

# BENJAMIN LEIGH SMITH SECOND ARCTIC EXPEDITION - 1872

## Conversion of Observations to IMMA

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12 August 2014

Updated 17 December 2014, and 31 August 2015

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### Abstract

This document describes the field by field translation specification (TRANSPEC) for the data contained in the file "ARCTIC SST - 1872.xls" (Microsoft Excel Spreadsheet) digitized as part of the ACRE project by the UK Met Office.

## 1 Introduction

The Microsoft Excel document "ARCTIC SST - 1872.xls" contains digitized observations from the second (of five) Arctic voyage of Mr. Benjamin Leigh Smith to Svalbard and Jan Mayen in the summer of 1872 aboard the Schooner *Sampson*. In 1871, Leigh Smith undertook an scientific voyage to Svalbard during which he made several notable discoveries, including water temperatures at depth that were significantly warmer than surface temperatures. One of the goals of the 1872 voyage was to replicate those observations.

This document describes the translation from the Excel spreadsheet of digitized observations to the International Maritime Meteorological Archive (IMMA) format. Although the observations include subsurface water temperature observations, these are not included in the IMMA translation because those observations only contained the maximum and minimum temperatures observed during the soundings, and are not specific to a particular depth. The omitted observations are to be found in the Supplemental data attachment to the IMMA record, and may also be included in the World Ocean Database (Boyer et al., 2013).

### 1.1 The Voyage

As described by Wells (1873) and Capelotti (2008), the *Samson* departed Hull, UK on 13 May 1872 and arrived in the Shetland Islands on 26 May. She reached Jan Mayen Island on 3 June. From 23 June to 17 July *Sampson* navigated along the ice field edge toward Spitzbergen while periodically occupying ocean stations to take soundings and temperature measurements. On 11 July they achieved their most northerly position at 80°30' N, during which the ship was

damaged by the ice. Afterward, Sampson entered Wijdefjorden on 1 August and remained in the fjord, enduring damage from ice until 24 August when she was able to sail to Fair Haven on the northwest coast of Svalbard, reaching Fuglefjorden on 29 August where Leigh Smith met up with a Swedish expedition led by Adolf Erik Nordenskiöld. On 30 August, the Sampson sailed for Hull, terminating the expedition on 26 September. A diagram of the route of the vessel is provided in Figures 1 and 2.

## 1.2 The Observations

During the course of the expedition, Leigh Smith and Capt. John Wells, RN took observations at 14 ocean stations of air temperature, sea surface temperature, and water temperature at various depths. Observations were made using a Miller-Casella pressure protected thermometer (Capelotti 2008). Rice (2003; p. 37) describes the Miller-Casella thermometer (Fig. 3) as a self-registering instrument bearing a U-shaped tube having end bulbs filled with a creosote-alcohol solution and Mercury occupying the central part of the tube, with an index at either end. The larger bulb was encased in another bulb containing alcohol and designed to protect the thermometer from the effects of pressure, whilst the entire instrument was encased in copper casing. Subsurface temperatures were observed at depths ranging from 6 to 600 fathoms (36 to 3600 ft). Earlier in 1872, Leigh Smith had provided a similar set of instruments to Capt. David Gray of the whaling vessel *Eclipse*. Capt. Gray used the instruments to take water temperature (surface and subsurface) observations at 9 additional stations in the North Atlantic between Greenland and Norway, and the *Eclipse* sea surface temperatures are included in this translation.

Wells (1873, pp 189-191) further describes the general conditions encountered during each of the observation ocean stations. Following the remarkable 600 fathom observation of 64°F, Leigh Smith had his thermometer checked and calibrated by the instrument's designer, L.P. Casella, who certified "that it 'has been tested in the hydraulic press, as well as carefully compared with my standard, and found correct in every way, no change whatever having taken place in the instrument.'" (Wells 1873, p. 192).

In addition to water and air temperatures, latitude and longitude position is given to the whole minute. While date is also provided, the hour of observation is not given owing to the likelihood that the observations took a considerable amount of time to obtain.

## 1.3 Structure of this document

Section 2 describes the preparation of the data and the software used to perform the translation. Section 3 describes the mapping of the Excel native format to the IMMA format. Section 4 describes the outcome of the translation effort, including any changes made to the data or issues that arose during processing. Section 5 contains references, including figures, tables and a bibliography of works cited herein.

## 2 PREPARATION AND SOFTWARE

### 2.1 Software used

To process the data in the ARCTIC SST - 1872.xls file, the author used fortran code and the IMMA1 program as documented.

## 3 IMMA VARIABLE ALLOCATION

Of the data collected by Mr. B. Leigh Smith and Capt. J.C. Wells aboard the *Sampson* (Fig. 4) and Capt. D. Grey aboard the *Eclipse* (Fig. 5) during the summer of 1872, only air temperature (°F) and sea surface temperature (also °F) are to be included in translation to IMMA format.

Observations of temperature at depth are ignored herein. Air temperature was not observed by Capt. Grey.

### 3.1 Observed Variables

The variables documented by the two vessels (hereafter “native”) translate to IMMA format as follows:

Year:	Native year is given as 1872. No conversion is necessary. Placed in IMMA Element 1 (YR), ASCII Positions 1-4.
Month:	Native months are provided in alphabetical format (e.g., June, July). Native months are converted to their two-digit equivalents (e.g., June = 6) with a leading blank space in the case of single digit months, and placed in IMMA Element MO, ASCII Positions 5-6.
Day:	Native days are provided in numeric format. No conversion is necessary. Leading blank space for single digit dates is retained. Placed in IMMA Element 3 (DY), ASCII Positions 7-8.
Station:	The station number assigned by the observer as a reference for the observations taken at the indicated latitude and longitude. Not translated to IMMA.
Latitude:	Native latitude provided in degrees to minutes and includes hemisphere indicator (i.e., N). Observations converted to positive degree decimals to hundredths (e.g., 68° 52' N = 68.87) and multiplied by 100 to conform with IMMA format precluding decimal points (e.g., 68.87 = 6887). Output placed, with right justification, in IMMA Element 5 (LAT), ASCII Positions 13-17.
Longitude:	Native longitude provided in degrees to minutes and includes hemisphere indicator (i.e., W). Observations converted to 360-degree value (beginning with 0° at the Prime Meridian and

ascending eastward to 359.99°) and converted to degree decimals to hundredths (e.g., 6°40' W = 360 - 6.67 = 353.33). To conform with IMMA format precluding decimal points, converted longitude is multiplied by 100 (e.g., 353.33 = 35333) and placed, with right justification, in IMMA Element 6 (LON), ASCII Positions 18-23.

- Depth:** Depth of sounding for water temperature measurements. In Fathoms. Not translated to IMMA.
- Air Temperature:** Native air temperature is observed in whole degrees Fahrenheit (°F). Native values are converted to degrees to tenths Celsius using the equation:  $(5/9) \times (°F - 32) = °C$  (e.g., 37°F = 2.8°C), and the resulting value is multiplied by 10 to obtain the IMMA equivalent value (e.g., 2.8°C = 28). The value is placed, with right justification, in IMMA Element 29 (AT), ASCII Positions 70-73.
- Sea Surface Temperature:** As with Air Temperature. The value is placed, with right justification, in IMMA Element 35, ASCII Positions 86-89.
- Min:** Minimum water temperature (°F) of the sounding column. Not translated to IMMA.
- Max:** Maximum water temperature (°F) of the sounding column. Not translated to IMMA.

Note: An hour of observation was not provided by the original observer. Therefore, the HR field in IMMA (pos. 9-12) is left blank.

### 3.2 IMMA Elements Included

In addition to the observed, native variables, IMMA format allows for a number of parameters associated with the observations and the vessel to be included. The following IMMA Elements, listed by their abbreviation (ref. R2.5-imma\_short.pdf), contain such information and are included in the final IMMA record:

IMMA Element Included					
Element Number	Abbreviation	Name	Field Position	Value	Value Meaning
7	IM	IMMA Version	24-25	1	IMMA Version
8	ATTC	ATTM Count	26	2	ATTM I and Supplement.
10	LI	Latitude/Longitude Indicator	28	4	Degrees and Minutes
14	II	ID Indicator	33-34	10	Composite

					information from early ship data
15	ID	Ship Identification/Call Sign (right blank fill)	35-43	Sampson / Eclipse	Vessel Names
16	CI	Country Code	44-45	GB	Great Britain
28	IT	Indicator of All Temperatures	69	4	Degrees F to tenths *
34	SI	SST Measuring Method	84-85	7	Others (other type of measurement method). **
49	ATTI	ATTM ID	109-110	1	Attachment I
50	ATTL	ATTM Length	111-112	65	Length Attm I
54	DCK	Deck	119-121	246	ACRE Data
55	SID	Source ID	122-124	168	ACRE Historical Digitised (expeditionary and other spreadsheets)
56	PT	Platform Type	125-126	5	Ship
197	ATTI	ATTM ID	373-374	99	Supplemental Attachment
198	ATTL	ATTM Length	375-376	0	Supplemental ATTM length (default value)

\* Author assumes that air temperature could have been resolved to a half degree precision, but that no half degree observations were noted.

\*\* The Miller-Casella thermometer is a self-registering, rather than reversing thermometer, and therefore does not fall into the SI category (11) for reversing thermometer or mechanical sensor.

All remaining IMMA1 Fields are set to missing (left blank). Certain fields will be occupied by flags and coding set by the ICOADS dupelim and trimming QC checks.

### 3.3 Supplemental Data Attachment

In addition to the translation from native format to IMMA1 format, the data as originally reported in the XLS file are included in the IMMA record as a supplemental data attachment. For ease of interpretation and reading purposes, the native data have been converted to comma delimited (CSV) format prior to be included in the supplemental attachment. The native data record is in the order specified in Section 3.1, with the addition of the particular ship's name provided at the beginning of each supplemental record.

For example, the supplemental record:

SAMPSON,1872,6,1,1,68 52 N,6 40 W,600,42.0,37.5,30.0,37.5

is interpreted as follows:

Ship Name:	SAMPSON
Year:	1872
Month:	6 (June)
Day:	1
Station:	1
Latitude:	68° 52" North
Longitude:	6° 40" West
Depth:	600 ftm (depth of sounding)
Air Temperature:	42.0 °F (Air temperature)
Sea Surface Temp.:	37.5 °F
Min Temperature:	30.0 °F (minimum recorded temperature of water column)
Max Temperature:	37.5 °F (maximum recorded temperature of water column)

Missing values are indicated by an empty field between commas (,,).

## **4 SUMMARY OF TRANSLATION EFFORT**

### **4.1 Preparation of Input Data**

Data were transcribed from the data tables present in Wells (1873) to a Microsoft Excel spreadsheet as part of the Atmospheric Circulation Reconstructions over the Earth (ACRE) program of the UK Met Office. Individual data records did not include the ship's name, and dates, latitudes and longitudes were often omitted when the Sampson took several observations on a given date (see Fig. 4). To prepare the data for translation, these data (Ship Name, latitude, longitude, and date) were added where they were not provided by the original tables. In addition, the tables (Figs. 4 and 5) indicate in several places (6 and 10 July for the Sampson, and 20 April for the Eclipse) of a sounding that reached the bottom. This indication was transcribed into the Excel spreadsheet as an empty record, and was therefore removed prior to processing.

One observation, from 3 July 1872 taken aboard the Eclipse could not be used because it did not include latitude or longitude, and it could not be determined whether the ship had remained at the previously reported location. However, the fact that this observation was given a new station number (23) indicates that it was likely at a different (unknown) location. This observation was therefore not translated for inclusion into ICOADS.

The Excel table was stripped of headers and the data transformed into a comma delimited file for more efficient ingest by the fortran programs. A final adjustment to the original transcribed

observations was a decision to separate the degrees, minutes, and hemisphere indicator of latitude and longitude into separate comma-delimited fields prior to ingest. The “Text to Columns” feature of Excel was used to perform this function.

## 4.2 Output

A file ArcticSST\_1872imma.txt was produced that contains the input data output in IMMA1 format. This file was subjected to dupelim and trimming processing before being entered into ICOADS.

## 5 REFERENCES, FIGURES, AND TABLES

### 5.1 References

Boyer, T.P., J.I. Antonov, O.K. Baranova, C. Coleman, H.E. Garcia, A. Grodsky, D.R. Johnson, R.A. Locarnini, A.V. Mishonov, T.D. O'Brien, C.R. Paver, J.R. Reagan, D. Seidov, I. V. Smolyar, and M.M. Zweng, 2013: World Ocean Database 2013. NOAA Atlas NESDIS 72. NOAA, Dept. of Commerce. 208 p. On-line: <http://www.nodc.noaa.gov/OC5/WOD/docwod.html>

Capelotti, P.J., 2008: Benjamin Leigh Smith's second Arctic expedition: Svalbard and Jan Mayen, 1872. *Polar Record*, **44** (230) 255-264. Doi: 10.1017/S0032247408007444. Online: <http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=1887376&fulltextType=RA&fileId=S0032247408007444>

Rice, A.L., 2003: The *Challenger* Expedition: The end of an era or a new beginning? *In* Understanding the Oceans: A Century of Ocean Exploration. Deacon, M., T. Rice, and C. Summerhayes, Eds. Routledge, 320 p.

Wells, J.C., 1873: The Gateway to Polynia: A Voyage to Spitzbergen from the Journal of John C. Wells, R.N.. Henry S. King & Co., London. 355 p. Online: [http://books.google.com/books/about/The\\_Gateway\\_to\\_the\\_Polynia.html?id=mk0EAAAAYAAJ](http://books.google.com/books/about/The_Gateway_to_the_Polynia.html?id=mk0EAAAAYAAJ)

5.2 Figures and Tables

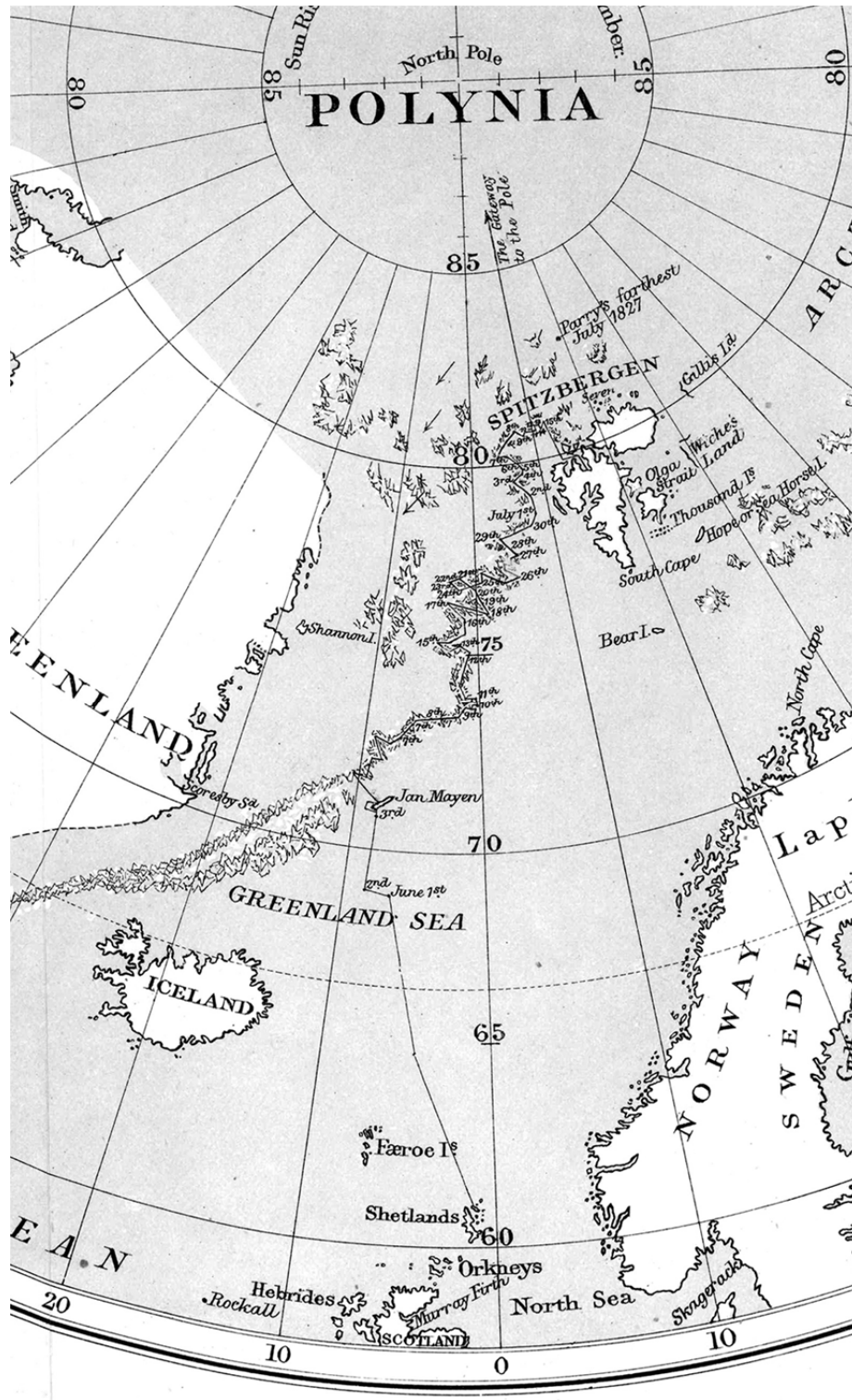
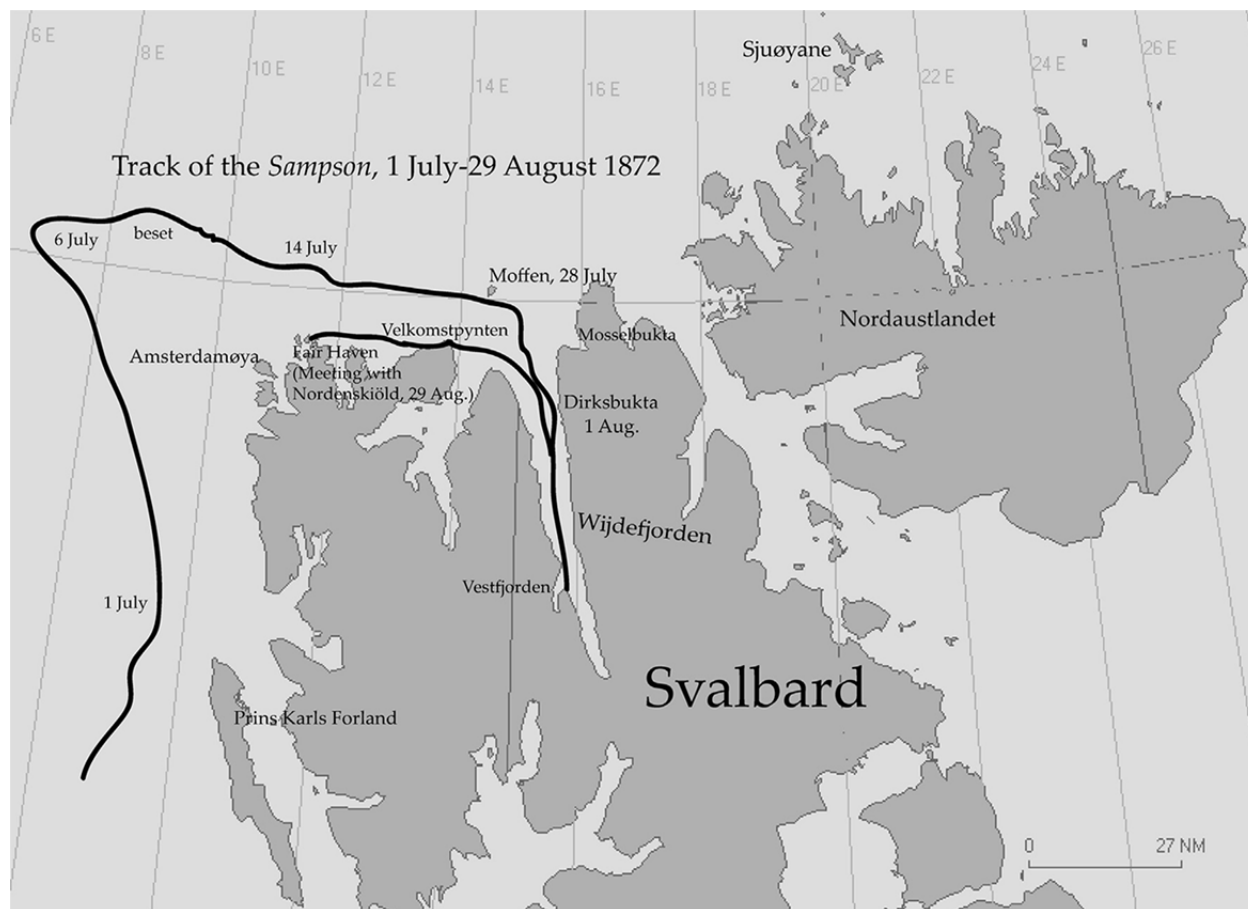
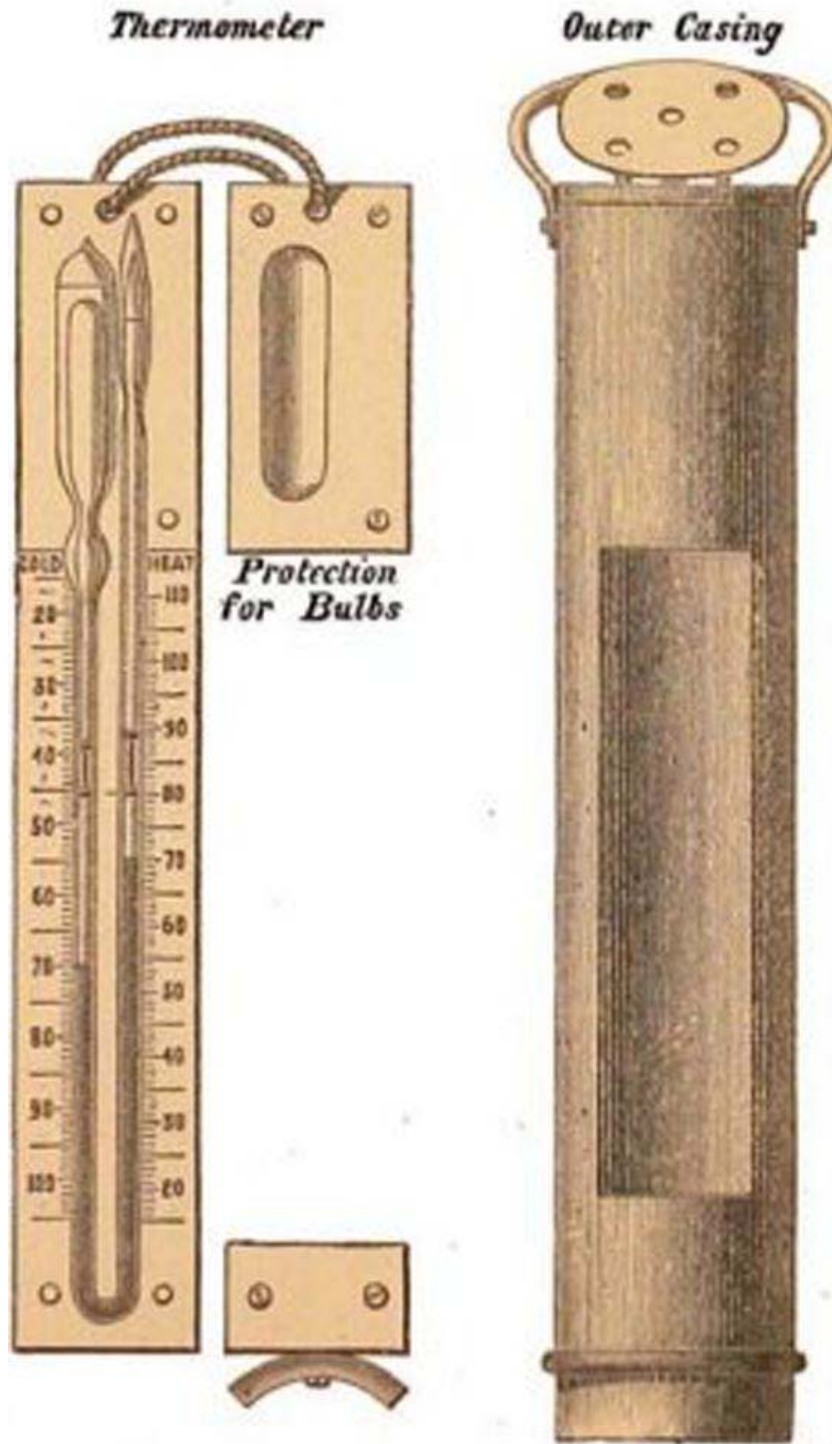


Figure 1. Route of the *Sampson* from the Shetland Islands to Spitzbergen between 28 May and 1 August 1872. From Wells (1873) as appearing as Fig. 1 in Capelotti (2008).





**Figure 2.** Route of the *Sampson* between 1 July and 29 August 1872 in and around Spitzbergen. From Capelotti (2008, Fig. 4).



**Figure 3.** Miller-Casella pressure-protected, self-registering thermometer for hydrographic sampling. The tube is filled with Mercury, whilst the bulbs are filled with a creosote-alcohol solution. An outer, alcohol-filled bulb protects the larger bulb from the effects of pressure at depth, and the thermometer is housed in a cylindrical copper casing. Image: NOAA

1872.	Station.	Lat.	Long.	Depths in fathoms	Temperature.			
					Air.	Sur- face.	Min.	Max.
<b>June</b>								
1.	1.	68 52 N.	6 40 W.	600	42	37½	30	37½
13.	2.	75 6 N.	2 30 W.	100	36	31	28	35
15.	3.	75 7 N.	3 48 W.	100	36	32	28	35
				50	..	31	29½	32½
17.	4.	76 13 N.	2 22 W.	100	34	31	29½	34
18.	5.	76 3 N.	0 10 E.	150	35	33	30½	40
				200	..	33	30½	48
19.	6.	76 21 N.	1 5 E.	150	35	32	30½	32
				250	..	32	30½	39½
20.	7.	76 35 N.	0 3 W.	6	34	33	30	33
				25	..	33	30	35
				150	..	33	30	39½
22.	8.	76 41 N.	2 10 W.	150	35	32	29½	39½
27.	9.	77 18 N.	5 0 E.	25	37	34½	32	34½
				250	..	34½	32	39
<b>July</b>								
1.	10.	78 20 N.	7 2 E.	6	36	36	33	36
				600	..	36	33½	36½
6.	11.	79 54 N.	6 34 E.	6	35	34½	33	34½
				12	..	34½	33	35
				25	..	34½	33	37
				50	..	34½	33	37
				200	..	34½	33	40
				Bottom				
7.	12.	80 4 N.	5 12 E.	600	37	34½	31½	39
10.	13.	80 23 N.	9 0 E.	12	35	31	28	31
				50	..	31	28	31½
				Bottom				
12.	14.	80 32 N.	9 50 E.	600	36	31	28½	64

Figure 4. Ocean station observations taken by Mr. B. Leigh Smith and Capt. J.C. Wells aboard the *Sampson* between 1 June and 12 July 1872. Image from Wells (1873).

Temperatures taken by Capt. David Grey, of the  
*Eclipse* whaler :—

1872.	Station.	Lat.	Long.	Depths in fathoms	Temperature.			
					Air.	Sur- face.	Min.	Max.
April								
13.	15.	68 45 N.	13 58 W.	220		29	28·8	32
15.	16.	68 52 N.	15 40 W.	220		29	29	31·5
20.	17.	68 12 N.	16 40 W.	270		28·8	28	31
May				Bottom				
14.	18.	75 0 N.	16 20 E.	85		29	29	32
June								
6.	19.	78 20 N.	0 20 E.	400		30	30	33
8.	20.	78 14 N.	0 18 W.	220		30	29	30
				400		30	30	32
18.	21.	75 5 N.	6 15 W.	400		32	29·5	32
				200		32	30	32
23.	22.	74 50 N.	6 50 W.	100		32	30	32
				400		31	30	32
July								
3.	23.			200		34	30·5	34

Figure 5. Ocean station observations taken by Capt. David Grey aboard the *Eclipse* whaler between 13 April and 3 July 1872. Observations were made using instruments and methods identical to those used by Mr. B. Leigh Smith and Capt. J.C. Wells aboard the *Sampson*. Leigh Smith supplied the instruments to Capt. Grey. Image from Wells (1873)