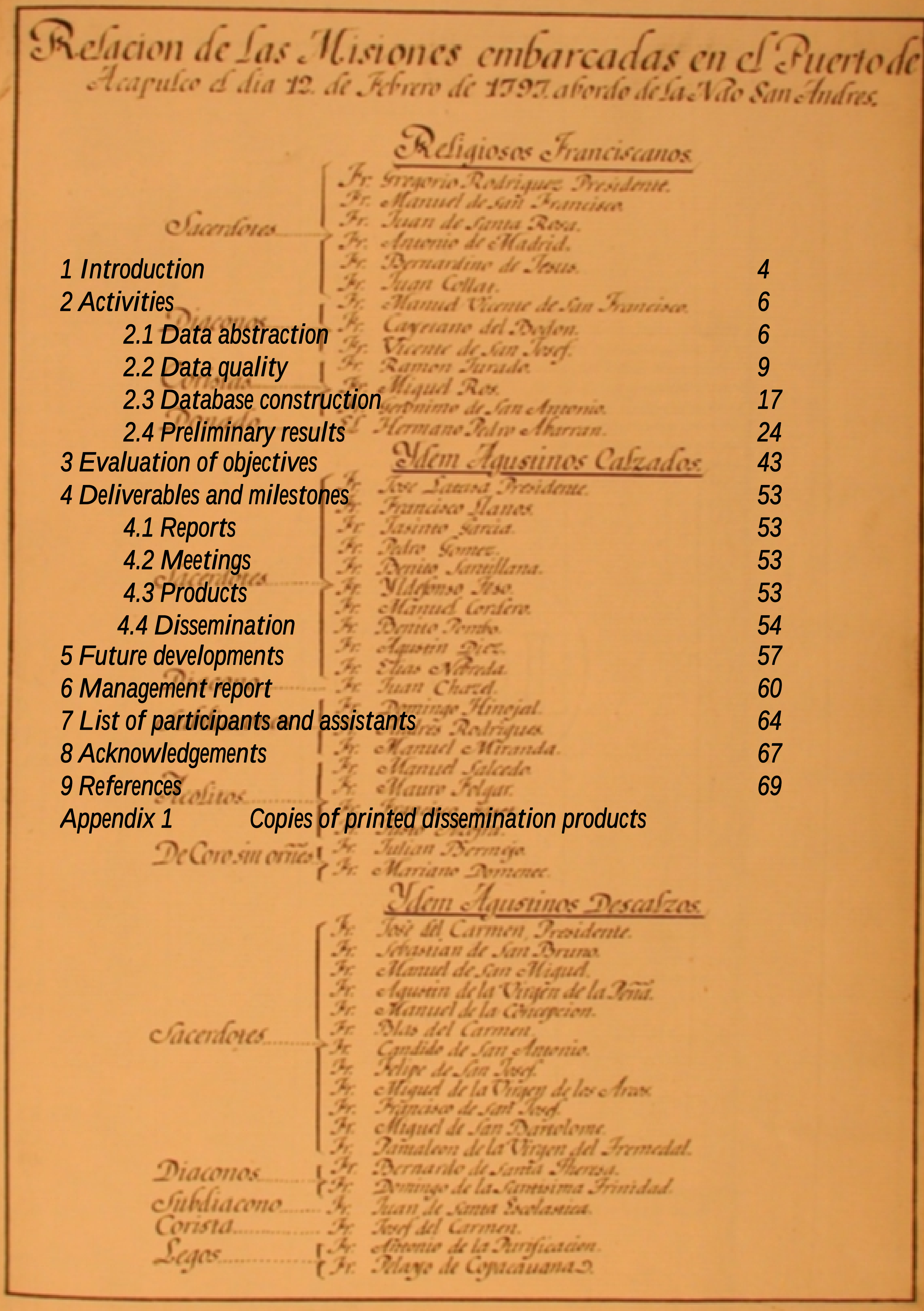
UE contract EVK2-CT-2000-00090


Relacion de las Misiones embarcadas en el Puerto de Acapulco el dia 12. de Febrero de 1797. abordo de la Nao San Andres.

Religiosos Franciscanos

Ydem Agustinos Calzados

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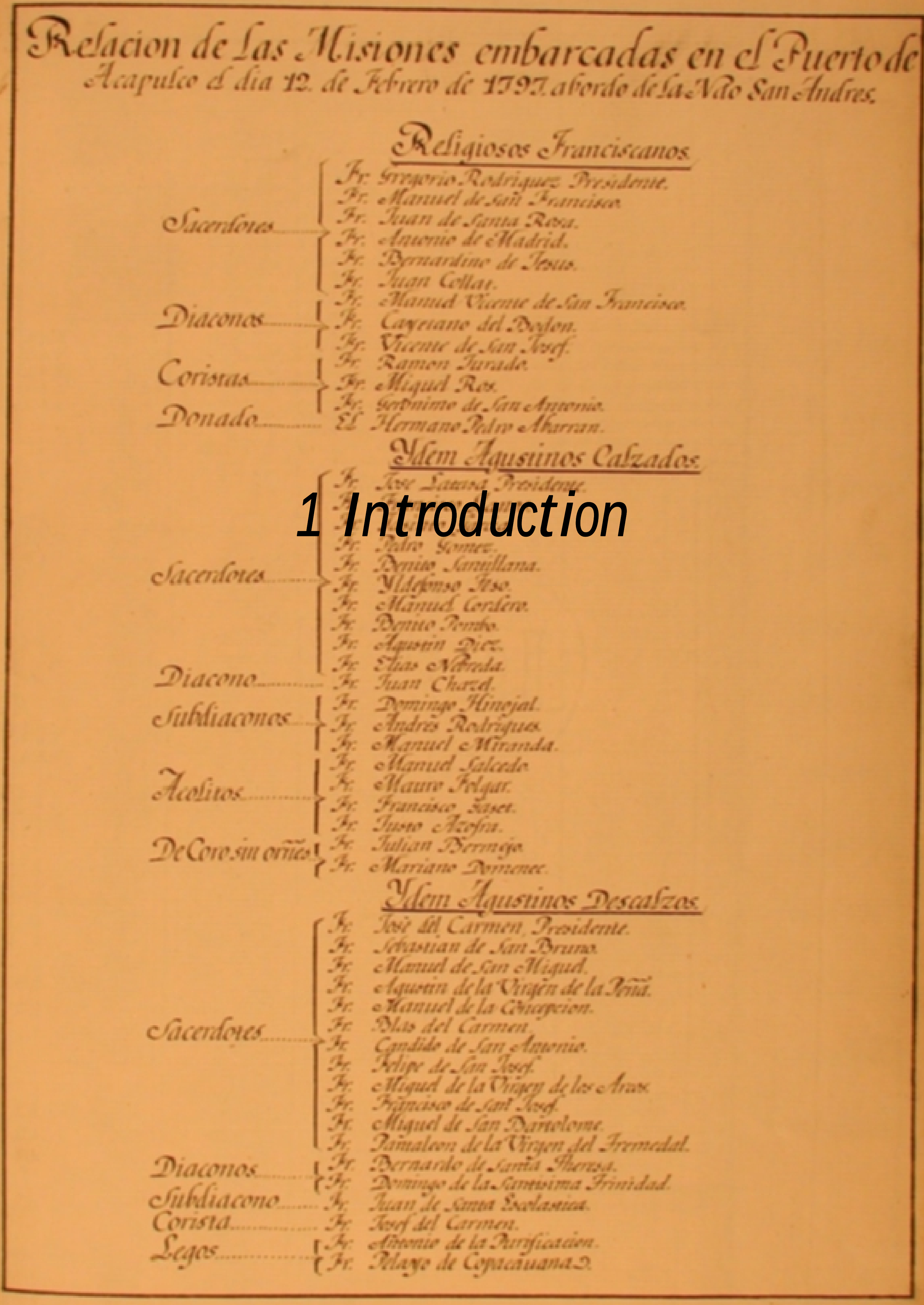
1 Introduction



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Subdiaconos: Fr. Domingo Hinojal. Fr. Andres Rodriguez. Fr. Manuel Miranda.

Acolitos: Fr. Manuel Salcedo. Fr. Mauro Folgar. Fr. Francisco Saset. Fr. Justo Azofra.

De Coro sin orden: Fr. Julian Bermejo. Fr. Mariano Domenec.

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Subdiacono: Fr. Juan de Santa Escolastica.

Corista: Fr. Josef del Carmen.

Legos: Fr. Antonio de la Purificacion. Fr. Pelayo de Copacauana.

1 Introduction

This is the final report of EU funded CLIWOC project (EVK2-CT-2000-00090). The project started on 1 December 2000 and continued until 30 November 2003. Project partners are: Universidad Complutense de Madrid, Spain (partner 1 and coordinator), University of Sunderland, UK (partner 2), Royal Netherlands Meteorological Institute (KNMI), the Netherlands (partner 3), IANIGLA, CONICET, Argentina (partner 4) and University of East Anglia, UK (partner 5). A warm and highly cooperative working environment has developed among the partners. This has led to a very active and fruitful interchange of experiences that has resulted in the efficient and successful completion of the project.

The aim of this report is to provide a global view of the main project activities and achievements. Chapter 2 reviews the four principal activities as described in the working packages: data abstraction (wp 1-4), control of the data quality (wp 5), database construction (wp 6) and the first scientific results (wp 7). In chapter 3 the project objectives are evaluated, while the milestones and deliverables are reviewed in chapter 4. Fortunately, the results have been so encouraging and successful that CLIWOC related undertakings have not ended with the formal conclusion of the project. The partners are committed to continuing the activities of the CLIWOC project and building on its successes; these activities are described in chapter 5. The management report is included as chapter 6, while chapters 7 and 8 include the complete list of participants and the acknowledgements.

2 Activities

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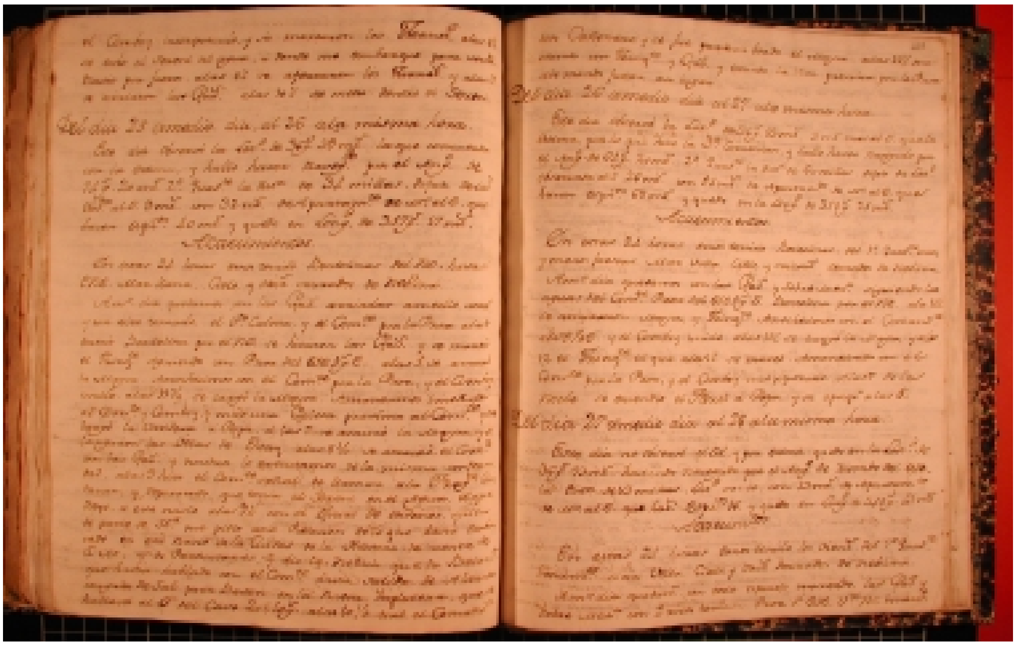
2 Activities

2.1 Data abstraction

The partners in the abstraction process employed different strategies. These were designed to adapt abstraction methods as efficiently as possible to the particular requirements of the Archives in each country. Thus, the abstraction from Spanish and Dutch logbooks has been made after producing digital images of the original logbooks preserved in the respective archives (Archivo del Museo Naval and Archivo General de Indias in Spain and the Nationaal Archief in The Netherlands). This procedure fosters better preservation of the original documents and minimises the working time at the archives. Additionally it contributes to a better access to the document contents, which includes a large volume of non-climatic information. This activity is one of the many multidisciplinary features of the project. After solving some of the copyright issues, which vary among the countries, the projects web page (www.ucm.es/info/cliwoc) will host all the images of the logbooks that are made freely available by the host archives. Figure 1 shows some examples of logbook pages from the different countries.

a)



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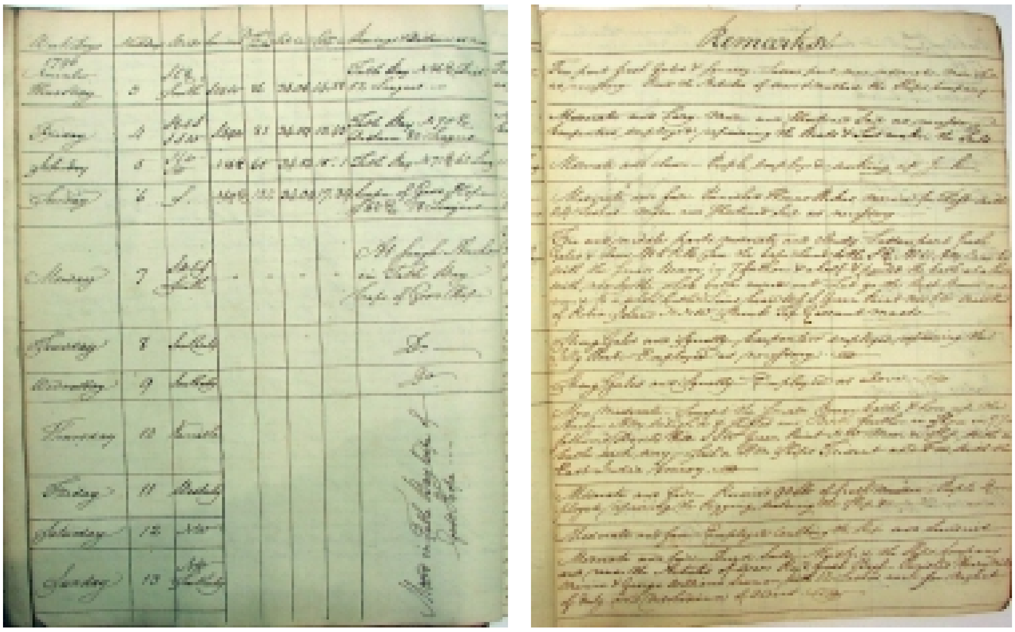

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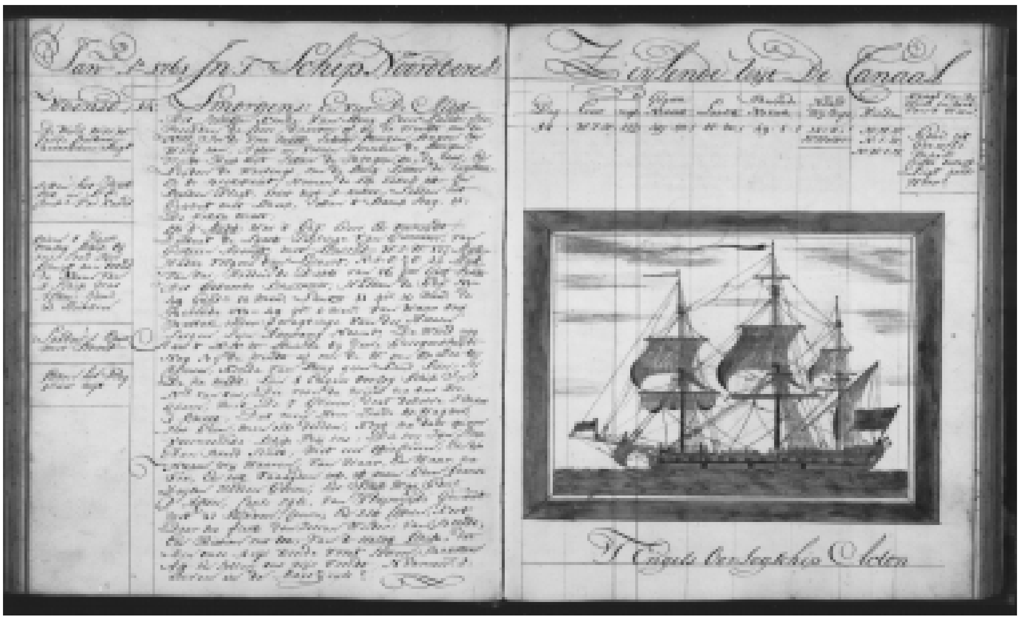


Figure 1. *Sample logbook pages from different countries showing typical layout. a) from Spain, b) England and c) the Netherlands*

Because of the much greater volume of logbooks to be consulted and the different logistic requirements, the English data have been abstracted directly from the original documents into the database. In addition, Partner 2's team were based in the Archives of the National Maritime Museum (Greenwich, London) thereby minimising the need to prepare 'transportable' digital images.

Finally, many French logbooks have been abstracted from microfilm images that have been bought from CARAN (Centre d'Accueil et de Recherche des Archives Nationales).

To ensure homogeneity in the abstracted data, the partners agreed:

1) To use a common protocol for the raw database. All meteorologically relevant data of the midday (noon) observation were extracted, i.e. the date, geographical position, wind direction, wind force, present weather, sea state and, when available, sea ice reports, air temperature and air pressure data. Spanish and French logbooks contain usually one observation per day, generally at noon, but UK and Dutch logbooks include sub daily observations as well, although with less detail than the noon observations. For reasons of efficiency, the sub-daily observations were generally ignored in the extraction, but metadata such as the archive where the logbook is kept and its catalogue code, the ship's name and type, the names of the logbook keepers, reports of encounters at sea and, for users outside the climatological fields, recordings of notable events on board were all abstracted. The latter includes references to deaths on board, punishments, sightings of birds, whales, etc., as well as other information. This subset of information may be particularly relevant to historians interested in non-climatic applications of the database, such as military studies, trade and economic history etc.

2) To abstract the logbook observations into the working database without any preliminary conversion or elaboration of the content. This allows for greater flexibility in the post-processing and in the preparation of the different versions of the database, thereby optimising its potential and permitting easy reference back to the source material.

3) To make preliminary and intermediate integration exercises. From the outset this has been a highly successful exercise, allowing data inhomogeneities and

curiosities to be detected, speeding the production of the final database and permitting the easy integration of information from the different sources.

In total, 1,624 logbooks were digitized, comprising of 273,269 observations. Table 1 shows the distribution over the countries.

	Logbooks	***Observations***
Spain	408	50,935
UK	591	88,475
Netherlands	613	126,541
France	12	7,318
TOTAL	***1,624***	***273,269***

Table 1. *Number of CLIWOC logbooks and observation by country***.**

2.2 Data quality

One of the main objectives of CLIWOC was to obtain a high quality dataset. Consequently much effort has been invested in checking and assuring the quality of the abstracted data. Package 5 was principally devoted to the many quality issues. Three main levels of quality control may be distinguished:

1) quality of the data transcription,
2) quality of the data interpretation,
3) quality checks of the derived observations.

1) Quality of the data transcription

In order to evaluate and minimize the errors when keying the data from the original documents into the raw database, a common procedure was implemented. A sample of 5% of the total keyed pages was routinely sampled every month to check for typing or other errors. Where significant errors were found that month's work, it was re-abstracted.

2) Quality of data interpretation

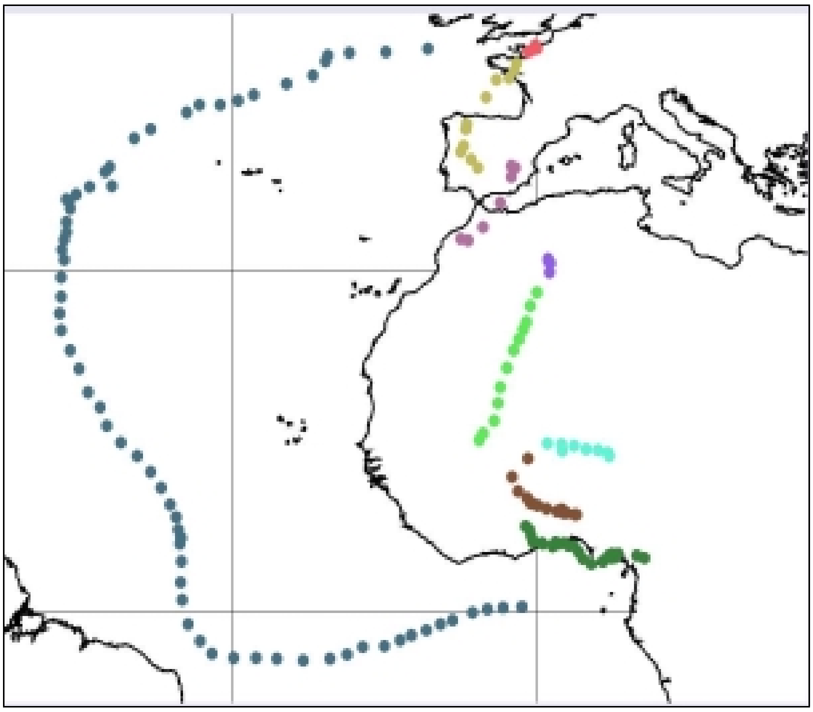
The correct typing of the original logbooks was only the first step of the process. These raw data were, however, written in archaic versions of four languages (Spanish, English, Dutch and French), all of which had to be translated into their modern English equivalent if the database was to be useful and accessible.

With this aim in mind, a multilingual dictionary was produced. It is currently available from the project web page, and is one of the first attempts in the literature to express the wealth of archaic logbook wind force terms in a form that is comprehensible to the modern-day reader. Oliver and Kington (1970) and Lamb (1982) have drawn attention to the importance of logbooks in climatic studies, and Lamb (1991) offered a conversion scale for early eighteenth century English wind force terms, but no studies have thus far pursued the matter to any greater depth. At an early stage in the project it was apparent that many of the logbook weather terms, whilst conforming to a conventional vocabulary, possessed meanings that were unclear to twenty-first century readers or had changed over time. This was particularly the case for the important element of wind force; but no special plea is entered for the evolution in nautical vocabulary, which often reflected more wide-ranging changes in the respective native languages.

The key objective was to translate the archaic vocabulary of the late eighteenth and early nineteenth century mariner into items in the current international standard of the Beaufort Scale. Only then could the project's scientific programme be embarked upon. The dictionary is the result of the largest undertaking into logbook studies that has yet been carried out. Several hundred logbooks from British, Dutch, French and Spanish archives were examined, and the exercise offered a unique opportunity to explore the vocabulary of the one hundred year period beginning in 1750. The logbooks from which the raw data have been abstracted range widely across the North and South Atlantic and the Indian Oceans. Only the Pacific, largely in consequence of the paucity of regular naval activity in that area, is not well represented. The range of climates encountered in this otherwise wide geographic domain gives ample opportunity for the full range of the mariner's nautical weather vocabulary to be assessed, from the calms of the Equatorial regions, through the gales of the mid-latitude systems to the fearsome storms of the tropical latitudes. The Trade Winds belts, the Doldrums, the unsettled mid-latitudes, even the icy wastes of the high latitudes, are all embraced in this study. The text seeks to provide a means of understanding archaic wind force terms and, other than to indicate those items that were not commonly used, no information is given on the frequency with which different terms appeared in the logbooks. The work is offered to the wider academic community in the hope that it will prove to be of as much value as it has been to the CLIWOC team. The complete text of the dictionary can be obtained in PDF-format from the project web page: www.ucm.es/info/cliwoc

3) Quality checks of the derived observations

After the extraction and an initial quality control, which included a calendar check of data from English logbooks prepared between 1750 and 1752 (a period when the Julian calendar was still in use), the data were sent to the Dutch partner. For every ship, the route was plotted, checked and adjusted according to the present-day prime meridian convention (i.e. Greenwich). In total, 636 different zero meridians were identified as being used over the study period. The reason for this vast number is the habit in those days of changing the zero meridian at each major landfall or sighting. Despite such longitude corrections, some coordinates continued to suggest overland and otherwise obviously erroneous positions. This is because most of the longitude determinations were based on dead reckoning, and the accumulation of small errors could result in an increasing miscalculation of the ship's longitude as the voyage progressed. After determining the part of the voyage that needed correction, the final step was to apply incremental adjustments to the ship's longitudes throughout that leg of the voyage and thereby to estimate the most likely track. This was done according to the method originally developed by Jackson et al. (2000). Figure 2 shows an example of the effect of longitude adjustments on the track of a ship's voyage. Note that in this example the outward journey contained many more land sightings and hence more changes in longitude zero points than the return trip, which went over the open ocean with far fewer land sightings.



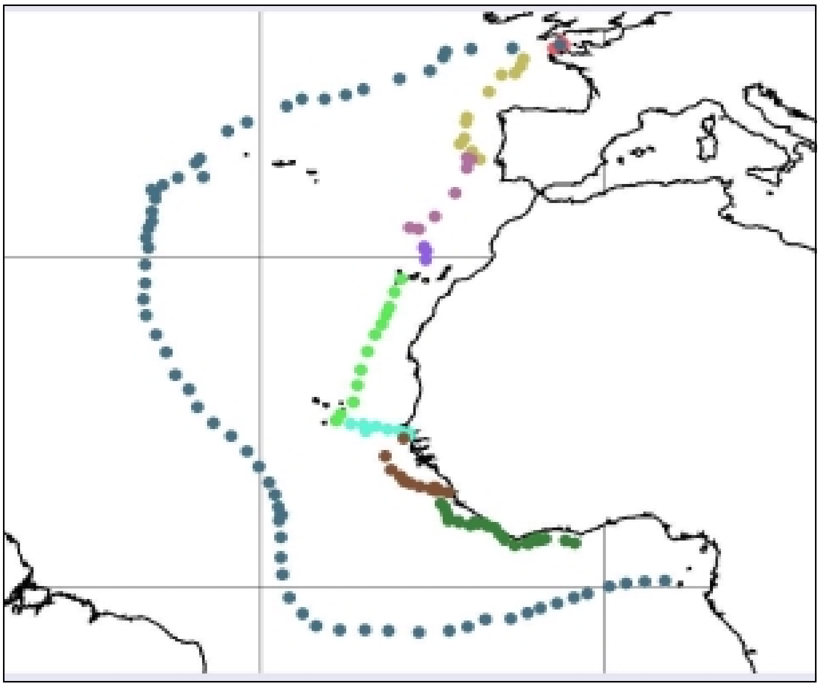


Figure 2. *The top figure shows the positions of HMS* Surprise *(1750-1751) without correcting the longitude to the current standard, i.e. Greenwich. Each different colour corresponds to a different zero meridian, which are, in order: Start Point, Ushant, Cape Roxent, Madeira, Point Negro, Isle of May Bay, Cape St. Maries, Bananas and (at the return trip) St. Thomas's. The bottom figure shows the corrected positions.*

The figure is typical for CLIWOC in the sense that more than 50% of ship tracks needed major revision. Only when the reliability of the original data had been confirmed and corrected if necessary, could attention could turn to the question of observational bias and intrinsic errors in the key meteorological observations.

The first task was to search for bias in the scale used for recording of wind direction. In theory, winds were recorded on 32-point compass, but a sample of over 4000 observations showed that there was a bias towards using only the 16- (NNE, SSE etc.), 8- (NW, SW etc.) and 4-point (N, W, etc.) elements of the compass. Table 2 shows the observed – expected values and chi-square statistics over the first eight decades of the study period. In all decades except the 1810s this tendency is statistically significant at the 0.01 level.

Decade	4-point	8-point	16-point	32-point	Test Stat
1750s	171.25	764.25	423.5	-1359	**1278**
1760s	116.25	252.25	201.5	-570	**482**
1770s	97.75	215.75	77.5	-391	**403**
1780s	72.75	223.75	208.5	-505	**433**
1790s	35.63	192.63	65.25	-293.5	**266**
1800s	75.75	114.75	123.5	-314	**240**
1810s	14.75	1.75	-7.5	-9	4.5
1820s	20.63	17.63	39.25	-77.5	**50.7**

Table 2. *Observed minus expected frequencies based on the null hypothesis of no bias in the use of the 32-point compass. Chi-square statistics in bold are statistically significant at the 0.01 level.*

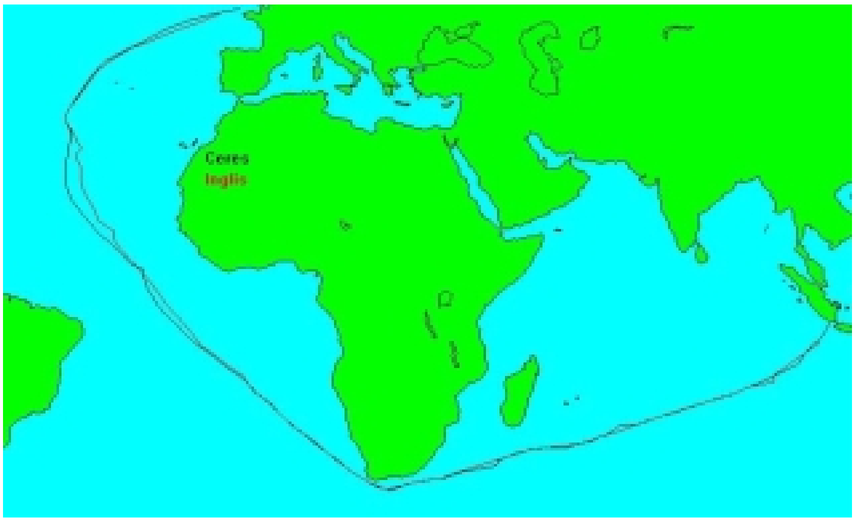


Figure 3. *One of the 'dual' voyages (East India Company ships* Ceres *and* Inglis*) used in the study of data consistency.*

Secondly, an examination was made of the consistency with which wind force and wind direction (the two principal weather elements) were recorded. This was performed by taking records from ships in company over long voyages. The differences between such independently derived data sets provided a measure of data reliability. The results for wind direction are shown in Figure 4, in which the mean difference is 2.47 compass points, with a modal class of 1 compass point. It shows also that 45 per cent of differences were 1 point (22 degrees) or less.

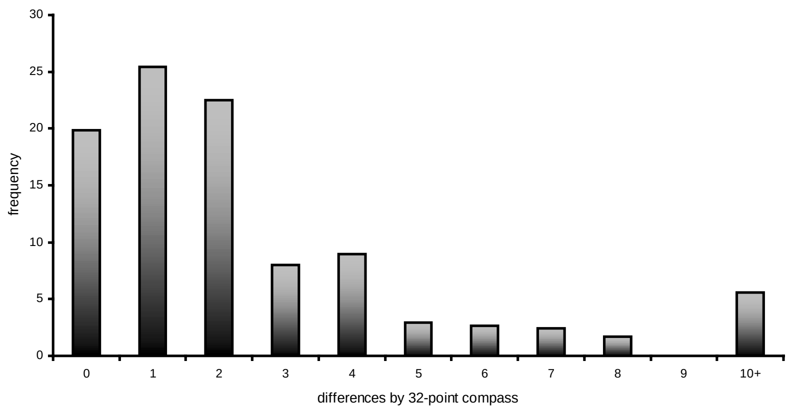


Figure 4. *Histogram of wind direction differences from independent observations of the same conditions. Sample size = 413 pairs of observations.*

Finally, wind force records were compared after their conversion to present-day Beaufort Scale equivalents. The sample size was 461 pairs of records. Figure 5 summarises the differences and shows a mean of 0.9 of a wind force and a modal class of zero. Table 3 provides a more detailed statistical summary of the wind force analysis. All correlations between the series were significant at the 0.05 level (all except one at the 0.01 level). The mean differences in all pairs of voyages were less than one force on the Beaufort Scale (but were significant in a number of cases).

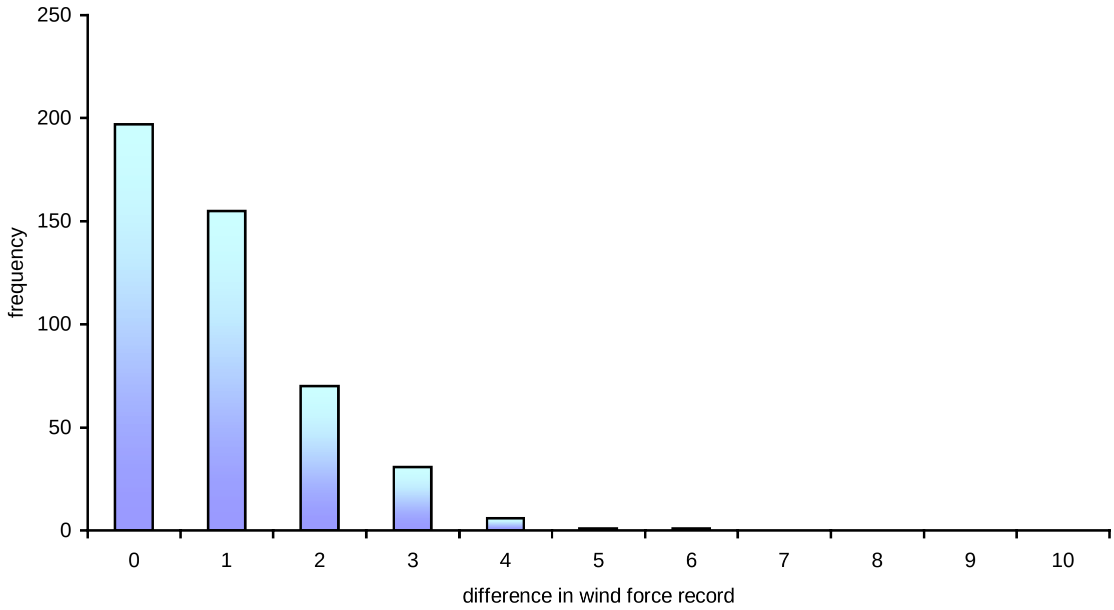


Figure 5. *Histogram of wind force differences from independent observations of the same conditions. Sample size = 461 pairs of observations.*

Larger Vessel	Smaller Vessel	Dates	Year	Region	Wind Speed Corr.	n	Sig.	T-test of means Diff.	Dig.
Victorious	*Sphinx*	Apr - Jun	1795	N & S Atlantic	0.70	64	<**0.01**	0.28	0.15
Jupiter	*Star*	Jan - Jul	1800	Indian Ocean	0.77	94	<**0.01**	0.40	0.02
Diana	*Calypso*	Sep - Nov	1799	N Atlantic	0.75	53	<**0.01**	0.12	0.48
Lancaster	*Rattlesnake*	Jul - Nov	1800	Indian Ocean	0.84	41	<**0.01**	0.41	0.04
Ceres	*Inglis*	Feb - May	1816	Atl & Ind Oceans	0.74	75	<**0.01**	0.17	0.20
Warley	*Ceres*	Apr - May	1815	N & S Atlantic	0.75	32	<**0.01**	-0.55	**0.01**
Belleisle	*Decade*	Jun - Aug	1806	N Atlantic	0.67	40	<**0.01**	-0.34	0.07
Neirede	*Camel*	Apr-May	1806	N & S Atlantic	0.61	41	<**0.01**	-0.44	**0.01**

Table 3. *Summary table showing the comparisons between wind force records from nine dual voyages.*

A final issue surrounded the question of wind direction. These records were usually based on readings from a magnetic compass, the use of which was widespread in the CLIWOC period. Navigators were aware of the differences between the direction of true and magnetic north, termed the ‘magnetic variation’. The absolute magnetic variation could be as much as 10 degrees, sometimes even over 30 degrees. The question arose as to whether the reported wind directions were related to true north or magnetic north There were no international conventions at the time and studies of contemporary texts did not answer this question adequately or consistently for all of the participating countries, although it did provide some useful information the case of English logbooks. Consequently additional analysis of the CLIWOC database was carried out. A comparison of the average wind directions of the four nations in an area of relatively constant winds (the Trade winds belt in the North Atlantic) with the present-day climatic values indicate that the British used magnetic wind directions throughout the CLIWOC period. The pre-1800 Spanish data shows a preference for wind directions relative to true north, while the Dutch made a switch from magnetic to true directions somewhere in the period 1790-1810. For the French data and the post-1800 Spanish data the analysis was inconclusive. Table 4 shows which north is assumed in the CLIWOC wind direction procedure.

Spain	≤1800	True
	>1800	True*
UK	≤1800	Magnetic*
	>1800	Magnetic*
Netherlands	≤1800	Magnetic
	>1800	True
France	≤1800	Magnetic*

Table 4. *Recording of wind direction with respect to magnetic or true north by country and period. In the CLIWOC database, this table is used to convert to true wind direction. Values marked with an asterisk are not based on empirical evidence.*

The conclusions of this chapter can be summarized as follows:

a) The results of the verification/quality control analysis strongly suggest that the CLIWOC data are based on reliable and consistent records of the conditions at the time, in particular: 1. magnetic and true wind directions can be identified and 2. the majority (67%) of recorded wind directions are reliable to within 22 degrees.
b) Wind force records are reliable to within one force on contemporary 12-point scales.
c) *N*-sample independent wind force series are significantly correlated.
d) Wind force terms in all participant languages can be confidently and reliably expressed in modern-day Beaufort scale equivalent forces and speeds.

2.3 Database construction

The construction of the database was the main objective of working package 6. This section summarizes the main results obtained using release 1.5. The previous versions were more limited in scope.

After being properly corrected for position and date, the observations were put in the database in IMMA standard format (Woodruff, 2003). This format allows the use of the present day unit conventions in a core record along with the original data in attachments to the core. For all records, the original data were kept. These were stored in the original languages; their equivalents being derived from the dictionary. The meteorological content was treated similarly: the original units and descriptive wind force terms were kept and linked to the values in modern units by a lookup table. The wind force dictionary, which is presented in four principal sections, one for each partner-language, provides a means of converting wind descriptors into Beaufort force numbers and is included as a dynamical module within in the database, which allows for efficient updating. Temperature recordings were converted to Celsius, while barometer readings were converted to hPa from a variety of units. Again the original recordings are kept in the IMMA-attachments and the converted recordings are in the IMMA core.

The CLIWOC philosophy recognized the need for easy accessibility to the data. Since a long-term aim of the project team was incorporating the data into the ICOADS database, early contacts were made with its management group. It was agreed subsequently that the format for the final CLIWOC database would accord with the IMMA standards. The core of the records in this format contain the basic coordinates and meteorological elements in present SI units, together with pointers to attachments, where the original recorded material is stored. For wind speed, the transformation from the original terminology to the SI units involves two steps: first from the old terms to those of the Beaufort scale, using the dictionary and, second, by assigning average m/s values to the Beaufort forces according to the WMO code 1100 scale. See Table 5 for this conversion series, and for the assignment of non-integer Beaufort force numbers where greater descriptive detail allowed for such more detailed identifications.

Beaufort	Class boundary [m/s]	Lower-half value [m/s]	Midpoint value [m/s]	Higher-half value [m/s]	Class boundary [m/s]
0	0	0.0	0.0	0.1	0.2
1	0.3	0.6	1.0	1.2	1.5
2	1.6	2.0	2.6	2.9	3.3
3	3.4	4.0	4.6	4.9	5.4
4	5.5	6.1	6.7	7.3	7.9
5	8.0	8.7	9.3	10.0	10.7
6	10.8	11.6	12.3	13.1	13.8
7	13.9	14.7	15.4	16.3	17.1
8	17.2	18.1	19.0	19.8	20.7
9	20.8	21.7	22.6	23.5	24.4
10	24.5	25.5	26.8	27.4	28.4
11	28.5	29.5	30.9	31.6	32.6
12	32.7	33.9	35.0		

Table 5. *Assignment of m/s values to the Beaufort forces.*

Temperature, and other instrumental data were standardized to SI units using conventional arithmetic conversion factors. Barometer readings were converted to hPa using basic procedures. First the readings were converted to millimeters (using 25.4 and 27.0699534 millimeters for English and French inches, respectively) and then to hPa after which the pressure was reduced to standard gravity. No correction for the temperature or the height above the sea surface was applied to the pressure data The adjustments for magnetic wind directions were calculated with software that was kindly made available by Andrew Jackson of the University of Leeds Geophysical Research Group. Pointers are also included in the database to non-meteorological data such as casualties and conditions on board, and to pathways to digital images of the pages (where available) of the logbook from which the data were abstracted.

All data are available individually i.e. daily, but they are also presented in monthly summaries of u and v vectors in 8°×8° grid boxes for wind. For the period 1824-1854 there were sufficient data for monthly summaries of pressure and temperature also. In due course, the data will be incorporated in the monthly summaries of ICOADS and integrated with the Maury data collection. To facilitate an even larger group of users, the data are stored in Microsoft Access format as well. Both Access97 and Access2000 are downloadable from the CLIWOC website.

Partner 1 will maintain the CLIWOC database. The data will also be accessible through KNMI and ICOADS as a separate data set. Future investigations will determine if the methodologies developed during the production of the CLIWOC database are applicable to other data sets from similar sources.

The database is currently available as CD-ROM, and from the website. Table 6 shows the number of CLIWOC data days by ocean, country of origin and 50-yr period. Here, the border between the Atlantic and Indian Oceans is put at 20°E (near Cape Town); the border between the Indian and Pacific Oceans at 120°E (a meridian that runs close to Manila), and the border between the Pacific and Atlantic Oceans at 70°W (Drake Strait). Figure 6 show the geographical coverage of CLIWOC by country over its entire 1750-1854 period.

		N-Atlantic	**S-Atlantic**	**Indian Ocean**	**Pacific**	**All Oceans**
Spain	≤1800	28,236	11,622	319	1,614	41,791
	>1800	399	190	301	89	979
UK	≤1800	31,603	12,530	16,104	1,281	61,518
	>1800	9,270	5,202	7,002	200	21,674
Netherlands	≤1800	20,045	5,109	5,142	0	30,296
	>1800	31,932	18,348	26,617	1,481	78,378
France	≤1800	3,898	158	159	896	5,111
	>1800	32	28	46	0	106
TOTAL		***125,415***	***53,187***	***55,690***	***5,561***	***239,853***

Table 6: *Number of CLIWOC data per ocean, country and period.*

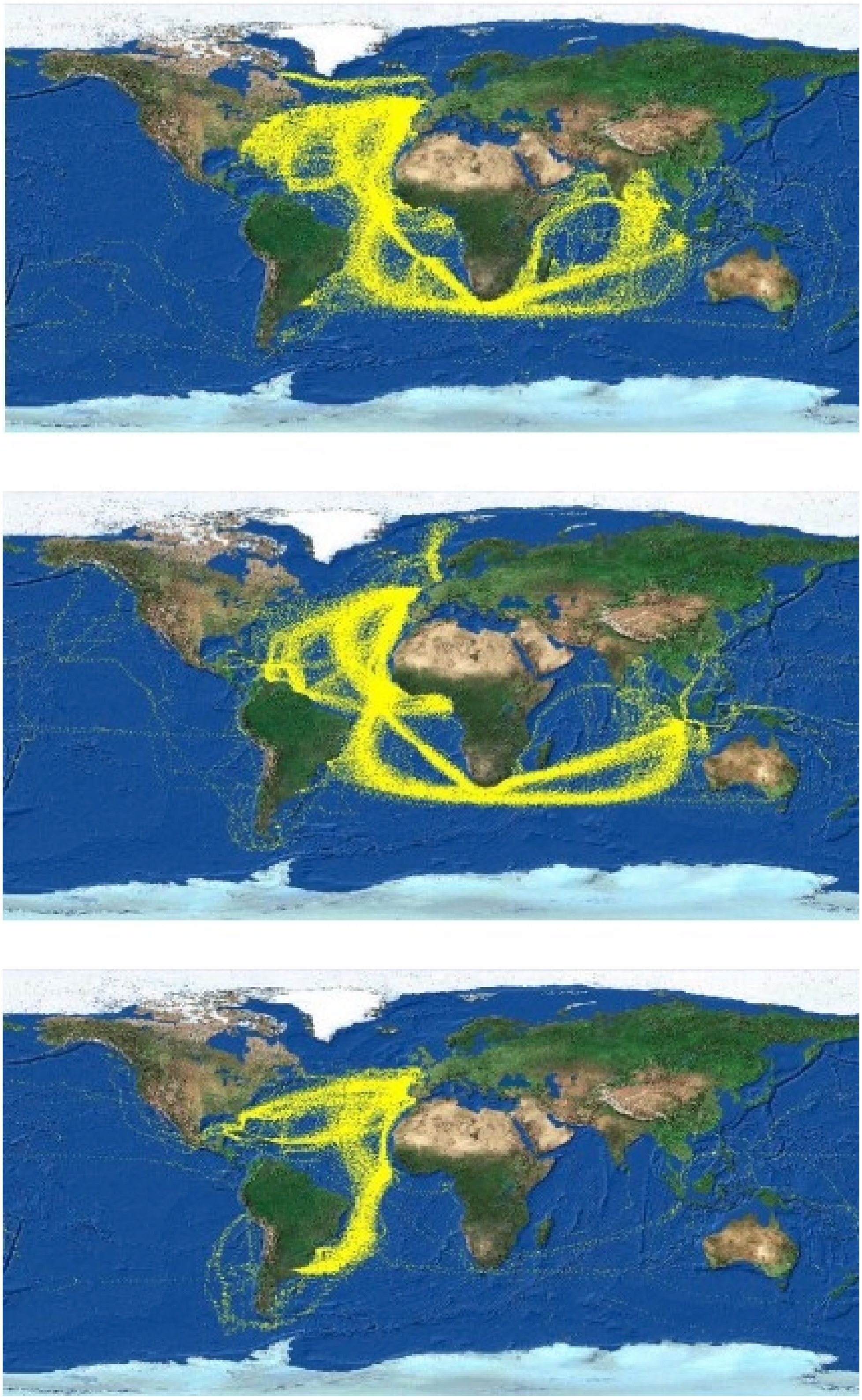
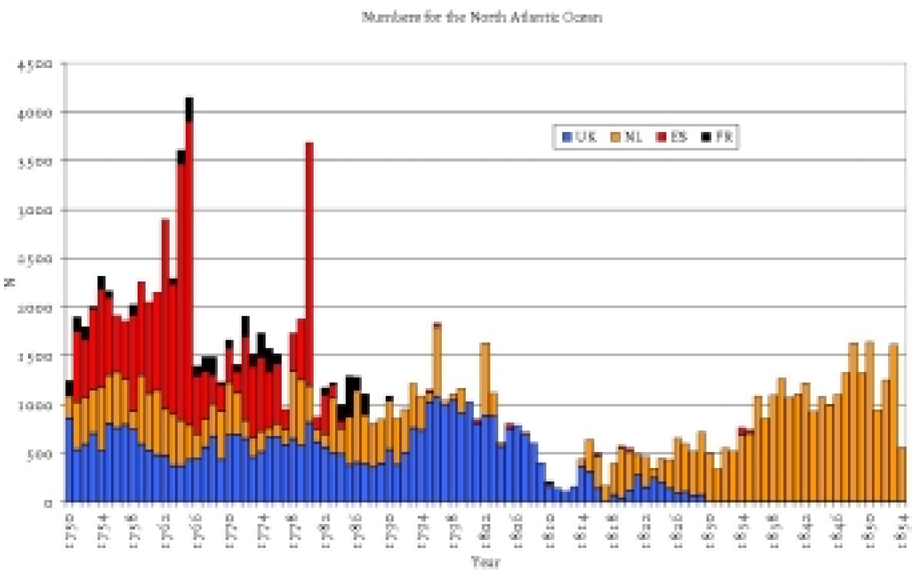


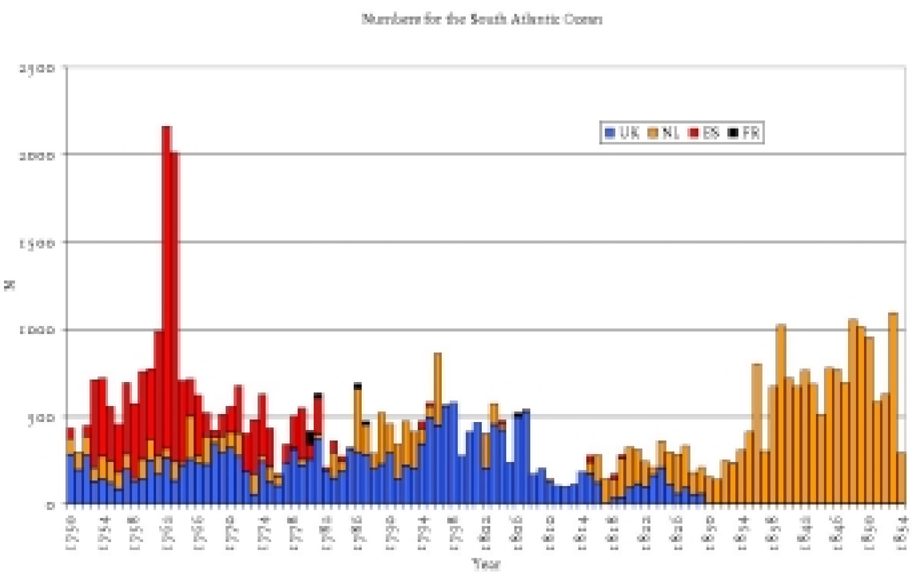
Figure 6. *Geographical distribution of the observations per collecting country; from top to bottom: United Kingdom, The Netherlands and Spain.*

Table 6 and Figures 6 and 7 show the following three features. First, the Atlantic and Indian oceans are well covered with data; but the Pacific coverage is poor. Second, the UK and Dutch cover the Atlantic and the Indian Oceans, in both the 18th and the 19th century. Third, the Spanish and French ships' tracks are predominantly from the 18th century, and principally enhance the data density over the Atlantic Ocean.

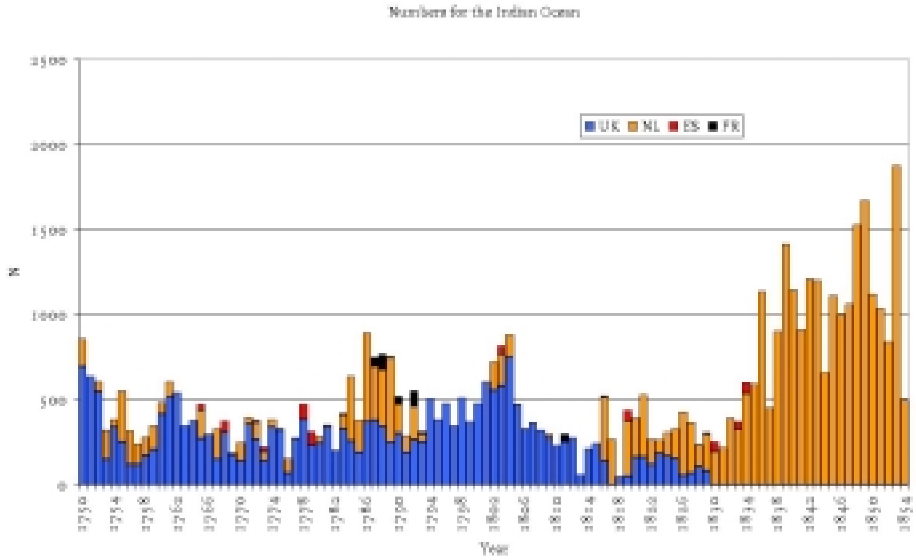
a)



b)



c)



d)

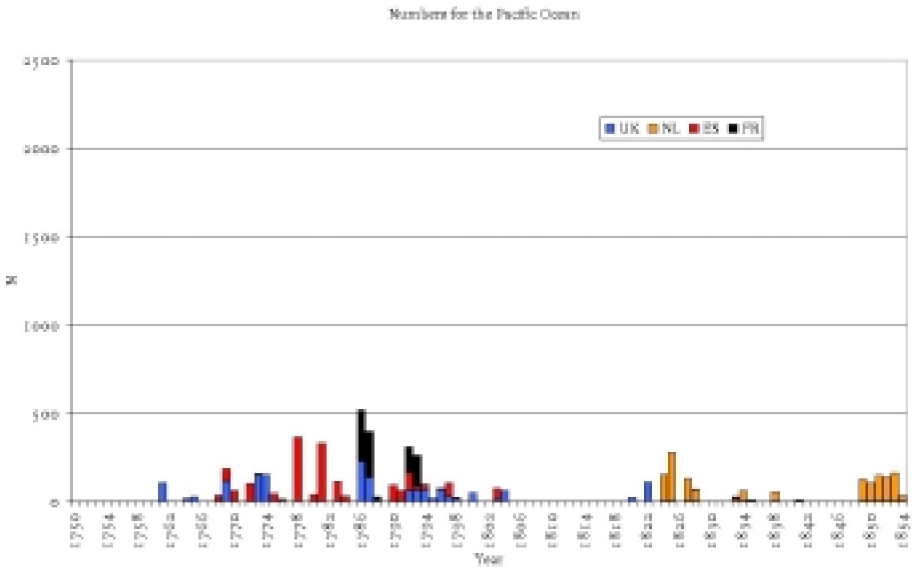


Figure 7. *Number of observations per year per ocean area for each country. Graph 7a and 7b show the North and South Atlantic Ocean, respectively. Graph 7c shows the Indian Ocean, while 7d depicts the number of observations in the Pacific Ocean.*

Figures 7a and 7b show that the Dutch/UK contributions are such that they produce a consistent temporal coverage for the North and South Atlantic Oceans, while the Spanish and French data are concentrated in the 18th century coverage. Over the Indian Ocean, the data come primarily from the Dutch and UK sources. The number of observations gathered for the Indian Ocean (Figure 7c) is roughly one third of that for the N-Atlantic (Figure 7a). This suggests that evidence of the North Atlantic Oscillation (NAO) may be more confidently derived from the CLIWOC database than of the El Niño Southern Oscillation (ENSO).

Table 7 shows the number of observation that report both wind force and wind direction, as well as the number of reported air pressure and air temperature recordings per ocean for the period 1800-1854. Pre-1800 numbers are not included in the table, as there were few instrumental observations being made at the time. The numbers of pressure and temperature recordings in Table 7 are strikingly similar. This is a consequence of the fact that ships that were instrumented usually carried both a thermometer and a barometer.

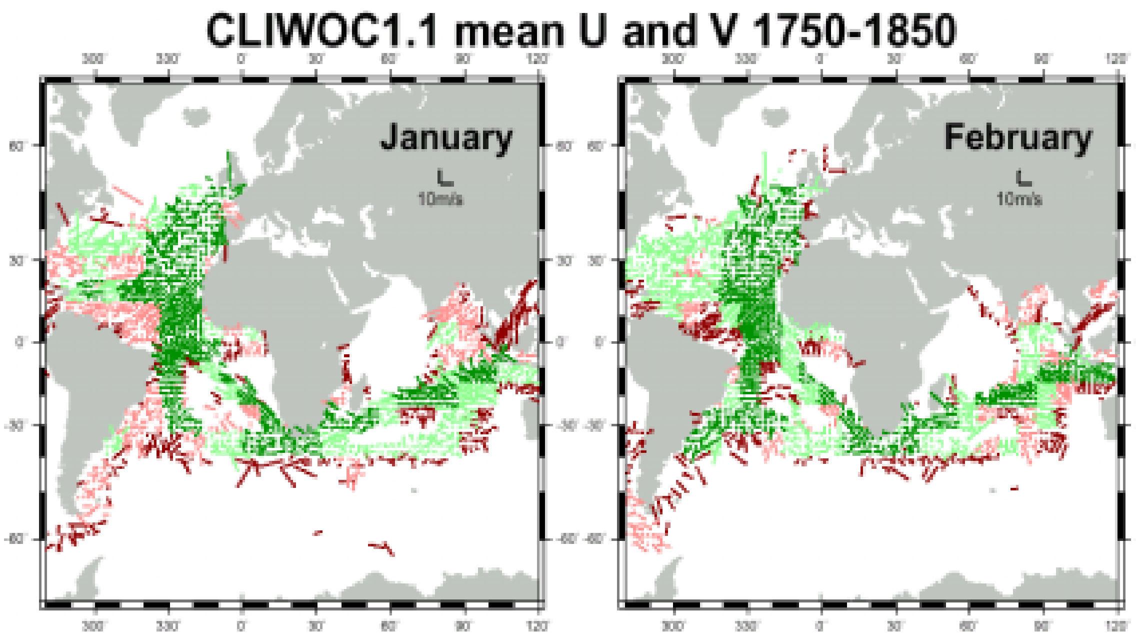
	N-Atlantic	**S-Atlantic**	**Indian Ocean**	**Pacific**	**All Oceans**
Wind	38,353	21,533	30,289	1,696	91,871
Air temperature	18,203	11,348	15,833	1,046	46,430
Air pressure	18,294	11,322	16,105	908	46,629

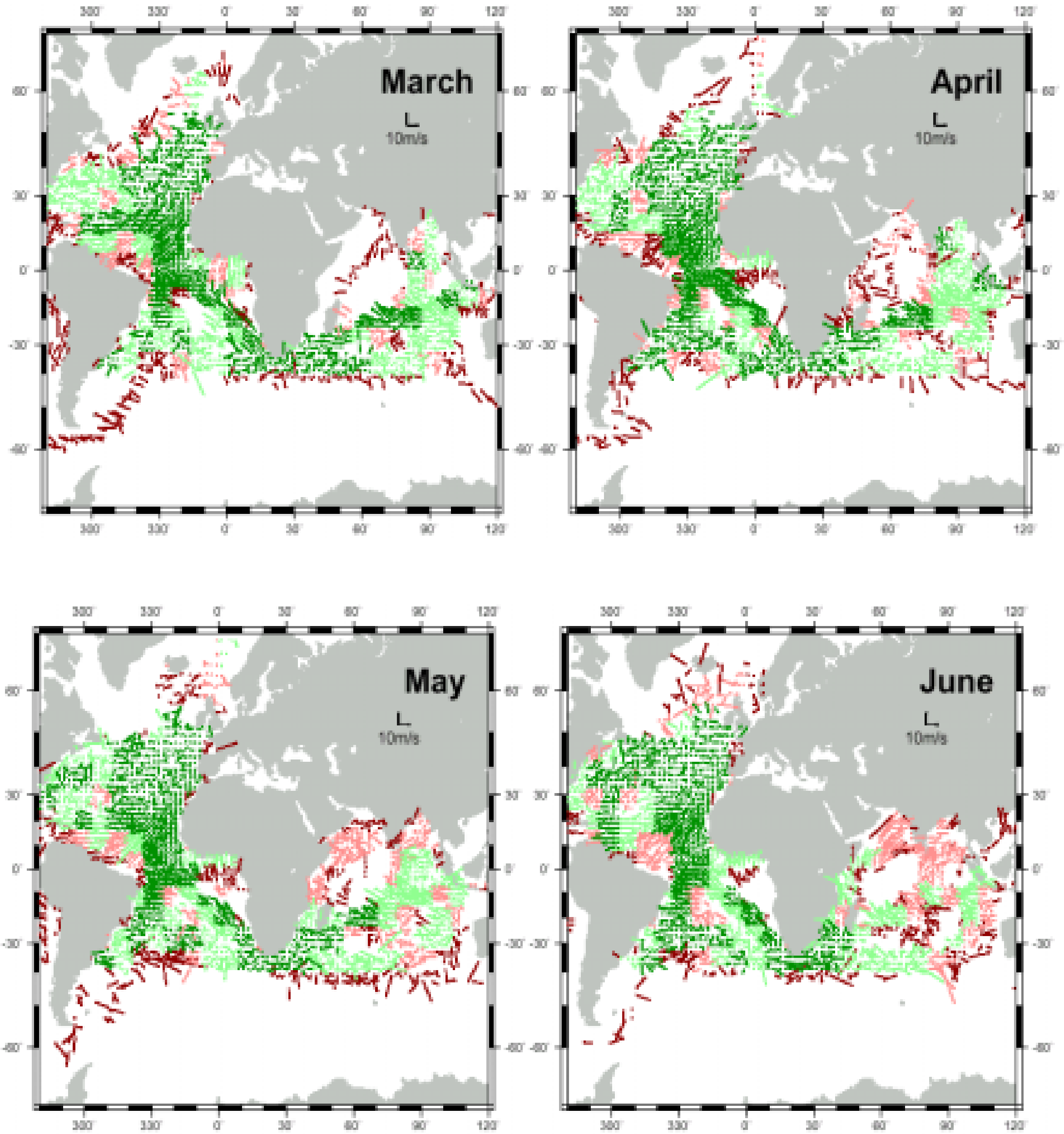
Table 7. *Number of CLIWOC data 1800-1854 per ocean and element; the numbers of pre-1800 pressure and temperature observations are negligible.*

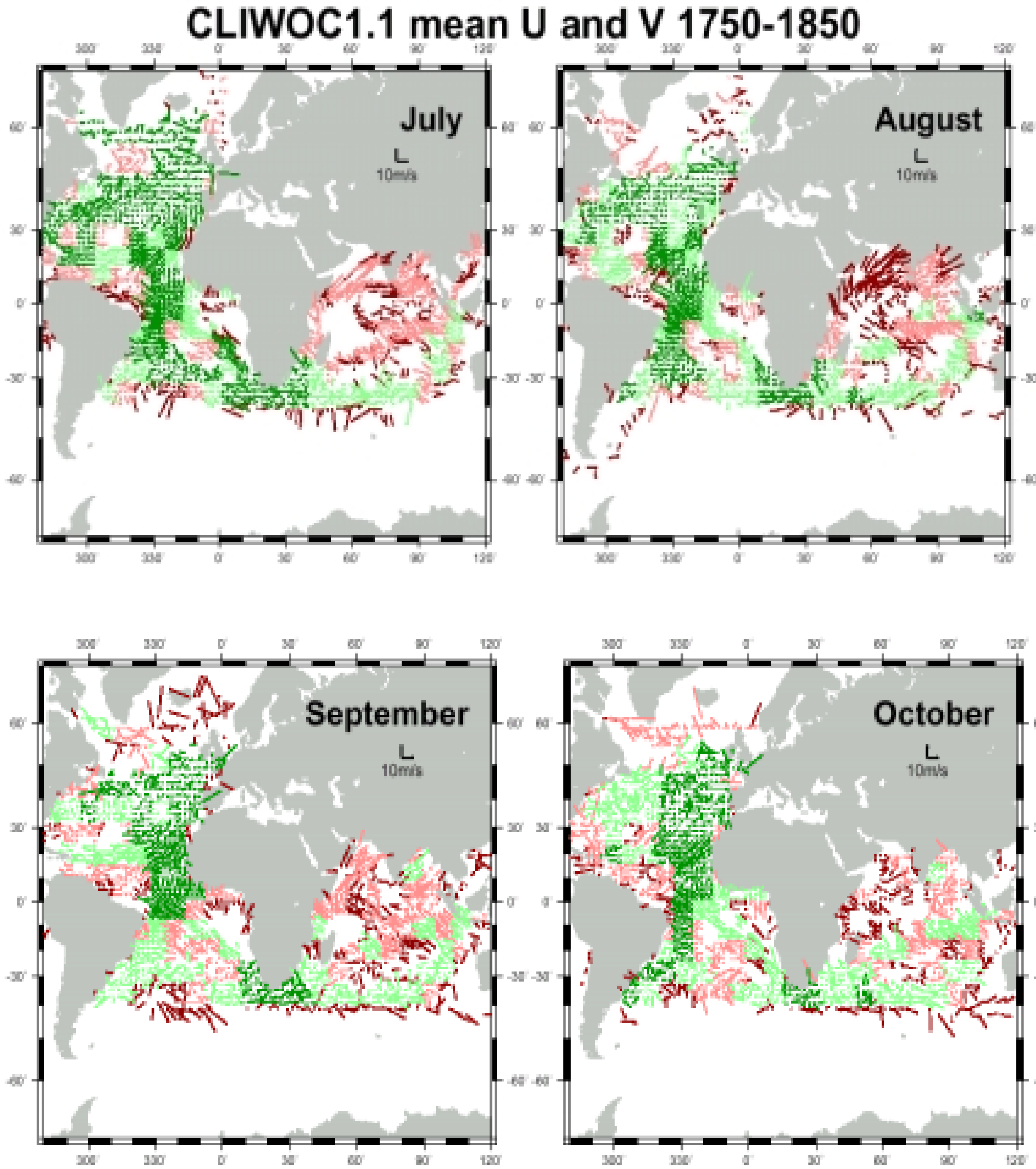
2.4 Preliminary results

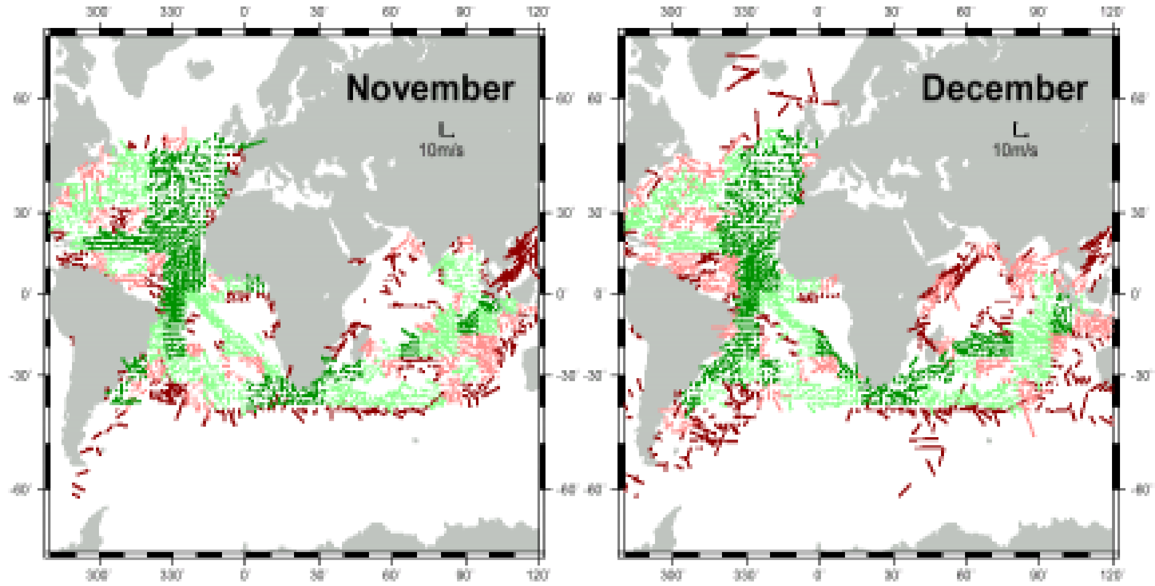
This section summarizes some of the most relevant scientific results obtained so far. The partners recognize that the full potential of CLIWOC can only be reached in the long term, and the careful scientific exploitation of CLIWOC data will be matter of years in coming to fruition Consequently, as foreseen in the project contract, these results are only a minor part of the expected outcomes, and are mostly intended to show the great potential of CLIWOC. Additionally, and again as noted in the contract, they are focused on obtaining a reconstruction of the North Atlantic Oscillation index (NAO).

The first derivative is the provision of surface wind climatologies for the period 1750-1850. Figure 8a shows monthly maps of surface winds, in which the seasonal and spatial patterns of average conditions can be clearly seen. Using this wind climatology (with average values of *u* and *v* components for 1961-90) we reduced all the ICOADS and CLIWOC data to anomalies for each month in each year, 1750-1997. In addition to the *u* and *v* wind anomalies, we also retained the number of observations each month in each 2ºx 2° square. Figure 8b shows the difference in vector winds for the 12 months of the year between the CLIWOC average (for 1750-1850) and ICOADS (for 1961-90). There is little difference between the two fields, and the consequent anomaly-difference vectors are small compared to those for the absolute winds in Figure 8a. Differences are larger in regions of sparser coverage and where day-to-day variability is high (e.g. the westerlies at high latitudes in the Southern hemisphere and in the northern North Atlantic). This high level of agreement between CLIWOC and ICOADS climatology serves as an additional check and confirmation of the high quality of the data abstracted in CLIWOC.

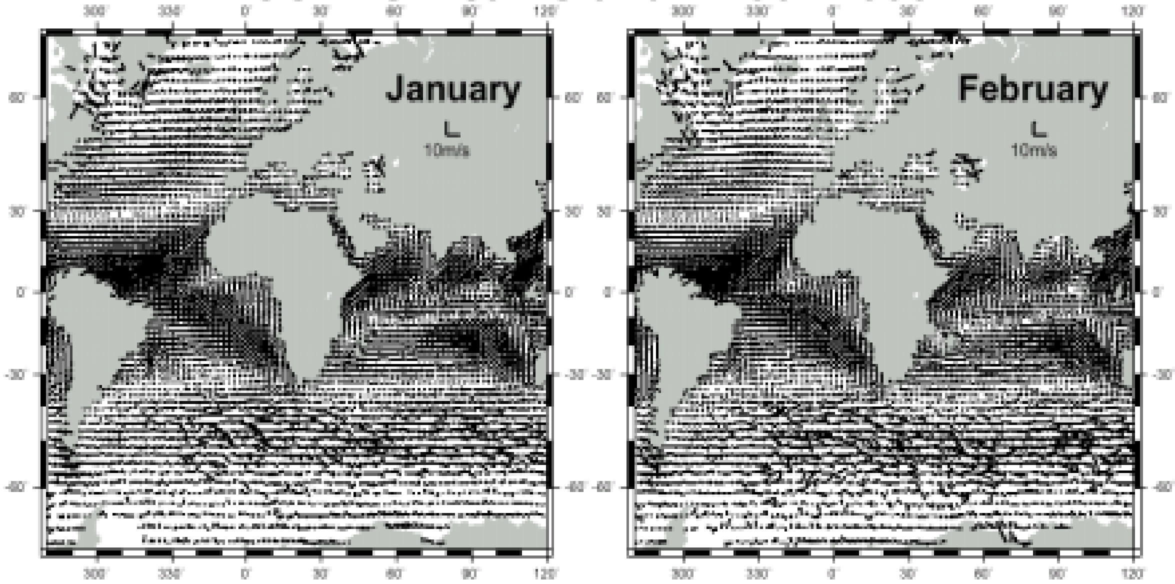


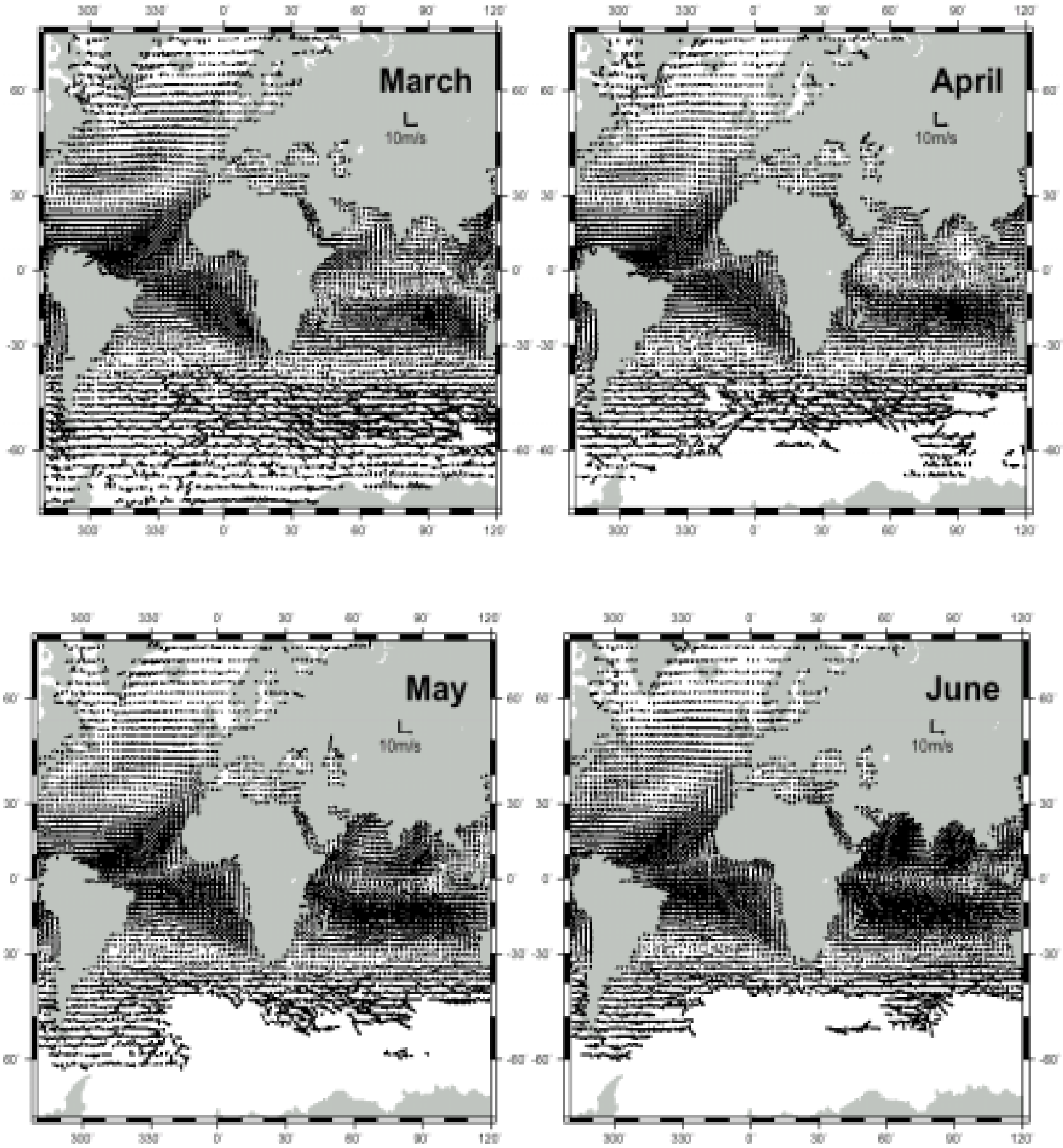

March
10m/s
April
10m/s
May
10m/s
June
10m/s

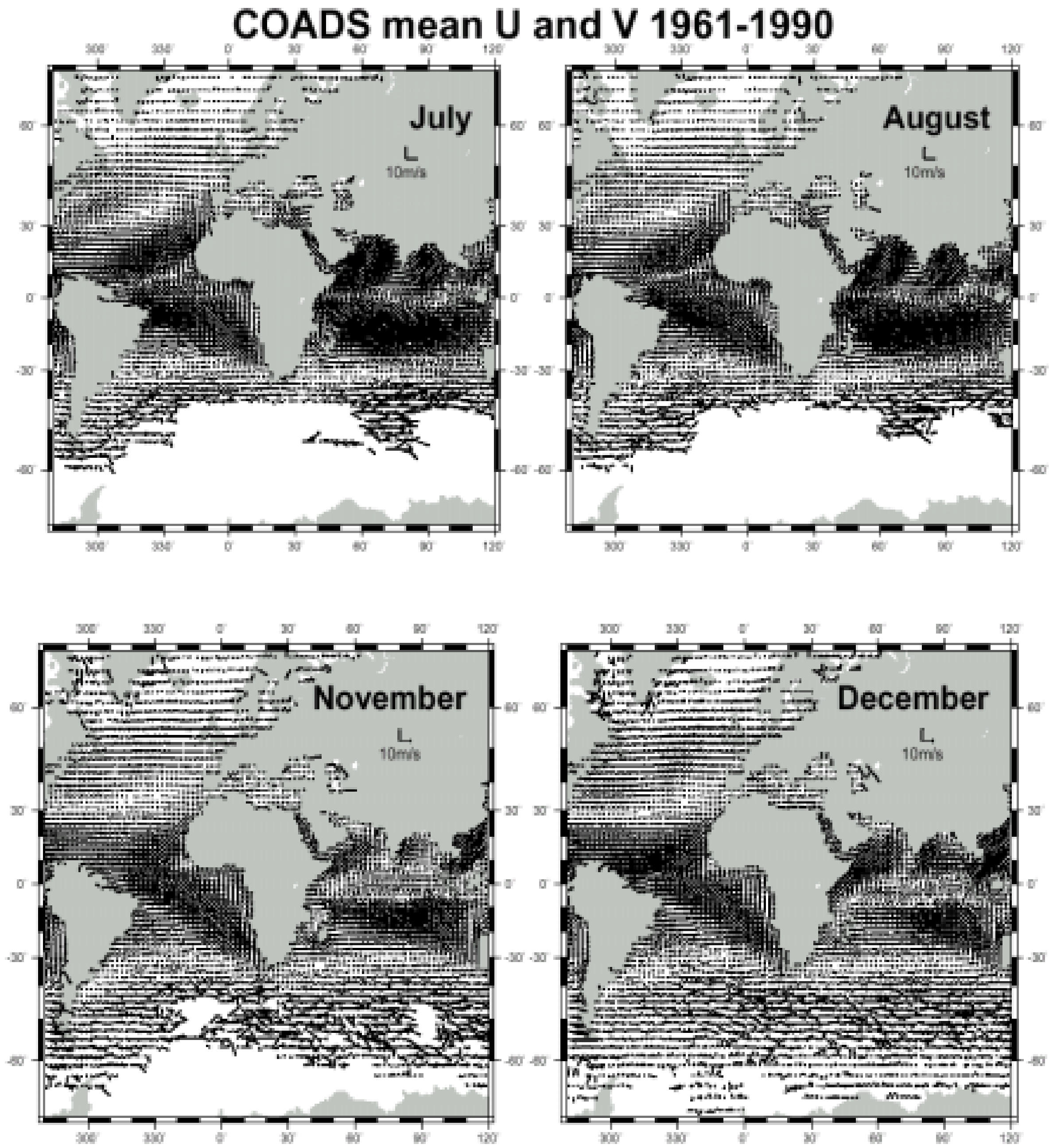

CLIWOC1.1 mean U and V 1750-1850
July
10m/s
August
10m/s
September
10m/s
October
10m/s

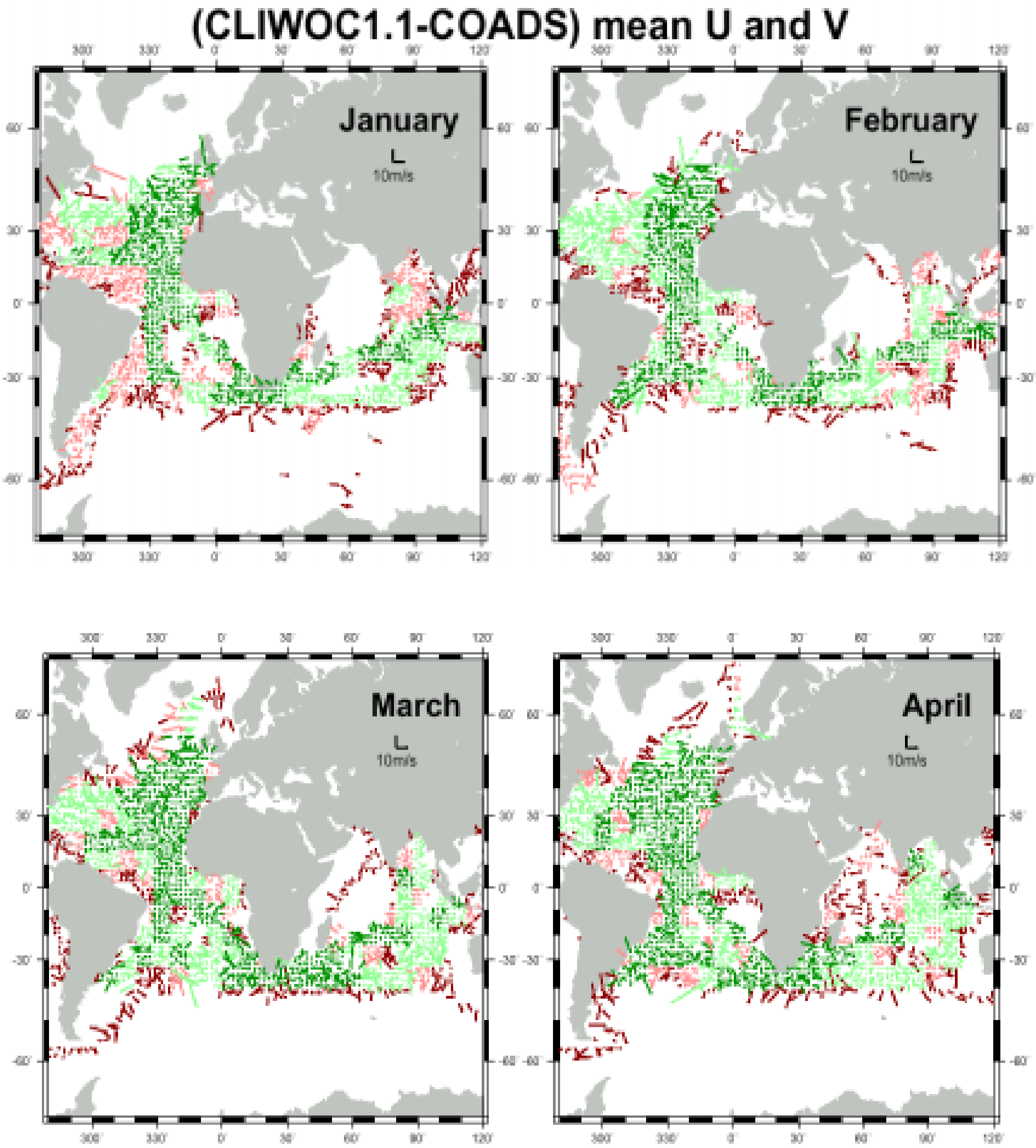


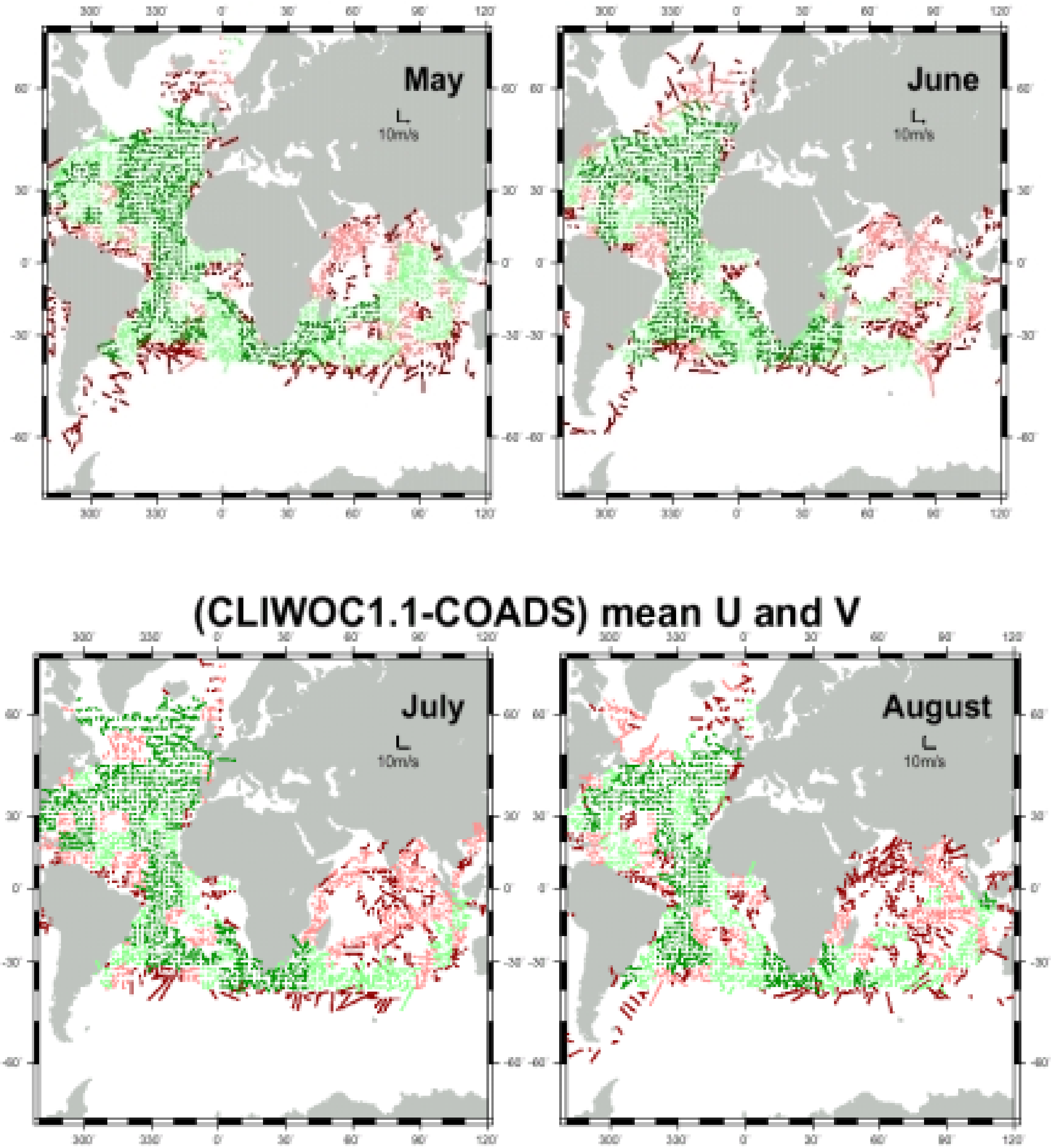
COADS mean U and V 1961-1990




March
April
May
June
10m/s
300° 330° 0° 30° 60° 90° 120°
60° 30° 0° -30° -60°


COADS mean U and V 1961-1990
July
August
November
December
10m/s


(CLIWOC1.1-COADS) mean U and V
January
10m/s
February
10m/s
March
10m/s
April
10m/s


May
10m/s
June
10m/s
(CLIWOC1.1-COADS) mean U and V
July
10m/s
August
10m/s

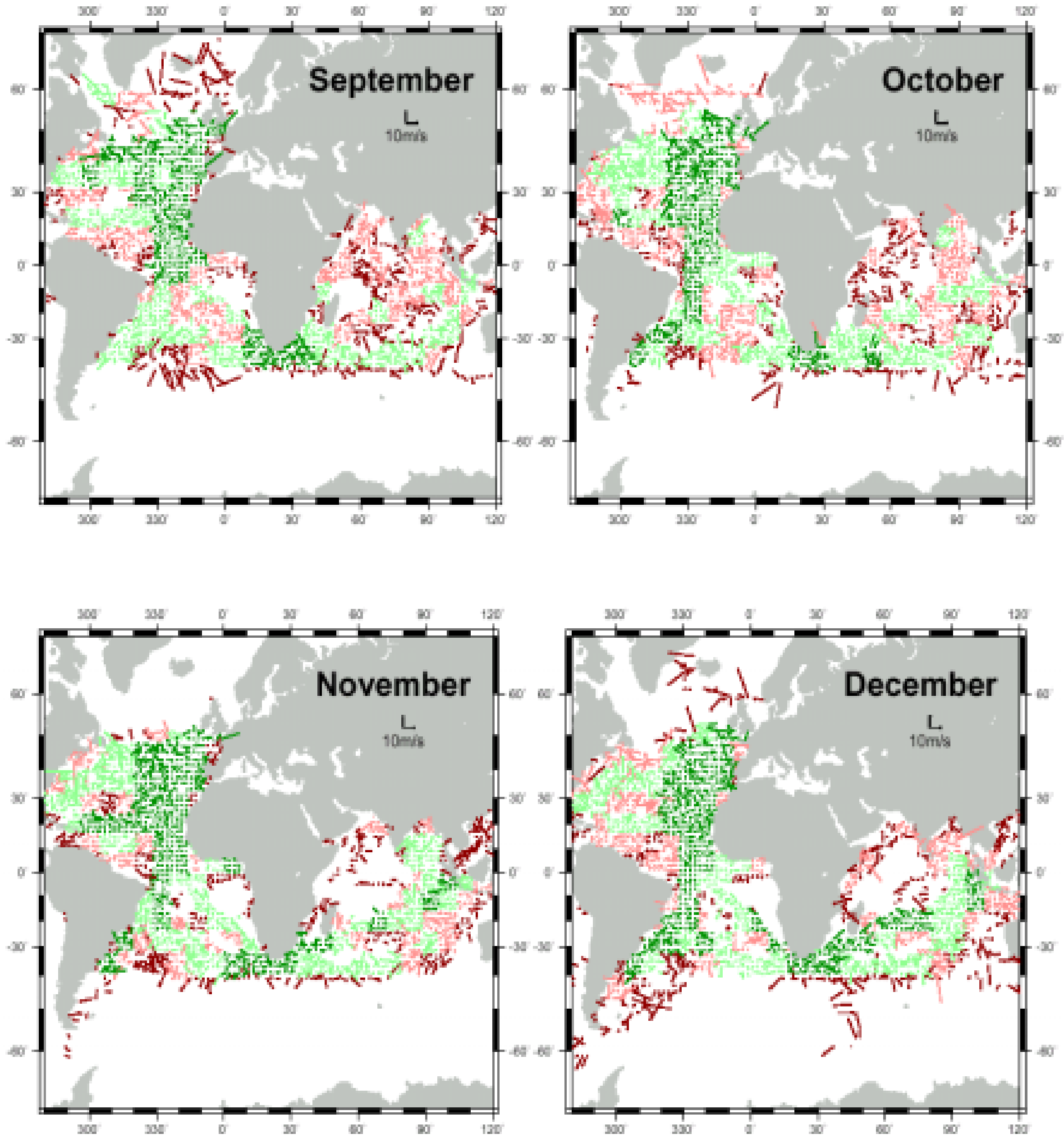


Figure 8. ***a)*** *average CLIWOC and ICOADS wind vectors for each of the 12 months for the 1961-1990 period on a 2º grid.* ***b)*** *differences in wind vectors for each of the 12 months, CLIWOC for 1750-1850 minus ICOADS for the 1961-1990 period on a 2º grid. The colours on this plot represent the following: dark red, <20; red, <50; light green, <100, and dark green >100 observations during the 101 years on the 2º grid.*

Orthogonal spatial regression (OSR) techniques were used to relate the predictor variables (*u* and *v* components of the wind) to the predictand data (circulation index). In OSR, the amplitude time series of the Principal Components (PCs) of the *u* and *v* wind component series for each ocean basin are offered for regression against the circulation data (single time series of the NAO). PCs are retained only when their eigenvalue exceeds one.

OSR is a form of multiple linear regression, simplified by the orthogonality constraint on the variables on both sides of the equation. This means that the whole procedure is relatively simple compared to stepwise regression. It is a recommended technique when, in response to their spatial character, there are strong interdependencies between the *u* and *v* wind components. The technique remains principally regression-based, however, and it is essential to develop the equations over one period (calibration) and to test them over an independent (verification) period. Here we use 1881-1940 for calibration and 1941-1997 for verification.

Despite the unavoidable limitations of the CLIWOC/ICOADS cover for the study period, sufficient data were available to provide useful reconstructions of circulation patterns. The results also indicated that with additional data of this type yet more comprehensive and detailed reconstructions are possible using the same methods and procedures.

OSR was employed to reconstruct ‘seasonal’ NAO series based on the *u* and *v* wind component data for the N. Atlantic (24º-56ºN). Again, the calibration period was 1881-1940 with verification over the 1941-1977 period. Table 8 summarizes the pertinent statistics. The principal conclusion is that the ‘winter’ season performs much better than the ‘summer’ season. This has been found for all attempts to reconstruct either circulation indices or pressure data and relates to the less well-organized state of the atmospheric circulation in the NH summer season.

Circulation Index (Season)	**Calibration (1881-1940)**	**Verification (1941-1997)**	**# PCs [1]**	**%Variance [2]**
NAO (DJF)	0.937	0.907	15	82.5
NAO (MAM)	0.764	0.631	15	82.0
NAO (JJA)	0.555	0 225	15	81.5
NAO (SON)	0.835	0.788	16	83.7

Table 8. *Calibration (1881-1940) and verification (1941-1997) period statistics (correlation coefficients) for 'seasonal' NAO reconstructions.* [1] *Number of u and v wind component PCs retained (where Eigenvalue > 1). Maximum number of variables for the NAO data was 60 u/v series).* [2] *Percentage of variance of the accounted for by the PCs.*

Figure 9 presents time series plots for four reconstructions; those for NAO winter (DJF), spring (MAM) and autumn (SON) and the SOI (Southern Oscillation Index). There is obviously good agreement between the reconstructions and the station-pressure-based circulation indices, but apart from the 1820-50 period, which is the 'overlap' period when the index is based on homogenized instrumental data, the CLIWOC data cannot be fully tested, i.e. back to 1750 in respect of the formal NAO series. To assess the reconstructions over their entire period, we compared them with terrestrial-based proxy reconstructions. We made use (Figure 10) of the seasonal values of NAO indices from Luterbacher et al. (2002), in which European documentary and instrumental sources from as early as 1500 are employed. We also compared (Figure 11) our reconstructions of the winter (DJF) NAO estimates from tree-ring measurements from Europe, North Africa and North America (Cook, 2003) and from ice-core isotope measurements from Greenland (Vinther et al., 2003). All such terrestrial based series extend back much earlier than 1750, Luterbacher et al. (2002) to 1500, Cook (2003) to 1400, Vinther et al. (2003) to 1245.

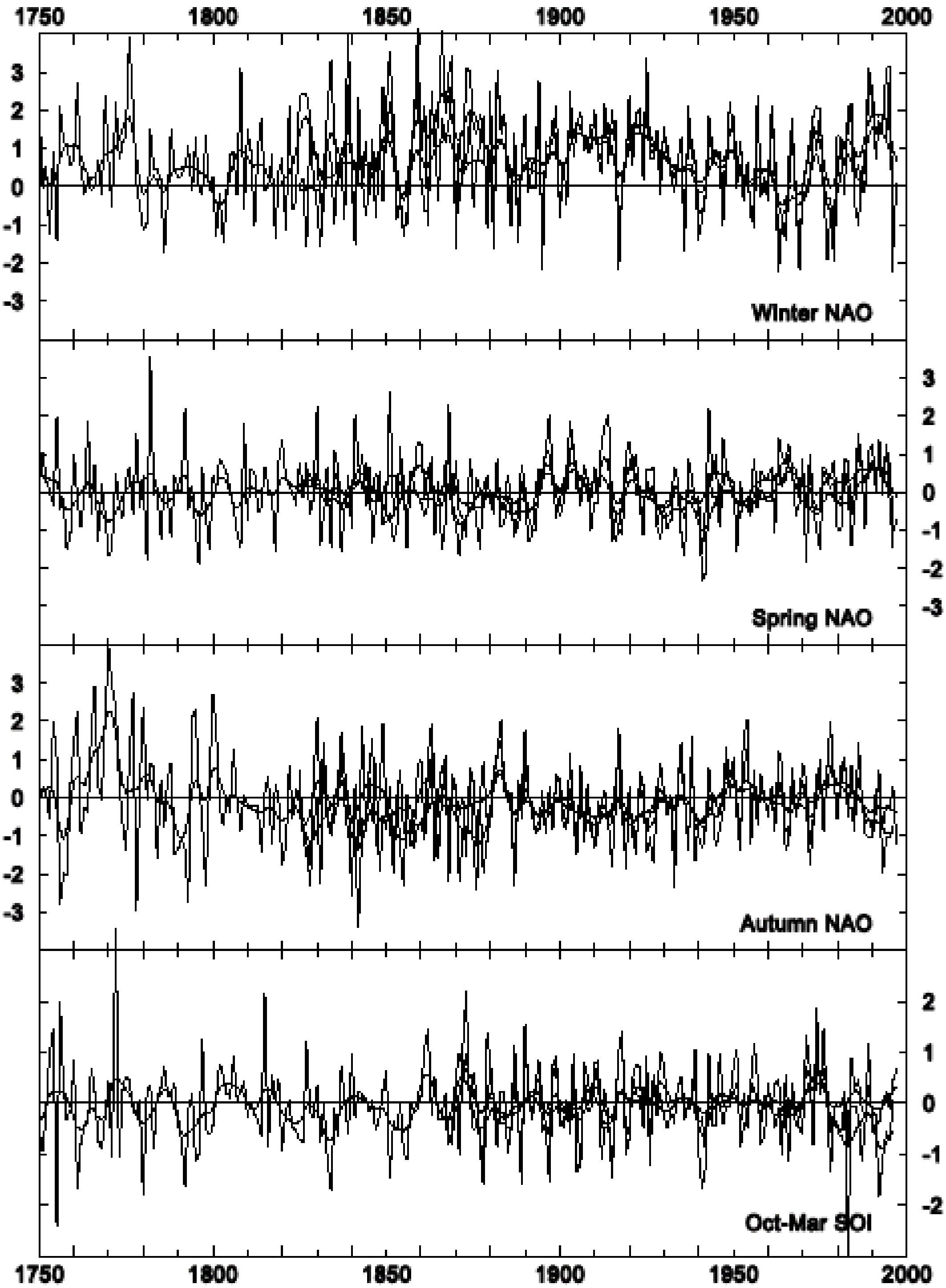


Figure 9. *Reconstructions of the NAO and SOI, 1750-1997 compared with instrumental data.*

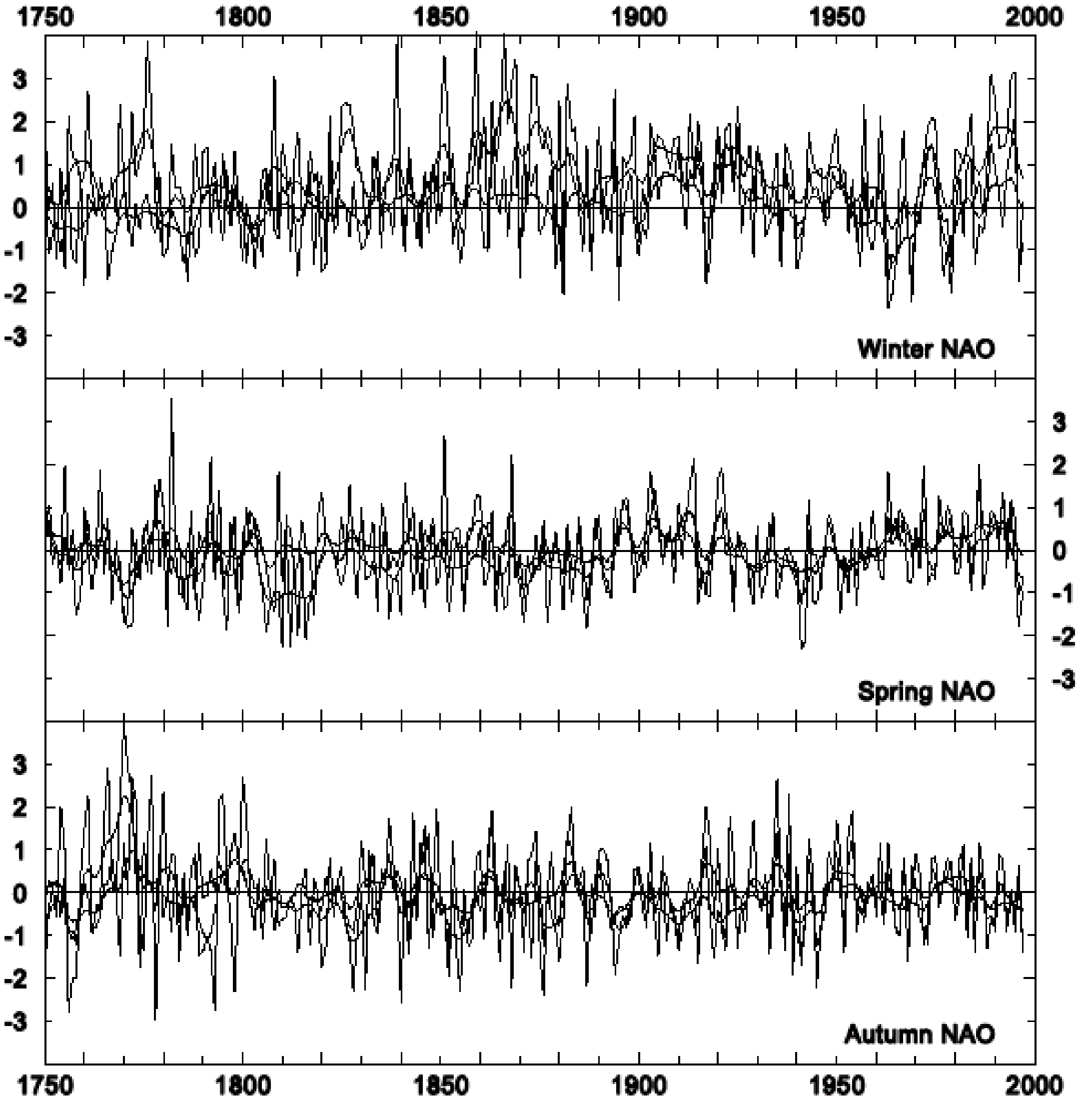


Figure 10. *Comparisons of the wind-based reconstructions (CLIWOC) for the NAO with those from Luterbacher et al (2002) for the winter (December-February), spring (March to May) and autumn (September to November) seasons.*

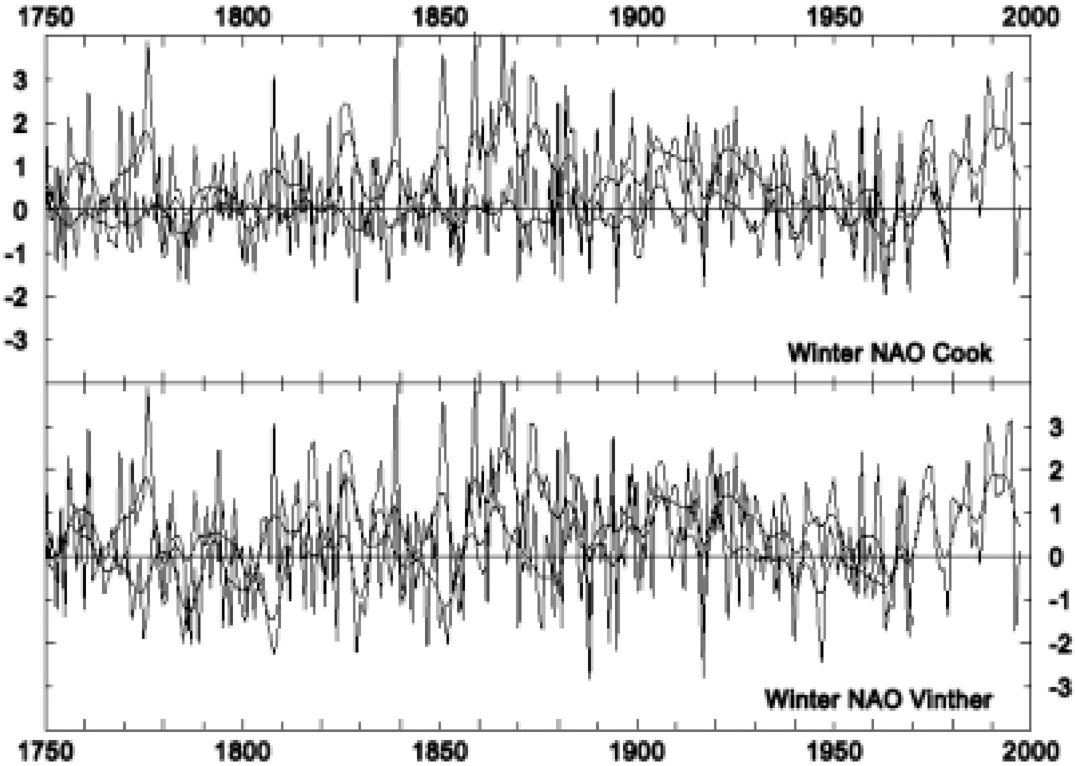


Figure 11. *Comparisons of wind-based (CLIWOC) reconstructions for the NAO with reconstructions from tree-rings and ice-cores by Cook (2003) and Vinther et al (2003).*

Table 9 gives means and standard deviations over two periods (1881-1997 and 1750-1850) for both indices and for 1825-1880 for the NAO from these various sources. Table 10 gives correlations between the series over the same selected periods.

NAO–Winter (DJF)	Instrumental	CLIWOC	Luterbacher	Cook[1]	Vinther[2]
1881-1997	0.58/1.25	0.78/1.18	0.04/0.99	-0.13/0.83	0.09/1.16
1825-1880	0.62/1.26	1.04/1.47	0.14/0.76	-0.16/0.73	0.02/1.16
1750-1850	---	0.54/1.14	-0.14/0.77	-0.13/0.66	-0.13/1.20

[1] Series ends in 1979, [2] Series ends in 1970

NAO – Spring (MAM)	Instrumental	CLIWOC	Luterbacher
1881-1997	0.04/0.89	0.03/0.69	0.00/0.90
1825-1880	-0.10/0.86	0.09/0.78	-0.26/0.83
1750-1850	---	0.00/0.91	-0.27/0.88

NAO – Autumn (SON)	Instrumental	CLIWOC	Luterbacher
1881-1997	-0.18/0.94	-0.16/0.74	-0.02/0.96
1825-1880	-0.48/1.02	-0.20/1.25	-0.12/0.87
1750-1850	---	0.04/0.91	-0.01/0.76

Table 9. *Means/Standard Deviations for the NAO for Winter (DJF), Spring (MAM) and Autumn (SON).*

NAO – Winter (DJF)	**CLIWOC**	**Luterbacher**	**Cook[1]**	**Vinther[2]**
1881-1997 (Instrumental)	0.91	0.89	0.72	0.52
1825-1880 (Instrumental)	0.52	0.80	0.55	0.43
1750-1850 (This paper)	---	0.17	0.02	0.18

[1] Series ends in 1979, [2] Series ends in 1970

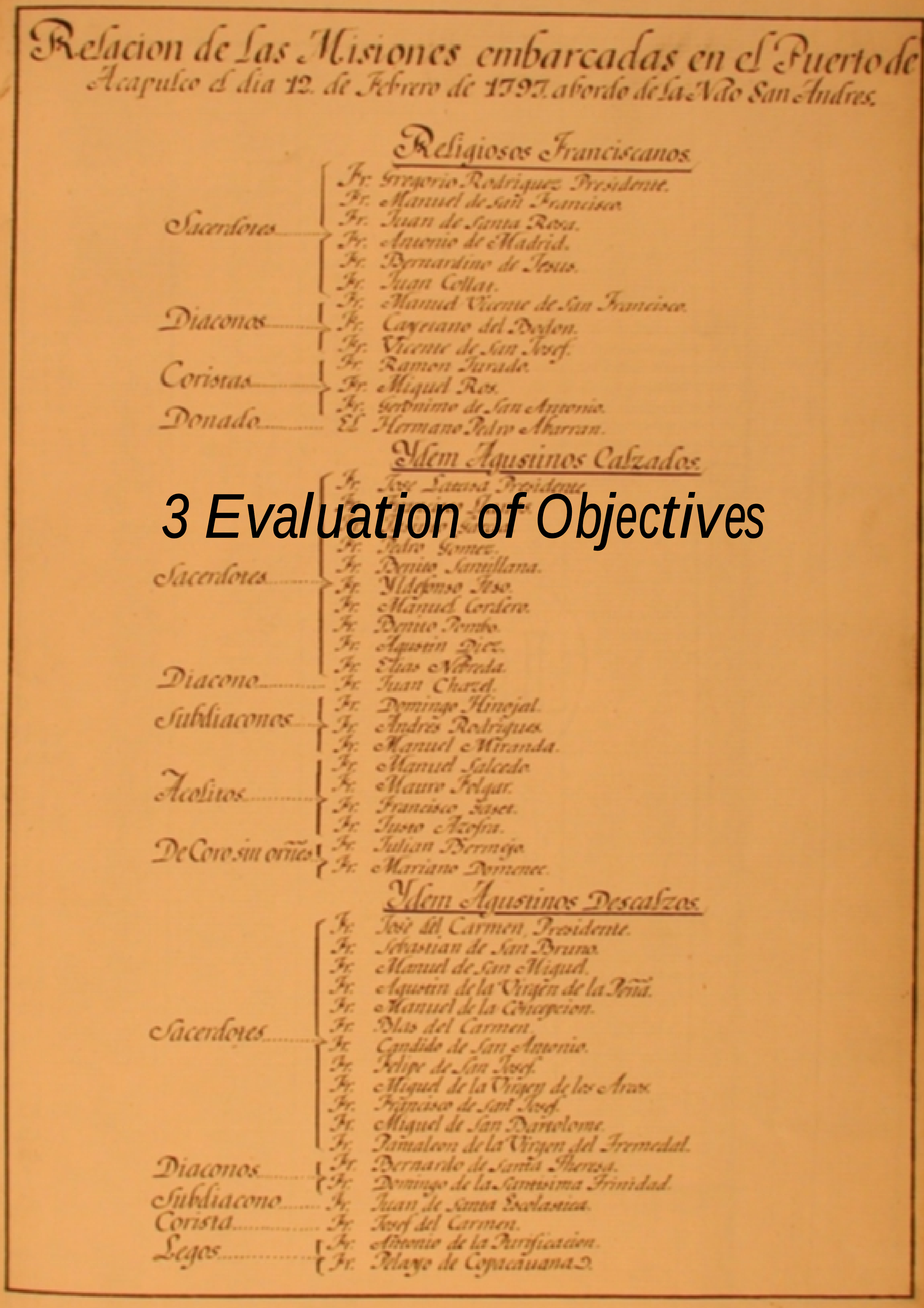
NAO – Spring (MAM)	**CLIWOC**	**Luterbacher**
1881-1997 (Instrumental)	0.70	0.72
1825-1880 (Instrumental)	0.27	0.77
1750-1850 (This paper)	--	0.26

NAO – Autumn (SON)	**CLIWOC**	**Luterbacher**
1881-1997 (Instrumental)	0.81	0.70
1825-1880 (Instrumental)	0.27	0.68
1750-1850 (This paper)	--	0.23

Table 10. *Correlation Matrices for the NAO for Winter (DJF), Spring (MAM) and Autumn (SON) for selected periods.*

The initial results for the CLIWOC period (1750-1850, using version 1.1 of the database) are relatively poor compared to the land-based proxies of Luterbacher et al. (2002), Cook (2003) and Vinther et al. (2003). From Figures 9, 10 and 11, this can be seen to be due to a few outliers over the 101-year period. Work is still continuing to determine the reason for this, but it is hoped that they will improve with the final version of the CLIWOC database. At the moment it appears that the outliers are due to too few observations in specific seasons in the regions found to be important from the OSR program. The calibration and verification statistics (Table 8) found using the ICOADS data over the 1881-1997 period clearly indicate that wind vector data can produce a reliable NAO reconstructions for all seasons except summer. In Figure 10, comparisons with the Luterbacher et al. (2002) reconstructions (which is considered to be the best of the ‘other’ reconstructions used) indicate that low-frequency aspects (on decadal timescales) of the reconstruction are reasonably well produced. As noted in the introduction to this report, the results are preliminary and are likely to be improved as more data for the period are entered into the CLIWOC database.

3 Evaluation of Objectives


Relacion de las Misiones embarcadas en el Puerto de Acapulco el dia 12. de Febrero de 1797. abordo de la Nao San Andres.

Religiosos Franciscanos

Sacerdotes — Fr. Gregorio Rodriguez Presidente. Fr. Manuel de San Francisco. Fr. Juan de Santa Rosa. Fr. Antonio de Madrid. Fr. Bernardino de Jesus. Fr. Juan Collar.

Diaconos — Fr. Manuel Vicente de San Francisco. Fr. Cayetano del Boson. Fr. Vicente de San Josef.

Coristas — Fr. Ramon Jurado. Fr. Miguel Ros. Fr. Geronimo de San Antonio.

Donado — El Hermano Pedro Abarran.

Ydem Agustinos Calzados

Sacerdotes — Fr. Jose Lanza Presidente. [illegible] Fr. Pedro Gomez. Fr. Benito Santillana. Fr. Ildefonso Ytso. Fr. Manuel Cordero. Fr. Benito Pombo. Fr. Agustin Diez. Fr. Elias Noreda.

Diacono — Fr. Juan Chazel.

Subdiaconos — Fr. Domingo Hinojal. Fr. Andres Rodriguez. Fr. Manuel Miranda.

Acolitos — Fr. Manuel Salcedo. Fr. Mauro Folgar. Fr. Francisco Saset. Fr. Justo Azofra.

De Coro sin orñes — Fr. Julian Bermejo. Fr. Mariano Domenec.

Ydem Agustinos Descalzos

Sacerdotes — Fr. José del Carmen, Presidente. Fr. Sebastian de San Bruno. Fr. Manuel de San Miguel. Fr. Agustin de la Virgen de la Peña. Fr. Manuel de la Concepcion. Fr. Blas del Carmen. Fr. Candido de San Antonio. Fr. Felipe de San Josef. Fr. Miguel de la Virgen de los Arcos. Fr. Francisco de San Josef. Fr. Miguel de San Bartolome. Fr. Pantaleon de la Virgen del Fremedal.

Diaconos — Fr. Bernardo de Santa Theresa. Fr. Domingo de la Santisima Trinidad.

Subdiacono — Fr. Juan de Santa Escolastica.

Corista — Fr. Josef del Carmen.

Legos — Fr. Antonio de la Purificacion. Fr. Pelayo de Copacauana.

3. Evaluation of objectives

While chapter 2 is principally concerned with how the project's activities had been developed and with the most relevant results, this chapter reviews how the projects objectives have been achieved.

Objective 1. *To produce and make freely available for the scientific community the World's first daily oceanic climatological database for the period 1750 to 1850.*

This objective has been achieved by producing the database, making it available as CD-ROM, and through the project's web page.

Objective 2. *To realize the potential of the database to provide a better knowledge of oceanic climate variability over the study period.*

The quality checks and the first results show that the data are consistent and reliable. The results obtained in the preliminary analysis of the data show that they can contribute significantly to a better understanding of past climate variability over the ocean and at a global scale.

Objective 3. *To use the information to extend and enhance existing oceanic-climate databases.*

The participation, as adviser, of Scott Woodruff from NOAA has facilitated the integration of CLIWOC data into the ICOADS (International Comprehensive Oceanic and Atmospheric Dataset); the most widely used database of this type among the scientific community. The adoption of the IMMA format provides an integrative connection into ICOADS. Additionally, CLIWOC can be directly downloaded from ICOADS and remains a clearly identifiable European contribution to this system.

Objective 4. *To disseminate the proposal's findings and to stimulate interest and awareness in this source with a view to fostering its further development and realising its scientific potential.*

Throughout the execution of the project, the team members were aware of the importance not only of establishing useful data but also of drawing wide attention to its existence and to the benefits of its application. Dissemination has been a highly successful component of the project, and the following section summarizes the achievements in this area.

a) *Papers in scientific publications which contain references to CLIWOC*

- García-Herrera, R, Wheeler, D., Können, G.P., Prieto, M.R. and Jones, P.D.. 2001. CLIWOC: a cooperative effort to recover data for oceanic areas (1750-1850). *PAGES Newsletter* **9**, 2, 19.
- García, R. and García-Herrera, R.: 2003. Sailing ships records as proxies of climate variability over the world's oceans. *Global Change Newsletter* **53,**10-13.
- García-Herrera, R., García, R., Hernández, E., Prieto, M.R., Gimeno, L. and Díaz, H.F.: 2003. Using Spanish archives to reconstruct climate variability. *Bulletin of the American Meteorological Society*. doi 10.1175/BAMS-84-8-1025; 1025-1035.
- Prieto, M.R., García-Herrera, R. and Hernández, E.: 2004. Early records of Icebergs in the Southern Ocean from Spanish Documentary Sources. *Climatic Change* (accepted).
- Wheeler, D. and Wilkinson, C.: 2004. From calm to storm: the origins of the Beaufort wind scale. *Mariners Mirror* (accepted)
- Wheeler, D.: 2003. Naval documents in historical climatology: an example from a seventeenth century logbook. *Journal for Maritime Research* (accepted).

b) Forthcoming papers

- Monographic issue on *Climatic Change*. Expected publication date: Summer 2005. Content outline:

1. García-Herrera, R., Können, G.P., Wheeler, D., Prieto, M.R., Jones P.D., and Koek, F.B.: 2005a, 'CLIWOC: A climatological database for the world's oceans 1750-1854'
2. García-Herrera, R., Wilkinson, C., Koek, F.B., Prieto, M.R., et al.: 2005b,

'Description of logbooks'.

3. Prieto, M.R., et al.: 2005, 'Determination of terms for wind force/present weather.
   The Spanish and French cases',
4. Wheeler, D., et al.: 2005a, 'Determination of terms for wind force/present weather.
   The English case'
5. Koek, F.B., and Können, G.P.: 2005, 'Determination of terms for wind force/present weather. The Dutch case'
6. Wheeler, D., et al.: 2005b, 'Quality of CLIWOC data'
7. Können, G.P., and Koek, F.B.: 2005, 'Description of the CLIWOC database'
8. Jones, P.D., Salmon, M.I. et al.: 2005, 'Interpretation and Preliminary Results'
9. Wilkinson, C. et al.: 2005, 'Other potential usages including non-climatic ones'
10. Woodruff, S. D., and Diaz, H. et al.: 2005, 'ICOADS/Maury records in the 19th century'

c) Presentations in scientific meetings and Conferences

- R. García, D. Wheeler, G.P. Können, M.R. Prieto and P.D. Jones. CLIWOC: A climatological database for the world's oceans 1750-1850. Poster at: *AGU NAO Chapman Conference***.** Ourense, Spain. 28th November –1st December 2001.
- D. Wheeler. Historical sources from English Archives. Oral presentation at: *Workshop on Atlantic Basin Hurricanes Reconstruction from High Resolution Records.* Columbia, S. Carolina, USA. 25- 27, March, 2001.
- R. García-Herrera. Spanish sources to reconstruct climate in the Americas during the 19th century. Invited oral presentation at: *Fall Meeting of the American Geophysical Union*, S. Francisco, USA. 10-14, December 2001.
- R. García-Herrera, E. Hernández, F. Rubio and M. R. Prieto. Historical sources from English Archives. Oral presentation at: *Workshop on Atlantic Basin Hurricanes Reconstruction from High Resolution Records*. Columbia, S. Carolina, USA. 25- 27, March, 2001.

- R García-Herrera, D. Wheeler, G.P. Können, M.R. Prieto and P.D. Jones. CLIWOC: a database for the World's Oceans 1750-1850. Overview and preliminary results. Solicited oral presentation at: *EGS-AGU-EGU Joint Assembly*. Nice, France. 6-11 April 2003.
- R. García-Herrera, D. Wheeler, G.P. Können, M.R. Prieto and P.D. Jones. CLIWOC: a database for the World's Oceans 1750-1850: Overview and Preliminary results. Oral presentation at: *IUGG Conference*. Kyoto, Japan, 6-15 July 2003.
- R. García-Herrera, D. Wheeler, G.P. Können, M.R. Prieto and P.D. Jones. CLIWOC: base de datos climáticos sobre los océanos entre 1750 y1850. Poster at: *XXIX Reunión Bienal de la Real Sociedad Española de Física.* Madrid, Spain, 7-11 July 2003.
- R. García-Herrera, D. Wheeler, G.P. Können, M.R. Prieto and P.D. Jones. CLIWOC: a cooperative effort to recover climate data from oceanic areas (1750-1850). Oral presentation at *2nd International Conference of the European Society for Environmental History.* Prague, Czech Republic, 2-7 September 2003.
- D. Wheeler. The CLIWOC project: important steps in providing reliable climatic data from logbook accounts. Oral presentation at *2nd International Conference of the European Society for Environmental History*. Prague, Czech Republic, 2-7 September 2003.
- F.B. Koek and G.P. Können. CLIWOC extends the pre-instrumental meteorological databases back in time with quantitative data over the oceans. Oral presentation at *2nd International Conference of the European Society for Environmental History*. Prague, Czech Republic, 2-7 September 2003.
- R. García-Herrera, D. Wheeler, G. Konnen, M. R. Prieto and P. Jones. CLIWOC: A database for the world's oceans 1750-1850. Oral presentation at *2nd JCOMM Workshop on Advances in Marine Climatology (CLIMAR-II)*. Brussels, Belgium, 17-22 November 2003.

Forthcoming meetings

- Proxy, documentary and early instrumental marine climate data. Scheduled EGU session CL21, to be held at the 1st General Assembly, Nice, France 25-30 April, 2004, convened by R. García-Herrera, S.D. Woodruff and P.D. Jones.

c) Papers in non-scientific journals

- ‘Windkracht 2 heette op zee Labberkoelte’, *De Volkskrant*, April 2001, The Netherlands
- ‘Klimaatkenners gebruiken oude scheepsjournalen’, *Nederlands Dagblad*, 20 April 2001, The Netherlands
- ‘Zoektocht naar scheepsjournalen’**,** *De Telegraaf*, mei 2001. The Netherlands.
- ‘CLIWOC’**,** *NIWI Nieuws*, No. 50, December 2001 The Netherlands.
- ‘Viento en popa a toda vela’. 2002. *Gaceta Complutense*. Madrid, Spain.
- ‘Klimaatonderzoek in scheepslogboeken’, *De Telegraaf Online*, 31 July 2003, The Netherlands.
- ‘Weerkundigen bestuderen logboeken’, *Trouw*, 31 juli 2003. The Netherlands.
- ‘Scheepslogboeken inzicht oud klimaat’, *Spits*,31 juli 2003. The Netherlands.
- ‘Oude logboeken bron voor klimaatonderzoek’, *Algemeen Dagblad*, 31 juli 2003. The Netherlands.
- ‘Logboeken navlooien op weergegevens', *Utrechts Nieuwsblad*, 1 augustus 2003. The Netherlands.
- ‘De computer als tijdmachine’, *Automatisering Gids*, 15 augustus 2003. The Netherlands.
- ‘Bramzeilskoelte uit 't zuidoosten’, *Eindhovens Dagblad Online*, 18 augustus 2003. The Netherlands.
- ‘Weersinformatie in oude scheepslogboeken’, *Zeilen*, September 2003. The Netherlands.

- ‘Logbook project comes alive at the Museum’. *The Martime Year Book* 2002-3 (National Maritime Museum, Greenwich), vol.10, pp.15-17.
- ‘Whatever the Weather’**,** *Maritime Life and Traditions* 19, 76, Summer 2003.
- ‘Nelson’s Weather Eye’**,** *New Scientist* 180, 40-43. December 2003.
- ‘Nelson helps in battle to understand climate crisis’**,** *Eastern Daily Press*, December 2003.
- ‘Weerbericht uit logboeken’; *Intermediair-2*, 8 January 2004. The Netherlands.
- ‘Bovenmarszeilskoelte ofwel windkracht 2’; *Het Parool*, 22 January 2004. The Netherlands.
- ‘Los cuadernos de bitácora de los siglos XVIII y XIX, claves en el estudio del cambio climático’, *ABC*, 19 January, 2004

- ‘Logging a Century of Climate Change’; *Science*, 30 January 2004.

d) TV presentations

- D. Wheeler, *‘Battlefield Detectives: the weather at the Battle of Waterloo’*, Granada TV, UK, March 2003 (rebroadcast Sept 2003).
- F.B. Koek; *‘Short news’*, RTV Utrecht (TV), The Netherlands, 31 July 2003.
- F.B. Koek, F. Barnhoorn; *‘Stem van Nederland’*, SBS6, The Netherlands, 31 July 2003.
- F.B. Koek, G.P. Können, F. Boekhorst; *‘Twee Vandaag’*, TV2, The Netherlands, 6 August 2003.
- BBC http://news.bbc.co.uk/2/hi/science/nature/3344749.stm (Ranked in the BBC top-30 most visited websites.
- D. Wheeler; Channel 4 National News item, UK, 10 February 2004

e) Radio presentations

- D. Wheeler and C. Wilkinson ‘*Captain’s log*’. BBC Radio 4 on 10th September 2001. (rebroadcast July 2002, BBC Radio 4) UK.

- F.B. Koek, *'MaDiWoDo'*, VPRO radio 747, The Netherlands, 22 May 2003.
- F.B. Koek, *'Short news'*, RTV Utrecht (Radio), The Netherlands, 31 July 2003.
- F.B. Koek; *'Short news'*, Business News Radio, The Netherlands, 5 Augustus 2003.
- F.B. Koek, *'Short news'*, Wereldomroep, The Netherlands, 7 August 2003.
- R. García Herrera, **'***El Laboratorio***?,** Telemadrid Radio, Spain, 19 January 2004.
- R.García Herrera, *'La tierra a tus pies'***,** Onda Cero, Spain, 21 January 2004.
- R. García Herrera, **'***Esto es vida'*. Radio Intereconomía, Spain 21 January 2004.

f) Conferences and Lectures for a general audience

- C. Wilkinson. **'Exploiting the Scientific Research of National Museums'** Natural History Museum, London, UK, 22 July, 2001.
- F.B. Koek, *'CLIWOC'*, NIWI, Amsterdam, The Netherlands, 15 January 2002.
- C. Wilkinson. Sept 2003. "*Investigating past Climate from Ships' Logbooks***"** National Maritime Museum, Greenwich, London UK; (Archives Awareness Month) in association with the Open University.
- F.B. Koek, **'***CLIWOC, Onderzoek naar klimaatverandering op de oceanen'***,** Stichting Kaap Hoorn-vaarders, Hoorn, The Netherlands, 19 October 2003.
- C. Wilkinson. Nov 2003. **'***Royal Navy Logbooks and the American Revolution'*, Charleston Museum, Charleston South Carolina, USA.
- C. Wilkinson. Nov 2003. '*Ships' Journals: Evidence of the changing Experience of Sea Voyages in the 18th Century'* National Maritime Museum, Greenwich London, UK.
- D. Wheeler March 2003 '*Diarios de navegacion – Fuentes antiguas para datos climatologicos'*, University of Barcelona, Spain.

g) Miscellaneous

- CLIWOC figures have been included in the book: *‘Patrick O’Brian’s Navy’*; R. O’Neill (ed). 2003 Salamander Books, London 160pp.
- More than 2900 web pages contain citations to CLIWOC. The most relevant being:

http://www.ucm.es/info/cliwoc
http://www.knmi.nl/~koek/cliwoc.htm
http://www.nmm.ac.uk/site/navId/005002007004
http://www.knmi.nl/onderzk/hisklim/CLIWOC/CLIWOC.html
http://www.worldchanging.com/archives/000256.html
http://www.niwi.knaw.nl/en/geschiedenis/projecten/cliwoc/toon
http://www.cdc.noaa.gov/~sdw/cliwoc/
http://www.cosis.net/abstracts/EAE03/00098/EAE03-J-00098.pdf
http://dss.ucar.edu/datasets/ds530.0/docs/cliwoc/
http://www.nationaalarchief.nl/nieuws/pers/klimaatonderzoek.asp?ComponentID=7404&SourcePageID=5084
http://www.port.nmm.ac.uk/ROADS/subject-listing/hier/res.html
http://www.ifremer.fr/envlit/actualite/20040105.htm
http://www.scitech.org.au/sciencewa/current_stories/int/story_int_sailing.html
http://www.sunderland.ac.uk/caffairs/noticeb.shtml
http://www.innovations-report.com/html/reports/earth_sciences/report-23950.html
http://www.rnw.nl/wetenschap/html/klimaat030909.html
http://www.business.com/search/rslt_default.asp?r4=t&query=meteorological+instruments&type=news
http://pub59.ezboard.com/faboutnelsonfrm1.showMessage?topicID=385.topic
http://www.cru.uea.ac.uk/cru/research/
http://nationalmuseums.org.uk/science_technology.html
http://www.scirpus.ca/cgi-bin/dictqaa.cgi?option=c
http://www.nsnet.com/
http://www.24hourmuseum.org.uk/nwh_gfx_en/ART18922.html
http://www.royal-met-soc.org.uk/othermeet.html

http://www.americanrevolution.org/charleston.html

http://unfccc.int/resource/docs/gcos/eugcos.pdf

http://www.aamsept2003.com/whatson-event-000413.html

http://www.radio.com.pl/news/nauka/default.asp?newsID=2802

http://www.dar.csiro.au/library/whatsnew/bp0336.html

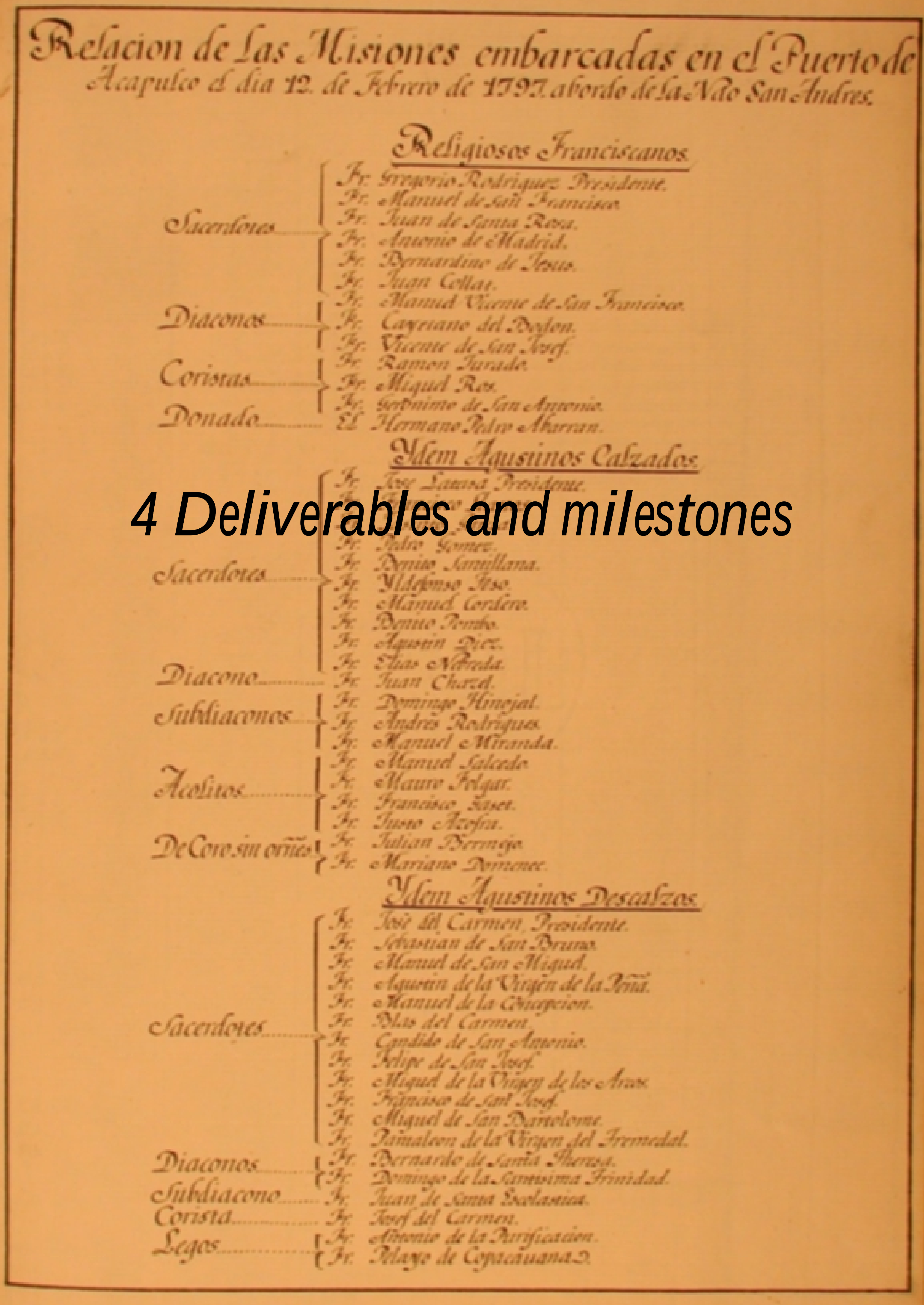
http://grads.iges.org/c20c/related/Report_WMOBulletin_27mar02.doc

www.giub.unibe.ch/~juerg/Final_Past_Medclivar.doc

http://www.sciencemag.org/content/current/netwatch.shtml

Appendix 1 contains a copy of all the printed dissemination activities.

4 Deliverables and milestones



Relacion de las Misiones embarcadas en el Puerto de Acapulco el dia 12. de Febrero de 1797. abordo de la Nao San Andres.

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4 Deliverables and milestones

This section reviews the achievement of deliverables and milestones included in the project contract. They can be divided into four different classes: reports, meetings, products and dissemination activities.

4.1 Reports

It was agreed to produce 5 progress biannual reports and seven meeting reports. They were all produced on time, and sent to the scientific officer. Additionally, 30 quality control and assessment reports were produced, as planned, during the abstraction process.

4.2 Meetings

Finally seven meetings were held:
Kick-off meeting in Seville (Spain), February 2001
Meeting 2 in Greenwich (UK), September 2001
Meeting 3 in Córdoba (Spain), February 2002
Meeting 4 in De Bilt (The Netherlands), September 2002
Meeting 5 in La Gomera (Spain), February 2003
Meeting 6 in Prague (Czech Republic), September 2003
Closing meeting in Brussels (Belgium), November 2003.

4.3 Products

The main products of CLIWOC are the dictionary and the database. The dictionary was initially scheduled for month 12 and was conceived as a task of the highest priority. However, it was soon realised that the dictionary could only be properly developed after a careful examination of a representative sample of the terms used in the logbooks. Thus it was decided to postpone it until month 33. This has allowed us to prepare a dictionary, which not only includes all the terms of the database, but also provides accurate modern equivalents and valuable additional material gathered during the progress of the project.

The database is currently available as version 1.5. A previous version was freely available as release 1.0. Release 2.0 will be available in the CD-ROM format during the spring of 2004.

4.4 Dissemination

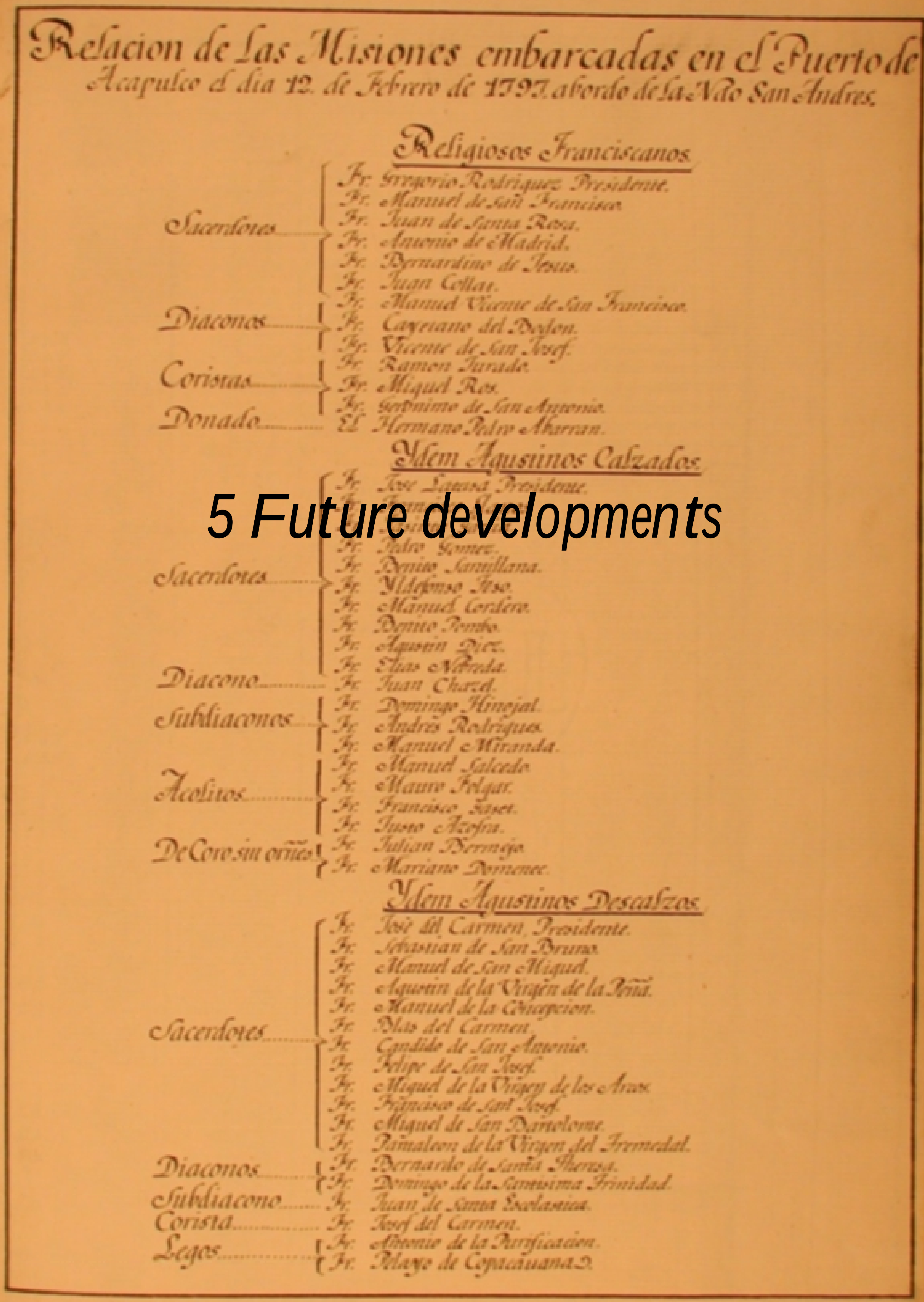
The web page has been operational since month 6; the University Complutense of Madrid will continuously update it. It has received a total of 5379 visits during the period 15-March-2001 to 15 February 2004. Their distribution is shown in table 11.

	Country		
1.	USA	1811	33.7 %
2.	Spain	985	18.3 %
3.	UK	694	12.9 %
4.	The Netherlands	685	12.7 %
5.	Canada	212	3.9 %
6.	Australia	120	2.2 %
7.	Germany	107	2.0 %
8.	France	60	1.1 %
9.	Belgium	55	1.0 %
10.	Denmark	46	0.9 %
	Unknown	158	2.9 %
	Others	446	8.3 %
	Total	5379	100.0 %

Table 11 *Distribution of the visits received by the CLIWOC project web paged in the period 15-March-2001 to 15-february-2004.*

The opening and concluding brochures were ready in months 6 and 35, as expected. They are included in Appendix 2 of this report. The papers and presentations derived from CLIWOC have been summarised in section 3 of this report. They are much greater in number, and wider in terms of the media used for their dissemination, than had originally been envisaged. This development reflects not only the scientific but also the high level of general interest engendered by CLIWOC. A workshop was initially planned, however, in the course of the project, the partners agreed to its substitution by a themed session to be held at the European Geophysical Union's first Assembly. The session is titled 'Proxy, documentary and early instrumental marine climate data', it is scheduled by EGU for session CL23 at their *1st General Assembly*, to be held in Nice, France 25-30 April, 2004. R. García-Herrera, S.D. Woodruff and P.D. Jones will act as conveners. It is believed that this session will contribute more effectively to CLIWOC's dissemination than the planned workshop.

5 Future developments



5. Future developments

The social and scientific interest generated during CLIWOC led the partners to believe that it will be a lasting initiative. It has proven that logbooks data contain significant climatic information, and it has provided a useful methodology to make the old logbooks understandable and accessible to the scientific community. Thus, there is no doubt that the project will continue after the formal ending in December 2003. Additionally the cooperative environment and collaborative team spirit reached among the partners, supports the continuation of the project. There are a number of means by which the impetus of the CLIWOC project can be sustained. Initially, the partners will try to maximize the dissemination initiatives and offer more detailed accounts of the project's achievements. This will be done through the *Climatic Change* monographic issue, described in section 3 and which is currently in preparation, and through a synthesis paper in a major journal with a more multidisciplinary character. The next stage will involve the detailed exploitation of the database. This will be done directly by the project's partners and by encouraging other teams not directly involved with CLIWOC. In addition, it must not be thought that the abstraction of the logbook collections currently available in the European archives has been completed. Much remains to be done, and Table 11 shows the best estimate of the volume of data in the remaining logbooks.

	Main Period	Keyed Data	Data/yr	Available	Exhaustion	Data/yr if Exhausted
CLIWOC	**1750-1854**	**0.3 M**	**3 k**	**2.2 M**	**14 %**	**22 k**
CLIWOC/Spanish	1750-1800	0.1 M	2 k	0.1 M	100%	2 k
CLIWOC/Dutch	1750-1854	0.1 M	1 k	0.2 M	50%	2 k
CLIWOC/UK	1750-1850	0.1 M	1 k	1.4 M	7 %	14 k
CLIWOC/French	1750-1800	7 k	0.14 k	0.5 M	1 %	5 k
US Maury	1830-1859	1.0 M	30 k	1.5 M	100%	30 k
ICOADS*	1854-1870	0.2 M	12 k	0.2 M	100%	12 k

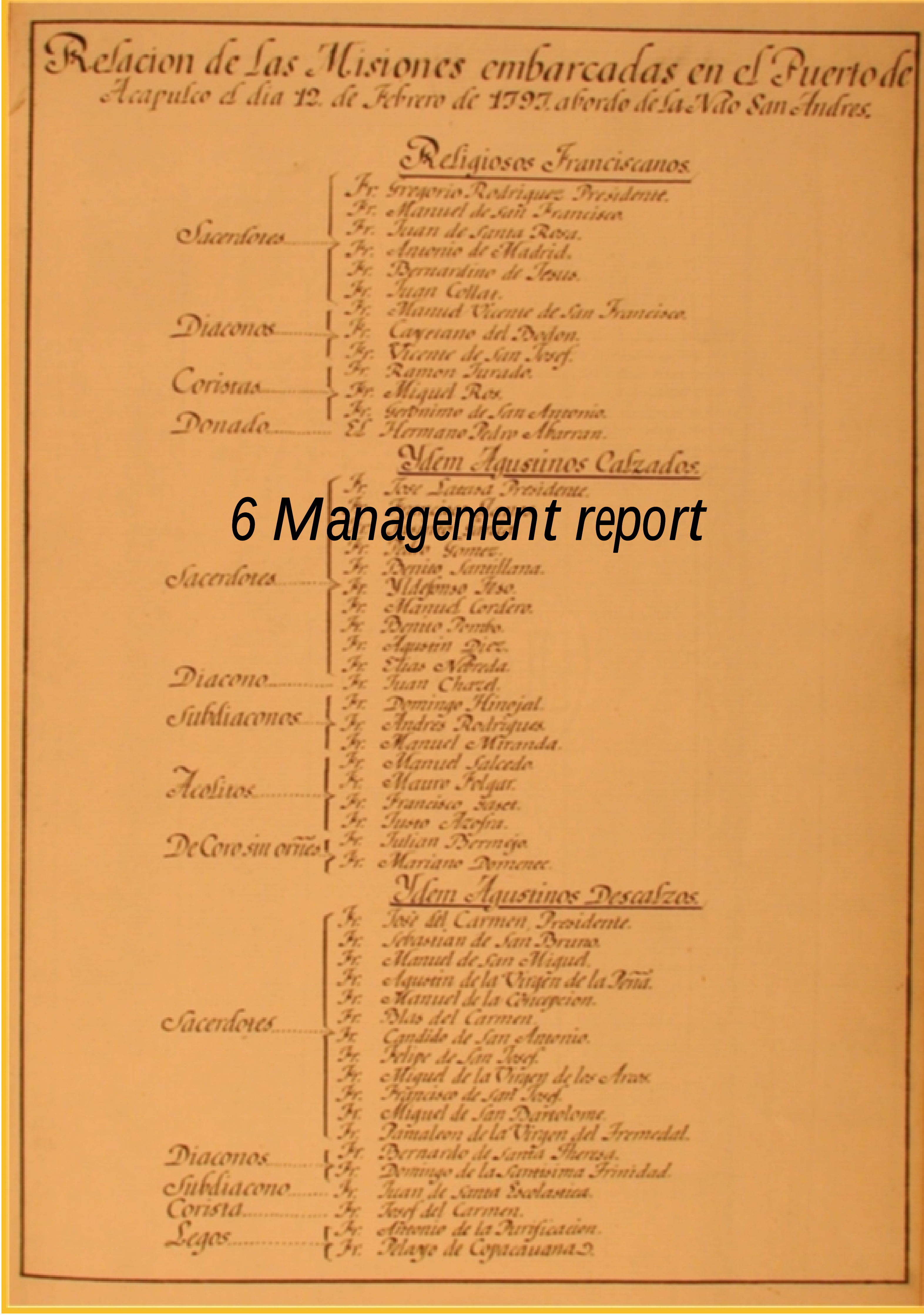
* Excluding the US Maury collection

Table 12. *Volume of data in the CLIWOC database and in the US Maury collection, and in the 1854-1870 period of ICOADS. All values are reduced to the number of ship-day observations.*

The results obtained at present confirm the high scientific interest and value of any additional abstraction exercises aimed at extending the time and space coverage and increasing the data density achieved in CLIWOC. This will require a combined effort from different institutions, and is an enterprise that the partners will actively promote.

Finally, the partners consider that CLIWOC experience can be used as guideline into a more general context of documentary sources. Thus, they will apply within FP6 call INFRASTR-4 with a proposal titled ENABLE. Its main objective being to perform a design study to create a European database of paleoclimatic data from a much wider range of documentary sources.

6 Management report



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6. Management report

This section reviews the management of the project, and is focused on the main items included in the project contract. According to the latter, the key areas with respect to management at the team level are:

i. *Appointment of suitably qualified staff for data abstraction*

Every team recruited the required personnel depending on their administrative procedures and the team's responsibilities. A small delay in the initial contracts occurred, but it was corrected during the project's lifetime and did not materially influence the outcomes or management of the project.

ii. *Quality control of primary data abstraction*

As described in section 2.2, the abstraction quality control procedure was common for all the partners and based on a 5% sample of the total abstracted data. The *a posteriori* checks provided additional verification of the abstraction quality.

iii. *Working database management*

The intermediate inter-group comparison exercises, which started in month six, have allowed a flexible design of the working database, which has grown in quality (including more accurate fields and information) and quantity. It has been managed on a real time basis and has always been accessible to all the project participants

iv. *Preparation of twice-yearly team reports (for inclusion in full report)*

The annual reports have been produced on schedule and approved by the scientific and administrative officials. Funding has arrived from the EU Commission and been distributed subsequently to all the participants without significant delays.

v. *Coordination with secondary level team groups*

The coordination within the groups has been made by the respective team leaders and did not present any significant problems.

vi. *General aspects of team management and communication with the coordinator and other team leaders*

The warm and friendly environment reached among the participants has allowed for easy communication and cooperation. The meetings have been very useful for discussion and consensus agreements, and have allowed for a fruitful exchange of ideas. As a result, the integration of all the working packages proceeded efficiently.

In addition to these responsibilities the project coordinator had to ensure:

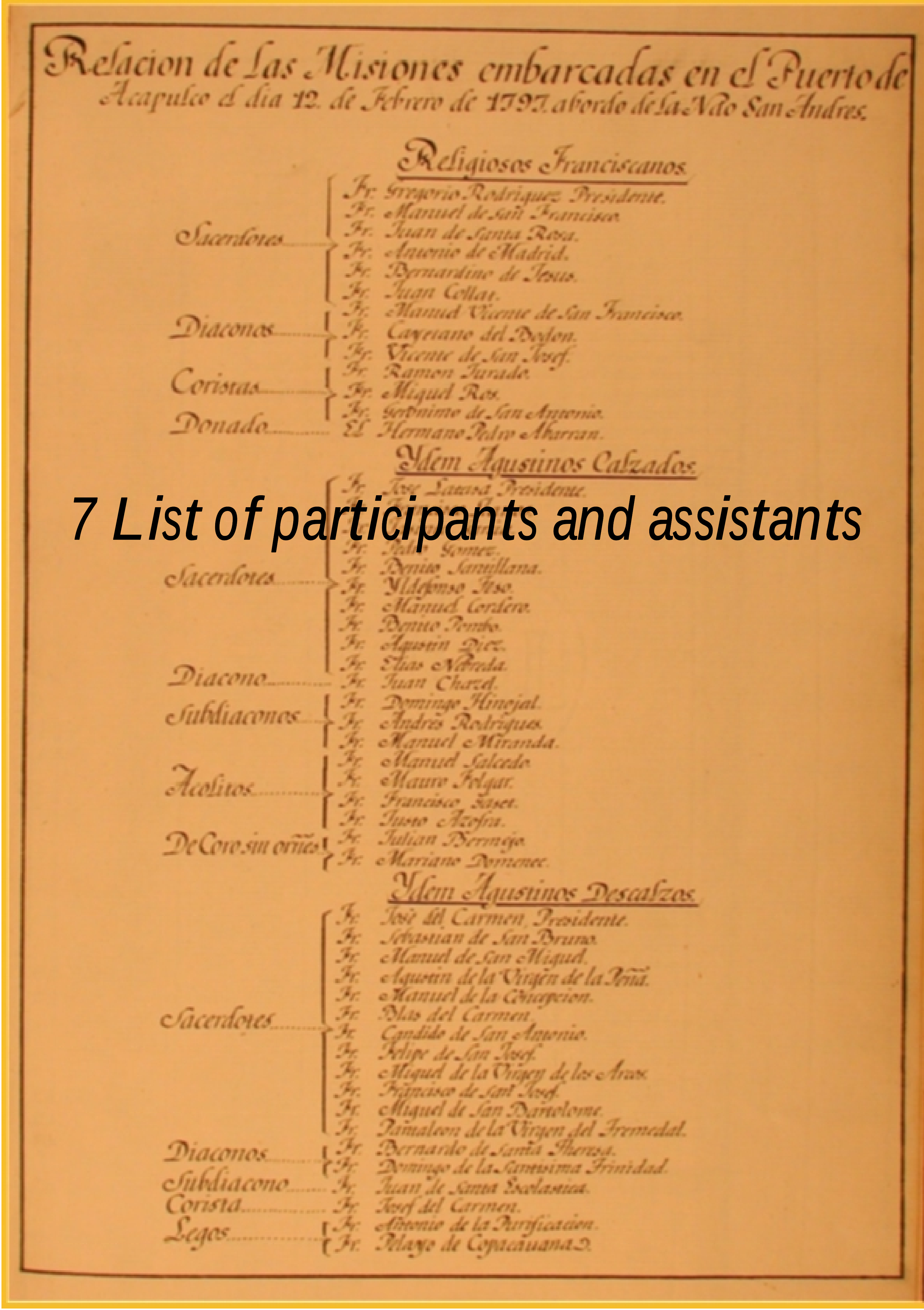
i. *that deliverables are achieved,*
ii. *milestones are reached on the specified dates,*
iii. *the preparation of the full reports,*
iv. *overall project management including effective communication between the teams and communication with the EU.*

As described in the previous sections, all the deliverables have been achieved, with the exception of the workshop, which was substituted by the EGU session with the agreement of all the partners. After obtaining the proper permission, the money initially budgeted for the workshop was invested in increasing the personnel for data abstraction.
The only milestone suffering a significant delay was the dictionary, which was postponed from month 12 to month 33. This decision was not the result of any problems in the project process, but brought about by a carefully considered change of strategy. The final result, that of a complete multilingual dictionary capable of providing the modern equivalent of all the archaic terms, whatever their original language, has fully justified this decision.
No problems arose in the project reporting or in the overall communication processes.

Summing up, the management of the project did not present any significant problems. Personnel were contracted by the different partners, in some cases with a small delay due to administrative requirements, and the money arrived on time. During the rest of the period, standard management procedures have been followed.

The final cost justification is included as Appendix 3 of this report.

7 List of participants and assistants



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7. List of participants and assistants

- From partner 1 Profs. Emiliano Hernández, Luis Gimeno and Pedro Ribera and in the abstracting team: Natalia Calvo, Guadalupe Fernández, David Gallego, Esther González, Eneko Mazo, Daniel Paredes, M. José Portela, Francisco Rubio. Pilar del Campo and Dolores Higueras at the Archivo del Museo Naval and Antonio López at the Archivo general de Indias.

- From partner 2 Dr. Clive Wilkinson (office manager) and the abstraction team of Ellie Gatrill-Smith, Catharine Ward and Simon Bailey worked diligently towards the successful conclusion of the abstraction of data from the English logbooks at the National Maritime Museum, Greenwich, Excellent coordination with the Museum was maintained through Dr. Nigel Rigby (NMM Director of Research).

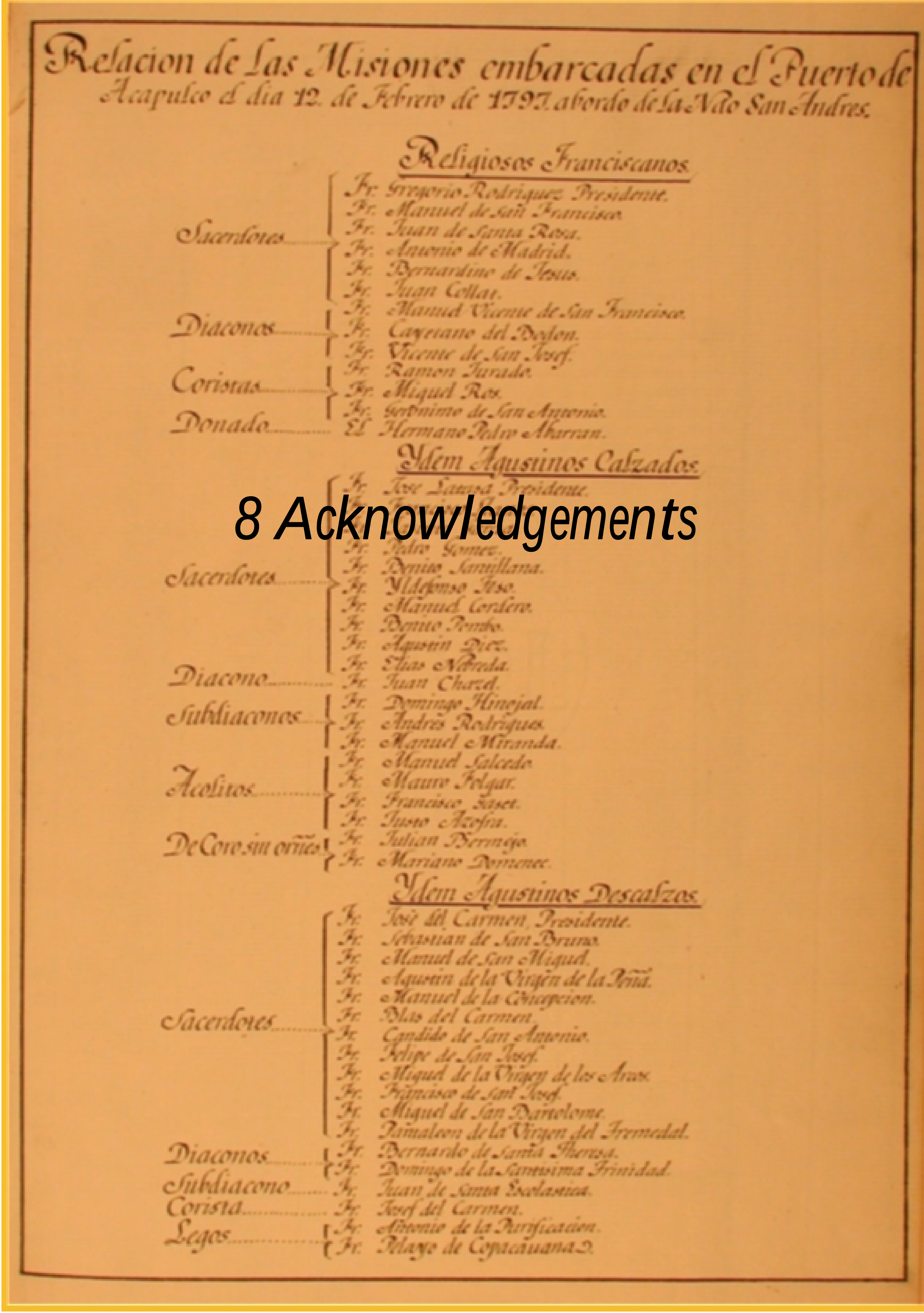
- From partner 3: the abstraction team: Esther Balkestein, Florie Barnhoorn, Pauline Beckers, Denise Berck, Frank Boekhorst, Chantal Dekker, Inge Hickmann, Niels Hupkes, Roel Huttenga, Maarten Koek, Renate Meijer, Bruni Oehlers, Simone Pathuis, Rob de Rooij, Jolanthe Schretlen, Ronald Schurink, Marja Segers, René Snoey Kiewit, Toni Spek, Tineke Tegelaers, Theo Tieken, Pim Vente, Eric Verlinde, Rolf de Weijert; Netherlands Institute for Scientific Information Services (NIWI): Richard Bos, Sirius Bosch, Dr. Peter Doorn, Drs. Berry Feith, Iolando da Mata Brito; Nationaal Archief: Suzanne Barbier, Liesbeth Keijser, Joop Korswagen, Ton van Velzen; Others: I. van den Bout, Prof. Dr. Femme Gaastra, H.A. Hachmer, Irene Jacobs, Drs. W. Kerkmeijer, Juliette Uitdenbogaard and W. Visser.

- From partner 4 The abstraction team: Tech. Carlos Baez, who worked carefully on the abstraction of data from the French and Spanish logbooks and Tech. Fabian Diaz, who contributed to the abstraction of data from French logbooks. Particular mention must also be made of the Executive Secretary of the Centro Regional de Investigaciones Científicas y Técnicas of Mendoza – Argentina (Ing. Carlos Wuilloud), who lent the microfilm readers and made special provision for the completion of the work. .

- From partner 5 Mike Salmon has performed all the calculations for the reconstruction of the circulation indices and the pressure data.

- David Parker from the UK Hadley Centre and Scott Woodruff, from the NOAA CDC acted as advisers. Their contribution has been valuable and contributed significantly to the project's development and success.

8 Acknowledgements



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