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 Sampson 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) × (°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:

<table>
<thead>
<tr>
<th>Element Number</th>
<th>Abbreviation</th>
<th>Name</th>
<th>Field Position</th>
<th>Value</th>
<th>Value Meaning</th>
</tr>
</thead>
<tbody>
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<td>IMMA Version</td>
<td>24-25</td>
<td>1</td>
<td>IMMA Version</td>
</tr>
<tr>
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<td>2</td>
<td>ATTM 1 and Supplement.</td>
</tr>
<tr>
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<td>Latitude/Longitude Indicator</td>
<td>28</td>
<td>4</td>
<td>Degrees and Minutes</td>
</tr>
<tr>
<td>14</td>
<td>II</td>
<td>ID Indicator</td>
<td>33-34</td>
<td>10</td>
<td>Composite</td>
</tr>
</tbody>
</table>
## 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 being 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:

*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.**
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


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
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<th>Lat.</th>
<th>Long.</th>
<th>Depths in fathoms</th>
<th>Temperature</th>
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<td>Bottom</td>
</tr>
</tbody>
</table>

**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:—

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<tr>
<th>Date</th>
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<th>Lat.</th>
<th>Long.</th>
<th>Depths in fathoms</th>
<th>Temperature</th>
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<td>220</td>
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</tr>
<tr>
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<td>6 15 W.</td>
<td>400</td>
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</tr>
<tr>
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<td>6 50 W.</td>
<td>400</td>
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<td>23</td>
<td></td>
<td>200</td>
<td>31</td>
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</table>

*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)