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Historical Meteorological and Oceanographic Data for the Maritime and Coastal Areas of Chile and the Southern Pacific

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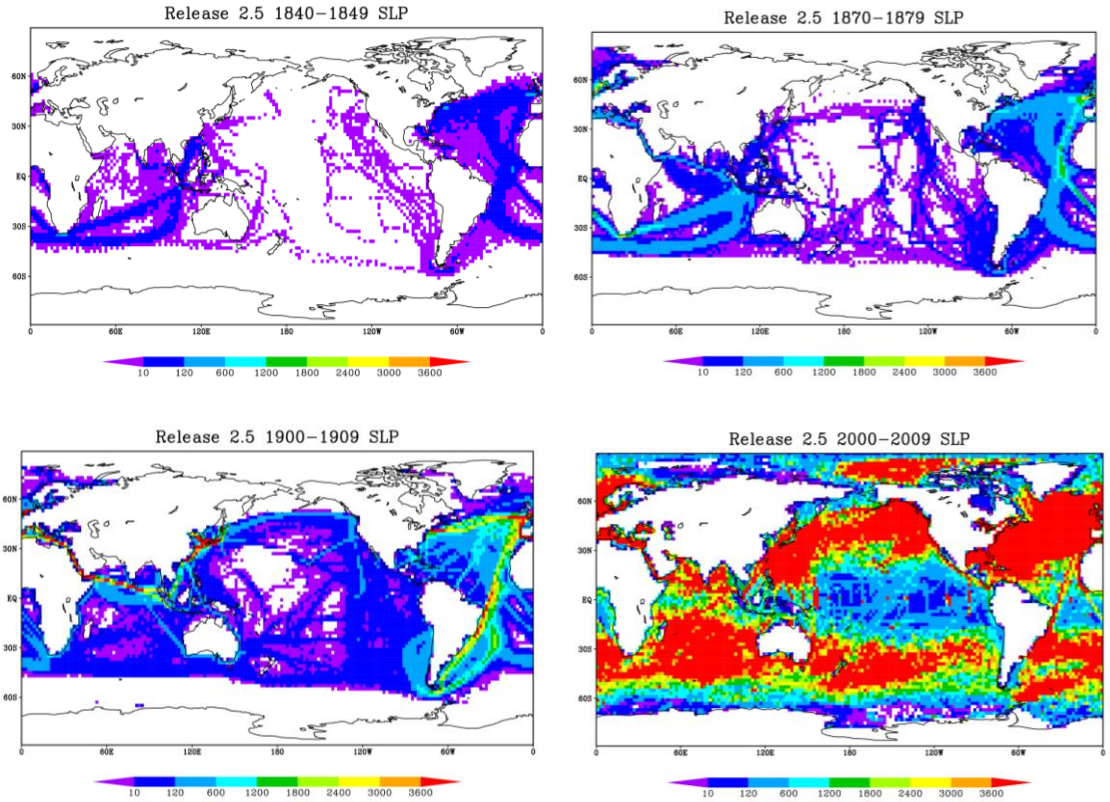
NOTE

INTRODUCTION

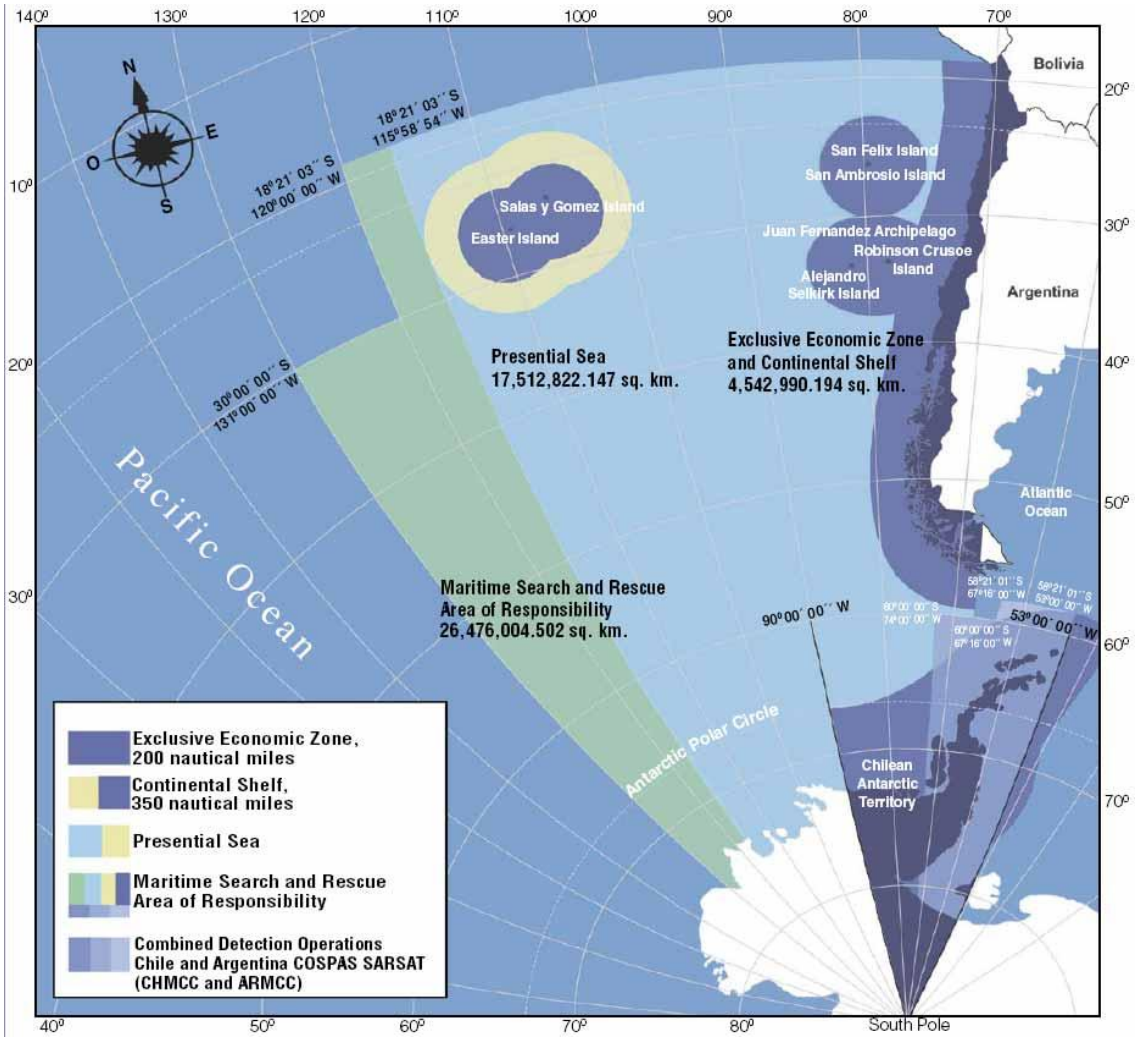
The terrestrial and maritime areas of Chile and the south-east Pacific are one of the least represented areas for historical climate data, such as barometric pressure, air temperature and sea temperature. The maps below give an indication of the global coverage of historical sea-level pressure observations. The colours show the total number of observations in a 2° box per decade using the "enhanced" monthly summaries (including ships, buoys and other platform types) from the latest version of International Comprehensive Ocean-Atmosphere Data Set (ICOADS) release 2.5.



Global Sea-Level Pressure (SLP) Data Coverage – ICOADS Release 2.5

In various archives there are undigitized pressure and temperature data available for about 170 years (back to c.1840) for Chilean maritime areas, with sea temperatures back to 1870, and sporadically available before that time. This data can be found in the archives of Chile and of Great Britain, and probably also in other European archives and in the United States.

The purpose of this report is to provide a regional overview of the historical meteorological and oceanographic data to be found in Chile and in Britain covering the south-east Pacific and the west coast of South America, in particular the maritime areas and coastal regions of Chile. The focus is on data that predates the modern ocean observing system. The report is intended to assist in the documentation, and efficient planning of the imaging, digitization and processing of the scientific data.



Chilean Maritime Areas

Combining the data from both Chile and Great Britian ensures a longer temporal coverage and a spatially extensive dataset that incorporates much of the southern and south-eastern Pacific. This report also examines the historic documents containing the data, providing a translation of the chief meteorological and other related elements from Spanish to English, as well as assessing their potential for climate studies. Combining material from different national archives also provides opportunities for the cross-checking of data, and data homogenization. This process will also assist in the study of data biases and other related issues, where meteorological data from, for example, Royal Navy logbooks is studied in a different geographical context.

A. Repositories of Archived Meteorological and Oceanographic Data

1. Archivo Nacional de Chile (National Archive of Chile), Santiago

http://www.archivonacional.cl

The National Archive of Chile in Santiago is housed in two buildings holding records from separate periods. The National Historical Archive is located centrally in Santiago at 50, Calle Miraflores. The site can be reached easily by Metro, the closest station being 'Universidad de Chile' This archive holds records of the colonial period from the earliest times to the founding of the Republic. The second archive, the National Archive of the Central State Administration is located at Matucana 51, Santiago, and can also be reached by Metro, either 'Quinta Normal' or 'Union Latinamericana'. This archive holds the records of the Chilean Republic.

National Historical Archive

The National Historical Archive holds the hydrographic file of Vidal Gormaz 1557-1914 (predominantly 1740-1895). Francisco Vida Gormaz was the first director of the Chilean Hydrographic Office. The file is yet to be examined for useful meteorological and oceanographic data for the early non-instrumental period. However as the file spans both the colonial and republican periods the entire collection is found in this, the earlier, section of the National Archive. A booklet *Indice del Archivo Hidrografico 'Vidal Gormaz'* is available in the reading room outlining that part of the 'Vidal Gormaz Collection' that is of hydrographic interest. A copy has been obtained. There is also catalogue *Historia del mar de Chile, Ministerio de Marine*. From this catalogue, 27 logbooks (diario de navegación) have been identified. Of those logbooks almost all are from Spanish vessels and only one is Chilean.

2009 - Several manuscript logbooks were examined; the Spanish warships *Resolucion* (1864-5), *Helice* (1862-3) near the Galapagos Islands, and *Triunfo* (1862). All contained meteorological data mostly pressure and air temperature. *Helice* had observations of sea temperature. These were not regular deck logbooks but appeared to be fair copies of some other document. Navigational and meteorological data in these documents is presented in an irregular fashion often as an extract. The documents were all in good condition and clear and easy to read. **Note 2010** - The logbooks of the *Resolucion*, *Triunfo* and other Spanish warships are held in the Naval and Maritime Museum in Valparaiso.

National Archive of the Central State Administration

From the National Archive of the Administration, the material of interest for marine meteorology is most likely to be found in two sections. These are the Ministerio de Marina 1817-1900 and the Subsecretaria de Marina 1901-2001. The former contains material for the 19th century, including logbooks, navigational data, lighthouse and bathymetric and other scientific data for the coast of Chile. The Subsecretaria de Marina 1901-2001 has

material on lighthouses and hydrographic exploration. This material is yet to be examined for meteorological and oceanographic data.

2. **Museo Naval y Maritimo (Naval and Maritime Museum) , Valparaiso**
   http://www.museonaval.cl

   The Naval and Maritime Museum is located on the Paseo 21 de Mayo, Cerro Artilleria, Valparaiso. It is a part of the establishment of the Chilean Navy (Armada de Chile) and is open to the public. The most convenient access to the Museum is via funicular, from Aduana in the port area. This is within walking distance from 'Puerto' the terminal station of the Valparaiso Metro. Visitors to the archive and library should carry suitable identification such as a passport, as the Museum is part of a defence establishment. There is a small reading room. Resources consist of a library, and manuscripts stored in a climate controlled repository with a further storage area largely filled with logbooks of the Chilean Navy. The logbooks commence from the 1860s to very recent times and retrieval and viewing of logbooks is restricted to those before 1960.

Armada de Chile

Main Operations Building

19th Century logbooks in temperature controlled storage area

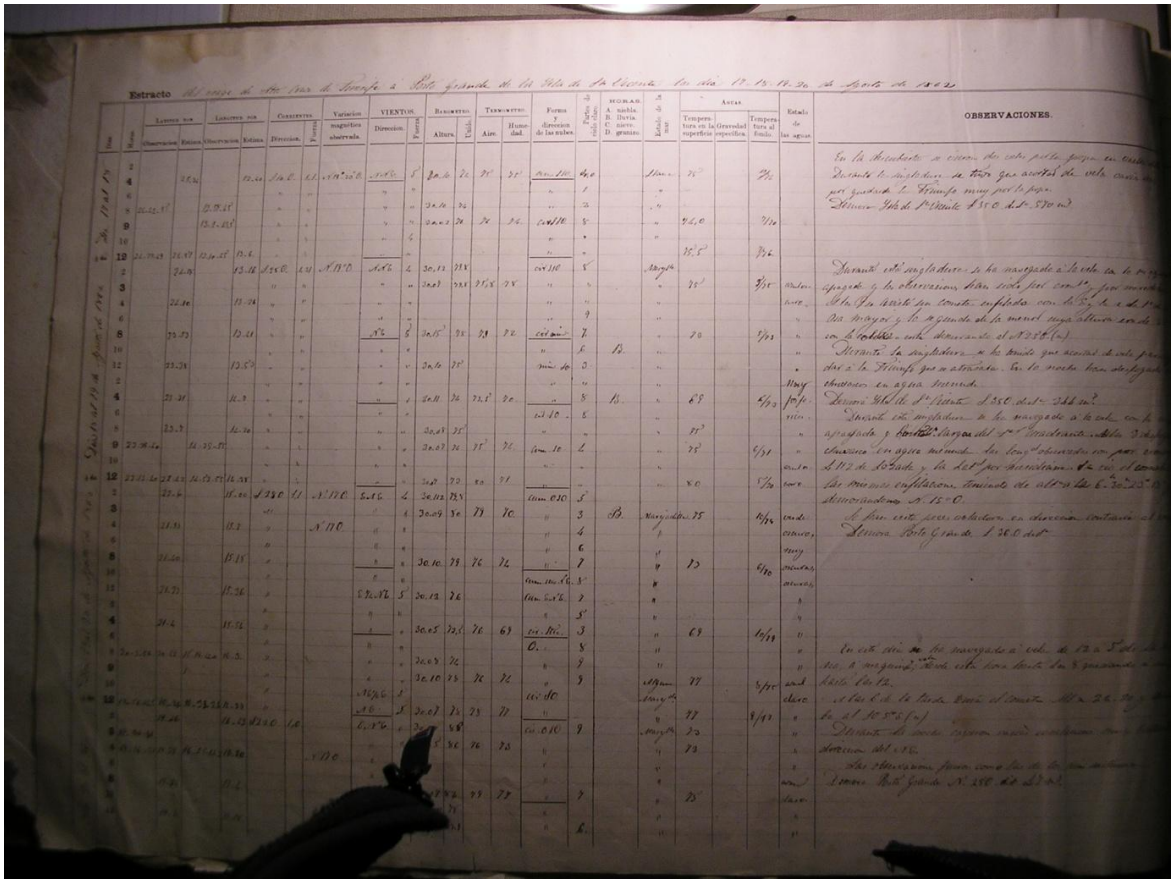
Bulk of logbooks kept in general storage area

19th Century Logbooks

The Museum holds 121 logbooks for the period 1861-1901, housed in a temperature controlled room. These are in various formats and sizes (see illustration above). Of these, 12 are engineering logs, and 109 are navigational logs (bitácora) and port logs (bitácora de puerto). Eight of the navigational logbooks are Spanish *diario de navegación***.** These are exceptionally fine documents with clear neat entries. Table one summarizes the scope and content of the eight Spanish logbooks and a page from one of these is illustrated below.

Ship	No. of Logs	Date range	Type of data	Frequency of Obs.	Location/Movements
Blanca	1	1862-1863	pressure & air temperature	daily/noon	West Indies
Princesa Asturias	2	1861-1862	pressure & air temperature	2-hourly	West Indies
Resolucion	1	1862-1863	Pressure, air temperature & SST	2-hourly	South Atlantic, Straits of Magellan & SE Pacific
Triunfo	1	1863-1865	Pressure, air temperature & SST	2-hourly	South Atlantic, Straits of Magellan & SE Pacific
Villa de Madrid	1	1864-1865	Pressure, air temperature & SST	daily/noon	Coast of Chile and Peru
Virgen de Covadonga	1	1863-1864	pressure & air temperature	4-hourly	West Indies
Unknown	1	1862-1863	pressure & air temperature	2-hourly	Cadiz & West Indies

Table 1 – Spanish Logbooks



Spanish navigation Journal 1862 - Museo Naval y Maritimo, Valparaiso

The remaining 109 Chilean naval logbooks from the 19th century range from 1876 to 1901. It is clear that not every logbook for every ship has been preserved. Why only certain logbooks have been preserved is not known and the fate of the others has not been determined. Many of the logbooks are from the period of the Pacific War against Peru (1879-1882). Most record barometric pressure and air temperature, usually at 4-hourly intervals. A significant number also record sea temperatures, both at sea and while in port.

The locations and movements of all but four of these vessels are exclusively along the coasts of Chile and Peru. The coastal waters off Peru are particularly well represented by vessels blockading Peruvian ports during the early 1880s during the War of the Pacific. Most of these vessels recorded SST at 4-hourly intervals. Positional data such as latitude and longitude is seldom recorded, although it is clear that the vessels are situated off shore of a named port. The four vessels, in locations other than the northern and central coasts of Chile and the coast of Peru, are those visiting the far south towards Punta Arenas. These are the *Esmeralda* 1876-1879 and *Magallanes* 1879. The logbook of the *Almirante Cochrane* 1890 covers the South Atlantic, Magellan Straits and the south-east Pacific. The *Baquedano* in 1901 visited Easter Island (Pascua), Juan Fernandez and the Patagonian fiords.

Some of the logbooks record meta data providing the builder of the vessel, the date of completion and other particulars, including dimensions, tonnage, armament, engines etc.

There are also very basic instructions on completing the logbook including weather observations. There is no meta data concerning the type and location of meteorological instruments in the logbooks. The Chilean Navy dates from 1818 and at present (2010) information concerning logs and journals for the period 1818 to 1876 has not been found.

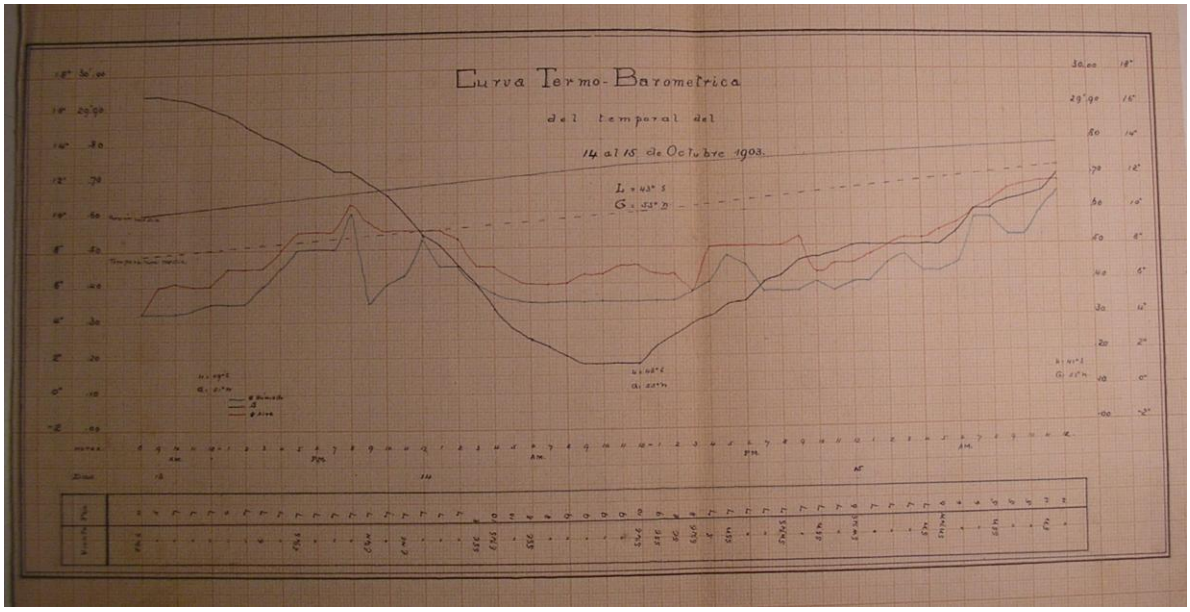
20th Century Logbooks

For the period after 1900 there are an estimated 6,000 logbooks. The Museum holds a typed list of all logbooks held in the main logbook store (see illustration of the store above). This list is organized according to the name of the vessel. Under each individual ship name, the logbooks are listed with the reference number and the month and year of the commencement and the end date of each logbook. For the period 1899 to 1960 there are 3094 logbooks for surface vessels and submarines. Logbooks after 1960 are on restricted access. The format and content logbooks is discussed in more detail in section 7 below.

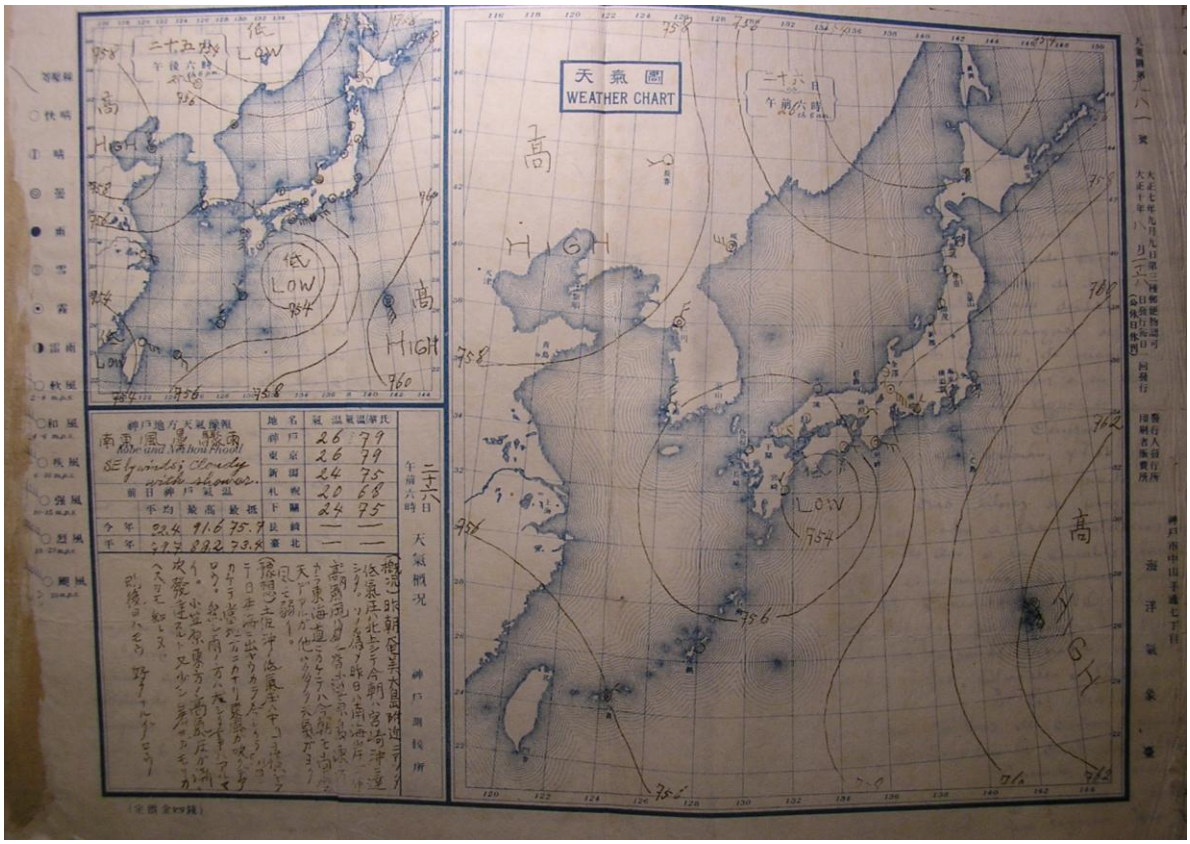
The wide movements and activities of the Chilean Navy are evident from an examination of the logbooks. Those studied in detail were the training ship (buque escuela) *Baquedano*, 1899-1935, a frigate of the same name (1946-1959), the battleship (acorazado) *Latorre*, (1923-1951) and the hydrographic vessel (buque hidrographo) *Vidal Gomaz,* (1943). The logs of the training ship *Baquedano*, include numerous trans-Pacific voyages, visiting Easter Island, Hawaii, Yokohama and Sydney. *Baquedano* performed a circumnavigation in the years 1903-1904, with visits to European waters and the Mediterranean in 1905 and 1906, and again in 1928 and 1929. The frigate *Baquedano* and the battleship *Latorre*, confined their movements, at least from those logbooks examined, to Chilean territorial waters. The *Vidal Gormaz* operated in the vicinity of Punta Arenas.

Historiales

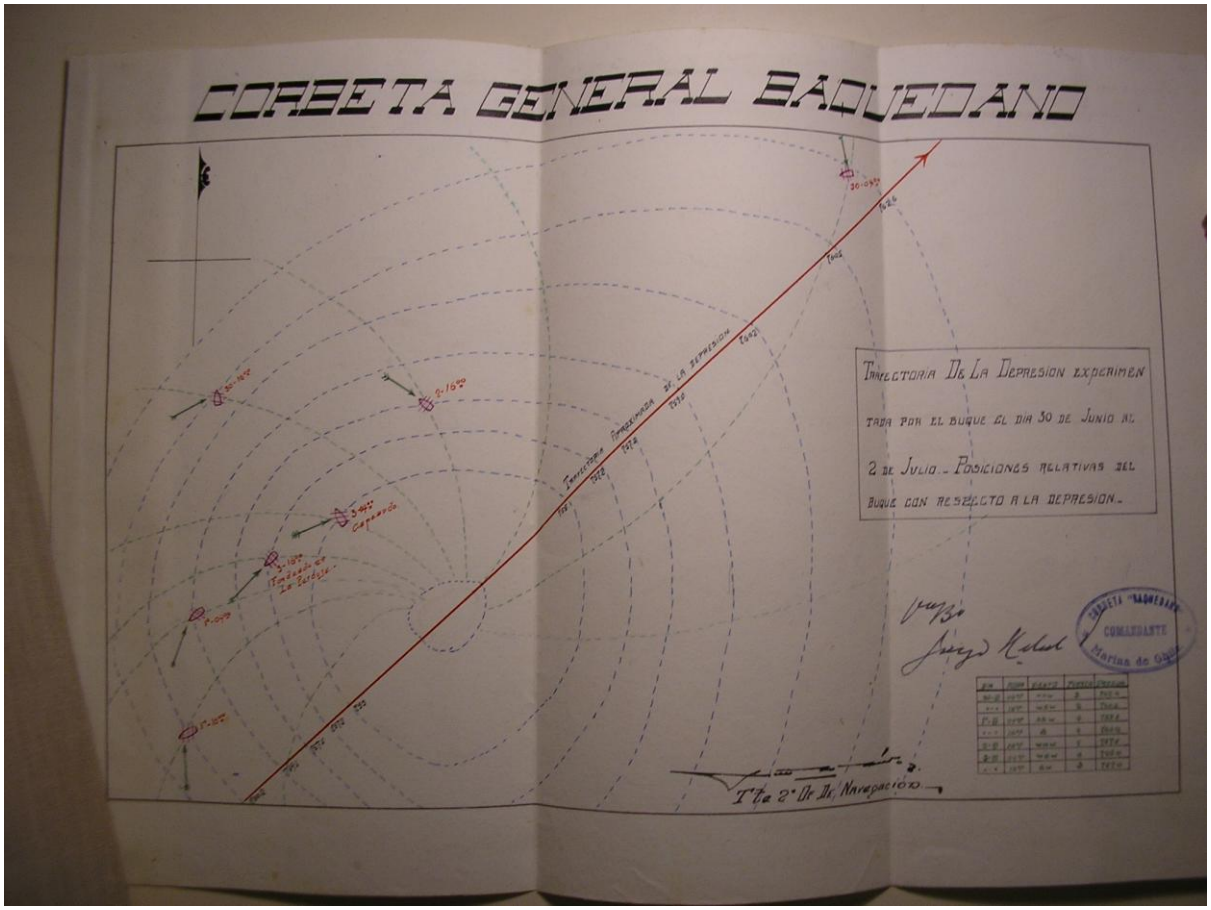
In addition to the logbooks, there are related documents called *historiales*. These are journals or histories of the vessels, usually written by the commanding officer. These historiales are narrative, describing the movements and activities of the vessel, often with a tabulated *résumé* of the ship's movements. The *historiales* also describe extreme weather events, and include either synoptic charts and barographs or more often a diagram of a low pressure area with the ship track through it. From those volumes examined, there was no tabulated meteorological data. This data is to be found in the logbook itself. The Museum holds 79 volumes of *historiales* covering a wide range of dates and types of vessels. These were originally the private property of the journal writer and were donated to the Museum. Therefore it is likely that many other volumes are privately held.



Barograph 14-15 October 1903 – *Baquedano*, Historiales vol. 15



Synoptic Chart – *Baquedano* Historiales vol. 19.



Track of Depression and Ship Positions– *Baquedano* Historiales vol. 20

Printed Sources

Several useful printed sources are held by the Museum, containing information on the history and movement of vessels, with some hydrographic and meteorological data. Among these are annual publications such as the *Memoria de Marina* 1836-1941, *Manual del Marino* 1817-1912, and the *Anuario Hidrografico de la Armada* which was first issued in 1874. This latter publication is also held by SHOA (section 3 below).

The *Memoria de Marina*, contain tables of meteorological data, scattered throughout the volumes. For example, the 1867 edition has daily meteorological observations (pressure, temperature, winds) for the station at Melinka, Islas Guaitecas (43.48S, 73.50W) for the years 1865-1867. The pressure observations were made using a cistern barometer and are recorded in English inches. The *Manual del Marino* has not yet been examined. The *Anuario Hidrografico* is especially rich in material. There are tables of barometric and other meteorological observations from various hydrographic voyages and surveys. Like the *Memoria de Marina*, there are also tables of observations from (near-marine) terrestrial locations. Volumes also contain *resumes* of voyages, making it possible to trace the movements of vessels. The collection of *Anuario Hidrografico* held in the archive of SHOA (see section 3 below) is being scanned for production in an electronic format.

3. **Sevicio Hidrografico y Oceanografico de la Armada de Chile (SHOA)**

   (Hydrographic and Oceanographic Service of the Navy of Chile), Valparaiso

   http://www.shoa.mi..cl

The Hydrographic Office was founded in 1874 and was re-named the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) in 1990. It is situated at Errázuriz 254, Playa Ancha, Valparaiso. SHOA has a technical library and archive specializing in hydrography, oceanography, cartography and meteorology. It contains over 12,000 books, including SHOA publications dating back to 1874. The library is available to naval staff, researchers and students. The archive contains all documentation used to produce nautical charts and other Chilean naval publications. The archive contains material dating back to 1834 at the time of the first hydrographic survey carried out by the Navy. Documents of historical significance are usually transferred to the Naval Museum. SHOA holds no logbooks.

SHOA has not archived the Chilean equivalent of the manuscript remark books and survey data books held by the UK and US hydrographic services. The information that British remark books commonly contain is to be found in print in the *Anuario Hidrografico de la Armada* which was first issued in 1874. These are being scanned (2010) into an electronic format. (see 'Printed Sources' above). More general enquires are being made to locate and document any other meteorological and oceanographic data either in manuscript or printed form. To date these enquires have revealed the existence of engineering logbooks held by a separate department of the Navy. These documents, dating from about the 1940s, contain records of SST observations from engine room intake (ERI) sensors. Further enquires are being made to determine how many, if any of, these logs have been archived.

4. **Dirección Meteorológica de Chile, MeteoChile, Santiago** (www.meteochile.cl).

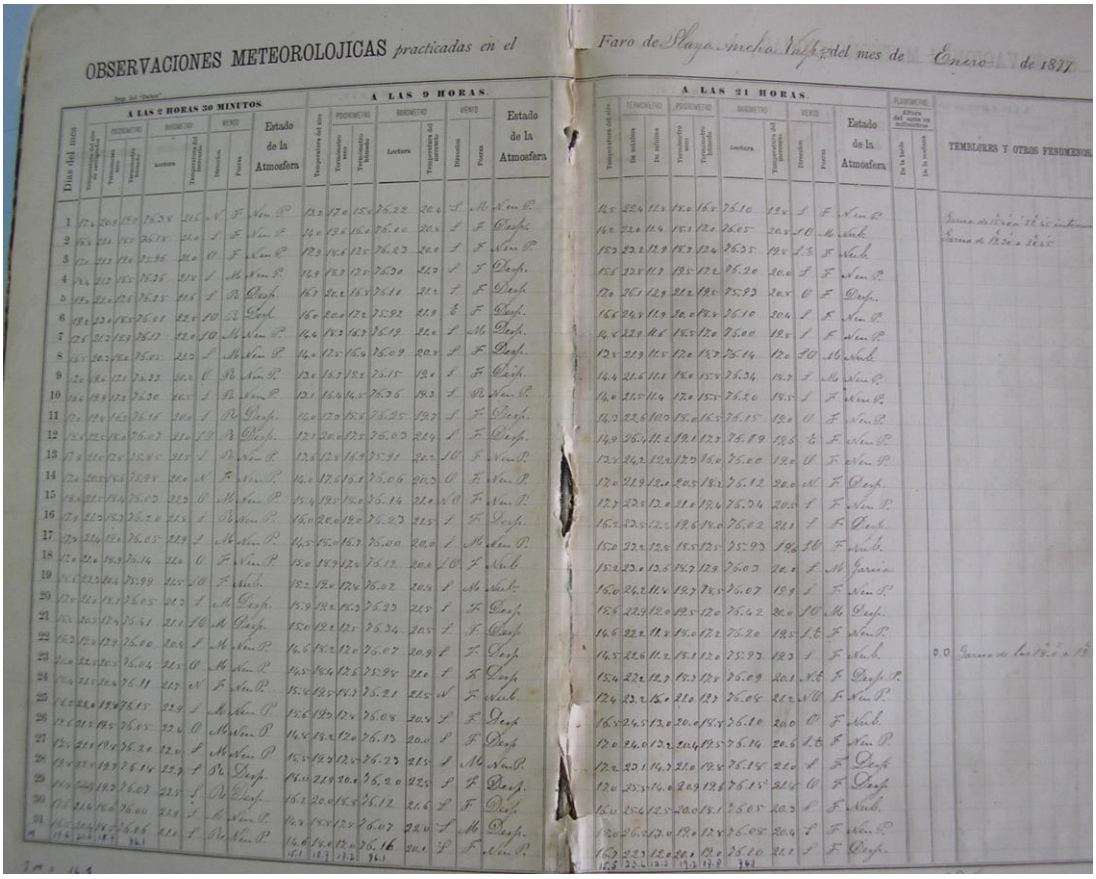
The Chilean Meteorological Office is situated at Av. Portales 3450, Central Station, Santiago, within walking distance of the Santiago Metro. The nearest metro stations are 'Quinta Normal' or 'Estacion Central' (see map below).

Dirección Meteorológica de Chile

Present day records archived at Dirección Meteorológica de Chile

The Office has an extensive library and archive with material from the second half of the 19th century to the modern day. The Office holds a collection of lighthouse (*faro*) records. These lighthouses are situated along the entire length of the extensive Chilean coastline from Peru to Tierra del Fuego and include the Pacific islands of Pascua (Easter Island), Isla San Felix and Juan Fernandez (Robinson Crusoe Island). The Office holds 71 bound volumes.

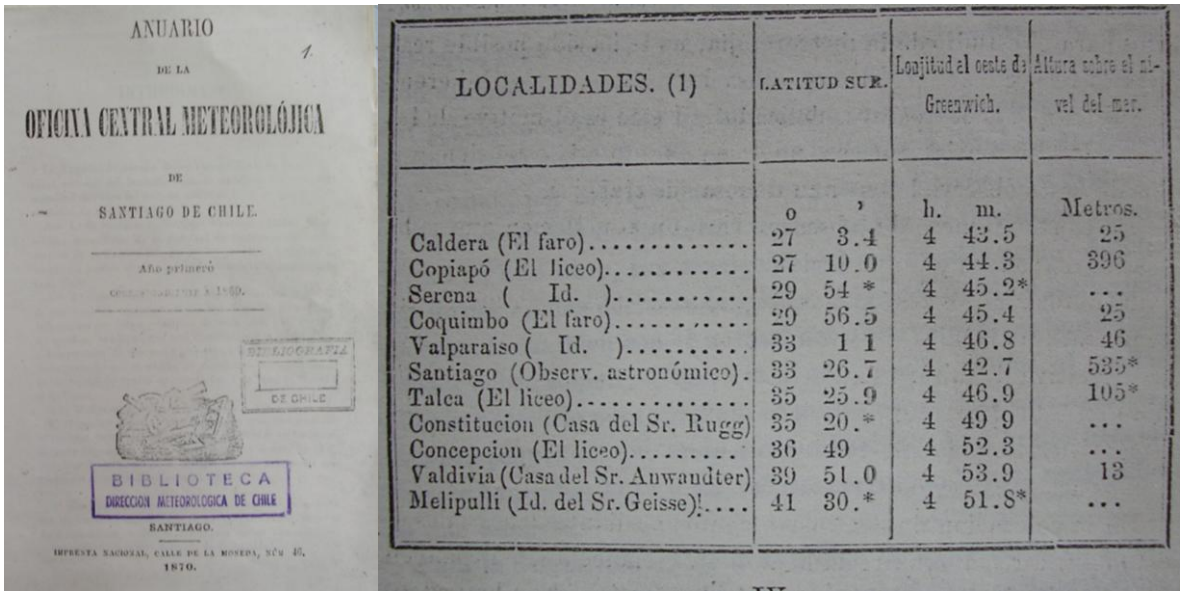
The only 19th century volume is for Playa Anchar, Valparaiso, 1877-1881, illustrated below. The remainder of the lighthouse records commence in 1914 and an inventory of these records has been made. More detail on the Lighthouse meteorological records is in section 6 below.



Sub-Daily meteorological data, Playa Ancha Lighthouse, Valparaiso 1877

To enlarge image, increase document magnification

The office also holds copies of the *Anurio de la Oficina Central Meteorolójia*. These commence in 1869 and continue through to 2008. Observations were made at 2.30am, 9am and 9pm. The position of the various stations is given (latitude and hours and minutes west of Greenwich) as well as the elevation of the station. (see images below). The observations consist of barometric pressure (reduced), temperature, maximum and minimum, relative humidity, winds and clouds. Note that the NOAA Central Library holds the volumes for 1871-75 and 1886 in electronic form. (http://docs.lib.noaa.gov/rescue/data_rescue_chile.html) Also see appendix, below.



ANUARIO

DE LA

OFICINA CENTRAL METEOROLÓJICA

DE

SANTIAGO DE CHILE.

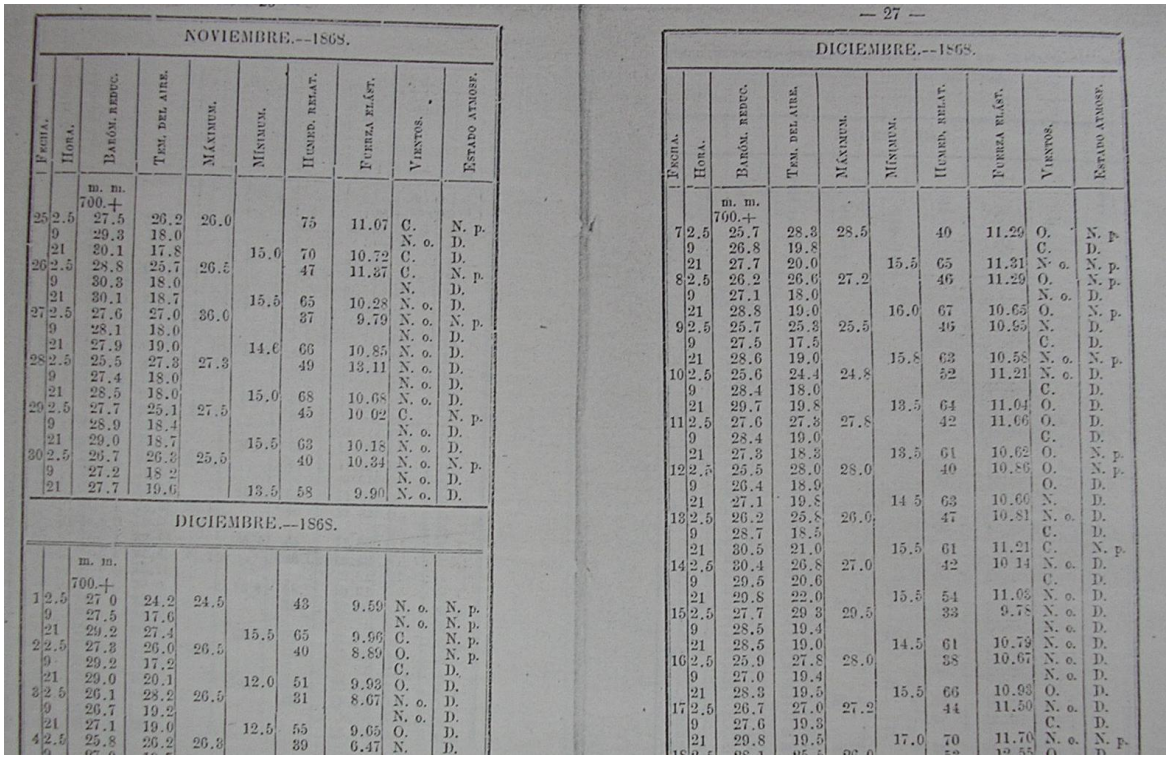
Año primero

SANTIAGO.

IMPRENTA NACIONAL, CALLE DE LA MONEDA, NÚM. 46.
1870.

LOCALIDADES. (1)	LATITUD SUR.		Longitud al oeste de Greenwich.		Altura sobre el nivel del mar.
	o	'	h.	m.	Metros.
Caldera (El faro)	27	3.4	4	43.5	25
Copiapó (El liceo)	27	10.0	4	44.3	396
Serena (Id.)	29	54 *	4	45.2*	...
Coquimbo (El faro)	29	56.5	4	45.4	25
Valparaiso (Id.)	33	1 1	4	46.8	46
Santiago (Observ. astronómico)	33	26.7	4	42.7	535*
Talca (El liceo)	35	25.9	4	46.9	105*
Constitucion (Casa del Sr. Rugg)	35	20.*	4	49 9	...
Concepcion (El liceo)	36	49	4	52.3	...
Valdivia (Casa del Sr. Anwandter)	39	51.0	4	53.9	13
Melipulli (Id. del Sr. Geisse)	41	30.*	4	51.8*	...

Meteorological Annual 1869, and locations of observations



NOVIEMBRE.—1868.

Fecha.	Hora.	Barom. reduc.	Tem. del aire.	Máximum.	Mínimum.	Humed. relat.	Fuerza elást.	Vientos.	Estado atmosf.
		m. m. 700.+							
25	2.5	27.5	26.2	26.0		75	11.07	C.	N. p.
	9	29.3	18.0					N. o.	D.
	21	30.1	17.8		15.0	70	10.72	C.	D.
26	2.5	28.8	25.7	26.5		47	11.37	C.	N. p.
	9	30.3	18.0					N.	D.
	21	30.1	18.7		15.5	65	10.28	N. o.	D.
27	2.5	27.6	27.0	36.0		37	9.79	N. o.	N. p.
	9	28.1	18.0					N. o.	D.
	21	27.9	19.0		14.6	66	10.85	N. o.	D.
28	2.5	25.5	27.3	27.3		49	13.11	N. o.	D.
	9	27.4	18.0					N. o.	D.
	21	28.5	18.0		15.0	68	10.68	N. o.	D.
29	2.5	27.7	25.1	27.5		45	10 02	C.	N. p.
	9	28.9	18.4					N. o.	D.
	21	29.0	18.7		15.5	63	10.18	N. o.	D.
30	2.5	26.7	26.3	25.5		40	10.34	N. o.	N. p.
	9	27.2	18 2					N. o.	D.
	21	27.7	19.6		13.5	58	9.90	N. o.	D.

DICIEMBRE.—1868.

		m. m. 700.+							
1	2.5	27 0	24.2	24.5		43	9.59	N. o.	N. p.
	9	27.5	17.6					N. o.	N. p.
	21	29.2	27.4		15.5	65	9.96	C.	N. p.
2	2.5	27.3	26.0	26.5		40	8.89	O.	N. p.
	9	29.2	17.2					C.	D.
	21	29.0	20.1		12.0	51	9.93	O.	D.
3	2 5	26.1	28.2	26.5		31	8.67	N. o.	D.
	9	26.7	19.2					N. o.	D.
	21	27.1	19.0		12.5	55	9.65	O.	D.
4	2.5	25.8	26.2	26.3		39	6.47	N.	D.

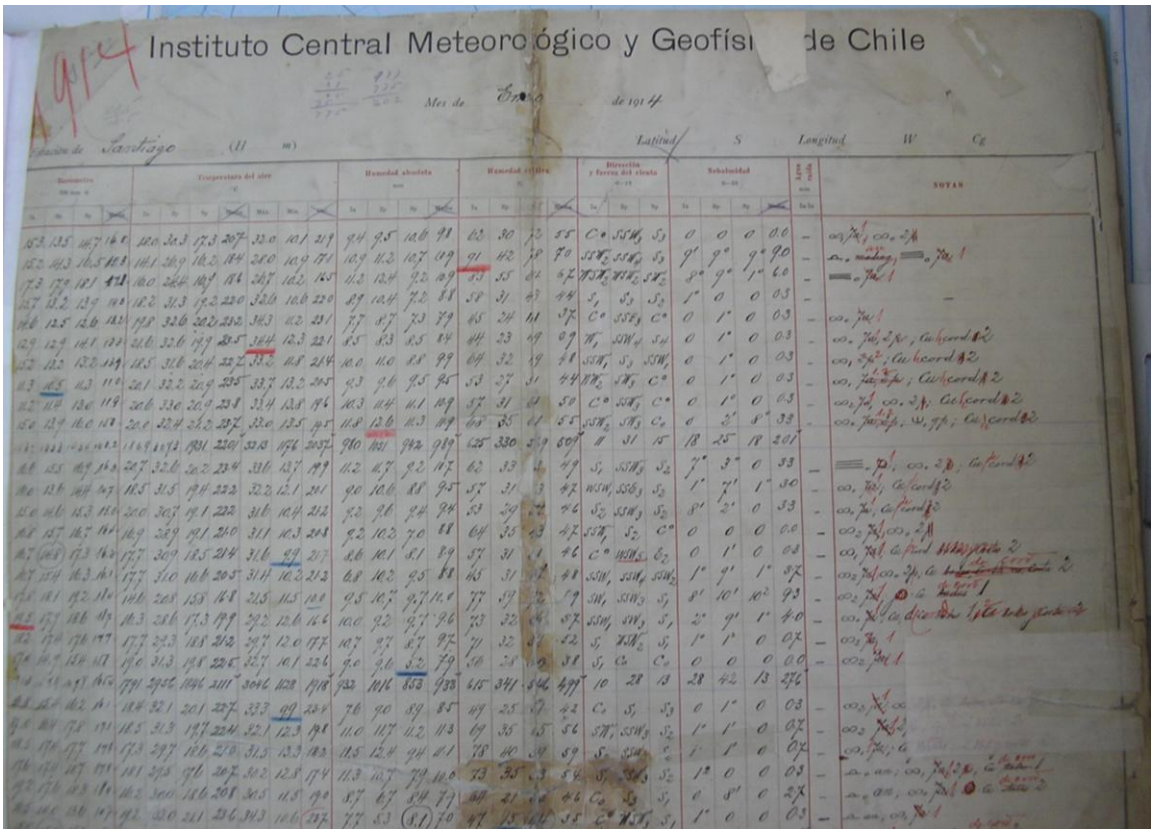
— 27 —

DICIEMBRE.—1868.

Fecha.	Hora.	Barom. reduc.	Tem. del aire.	Máximum.	Mínimum.	Humed. relat.	Fuerza elást.	Vientos.	Estado atmosf.
		m. m. 700.+							
7	2.5	25.7	28.3	28.5		40	11.29	O.	N. p.
	9	26.8	19.8					C.	D.
	21	27.7	20.0		15.5	65	11.31	N. o.	N. p.
8	2.5	26.2	26.6	27.2		46	11.29	O.	N. p.
	9	27.1	18.0					N. o.	D.
	21	28.8	19.0		16.0	67	10.65	O.	N. p.
9	2.5	25.7	25.3	25.5		46	10.93	N.	D.
	9	27.5	17.5					C.	D.
	21	28.6	19.0		15.8	63	10.58	N. o.	N. p.
10	2.5	25.6	24.4	24.8		52	11.21	N. o.	D.
	9	28.4	18.0					C.	D.
	21	29.7	19.8		13.5	64	11.04	O.	D.
11	2.5	27.6	27.3	27.8		42	11.66	O.	D.
	9	28.4	19.0					C.	D.
	21	27.3	18.3		13.5	61	10.62	O.	N. p.
12	2.5	25.5	28.0	28.0		40	10.86	O.	N. p.
	9	26.4	18.9					O.	D.
	21	27.1	19.8		14 5	63	10.66	N.	D.
13	2.5	26.2	25.8	26.0		47	10.81	N. o.	D.
	9	28.7	18.5					C.	D.
	21	30.5	21.0		15.5	61	11.21	C.	N. p.
14	2.5	30.4	26.8	27.0		42	10 14	N. o.	D.
	9	29.5	20.6					C.	D.
	21	29.8	22.0		15.5	54	11.08	N. o.	D.
15	2.5	27.7	29 3	29.5		33	9.78	N. o.	D.
	9	28.5	19.4					N. o.	D.
	21	28.5	19.0		14.5	61	10.79	N. o.	D.
16	2.5	25.9	27.8	28.0		38	10.67	N. o.	D.
	9	27.0	19.4					N. o.	D.
	21	28.3	19.5		15.5	66	10.93	O.	D.
17	2.5	26.7	27.0	27.2		44	11.50	N. o.	D.
	9	27.6	19.3					C.	D.
	21	29.8	19.5		17.0	70	11.70	N. o.	N. p.

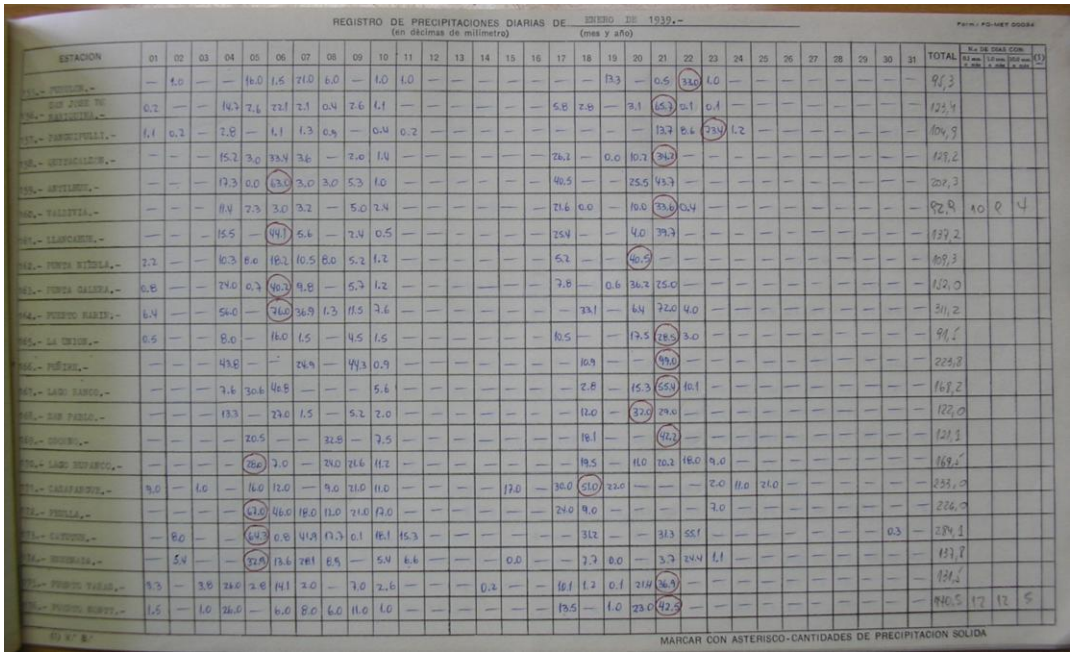
Sub-daily pressure and temperature (2.30am, 9am & 9pm) November-December 1868

Other sets of records are held both in printed and manuscript form from 1914. The example below from the Santiago station, 1914, includes sub-daily pressure and temperature, humidity, wind direction and strength, cloud cover and rainfall.



Sub-daily meteorological data Santiago 1914

There are also 81 sets of historic daily records of rainfall from numerous locations in Chile, including Easter Island. Some of these reports are printed, some are handwritten on pre-printed forms, while others are entirely handwritten. These are illustrated below. The records run from 1912 to 1960 with a volume for 1969. At various times, up to 340 separate stations recorded observations of rainfall. It is assumed that more modern records, post-1960 are archived in a different section of the Office, and these were not examined. A comprehensive inventory of all precipitation records would be useful, and an inventory of the 81 sets described above has been made.



REGISTRO DE PRECIPITACIONES DIARIAS DE ENERO DE 1939.-
(en décimas de milímetro) (mes y año)

ESTACION	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	TOTAL
[illegible]	—	1.0	—	—	16.0	1.5	21.0	6.0	—	1.0	1.0	—	—	—	—	—	—	—	13.3	—	0.5	33.0	1.0	—	—	—	—	—	—	—	—	91,3
SAN JOSE DE [illegible]	0.2	—	—	14.7	7.6	22.1	2.1	0.4	7.6	4.1	—	—	—	—	—	—	5.8	7.9	—	3.1	15.3	0.1	0.1	—	—	—	—	—	—	—	—	125,4
[illegible]	1.1	0.2	—	2.8	—	1.1	1.3	0.9	—	0.4	0.2	—	—	—	—	—	—	—	—	—	13.7	8.6	23.4	1.2	—	—	—	—	—	—	—	104,9
[illegible]	—	—	—	15.2	3.0	33.4	3.6	—	2.0	1.4	—	—	—	—	—	—	26.2	—	0.0	10.2	34.7	—	—	—	—	—	—	—	—	—	—	129,2
[illegible]	—	—	—	17.3	0.0	63.0	3.0	3.0	5.3	1.0	—	—	—	—	—	—	40.5	—	—	25.5	43.7	—	—	—	—	—	—	—	—	—	—	202,3
[illegible]	—	—	—	11.4	7.3	3.0	3.2	—	5.0	2.4	—	—	—	—	—	—	21.6	0.0	—	10.0	33.6	0.4	—	—	—	—	—	—	—	—	—	92,9	10 9 4
[illegible]	—	—	—	15.5	—	44.1	5.6	—	7.4	0.5	—	—	—	—	—	—	25.4	—	—	4.0	39.7	—	—	—	—	—	—	—	—	—	—	137,2
[illegible]	2.2	—	—	10.3	8.0	18.2	10.5	8.0	5.2	1.2	—	—	—	—	—	—	5.2	—	—	46.5	—	—	—	—	—	—	—	—	—	—	—	109,3
[illegible]	0.8	—	—	24.0	0.2	40.2	9.8	—	5.7	1.2	—	—	—	—	—	—	7.8	—	0.6	36.2	25.0	—	—	—	—	—	—	—	—	—	—	142,0
[illegible]	6.4	—	—	54.0	—	76.0	36.9	1.3	11.5	7.6	—	—	—	—	—	—	—	33.1	—	6.4	72.0	4.0	—	—	—	—	—	—	—	—	—	311,2
[illegible]	0.5	—	—	8.0	—	16.0	1.5	—	4.5	1.5	—	—	—	—	—	—	10.5	—	—	12.5	28.5	3.0	—	—	—	—	—	—	—	—	—	91,5
[illegible]	—	—	—	43.8	—	—	24.9	—	44.3	0.9	—	—	—	—	—	—	—	10.9	—	—	99.0	—	—	—	—	—	—	—	—	—	—	229,8
[illegible]	—	—	—	7.6	30.6	46.8	—	—	—	5.6	—	—	—	—	—	—	—	2.8	—	15.3	55.4	10.1	—	—	—	—	—	—	—	—	—	168,2
[illegible]	—	—	—	13.3	—	22.0	1.5	—	5.2	2.0	—	—	—	—	—	—	—	12.0	—	32.0	29.0	—	—	—	—	—	—	—	—	—	—	122,0
[illegible]	—	—	—	—	20.5	—	—	32.8	—	7.5	—	—	—	—	—	—	—	18.1	—	—	41.2	—	—	—	—	—	—	—	—	—	—	120,1
[illegible]	—	—	—	—	28.6	7.0	—	24.0	21.6	11.2	—	—	—	—	—	—	—	19.5	—	11.0	20.2	18.0	9.0	—	—	—	—	—	—	—	—	169,1
[illegible]	9.0	—	1.0	—	16.0	12.0	—	9.0	21.0	11.0	—	—	—	—	17.0	—	30.0	51.0	22.0	—	—	—	2.0	11.0	21.0	—	—	—	—	—	—	233,0
[illegible]	—	—	—	—	57.2	46.0	18.0	11.0	21.0	17.0	—	—	—	—	—	—	24.0	9.0	—	—	—	—	7.0	—	—	—	—	—	—	—	—	226,0
[illegible]	—	8.0	—	—	64.3	0.8	41.9	17.3	0.1	18.1	15.3	—	—	—	—	—	—	31.2	—	—	31.3	55.1	—	—	—	—	—	—	—	0.3	—	284,1
[illegible]	—	5.4	—	—	32.9	13.6	28.1	8.5	—	5.4	6.6	—	—	—	0.0	—	—	7.7	0.0	—	3.7	24.4	1.1	—	—	—	—	—	—	—	—	137,8
[illegible]	9.3	—	3.8	26.0	2.8	14.1	2.0	—	7.0	2.6	—	—	—	0.2	—	—	16.1	1.2	0.1	21.4	36.9	—	—	—	—	—	—	—	—	—	—	181,2
[illegible]	1.5	—	1.0	26.0	—	6.0	8.0	6.0	11.0	1.0	—	—	—	—	—	—	13.5	—	1.0	23.0	42.5	—	—	—	—	—	—	—	—	—	—	340,5	17 12 5

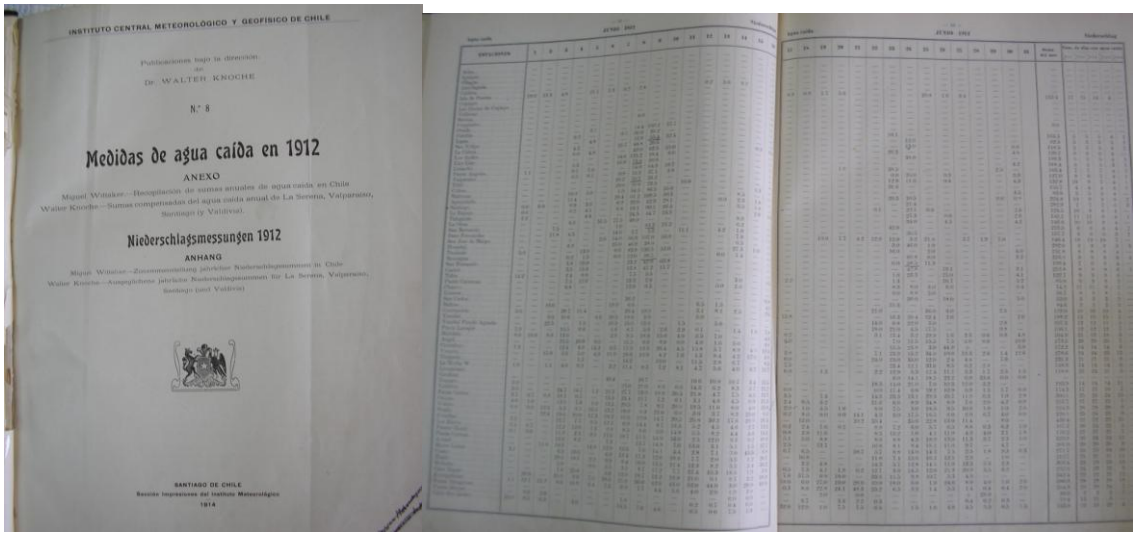
MARCAR CON ASTERISCO - CANTIDADES DE PRECIPITACION SOLIDA

Register of Precipitation – January 1939

Octubre 1948.-

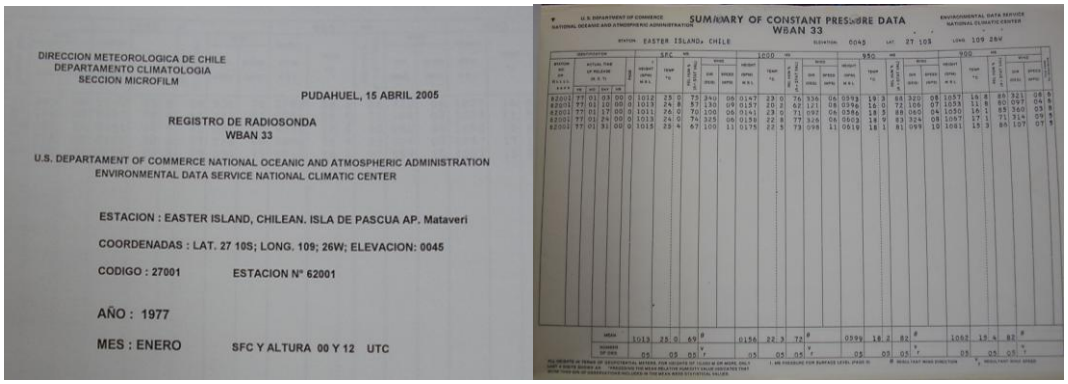
FECHA	Gobierno Militar	Sta. Gabriela	Alberico Vélez	Lago Vasco	La Unión	Puerto Montt	Est. Lago Vasco	Río Blanco	Río Sotito	Base Aeroviaria	Base El Tepú	Mobil	Reparos	Río Olay	Aeropuerto	Tenglo	Estrella	Bajo Llico	Buenaventura	Río Sotito
1	6.0	-	-	-	-	-	12.2	-	6.8	0.0	-	-	-	-	-	2.0		2.3	0.0	-
2	4.0	6.0	5.0	10.0	-		16.4	2.3	0.2	12.0	0.0	6.0	6.0	3.2	-	-		-	-	-
3	5.0	6.0	1.5	9.0	4.5		10.4	3.4	2.1	8.4	4.8	15.0	3.5	-	3.0	27.0		14.6	7.4	1.4
4	3.0	-	2.4	6.0	0.5		6.2	1.2	1.3	0.0	0.0	4.0	2.0	--	-	14.0		11.2	8.2	7.2
5	-	-	1.4	23.0	-		8.2	-	-	2.1	-	-	3.5	-	-	-		2.3	1.9	3.0
6	-	-	-	-	-	-	-	-	-	-	0.5	-	-	-	-	-		0.4	0.0	0.6
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	4.3	-	-		-	-	-
11	-	-	0.0	-	-	-	-	-	-	-	-	-	-	2.8	-	-		-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	1.3	-	-		-	-	-
13	-	-	-	-	-	-	-	-	-	-	-	-	-	2.1	-	-		-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-

Register of Precipitation October 1948

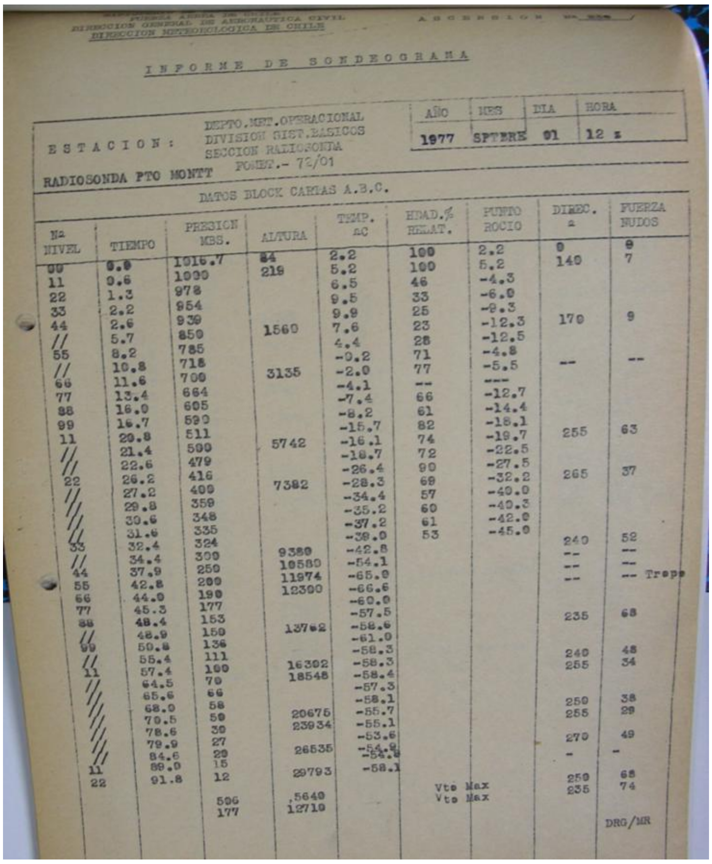


Daily Rainfall Records - 1912

Other sets of meteorological records extend to the present day representing various met stations, lighthouses and airfields. Detailed archive documentation is required to determine the range and extent of these records, some of which are archived on microfilm. Of particular interest are upper air radiosonde observations from a number of locations including Easter Island. Some of the data from Easter Island may already be held by NOAA's National Climatic Data Center (NCDC) as several documents contain printed references to NOAA. Some care should be taken that data is not duplicated in any subsequent digitization exercise.



Radiosonde Observations Easter Island 1977



FUERZA AEREA DE CHILE
DIRECCION GENERAL DE AERONAUTICA CIVIL
DIRECCION METEOROLOGICA DE CHILE

ASCENSION Nº

INFORME DE SONDEOGRAMA

ESTACION : DEPTO.MET.OPERACIONAL
DIVISION SIST.BASICOS
SECCION RADIOSONDA
POMET.- 72/01

RADIOSONDA PTO MONTT

AÑO	MES	DIA	HORA
1977	SPTBRE	01	12 z

DATOS BLOCK CARTAS A.B.C.

Nº NIVEL	TIEMPO	PRESION MBS.	ALTURA	TEMP. ºC	HDAD.% RELAT.	PUNTO ROCIO	DIREC. º	FUERZA NUDOS
00	0.0	1016.7	84	2.2	100	2.2	0	0
11	0.6	1000	219	5.2	100	5.2	140	7
22	1.3	978		6.5	46	-4.3		
33	2.2	954		9.5	33	-6.0		
44	2.6	939		9.9	25	-8.3		
//	5.7	850	1560	7.6	23	-12.3	170	9
55	8.2	785		4.4	28	-12.5		
//	10.8	718		-0.2	71	-4.8		
66	11.6	700	3135	-2.0	77	-5.5	--	--
77	13.4	664		-4.1	--	---		
88	16.0	605		-7.4	66	-12.7		
99	16.7	590		-8.2	61	-14.4		
11	20.8	511		-15.7	82	-18.1		
//	21.4	500	5742	-16.1	74	-19.7	255	63
//	22.6	479		-18.7	72	-22.5		
22	26.2	416		-26.4	90	-27.5		
//	27.2	400	7382	-28.3	69	-32.2	265	37
//	29.8	359		-34.4	57	-40.0		
//	30.6	348		-35.2	60	-40.3		
//	31.6	335		-37.2	61	-42.0		
33	32.4	324		-39.0	53	-45.0	240	52
//	34.4	300	9380	-42.8			--	--
44	37.9	250	10580	-54.1			--	--
55	42.8	200	11974	-65.9			--	-- Trops
66	44.0	190	12390	-66.6				
77	45.3	177		-60.0				
88	48.4	153		-57.5			235	68
//	48.9	150	13762	-58.6				
99	50.8	136		-61.0				
//	55.4	111		-58.3			240	48
11	57.4	100	16392	-58.3			255	34
//	64.5	70	18548	-58.4				
//	65.6	66		-57.3				
//	68.0	58		-58.1			250	38
//	70.5	50	20675	-55.7			255	29
//	78.6	30	23934	-55.1				
//	79.9	27		-53.6			270	49
//	84.6	20	26535	-54.9			-	-
11	89.0	15		-54.8				
22	91.8	12	29793	-58.1				
		506	,5640		Vto Max		250	68
		177	12710		Vto Max		235	74

DRG/MR

Radiosonde Data Puerto Montt 1977.

Additional material archived at MeteoChile includes synoptic charts, barographs and every type and format of meteorological record usually associated with such an institution.

5. Data for the Southern Pacific and Chilean Marine Areas in British Archives

Chile is a maritime nation and up to 80% of its modern trade is by sea. Due to the nature of the geography of Chile, trade has historically been carried on through ports such as Valparaiso. Many European maritime nations, Great Britain in particular, have strong historic maritime trade links with Chile. British archives therefore contain many thousands of documents connected with trade and trade protection in the eastern and south-eastern Pacific, including naval logbooks, remark books from hydrographic surveys, and merchant shipping meteorological logbooks. These are archived in the National Archives, Kew, London, the Hydrographic Office, Taunton and the National Meteorological Archive in Exeter. All of these documents contain weather observations, and after c. 1830/1840, sub-daily instrumental observations of pressure and air temperature. Sub-daily sea temperature observations can be consistently found from about 1860/1870. These records complement those found in the archives of Chile, making it possible to fill gaps in the temporal and geographic record. The data in these British records also provide an opportunity for comparison and homogenization with the corresponding Chilean marine and lighthouse observations.

5a. UK National Archives - Royal Navy Logbooks

19th Century Royal Navy Logbooks

The Recovery of Logbooks and International Marine Data (RECLAIM) Project http://icoads.noaa.gov/reclaim has produced an inventory of British Royal Navy vessels in the eastern Pacific for the period 1790 to 1913. This inventory includes all Royal Navy vessels stationed or passing through the eastern Pacific Ocean during that period. It includes vessels from the China station that returned to England by the eastern route either stopping at Valparaiso or sailing directly to the Drake Passage. In the early part of the 19th century, the inventory includes vessels from the South American station that passed around Cape Horn and into the Pacific. The complete commission is included, with the voyage out to the Pacific and the return. Detailed movements are provided where known. The purpose of this inventory is to assist with the selection, imaging and digitization of the meteorological and oceanographic observations in the logbooks for scientific study.

There are 918 logbooks in this inventory and these are held at the National Archives in London. Most are ships' logs (ADM 53) but there are also captain's logs (ADM 51) and master's logs (navigating officer - ADM 52) and logs from ships of exploration (ADM 55). Detailed information on these collections can be found in the report *British Logbooks in UK Archives 17th –19th Centuries* at **http://icoads.noaa.gov/reclaim**.

The number of days covered by these logbooks is calculated at nearly 363K. The estimated number of days of sea observations is calculated to be nearly 272K days, a figure that assumes that ¼ of the days in the logbook will be spent in port. The minimum number of days of recorded sub-daily air pressure and SST are calculated to be 186K and 101K respectively. These estimates are based on logbook formats known to record this type of data (1845-50 and later for pressure, and 1870 and later for SST). The figures do not include pressure and SST from logs before 1845. Earlier instrumental observations can be found in many of the pre-1845 logbooks, but are not included in this calculation as there is less consistency in the presence of data and it should not be assumed that all the logbooks of the earlier period will have instrumental observations. Pressure and SST totals are therefore conservative and actual totals are likely to exceed the estimates stated. All logbooks record sub-daily wind direction, wind force, precipitation and general weather, usually descriptive rather than instrumental.
The total number of images required to process all 918 logbooks is estimated to be 308K. This is an approximation taking account of changing logbook formats in the early 19th century. It should be noted that several of the logbooks (ADM 55 series and a few ADM 53 series, at the UK National Archives) have already been imaged under the CORRAL Project (UK Colonial registers and Royal Navy Logbooks, http://www.corral.org.uk/). All of these records await digitization (2010)

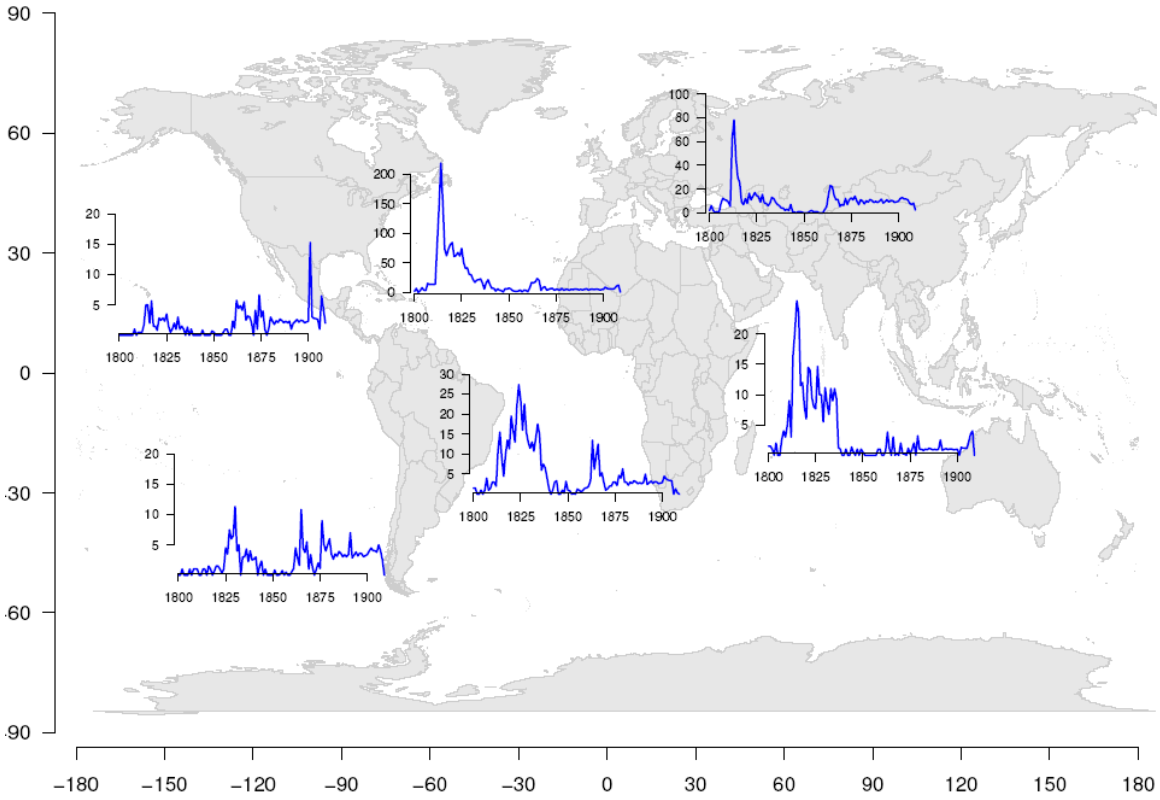
20th Century Royal Navy Logbooks

The Royal Navy did not have a permanent presence in the eastern Pacific in the 20th century and the gradual withdrawal of that presence began as early as the mid 1880s. However there are logbooks for vessels that passed through Chilean maritime areas and many of these have been imaged and some of them also digitized under various projects supported by the UK Met Office Hadley Centre, and the Atmospheric Circulation Reconstructions over the Earth (ACRE) Project http://www.met-acre.org/. These projects covered an extended World War II period, 1938-1947, and an extended World War I period 1914-1923. The latter period is presently (2010) being digitized under a UK based citizen science project. A sub-inventory of those vessels in the south-east Pacific and Chilean maritime areas 1914-1946, an extension of the 1790-1913 inventory discussed above, will be available in 2011. This new sub-inventory will list vessels, movements and the status of the digitization process. A provisional list of the 20th century Royal Navy vessels is included in Appendix B, to this document.

5b. UK Hydrographic Office - Royal Navy Remark Books

Remark books were kept on board many Royal Navy vessels but particularly those on voyages of exploration or hydrographic survey. Remark books reproduce much of the information in the ship's logbook, but often with greater detail and frequency.

Typically, from 1816, the most common observations to be found in the remark books are barometric pressure, air temperature and sea surface temperature, wind direction and force, and weather, although not every remark book contains instrumental data before about 1845. By 1845, there is always at least one daily observation, taken at noon, but sub-daily observations can frequently be found, and after 1860 are always present, usually three, four, six or more observations per day at set times or intervals. Less frequently recorded were wet and dry bulb temperature observations, hygrometer (humidity) readings, specific gravity (density) of seawater, and sub-surface sea temperatures. Information on the type and positioning of the various instruments became common in the remark books during the 1880s, mirroring similar information provided in ship's logbooks and journals. The graph below indicates the spatial and temporal distribution of remark books. The south-east Pacific is well represented in the period 1825-1840, and after 1875. No remark books have yet been imaged or digitized (2010).

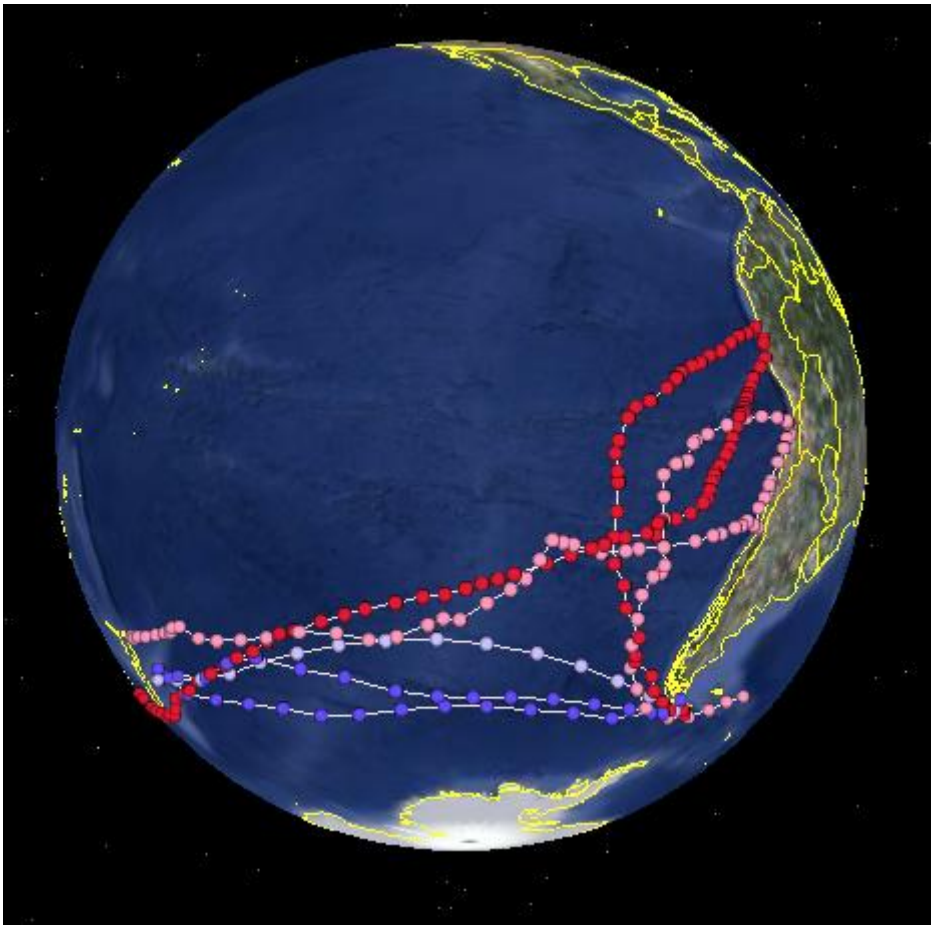


Range of Remarks Books (Philip Brohan, UK Met Office, Hadley Centre)

5c. UK National Meteorological Archive - Merchant Shipping Meteorological Logbooks

The UK National Meteorological Library holds a large collection of marine meteorological logbooks, registers and weather books, mostly kept on board merchant vessels. There are about 10,000 items for the period 1854 to 1904. See section B-2.4 below for a description of the format and content of these logs.

An inventory of these logbooks is being compiled (2010-2011) and the total number of documents covering the south-east Pacific and Chilean marine areas will not be determined until this work is completed. However a sub-inventory for vessels traversing the eastern Pacific during the 1880s has been compiled. It is made up of vessels visiting the west coasts of North and South America and includes all circumnavigations. For the 1880s there are 474 logbooks, yielding nearly 50K days of observations. This total includes the other ocean basins traversed by these vessels, and the actual amount of data for the Pacific is likely to be about 18K days. The utility of the data from these logbooks lies in the typical trajectory of these vessels. From the 474 logbooks for the 1880-1889 period, see the track chart below taken from just five vessels in the period 1886-87.



Tracks of Five British Merchants ships 1886-87

These are typical tracks of vessels sailing from Australia and New Zealand towards the Drake Passage or ports on the coast of Chile and Peru. These vessels sail through sea areas where meteorological and oceanographic observations are presently sparse or absent in databases. These sea areas are also scientifically significant for studies of El Niño and the Southern Annular Mode. None of this data has been digitized (2010)

6. Other Archives and Sources

Climatological Database of the World's Oceans 1750-1850 – CLIWOC Project

There are other sources and archives that will yield good quality meteorological and oceanographic data, as well as related sources of climatological interest. The CLIWOC Project database, http://www.ucm.es/info/cliwoc/ contains data for English and Spanish vessels rounding Cape Horn, either as part of a circumnavigation (for instance Cook's voyages) or sailing to destinations such as Valparaiso or Callao. Access is free and much of the data has already been incorporated into the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) http://icoads.noaa.gov/.

Salesian Museum, Punta Arenas

The Salesian Museum in Punta Arenas holds meteorological records from 1896 to 1954. These were digitized in 2006 by the International Environmental Data Rescue Organization (IEDRO). http://iedro.org/chile-new.html. The pressure observations have been added to the International Surface Pressure Databank (ISPD) 1768-2008, http://dss.ucar.edu/datasets/ds132.0/. The Museum also holds over I,000 photographic plates of glaciers from about 1870 to 1925.

Chilean Shipping Companies

Chilean shipping companies will have archived the logbooks from their ships. For example, Austral Broom SA have an archive of logbooks in Punta Arenas, and their vessels traverse sea areas that include Cape Horn, the Fuegian fjords, Strait of Magellan and connections with Puerto Montt. The Austral Broom archive and other shipping archives require further investigation and documentation. In the context of shipping companies, it is worth noting that today's meteorological observations are tomorrow's historic weather data.

Other Records

Chilean Lighthouse records before 1914 have not yet been located, except for the few examples at Meteo Chile and the National Archive. Further searches are required. Likewise the earliest examples of Chilean logbooks before the 1870s, have not been located. Logbooks from the time of the war of Independence and later may be held privately or in foreign archives. It is also known that the National Archive in Santiago holds records of insurance claims from the 18th and 19th centuries made by vessels damaged in the passage around Cape Horn and arriving at ports such as Valparaiso. Relevant extracts of winds and weather from the logbooks of these vessels were frequently transcribed as supporting evidence in an insurance claim. These records are of particular importance as the original logbooks from which the transcriptions were made have almost certainly not survived.

The logbooks of naval and merchant ships visiting the ports of Chile will include nationalities such as Prussia/Germany, the Netherlands, Spain and France. Any vessel making a circumnavigation via Cape Horn would have visited a Chilean port or passed directly through Chilean waters. The documentation of these passages will discover more vessels and indicate the direction of further archival research.

B. The Documents

1. Lighthouse Records

1.1 Extent and Range

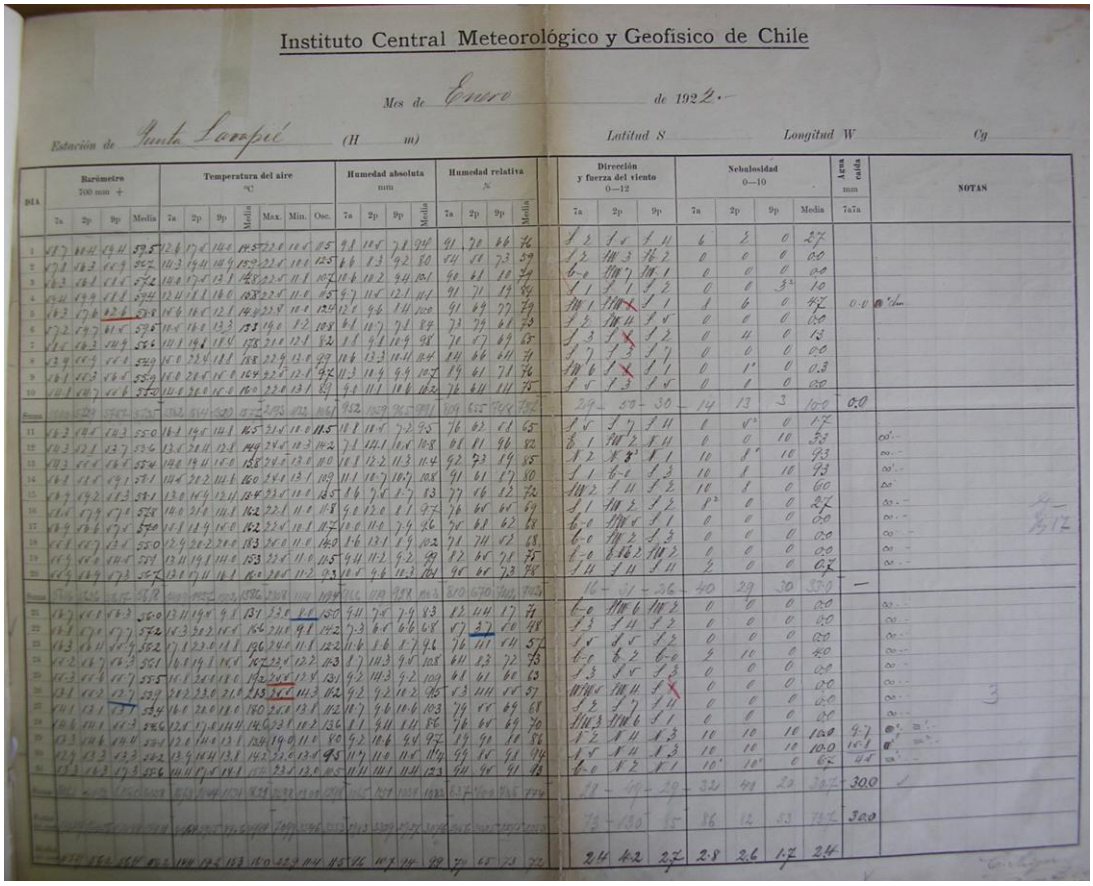
Lighthouses extend along the coast of Chile from Arica at 18° north, to Diego Ramirez Island at 56° south, and along the Strait of Magellan. The most easterly lighthouse is Punta Dungeness (52.23S, 68.25W) at the eastern entrance of the Strait of Magellan. Meteo-Chile hold 71 bound volumes, one from the 19th century, the other volumes dating from 1914. The Navy Meteo Service holds a further 35 sets of records from 1988 to 2008. The National Archive of the Administration holds three volumes of records for the lighthouse/met station at Caldera from 1868-1881, but there are likely to be many more at this Archive.

The transmission of information (in recent times) is for the meteorological observations, recorded on paper to be sent periodically to a central location locally. For instance the lighthouses in the eastern Straits of Magellan will transmit their records to Punta Arenas. These records are then sent to the Naval Meteorological Service in Valparaiso, thence to SHOA, and then Meteo-Chile in Santiago and ultimately to the National Archives of the Administration. On this basis, the National Archives of the Administration is a logical place to search for the lighthouse records prior to 1914 and the records between 1960 and 1988. This is an investigation (at 2010) that should be undertaken.

1.2 Lighthouse Records Format and Content

Only one example of 19th century lighthouse meteorological records has been seen and it is therefore not possible to say if this is typical of the format and content. The records from 1914 have a consistent format, except for the time of the observations. From 1914 to the mid 1920s, three daily sets of observations were made at 7am, 2pm and 9pm. After the mid 1920s and certainly by 1928, observations were made at 0700, 1300 and 2100 hours. By 1983, there were four daily observations at 0600, 1200, 1800 and 0000 hours. It has not yet been determined when the change of timings took place from three to four sets of daily observations. There are three slightly different formats corresponding to three distinct organizations performing meteorological services as outlined below.

Organization	Years	Times of observations
Instituto Central Meteorológico y Geofisico de Chile	1914-1922	7am, 2pm, 9pm
Servico de Meteorologia Agricola	1927-1928	7am, 2pm, 9pm
Oficina Meteorológica de Chile	1928-1940s+	0700, 1300, 2100
Oficina Meteorológica de Chile	1980s	0600, 1200, 1800, 0000

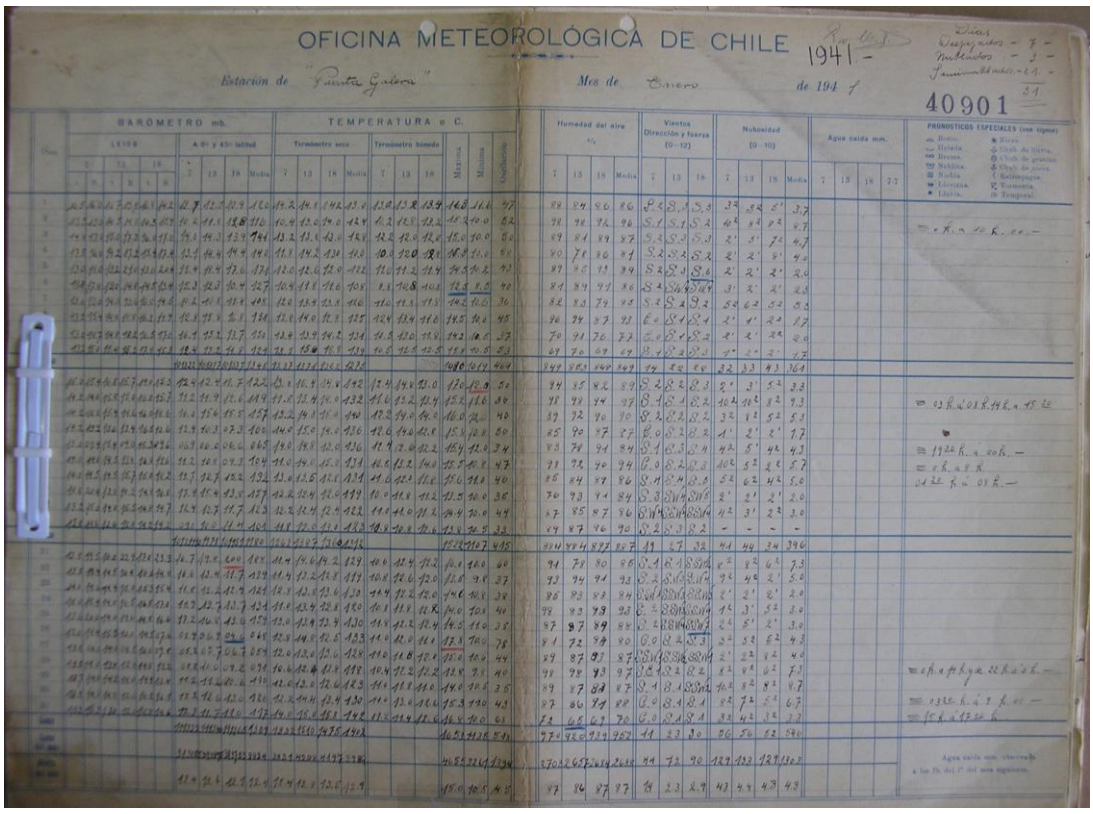


Instituto Central Meteorológico y Geofísico de Chile

Mes de Enero de 1922.

Estación de Punta Lavapié (H m) Latitud S Longitud W Cg

Meteorological Observations Punta Lavapié – January 1922



OFICINA METEOROLÓGICA DE CHILE 1941

Estación de "Punta Galera" Mes de Enero de 194 1

40901

Meteorological Observations Punta Galera January 1941

Apart from the observations being recorded at slightly different times, there are several other differences between the two formats illustrated above. The later format (1928 onwards – 1941 illustrated) has columns for both the barometer and the attached thermometer. These are the observations 'as read' (*leido*). There are also additional columns for corrections for temperature and latitude. The earlier format only records pressure observations, with no indication if these are 'as read' or corrected. The context therefore suggests that these earlier readings are uncorrected. The earlier format also records absolute and relative humidity, while the latter records wet and dry bulb observations. There are no differences in recording wind direction and force or clouds. The earlier format records daily rainfall while the latter records sub-daily rainfall at the same times as the other observations, with a total for the day.

2. The Logbooks - Format and Content

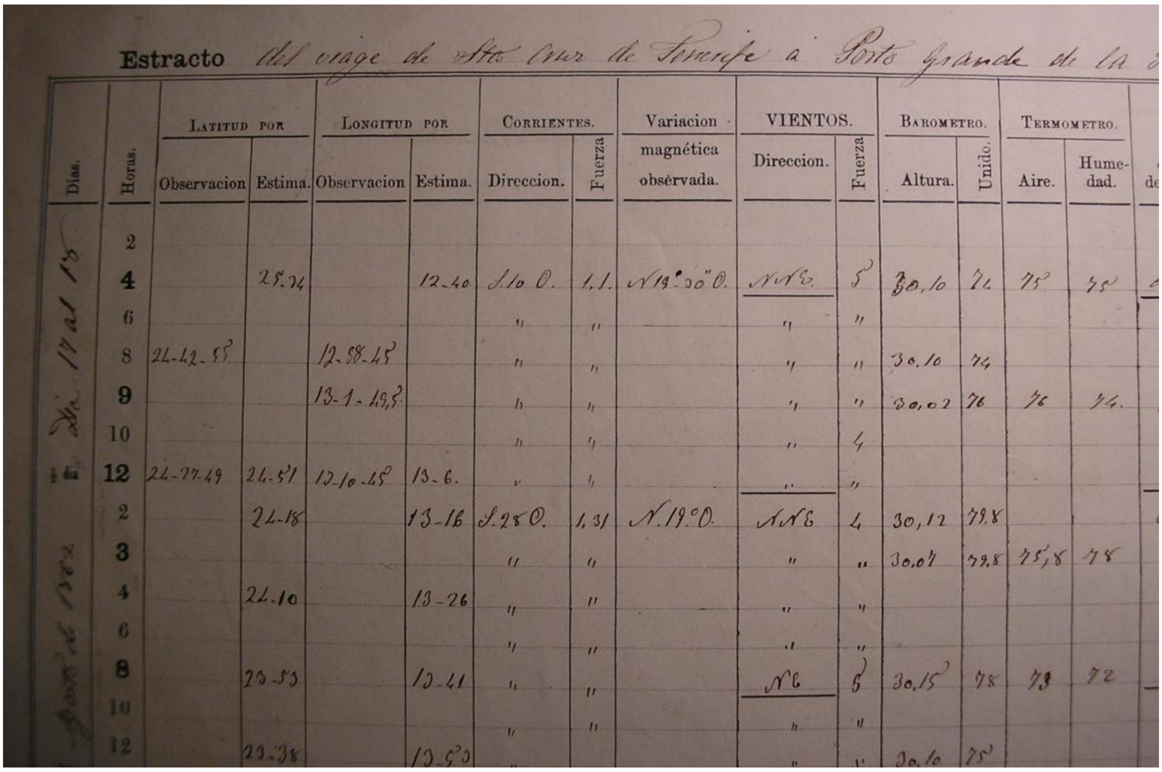
Marine journals and logbooks document the day-to-day events in the passage of a ship and are the ultimate primary record of a nation's maritime past. Deck logs and the navigational logbook in particular, document the daily positions and movements of the vessel, the weather conditions, the proximity of land, the expenditure or loss of material, the activities of the crew and any events worthy of remark. This detailed recording was necessary as officers were held accountable for the management and safe navigation of the vessels in their charge. Loss or damage to a vessel could be the subject of an official enquiry, a court martial or an insurance claim. Logbooks can therefore be considered legal documents and carry the corresponding weight and authority of all such documents held in state archives. They can be considered a true and faithful account.

Hundreds of millions of individual pieces of meteorological and oceanographic data have been recorded in the logbooks and journals of maritime nations from the earliest times to the present day and as such, they constitute an unsurpassed history of environmental conditions over the oceans for the past 300 years and more. All logbooks record wind direction and wind strength, usually descriptive, but later measured. From the late 18th century onwards logbooks frequently record air pressure and temperature and by the 1860s, sea surface temperature (SST). Logbooks also have observations of the strength and direction of currents, sea swell, incidents of rain, squalls storms and hurricanes or typhoons. Reports of icebergs, usually termed ice islands, and pack ice are common in higher latitudes. As such these records are of immeasurable value to climate scientists, and for decades have been the basis of studies of the marine climate in the past.

2.1. Spanish Logbooks in Chilean Archives

The logbooks found in the National Historical Archive in Santiago are, as noted above in section 1, almost exclusively Spanish and of a format not usually associated with regular deck logs. Similar examples were also found at the Naval and Maritime Museum in Valparaiso. These consist of pre-printed pages and the content suggests that they were

produced in this format as a response to the Brussels Conference of 1853. One particularly fine example from the Museum, dated 1862, is described on the cover as 'Estracto del Diario de Navegación' or abstract navigation Journal (see section 2 above). The data to be found in this type of journal is shown in the examples below. All three images are a detail of part of the page shown in section 2 above.

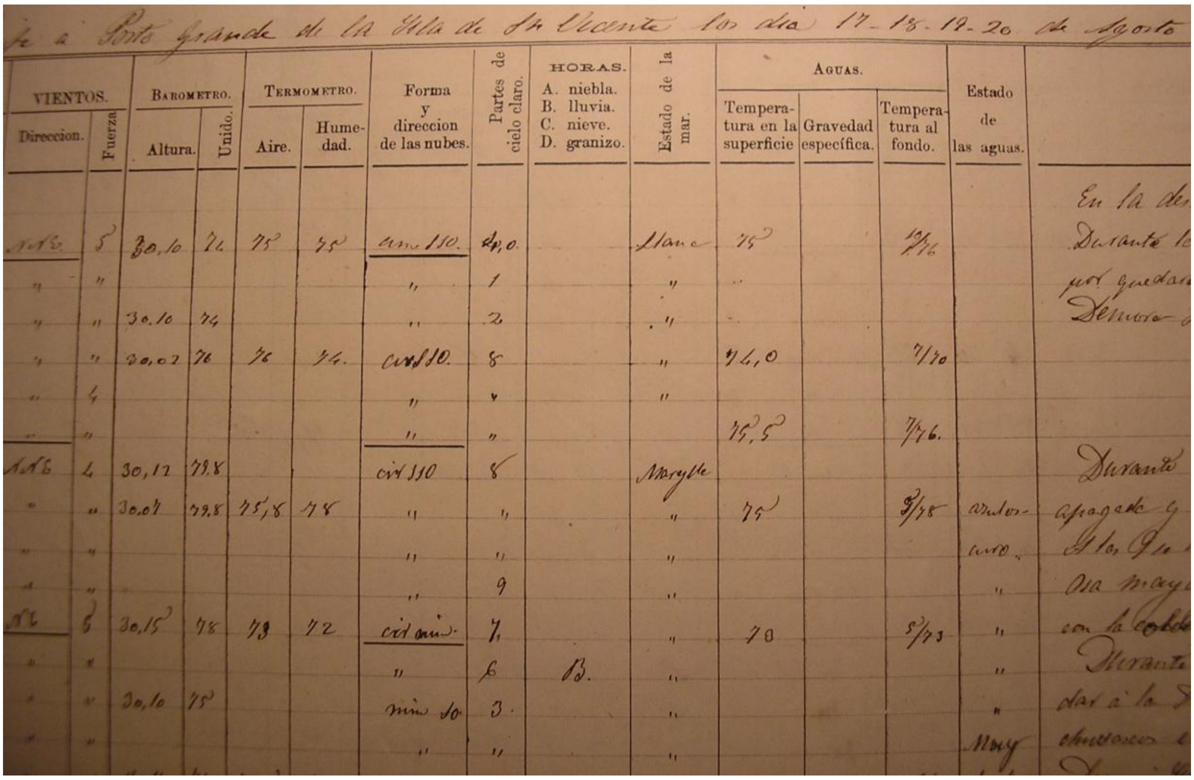


Estracto del viage de Sta Cruz de Tenerife á Porto Grande de la

Dias.	Horas.	Latitud por Observacion	Latitud por Estima.	Longitud por Observacion	Longitud por Estima.	Corrientes. Direccion.	Corrientes. Fuerza	Variacion magnética obsérvada.	Vientos. Direccion.	Vientos. Fuerza	Barometro. Altura.	Barometro. Unido.	Termometro. Aire.	Termometro. Humedad.
	2													
	4		25.24		12-40	S.10 O.	1.1.	N 13°30" O.	NNE.	5	30,10	72	75	75
	6					″	″		″	″				
	8	24-42-55		12-58-45		″	″		″	″	30.10	74		
	9			13-1-49,5		″	″		″	″	30,07	76	76	74.
	10					″	″		″	4				
	12	24-27-49	24.51	12-10-45	13-6.	″	″		″	″				
	2		24-18		13-16	S.28 O.	1,31	N.19°O.	NNE	4	30,12	77.8		
	3					″	″		″	″	30,07	77.8	75,8	78
	4		24.10		13-26	″	″		″	″				
	6					″	″		″	″				
	8		23-55		13-41	″	″		NE	6	30,15	78	73	72
	10								″	″				
	12		23.38		13-53	″	″		″	″	30.10	75		

Detail of left side of page - Spanish abstract navigation Journal 1862- Museo Naval y Maritimo, Valparaiso

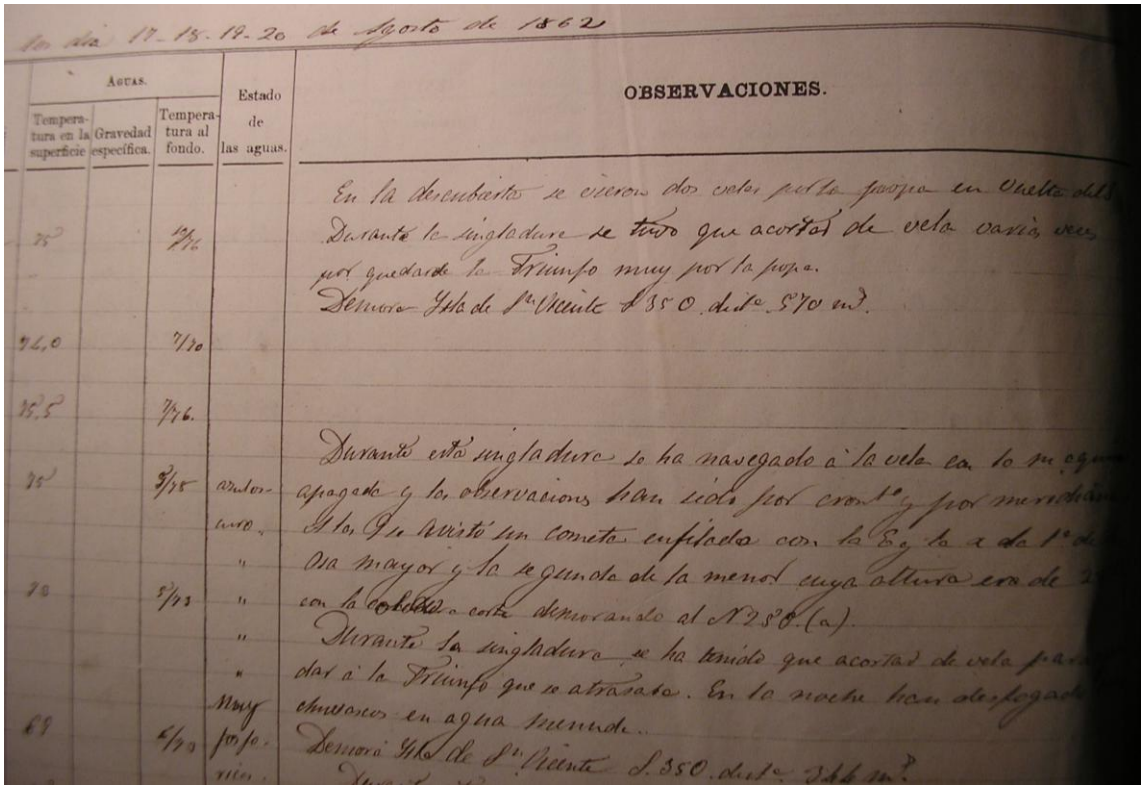
The section above shows the day ,hour, latitude and longitude (observed and estimated - NB. the prime meridian is the Naval Observatory, Cadiz, not Greenwich), current direction and force, magnetic variation, wind direction and force, barometric pressure and attached thermometer, air temperature and humidity.



Detail of centre section of page - Spanish abstract navigation Journal 1862
Museo Naval y Maritimo, Valparaiso

The section above shows wind direction and force, barometric pressure and attached thermometer, air temperature and humidity, type of cloud and direction (bearing from ship), amount of cloud cover, precipitation at a particular hour (*niebla*-fog, *lluvia*-light rain, *nieve*-snow, *granizo*-hail), sea state, sea surface temperature, specific gravity, (*temperatura al fondo*) sub-surface temperature, and (*estado de las aguas*) state of the waters (colour?).

The sub-surface sea temperatures column states a depth and temperature but the scale used for depth has not yet been determined. It is likely to be fathoms or the Spanish equivalent of the fathom. State of the water may indicate colour. The term '*claro*' or clear written in the lower part of the full logbook page suggests that this is the case.



Detail of right side of page - Spanish abstract navigation Journal 1862
Museo Naval y Maritimo, Valparaiso

The right-hand side of the page (above) shows the section for general observations or remarks. These remarks are not necessarily of a meteorological or oceanographic nature.

2.2. Chilean Logbooks

The Chilean naval logbooks are of mostly printed formats that vary slightly in layout over time but contain essentially the same information. Logbooks in both the National Archive and the Naval Museum are described using the terms outlined in the following table.

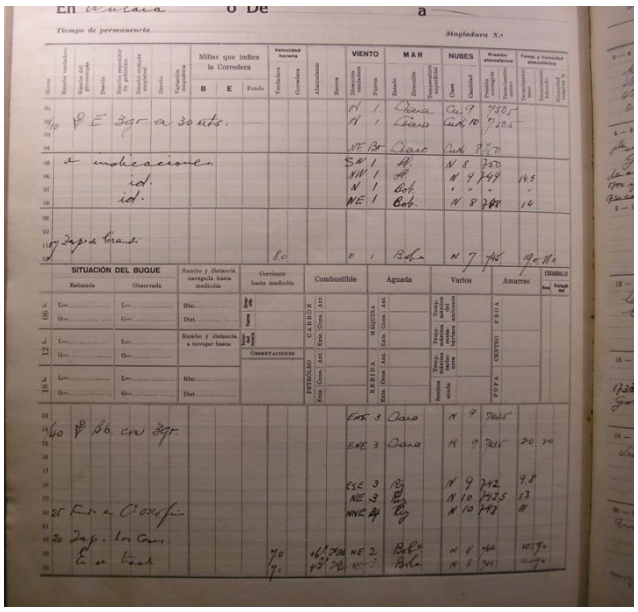
Chilean Document	English
Estracto del Diario de Navegación	Abstract Navigation Journal
Diario de Navegación	Navigation Journal
Diario del Mar	Sea Journal
Diario de Bitácora del Buque	Logbook
Bitácora	Logbook
Bitácora del Puerto	Port Logbook
Bitácora del Mar	Sea Logbook

Table 2

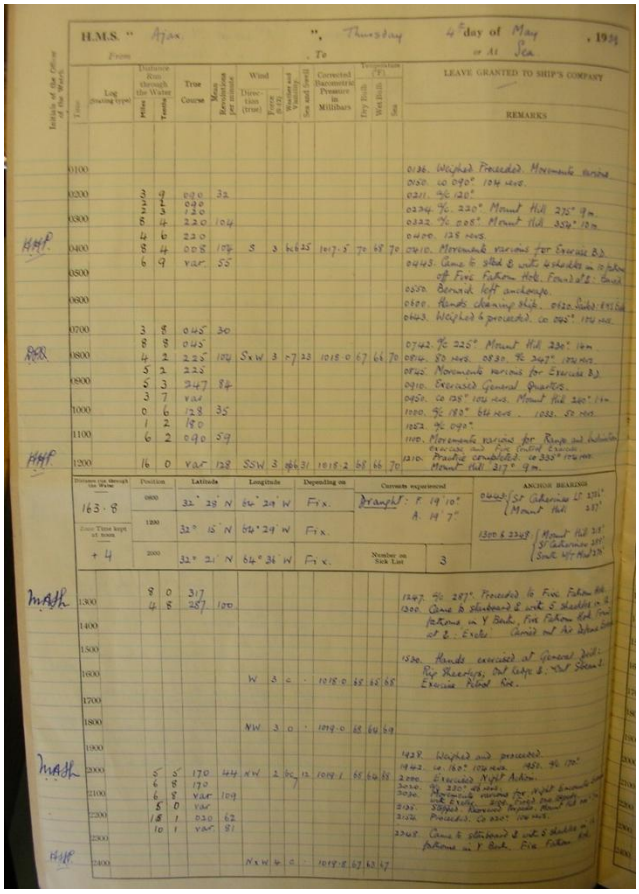
Timekeeping

All logbooks until about the late 1920s were kept according to the nautical day not the civil day. This means that the day, and the logbook page, commenced at 1pm and terminated at noon of the following day. The last entry in the logbook is therefore the noon observation.

The ‘remarks section’ or ‘Acaecimientos’ (occurrences) is double dated meaning that although the ship’s day runs from noon to noon, the dates according to the civil day are acknowledged. This double dating is a clear indication of a nautical day format. The civil day format of later logbooks from c. 1930 is similar to the format of British Royal Navy logbooks. Below are examples of the civil day format from the Chilean naval transport *Micalvi* and from the British cruiser HMS *Ajax.*



MICALVI - Transport 1935
Armada de Chile

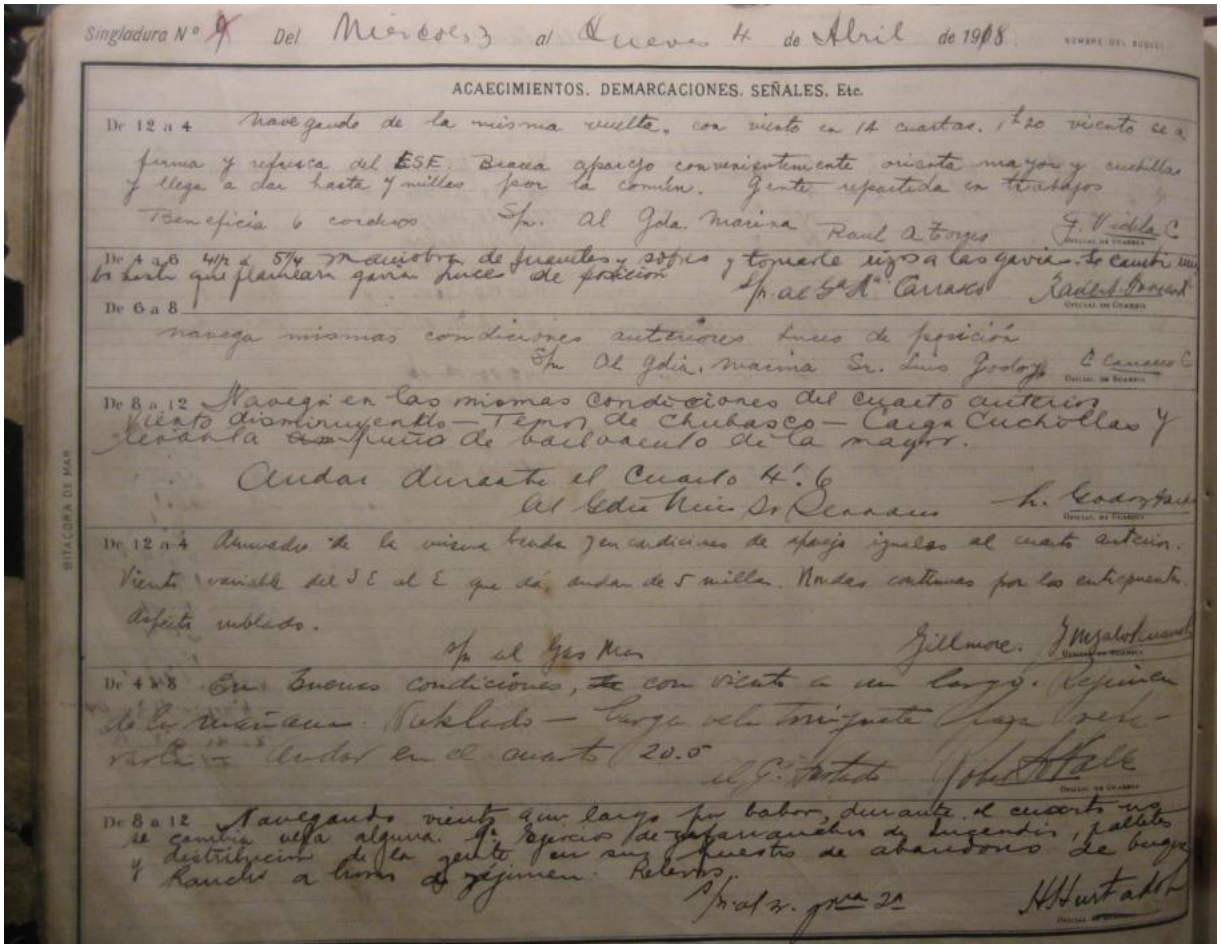


HMS *AJAX* – Cruiser 1939
Royal Navy

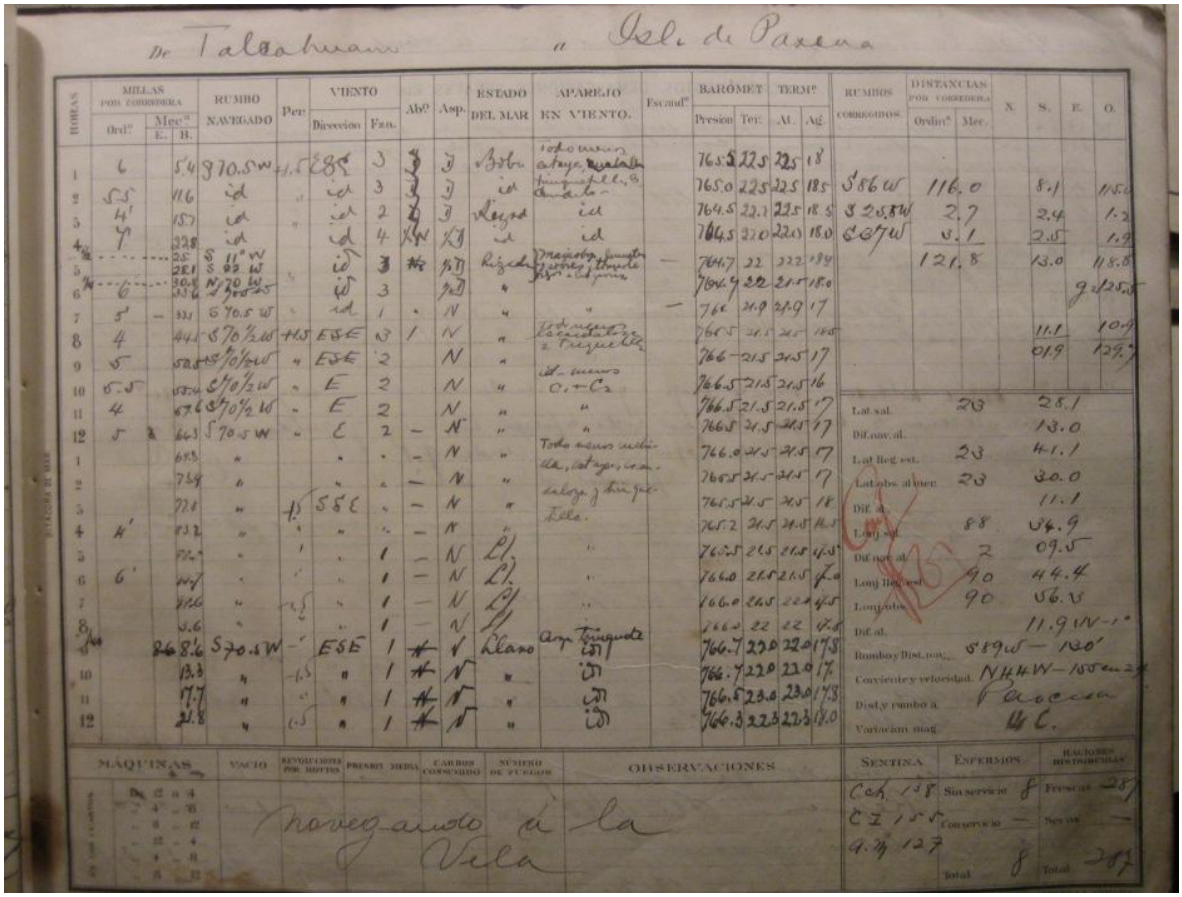
Navigation

It should be noted that the examples of Spanish journals held in both archives use the Naval Observatory at Cadiz as a zero meridian. All Chilean logbooks examined use the Greenwich meridian. The use of the Greenwich meridian was probably universal in Chile. The publication *Faros de Chile* (Lighthouses of Chile) No. 1, issued by the Ministerio de Marina, Santiago in October 1857 gives the longitude of lighthouses according to the Greenwich meridian. (UK National Archives: ADM 172/2)

The following images are from the logbook of the corvette (corbeta) General Baquedano, used by the Chilean Navy as a training ship (buque escuela), the first page contains the '*acaecimientos'* or occurrences, the second page presents the tabulated navigational and meteorological data. Note that in most logbooks the order of '*acaecimientos*' and tabulated data is reversed with the latter on the left-hand page.



Left-hand facing page of Logbook – *General Baquedao* 1918.



Right-hand facing page of Logbook *General Baquedano* 1918

The tables below represent sections of the page above, being a typical logbook page containing tabulated data. Each box shows a section of the logbook page concerned with navigation and meteorology. The Spanish terms are translated into English. Where there is doubt, '?' indicates that an explanation is to be sought. The pages of earlier logbooks do not greatly differ and many of the same headings can be found.

	Millas por Corredera			Rumbo Navegado	Per.
Horas	Ord[a]	Mec[a]			
		E.	B.		
	Miles for Log			Course	?
Hour	Ordinary Log	Patent Log			
		E.	B.		

Table 3A

A) **Top-left corner of the page.** This section lists the courses and distance made in each hour from 1pm. The final entry is for noon. The patent log is a mechanical log recording speed as opposed to the ordinary hand-held log and line. 'E.' is miles in

that hour and 'B.' a running total. Note that in the example page, the ordinary log is cast and recorded as well as the running total from the patent log. In most cases the two are roughly the same.

Rumbos Corregidos	**Distancias** por Corredra					
	Ordin[a]	**Mec**	**N**	**S**	**E**	**O**
Course Corrected	**Distance** for Log					
	Ordinary Log	**Patent Log**	**N**	**S**	**E**	**W**

Table 3B

B) Top-right corner of the page (This section is for the calculation of the ship's position by dead reckoning. The list of courses (corrected for magnetic variation) with the number of miles each hour, provide the number of miles of northing, southing easting or westing achieved during the preceding 24 hour period. The figures are then used to resolve a series of right triangles. Connecting the start and end points provides an estimate of the course and distance made good in the past 24 hours. This can then be transferred to a chart and the estimated latitude and longitude determined.

C)

Term	**English**
Lat. Sal	Departure Latitude (previous day)
Dif.nav.al	Difference in latitude
Lat lleg. est	Estimated latitude
Lat. Obs. Al mer	Observed latitude
Dif. Al.	Difference of estimated and observed
Lonj. Sal	Departure Longitude (previous day)
Dif. Nav.al	Difference in longitude
Lonj.lleg. est	Estimated longitude
Lonj. Obs.	Observed longitude
Dif. Al.	Difference of estimated and observed
Rumbo y Dist. Nav	Course made good
Corriente y velocidad	Direction and speed of current
Dist y rumbo a	Distance and bearing to …
Variacion mag.	Magnetic Variation

Table 3C

D) Right-centre of page This section provides the noon positions derived from B above.
1. The entries for 'Lat sal' and 'Lonj sal', or the previous noon position, are always the observed latitude and longitude of the previous day where entered.
2. The 'Dif nav al' is always the estimated difference in latitude or longitude over the previous day's observed position to produce a new estimate.

3. 'Dif al' is the difference between the new estimated and new observed positions.
4. ' Lat Obs. Al mer and Lonj Obs.' are observed latitude and longitude. All positions are expressed in degrees and minutes and tenths of a minute for example, 29° 47.2N
5. 'Rumbo y Dist. Nav' or course and distance made good (over the preceding day's position) is noted as degrees of a circle but expressed as a quadrant. So N25W 163 would be 25 degrees west of north (or a course of 335°) and 163 nautical miles This would be a true bearing as it is the course as applied to a chart. This type of course notation is the same as is commonly found in British logbooks up until the early 20th century.
6. 'Corriente y velocidad' or direction and speed of current uses the same notation as the course, with a variety of methods of recording speed but usually clearly expressed as miles in 24 hours. It is assumed that the direction is magnetic
7. 'Dist y rumbo a' or distance and bearing to. Example: Pascua S83W. Easter Island 263°.
8. 'Variacion mag' or magnetic variation can be expressed in the same notation as other bearings such as N15E but more commonly just as 15E or 15 degrees of easterly variation.

Table 3D - The Observations

Viento		Ab°	Asp.	Estado del Mar	Aparejo en Viento	Escand°	Baromet		Term°	
Dirección	Fza						Presion	Ter.	At	Ag
Wind		**Leeway**	**Aspect**	**Sea State**	**Sails set**	**?**	**Barometer**		**Thermometer**	
Direction	**Force**						Pressure	Therm.	Air	Sea

E) This section covers most of the page with the potential for hourly observations starting at 1pm, and with the last entry at noon.

1. The wind directions are given as standard compass points. The winds are uncorrected for magnetic variation. Note that by the 1930s and probably by the mid 1920s, as with British Royal Navy logbooks, wind directions are then recorded as true. The example of the *Micalvi* logbook page illustrated above with HMS *Ajax* shows wind directions as true (dirección verdadera).
2. Wind forces are according to the standard Beaufort Scale. The scale was in common use in the 1870s and probably earlier.

Sistema Beaufort 1870-1920		Sistema Beaufort 1921-	Metros por Segundo (1921)
0	Indica calma	Calma	1.03
1	Ventolina para gobernar	Ventolina	3.60
2	Viento mui flojo	Flojo	5.66
3	Viento flojo	Bonancible	8.23
4	Viento bonancible	Galeno	10.29
5	Viento fresquito	Fresquito	12.86
6	Viento fresco	Fresco	14.92
7	Viento frescachon	Frescachon	18.00
8	Viento duro	Duro	21.61
9	Viento mui duro	Muy Duro	25.21
10	Temporal	Temporal	29.32
11	Borrasca	Temporal	33.95
12	Huracan	Huracan	40.64

Table 3D/1

3. Column AB^{o} represents the word *abatimiento* lateral deviation or leeway.
4. Column Asp. Represents the word *aspecto.* The full word rather than the abbreviation is used in some earlier logs, for example the *Baquedano* 1901. The term *aspecto del cielo* is used in the logbook for the Baquedano 1908, meaning aspect or state of the sky. The column is usually filled with letters denoting a coding such as, D, N, Dp, Np and N_2. In later logbooks D is defined as *despejado* or clear and N as *nublado* or cloudy
5. Estado del Mar is sea state. Sea state descriptors were in general use from the 1870s and probably before this. The terms used from this time and at least until the late 1940s are outlined below with an English translation according to the description given in the instructions for completing the log. There was apparently no equivalent of the Douglas Scale used by the Chilean Navy up until c. 1950.
6.

Sea State Descriptors	
Llana	Flat
Cabrilleo	Ripples, small waves
Rizada	Small wind formed waves, choppy
Marullo	Larger waves
Boba	Heavy confused sea
Arbolada	Large waves with wind-blown crests
Gruesa	Violent sea

Table 3D/2

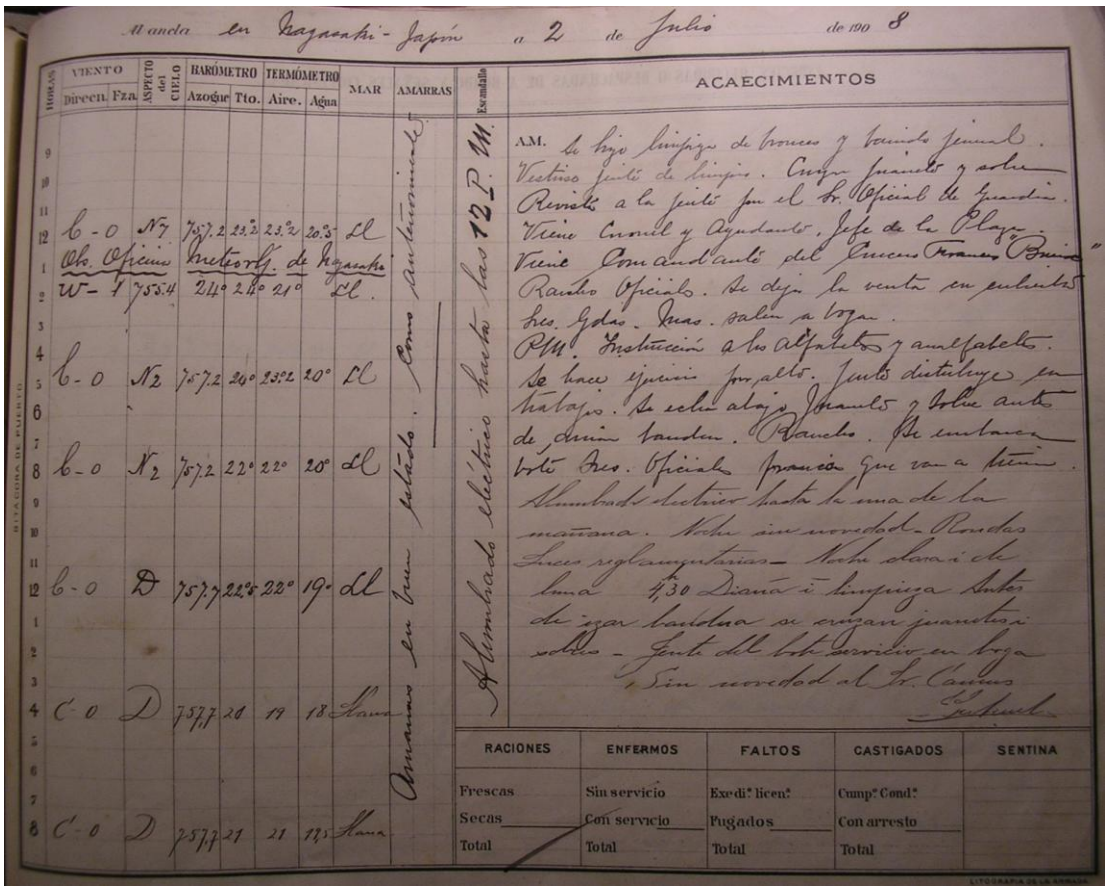
7. Aparejo en Viento. This column indicates which sails were set. In the case of the *Baquedano* log of 1918 it is frequently filled with the term 'vapor' or steam meaning the vessel was under steam propulsion. *Baquedano* used a combination of sail and steam.
8. Escand^{o}. This is likely to be an abbreviation of *escandallo*, a sounding instrument meaning that the column is used to record soundings or the depth of water below the ship. Logbooks of most other nations record this information under 'remarks' and the column only appears in Chilean logs in the first decades of the 20th century.
9. The remaining 4 columns record barometric pressure, attached thermometer, air temperature and sea temperature. At present the types of buckets used to draw water from the sea have not been determined. A variety of units for pressure and temperature were used over the period 1860s-1940s and these are outlined in table 4 using specific vessels as examples. The type and frequency of observation is also noted.

Table 4 - LOGBOOK DATA CHARACTERISITICS

YEAR	SHIP	Nat.	BP	AT	SST	Sub-Daily	Daily Frequency	Pressure Units	Temp Units	Movements	Notes
1861	**Princessa de Asturias**	Spain	1	1	0	0	Daily at noon	Inches	Far.	Spain to SE Pacific	Nautical day
1862	**Blanca**	Spain	1	1	0	0	Daily at noon	Inches	Far.	Spain to SE Pacific	Nautical day
1867	**Covadonga**	Chile	1	1	0	1	4 x	Centimtrs	Far.	Valparaiso	Nautical day
1874	**Chacabuco**	Chile	1	1	0	1	6 x	Inches	Cent.	Punta Arenas	Nautical day
1876	**Esmeralda**	Chile	1	1	1	1	6 x	Inches	-	Valparaiso, Lota, Punta Arenas, Straits of Magellan, Punta Arenas	Nautical day
1879	**Magallenes**	Chile	1	1	1	1	6 x	Inches	Far	Valparaiso and North	Nautical day
1883	**Amazonas**	Chile	1	1	0	1	6 x	Inches	Far.	Chimbote, Callao	Nautical day, Aneroid barometer,
1883	**Huascar**	Chile	1	1	0	1	6 x	Centimtrs	Cent.	Anchored in Callao, Peru	Nautical day
1901	**General Baquedano**	Chile	1	1	1	1	6 x	Millimtrs	Cent.	Valparaiso	Nautical day
1908	**Baquedano**	Chile	1	1	1	1	6x	Millimtrs	Cent.	Valparaiso, Tahiti, Yokohama, Nagasaki, Shang-hai	Nautical day
1916	**Blanco Encalada**	Chile	1	1	1	1	6 x	Millimtrs	Cent.	Valparaiso and Punta Arenas	Nautical day
1918	**Baquedano**	Chile	1	1	1	1	24 x	Millimtrs	Cent.	Valparaiso, Talcahuano, San Felix, Isla de Pascua (Easter Island), Honolulu, Yokohama, Kobe	Nautical day
1921	**Chacabuco**	Chile	1	1	0	1	12 x	Millimtrs	Cent.	At anchor in Valparaiso	Nautical day
1935	**Micalvi**	Chile	1	1	0	1	6 x	Millimtrs	Cent.	Not determined	Civil day
1948	**Sibbald**	Chile	1	1	0	1	24 x	millibars	Cent	Not determined	Civil day

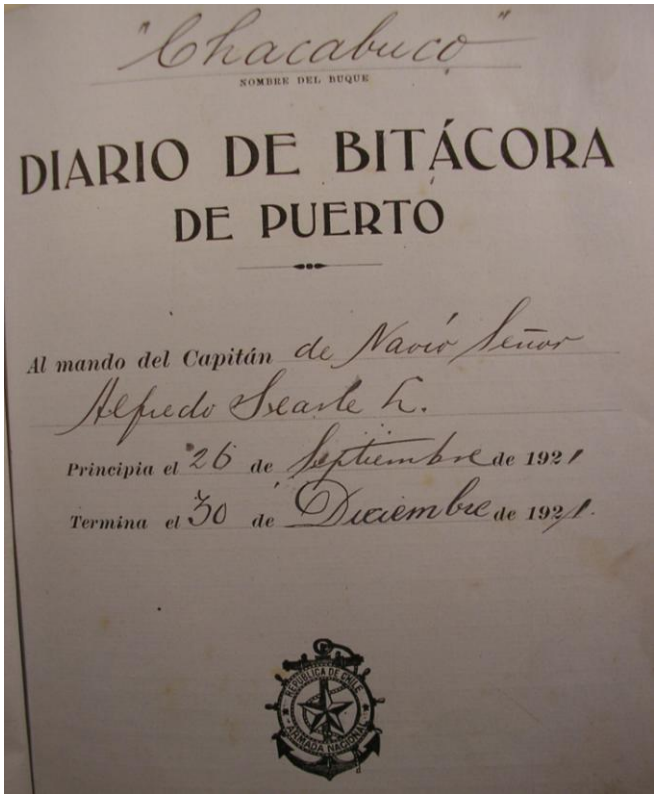
Port Logbooks

Many of the logbooks are clearly marked on the cover Bitácora del Mar or Bitácora del Puerto. It is relatively easy therefore to distinguish the sea and port logs. Some logbooks are a combination of port and sea and this is also marked on the cover. The port logbooks examined contained pressure and air temperature data with a few recording SST. Port logbooks will provide an opportunity to compare the observations of different vessels with each other and from the fixed terrestrial data from the port or a more particularly the lighthouse data once this is located.



Port Logbook of *General Baquedano*, anchored at Nagasaki, 2 July 1908

Data elements at four-hourly intervals consist of wind direction and force, state of the sky, barometric pressure, attached thermometer, air temperature, sea temperature and sea state.



"Chacabuco"

NOMBRE DEL BUQUE

DIARIO DE BITÁCORA DE PUERTO

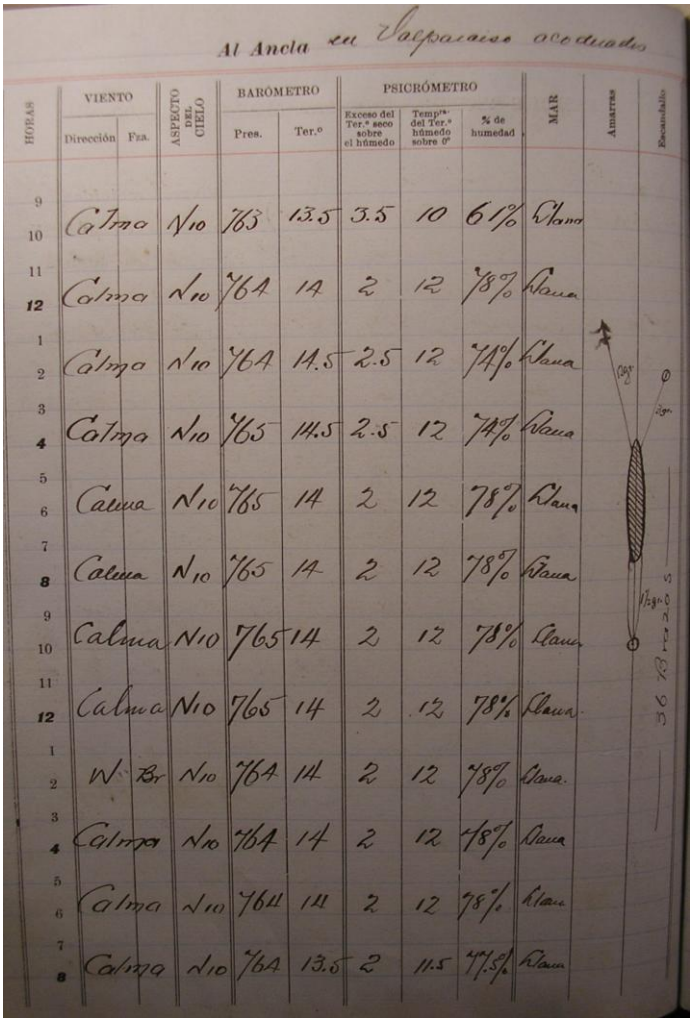
Al mando del Capitán de Navío Señor Alfredo Searle L.

Principia el 26 de Septiembre de 1921

Termina el 30 de Diciembre de 1921.

Port Logbook of the Cruiser ***Chacabuco*** September-December 1921, Valparaiso

Two-hourly data elements:
Wind direction and force
State of the sky
Barometric pressure
Attached thermometer
Psycrometer (temperature)
Humidity
State of the sea



Al Ancla en Valparaiso acostado

HORAS	VIENTO Dirección	VIENTO Fza.	ASPECTO DEL CIELO	BARÓMETRO Pres.	BARÓMETRO Ter.°	PSICRÓMETRO Exceso del Ter.° seco sobre el húmedo	PSICRÓMETRO Temp.ª del Ter.° húmedo sobre 0°	PSICRÓMETRO % de humedad	MAR	Amarras	Escandallo
9	Calma		N10	765	13.5	3.5	10	61%	Llana		
10											
11	Calma		N10	764	14	2	12	78%	Llana		
12											
1	Calma		N10	764	14.5	2.5	12	74%	Llana		
2											
3	Calma		N10	765	14.5	2.5	12	74%	Llana		
4											
5	Calma		N10	765	14	2	12	78%	Llana		
6											
7	Calma		N10	765	14	2	12	78%	Llana		
8											
9	Calma		N10	765	14	2	12	78%	Llana		
10											
11	Calma		N10	765	14	2	12	78%	Llana		
12											
1	W. Br		N10	764	14	2	12	78%	Llana		
2											
3	Calma		N10	764	14	2	12	78%	Llana		
4											
5	Calma		N10	764	14	2	12	78%	Llana		
6											
7	Calma		N10	764	13.5	2	11.5	77.5%	Llana		
8											

Meta Data – Chilean Logbooks

The logbooks contain a page describing the vessel in some detail. This includes the name of the commanding officer, date and place of the vessel's construction, dimensions and tonnage, armament, engines, boilers, fuel capacity (coal), and often information on the compass and corrections for compass deviation. There are frequently instructions on completing the log with general notes on making meteorological observations. These are presently awaiting translation. There was no record found in the examples viewed of any instrument meta data, whether instrument type, location or height above sea level. Enquiries with MeteoChile and the Armada de Chile are on-going to determine if records exist for the issuing and positioning of instruments for navy vessels.

2.3. British Royal Navy Logbooks Eastern Pacific 1790-1913 – Format and Content

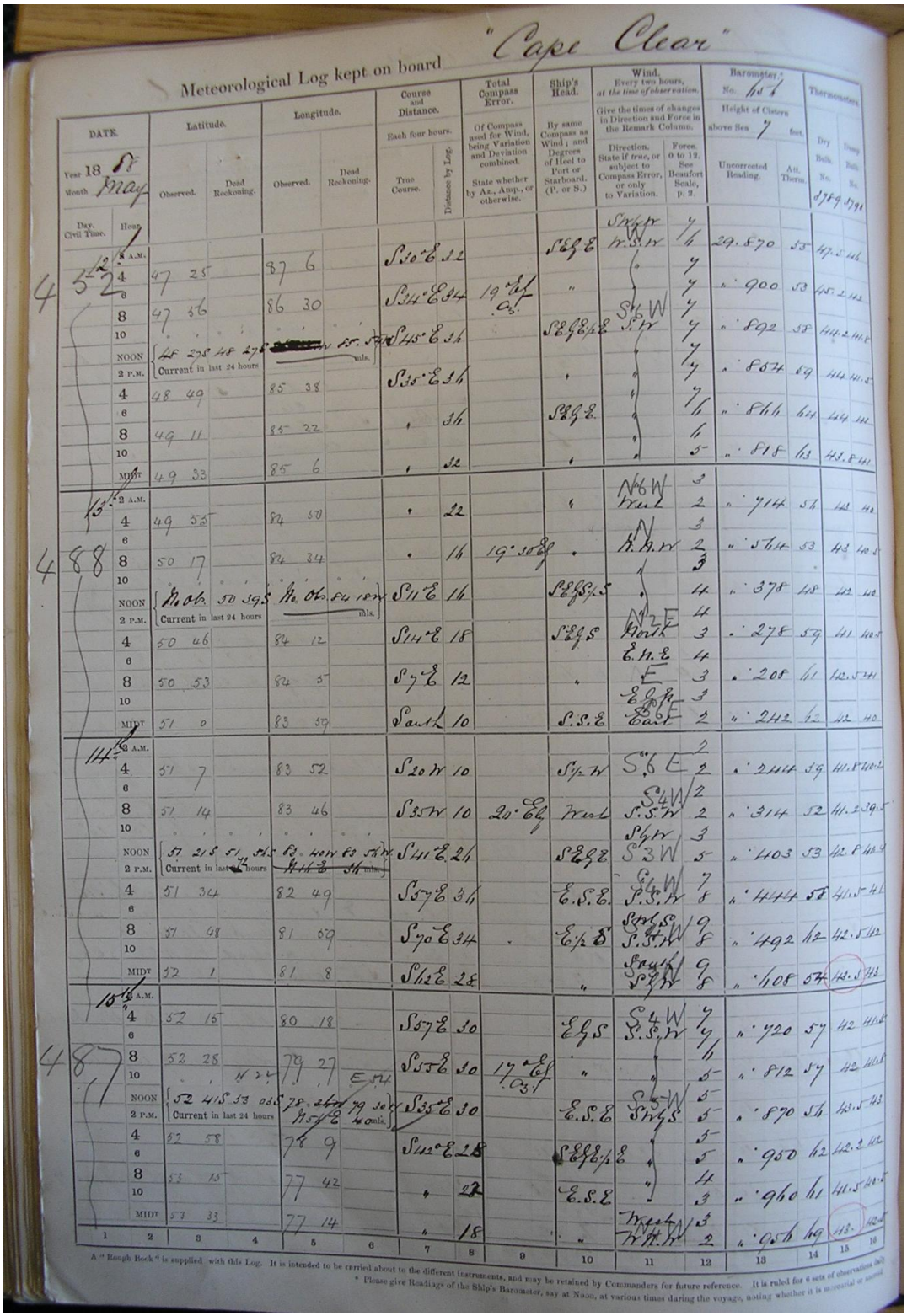
Details about the format and content of British logbooks, can be found in two reports: *British Logbooks in UK Archives 17th –19th Centuries* and *British Logbooks in UK Archives 20th Century*. Both reports are available at **http://icoads.noaa.gov/reclaim**.

Before about 1845-1850, there is no certainly that a typical British Royal Navy logbook will contain pressure or air and sea temperature observations. However may of those vessels that sailed to the Pacific did record these instrumental observations due to the nature of their voyage, which frequently involved exploration and hydrographic survey. During the 1820s and 1830s, the number of vessels visiting the eastern Pacific grew steadily and by January 1846, with the establishment of HMS *Nerus* as a base ship at Valparaiso, the Royal Navy had a continuous presence in the eastern Pacific for the remainder of the century. It should be noted however that the number of vessels station in the eastern Pacific declined from the early to mid 1880s, to just a handful of vessels by the turn of the 20th century. Below is a summary of the type of meteorological and oceanographic data recorded in the 19th century logbooks.

- Air temperature and pressure data will be found in all logbooks after 1850 and in the Pacific in most logbooks after 1820.
- Sea surface temperature was recorded by 1870 and possibly earlier in the mid 1860s.
- Wind force was recorded according to the Beaufort Scale
- Weather was recorded according to a lettered scheme from c. 1850s
- Wind directions were magnetic until c. 1920
- By the 1870s, observations were made at 4, 8 and 12, am and pm by regulation and more frequently in stormy weather
- Type, maker and position of instruments was cited in logbooks from the 1890s
- Sea state was consistently recorded from 1890s

It should be noted that there are also remark books and some meteorological registers for Royals Navy ships in the eastern Pacific in the 19th century.

2.4. 19th century British Meteorological Logs and Weather Books for the Southern Pacific: Format and Content



Meteorological Log kept on board "Cape Clear"

DATE. Year 18 88 Month May Day. Civil Time. Hour.	Latitude. Observed.	Latitude. Dead Reckoning.	Longitude. Observed.	Longitude. Dead Reckoning.	Course and Distance. Each four hours. True Course.	Course and Distance. Each four hours. Distance by Log.	Total Compass Error. Of Compass used for Wind, being Variation and Deviation combined. State whether by Az., Amp., or otherwise.	Ship's Head. By same Compass as Wind; and Degrees of Heel to Port or Starboard. (P. or S.)	Wind. Every two hours, at the time of observation. Give the times of changes in Direction and Force in the Remark Column. Direction. State if true, or subject to Compass Error, or only to Variation.	Wind. Force. 0 to 12. See Beaufort Scale, p. 2.	Barometer. No. 64 Height of Cisterns above Sea 7 feet. Uncorrected Reading.	Barometer. Att. Therm.	Thermometers. Dry Bulb. No.	Thermometers. Wet Bulb. No.
12 8 A.M.														
4	47 25		87 6		S 30° E	32		S 8 E						
6														
8	47 16		86 30		S 34° E	34	19° Ef	"						
10								S 8 E						
NOON	46 29	48 27			S 45° E	36								
2 P.M.	Current in last 24 hours			mls.										
4	48 49		85 38		S 35° E	36								
6														
8	49 11		85 32			36		S 8 E						
10														
MIDT	49 33		85 6			32								
13 2 A.M.														
4	49 55		84 50			22								
6														
8	50 17		84 34			16	19° 58f							
10														
NOON	No. 06. 50 39.5		No. 06. 84 18W		S 11° E	16		S 8 E						
2 P.M.	Current in last 24 hours			mls.										
4	50 46		84 12		S 14° E	18		S 8 E						
6														
8	50 53		84 5		S 7° E	12		"						
10														
MIDT	51 0		83 57		Sault	10		S.S.E						
14 6 A.M.														
4	51 7		83 52		S 20 W	10		S 1/2 W						
6														
8	51 14		83 46		S 35 W	10	20° Eg	Mast						
10														
NOON	51 21 51 [illegible]		83 40W 83 [illegible]		S 41° E	24		S 8 E						
2 P.M.	Current in last [illegible] hours		[illegible]	mls.										
4	51 34		82 49		S 57 E	34		E.S.E.						
6														
8	51 48		81 59		S 70 E	34		E 1/2 S						
10														
MIDT	52 1		81 8		S 42 E	28		"						
15 8 A.M.														
4	52 15		80 18		S 57 E	30		E by S						
6														
8	52 28		79 27		S 55 E	30	17° Ef	"						
10		N 24		E 54										
NOON	52 41.5 53 03.5		78 24W 79 30		S 35° E	30		E.S.E						
2 P.M.	Current in last 24 hours		[illegible]	4 mls.										
4	52 58		78 9		S 42° E	28		S 8 E 1/2 E						
6														
8	53 15		77 42			28		E.S.E						
10														
MIDT	53 33		77 14			18								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

A "Rough Book" is supplied with this Log. It is intended to be carried about to the different instruments, and may be retained by Commanders for future reference. It is ruled for 6 sets of observations [illegible]

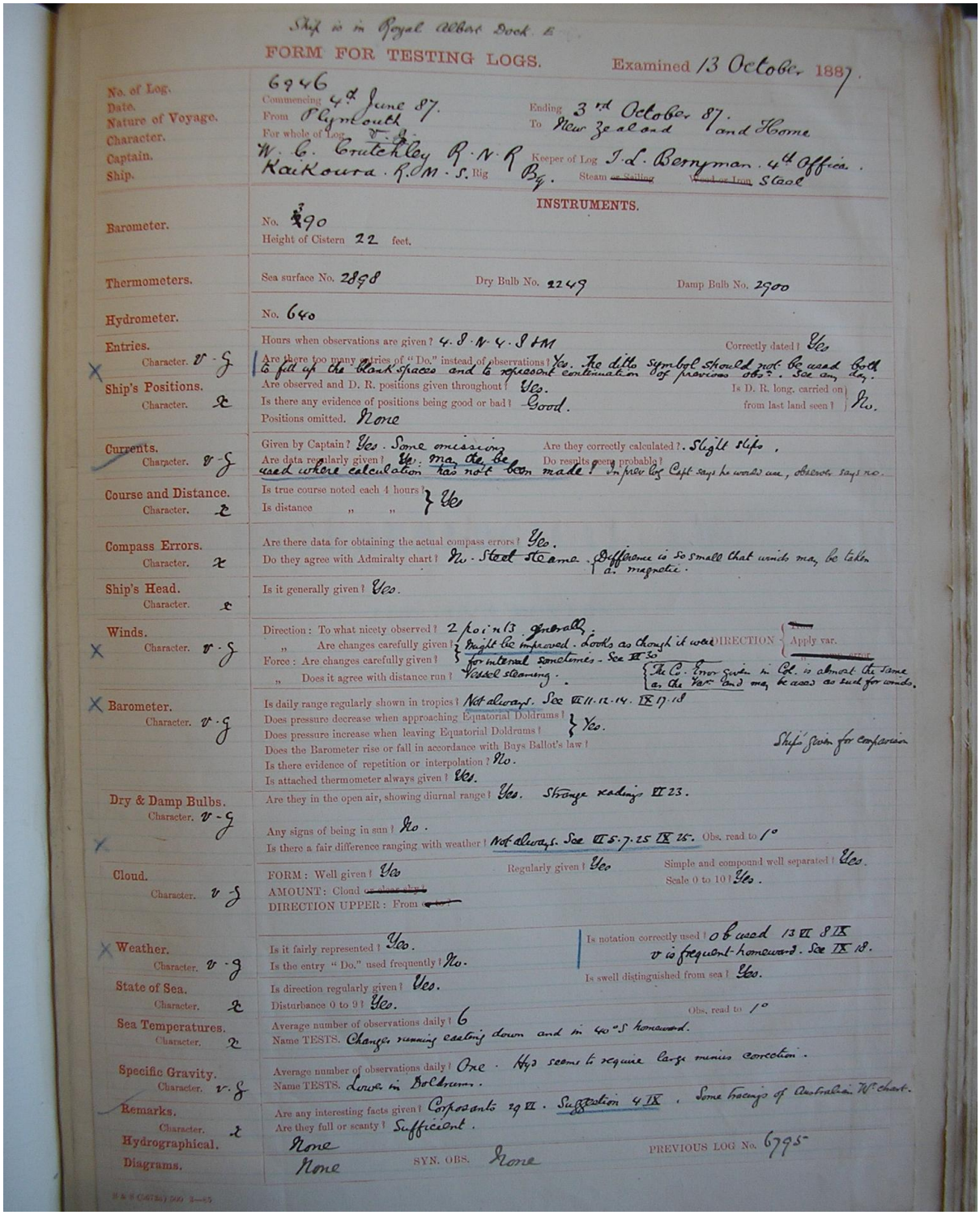
* Please give Readings of the Ship's Barometer, say at Noon, at various times during the voyage, noting whether it is [illegible]

Meteorological log of the Barque Cape Clear, May 12-15, 1888 (left-hand page)

The meteorological register (as illustrated above), sometimes referred to as a weather book, contains detailed tabular data, recorded on pre-printed pages at two-hourly intervals under the following headings

Date and Hour	Attached thermometer
Latitude by observation and dead reckoning	Dry and wet bulb temperature
Longitude by observation and dead reckoning	Clouds upper and lower
Course and distance	Proportion of the sky clouded
Total compass error	Direction of swell
Direction of ship's head	Sea disturbance (scale 0-9)
Wind direction and force	Sea temperature
Barometric pressure (uncorrected and with height of cistern)	Remarks

The registers contain copious metadata concerning the instruments, usually type and number, position, height above sea level, etc. The necessary correction to be applied to the observations was frequently recorded. Additionally, many of the registers include a 'Form for Testing Logs', a quality control document produced in the 19th Century for each log, by the Meteorological Office. The form for the RMS steamer *Kaikoura* in 1887, is reproduced below. The criteria used to evaluate the registers could be applied with advantage to the assessment of other logbooks for quality of observation.



Ship is in Royal Albert Dock. E

FORM FOR TESTING LOGS. Examined 13 October 1887.

No. of Log. 6946
Date. Commencing 4th June 87. Ending 3rd October 87.
Nature of Voyage. From Plymouth To New Zealand and Home
Character. For whole of Log
Captain. W. C. Crutchley R.N.R Keeper of Log J. L. Berryman. 4th Officer.
Ship. Kaikoura. R.M.S. Rig Bq. Steam or Sailing Vessel or Iron Steel

INSTRUMENTS.

Barometer. No. 390
Height of Cistern 22 feet.

Thermometers. Sea surface No. 2898 Dry Bulb No. 2249 Damp Bulb No. 2900

Hydrometer. No. 640

Entries. Character. V-G
Hours when observations are given? 4.8.N.4.8 PM Correctly dated? Yes
Are there too many entries of "Do." instead of observations? Yes. The ditto Symbol should not be used both to fill up the blank spaces and to represent continuation of previous obs?. See any day.

Ship's Positions. Character. E
Are observed and D. R. positions given throughout? Yes. Is D. R. long. carried on from last land seen? Yes.
Is there any evidence of positions being good or bad? Good.
Positions omitted. None

Currents. Character. V-G
Given by Captain? Yes. Some omissions Are they correctly calculated?. Slight slips,
Are data regularly given? Yes. may be be used where calculation has not been made? In prev log Capt says he works out, Observer says no.

Course and Distance. Character. E
Is true course noted each 4 hours? Yes
Is distance " "

Compass Errors. Character. E
Are there data for obtaining the actual compass errors? Yes.
Do they agree with Admiralty chart? No. Steel steamer. Difference is so small that winds may be taken as magnetic.

Ship's Head. Character. E
Is it generally given? Yes.

Winds. Character. V-G
Direction: To what nicety observed? 2 points generally.
" Are changes carefully given? Might be improved. Looks as though it were for interval sometimes - See IX 20
Force: Are changes carefully given? Vessel steaming.
" Does it agree with distance run?
DIRECTION Apply var.
The C. Error given in Col. 12 almost the same as the Var and may be used as such for winds.

Barometer. Character. V-G
Is daily range regularly shown in tropics? Not always. See VI 11.12.14. IX 17.18
Does pressure decrease when approaching Equatorial Doldrums? Yes.
Does pressure increase when leaving Equatorial Doldrums?
Does the Barometer rise or fall in accordance with Buys Ballot's law?
Is there evidence of repetition or interpolation? No.
Is attached thermometer always given? Yes.
Ship's Sea for Comparison

Dry & Damp Bulbs. Character. V-G
Are they in the open air, showing diurnal range? Yes. Strange reading VI 23.

Any signs of being in sun? No.
Is there a fair difference ranging with weather? Not always. See VI 5.7.25 IX 25. Obs. read to 1°

Cloud. Character. V-G
FORM: Well given? Yes Regularly given? Yes Simple and compound well separated? Yes.
AMOUNT: Cloud ~~or clear sky~~ Scale 0 to 10? Yes.
DIRECTION UPPER: From ~~clear~~

Weather. Character. V-G
Is it fairly represented? Yes.
Is the entry "Do." used frequently? No.
Is notation correctly used? Ob used 13 VI 8 IX
V is frequent homeward. See IX 18.
Is swell distinguished from sea? Yes.

State of Sea. Character. E
Is direction regularly given? Yes.
Disturbance 0 to 9? Yes.

Sea Temperatures. Character. E
Average number of observations daily? 6 Obs. read to 1°
Name TESTS. Change running easting down and in 40°S homeward.

Specific Gravity. Character. V-G
Average number of observations daily? One. Hyd seems to require large minus correction.
Name TESTS. Lower in Doldrums.

Remarks. Character. E
Are any interesting facts given? Corposants 29 VI. Suggestion 4 IX. Some tracings of Australian W^d chart.
Are they full or scanty? Sufficient.

Hydrographical. None
Diagrams. None SYN. OBS. None PREVIOUS LOG No. 6795

Form for Testing Logs – *Kaikoura,* Royal Mail Steamer, 1887

C. Summary Observations and Recommendations (provisional)

Chilean Logbooks

Logbooks of Chilean vessels at sea are marked on the cover as such. There are many very fine examples but there are also a significant number of vessels making coasting journeys

without recording position or giving a bearing and distance to a landmark. These vessels did record regular meteorological observations although the lack of positional data is of some concern. This can be overcome by a program that would take the start and end point of the voyage with input of course and speed, thereby estimating the ship's position at any hour of the day. This additional task would have to weigh the value of the meteorological data against the additional work involved in the input of sub-daily course and speed.

Other logbooks (19thC) not recording positional data were clearly stationed off ports such as Calloa and Mollendo during the period of the Pacific War, and the lack of geo-co-ordinates should not present a difficulty. These logbooks are of particular value as they were recording sub-daily SST off the coast of Peru

In view of these facts, some examination and pre-selection of logbooks for imaging would be desirable, but the cost of this additional task should be weighed against the time and cost of imaging all logs whether they contain useful and useable data or not. A further consideration is whether the Naval Museum would want all of the logbooks imaged. Basing the number of images in the collection on the assumption that there are approximately 3.2k logbooks for the period of 1860-1959 and assuming 190 images per log, based on the *Baquedano* 1918 logbook, the total number of images is likely to be 608k. Presently there are no estimates of the cost per image.

It is clear from table 4 that all of the logs of the Chilean navy contained sub-daily tabulated meteorological data. This varied from hourly to 6 x daily observations. Observations were a combination of pressure, attached thermometer, air and sea temperature, sea state, sea current course and velocity. Cloud cover descriptions were also evident in some logbooks. The pages of the logbook facing the tabular data (Acaecimientos) have not yet been examined as these pages require English translation. If however these conform to the content of logbooks of other nations, they are likely to contain descriptions of precipitation and other meteorological and oceanographic observations. For instance sea ice and icebergs were not noted in any of the logbooks examined but must exist in the logbooks of some vessels as such sightings are commonly remarked upon in the logbooks of other nations.

The operations of the Chilean Navy also cover an area of the Pacific that is data sparse. The data from the *Baquedano* logbooks and *historiales* demonstrate that the Chilean Navy did not confine itself to local waters. The *Baquedano,* a training ship*,* sailed several times from Valparaiso towards Easter Island, then to Honolulu and Yokohama and then Sydney and Auckland. At least one circumnavigation was noted, and there were several voyages to European waters. The noon observations of pressure, temperature and SST have been processed from the 1918 logbook (Valparaiso to Yokohama) but this represents only a fraction of the hourly observations recorded in that particular logbook. Comparisons of this data with existing marine data in the ICOADS 2.5 database has established that the 1918 *Baquedano* data is entirely new, and that existing ICOADS observations along the west coast

of South America are for vessels moving towards the Panama Canal and therefore unlikely to be Chilean naval vessels. The Chilean naval archive and the corresponding near marine (lighthouse data) for the Chilean coast and Easter Island, therefore represents a hitherto untapped repository of high quality, high resolution marine data.

British Logbooks

The amount of data from British logbooks in British archives for the southern Pacific and Chilean maritime areas is extensive. There are over 900 Royal Navy logbooks for the 19th century and an estimated 1,800 merchant shipping meteorological logbooks for the second half of the 19th century. Meteorological logbooks for the 20th century have (2010) not been documented, but will provide even further data. The 19th century Royal Navy Logbooks have been completely documented in preparation for an imaging and digitization project. The corresponding merchant shipping meteorological logbooks can be prepared in early 2011.

Recommendations and Additional Investigations

- Efforts should be made to fund the imaging and digitization of material from both Chilean and British archives.
- Digitization of the data should be undertaken by a 'citizen science' project with the data made freely available to the world-wide scientific community.
- Graduate students from interested universities, should be recruited to undertake dissertations based on further investigations of the archives for additional data sources, searches for meta data, including instruments, and observing practices, and any other issues relevant to the history and development of meteorological and oceanographic sciences in Chile and the Chilean maritime areas. It is important to establish as broad an historical context as possible for the study of the scientific data
- Additional study by students should also focus on early accounts of survey and exploration, 16-19c, not just for meteorological data (mostly pre-instrumental) but for early accounts and descriptions of glaciers and other relevant geo-scientific data.
- Further work is needed to document the archive of Meteo-Chile
- Further work is required to document the hydrographic, meteorological and geo-scientific content of the National Archive of Chile
- Relevant metadata must be found for instruments and observing practices for Chilean ships and lighthouses and for the corresponding British vessels
- Chilean shipping company archives require investigation and documentation

- To make contemporary surface marine meteorological observations more widely available internationally, the possibility of recruitment of Chilean merchant ships into the World Meteorological Organization's (WMO) Voluntary Observing Ship (VOS) Scheme should be investigated.
- Meteorological and other relevant data should captured from printed publications, where this process has not already been undertaken, specifically, the *Anuario de la Oficina Central Meteorolójica de Santiago de Chile, Anuario del Servicio Meteorolójico de la Dirección del Territorio Marítimo, Anuario Meteorológico de Chile* (See appendix A below), *Memoria de Marina* 1836-1941, *Manual del Marino* 1817-1912, and the *Anuario Hidrografico de la Armada* from 1874 onwards.

APPENDIX A

Chilean Meteorological Publications held by the NOAA Central Library

Electronic Format (pdf) http://docs.lib.noaa.gov/rescue/data_rescue_chile.html

Anuario de la Oficina Central Meteorolójica de Santiago de Chile

1871-1875, 1886

Anuario del Servicio Meteorolójico de la Dirección del Territorio Marítimo

1899-1910

Anuario Meteorológico de Chile

1912-1929, 1931-1946, 1949-1970

Appendix B

Royal Navy Vessels in the south-east Pacific 1914-1946

Ship	Ship Type	Period in south east Pacific	Years Imaged	Years Digitized or * to be digitized
Avoca	Armed Merchant Cruiser	Jun 1916-Sep 1918	1916-1918	*
Berwick	Armoured Cruiser	Jan-Apr 1919	1919	*
Celtic	Armed Merchant Cruiser	1915	1915	*
Dartmouth	Cruiser	Oct 1919-Jan 1920	1919-1920	*
Glasgow	Light Cruiser	Oct-Nov 1914, Jan-Feb 1915		
Good Hope	Armoured Cruiser	Oct-Nov 1914		
Kent	Armoured Cruiser	Sep 1915-Mar 1916	1915-1916	*
Lancaster	Armoured Cruiser	Apr-Nov 1916, Feb 1917-Jun 1918, Mar-May 1919	1916-1919	*
New Zealand	Battlecruiser	Sep 1913		
Newcastle	Light Cruiser	Dec 1914-May 1916	1914-1916	*
Ophir	Armed Merchant Cruiser	Sep-Nov 1918	1918	*
Orbiter	Armed Merchant Cruiser	Mar 1916-Jul 1918	1916-1918	*
Orama	Armed Merchant Cruiser	Dec 1914-Dec 1915	1914-1915	*
Otranto	Armed Merchant Cruiser	1914, Jun 1915-Aug 1916, Mar 1917-Apr 1918	1914-1918	*
Southampton	Light Cruiser	Nov 1919-Feb 1920 Nov 1920-Jan 1921	1919, 1920-1921	*
Weymouth	Light Cruiser	Jul-Dec 1920	1920	*

Ship	Ship Type	Period in south east Pacific	Years Imaged	Years Digitized
Yarmouth	Light Cruiser	Jan-Sep 1920	1920	*
Amazon	Destroyer	1928,		
Ambuscade	Destroyer	1928		
Achilles	Cruiser	Dec 1939		
Ajax	Cruiser	1936, 1938, Jan-Feb 1939	1938-1939	1938-1939
Colombo	Light Cruiser	Sep-Oct 1926		
Dauntless	Light Cruiser	Nov 1931-Mar 1932		
Dispatch	Cruiser	Nov 1939-Jan 1940, 1941	1939-1941	1939-1941
Diomede	Cruiser	Mar-May 1940 Jan-Feb 1941	1941	1941
Exeter	Cruiser	1934, Aug-Nov 1937 Dec 1938-Feb 1939	1938-1939	1938-1939
Orion	Cruiser	Aug-Sep 1941	1941	1941
Rajputana	Armed Merchant Cruiser	Jan-Apr 1940		
Uganda	Cruiser	Feb-Mar 1946		
Warspite	Battleship	Jan-Feb 1942	1942	1942
William Scoresby	Survey Ship	1925		