

OBSERVATIONS ON THE TEMPERATURE OF THE OCEAN AND ATMOSPHERE, AND ON THE DENSITY OF SEA-WATER, MADE DURING A VOYAGE TO CEYLON

Conversion of Observations to IMMA

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Abstract

This document describes the field by field translation specification (TRANSPEC) for the data contained in the file "ENGLAND TO CEYLON - 1816.xls" (Microsoft Excel Spreadsheet) digitized as part of the ACRE project by the UK Met Office.

1 Introduction

The Microsoft Excel document "ENGLAND TO CEYLON - 1816.xls" contains digitized daily averages of observations made by Dr. John Davy, MD, FRS (Figure 1) aboard a vessel as it sailed between England and Ceylon (now Sri Lanka). On board, Dr. Davy, a physician by training, conducted a number of physiological experiments and observations, chiefly measuring the body temperature and mental conditions of the ship's crew during the voyage in an attempt to identify any influence exposure to a tropical climate may have on the human body (Davy, 1839). However, throughout the voyage, Dr. Davy, assisted by ship's mates Messrs. Sleight and Powell, whom Davy describes as "intelligent and obliging men", made observations of air and sea surface water temperatures every two hours "carried on during the night as well as the day." (Davy, 1817) While only some of the 2-hourly observations were transcribed into Dr. Davy's 1816 letter to his brother, the letter included a table describing the averages, maxima, and minima of the observations for each day, along with an observation of prevailing wind direction and character of the day's weather.

While Dr. Davy in his correspondence or subsequent writings does not name the vessel on which he sailed, research by this author has determined that Dr. Davy was a passenger aboard the private sailing vessel *Prince of Orange*, a 360 ton, fully-rigged (three-masted) ship built in Sunderland in 1813 (see Figure 2). The *Prince of Orange* was listed in the "Ship Letter-Mail" section of the *Asiatic Journal* as scheduled to sail from England on 27 January 1816 bound for "Isle of France and Ceylon" (*Asiatic Journal*, 1816a). Details about the ship were obtained from a number of websites as the *Prince of Orange* was subsequently used as a convict transport to Australia, making trips in 1820 and 1821.

1.1 The observations

Beginning shortly after leaving England, Dr. Davy and his assistants commenced 2-hourly observations of air and water temperature, barometric pressure, and making observations of the prevailing wind direction and character of the weather. The observations span the period, 12 February 1816 to 12 August 1816. In addition, measurements of the specific gravity of the seawater collected for temperature measurements were made by Dr. Davy on a frequent, though not regular basis. The latter measurement was of particular interest to Dr. Davy, as he was hoping to demonstrate that his observations would “favour the general conclusion already formed by some philosophers, that the ocean resembles the atmosphere in being (*cæteris paribis*) of nearly the same specific gravity throughout.” (Davy, 1817). Davy also notes that while specific gravity measurements made before the ship passed into the Southern Hemisphere (Mar. 21) were made aboard the ship, while those thereafter were measured, with greater accuracy and precision, on land from samples preserved in stoppered vials. Dr. Davy (1817) notes of the specific gravities measured at sea, “I do not of course value so much, as those made on land: considered, however, merely approximations to the truth, which I am sure they are...”

With respect to the air and water temperature observations, Davy (1817) notes that he used “delicate pocket-thermometers, the bulbs of which projected about an inch from the ivory scale”, which were in degrees Fahrenheit (Figure 3). Davy goes on to state, ...

“In the experiments on the temperature of the ocean, the water was tried the instant it was drawn, before it was affected by the air. To find the temperature of the air, I always chose the coolest part of the ship on deck, and always put the instrument in the shade, and exposed it to the wind, taking care not to bring it near any surface that had the power of radiating much heat; circumstances, I need not remark, of importance to be attended to, and, in consequence of the neglect of which, the temperature at sea, in the intertropical regions, has by most observers been overrated.” (Davy 1817, pp. 280-81)

Temperature observations were apparently made to the quarter of a degree Fahrenheit as evidenced by the daily maxima and minima that are either recorded to .0 (decimal left blank), .25, .5, or .75 (Figure 4). When these observations were transcribed, values to 0.25 were converted to 0.3, and values to 0.75 were converted to 0.8 (rounded up to the nearest tenth). Air and SST daily means were recorded to the tenth of a degree Fahrenheit. Observations were either not made, or not recorded on the following dates: 13, 22 & 23 February, 13 May through 2 June, and 8 through 16 July. From the remarks of 24 February, observations were not made on the 22nd or 23rd due to “a strong gale for two days from the SW.” From the table entries and

from an 18 May 1816 letter Davy wrote to his brother from Cape Town (Asiatic Journal, 1816b), the ship was at anchor at Cape Town, South Africa 13 May – 2 June. Lastly, it appears no observations were made while the ship was anchored at Isle de France (Present day Mauritius) 8-16 July and thus no observations were made. The missing observations of 13 February are not explained.

The summary of observations made by Dr. Davy and his assistants and presented in the tables of Davy (1817) was transcribed as part of the Atmospheric Circulation Reconstructions over the Earth (ACRE) initiative (see www.met-acre.org). These transcriptions appear in the Microsoft Excel file “ENGLAND TO CEYLON - 1816.XLS”, and include the following elements:

- Date: Year, Month, and Day
- Position: Latitude and Longitude in degrees and minutes (Noon position)
- Specific Gravity of Sea Water at Temp 80°F (provided in SG x 10,000)
- Air Temperature for the date: Maximum, Minimum, Mean (°F to tenths) derived from observations made every two hours.
- Sea Temperature for the date: Maximum, Minimum, Mean (°F to tenths) derived from observations made every two hours.
- Barometric Pressure: Inches of Mercury to tenths (assumed to be mean of the day’s 2-hr observations).
- Wind Direction: 32 point compass headings (e.g., Northeast by North), assumed to be prevailing for the day.
- Weather: Descriptive remarks (e.g., Cloudy, wind strong, sea rough), assumed to be prevailing for the day.

1.2 Ancillary History

Interestingly, Davy arrived in Colombo, Ceylon on the birthday of the prince regent of Ceylon (12 August). On that date, it was decreed that all children who might in the future be born of domestic slaves in the maritime provinces of Ceylon were declared free (Henderson, 1868). However, as Ceylon was under British governance, slavery was not abolished until well after the Slavery Abolition Act of 1833 (which exempted Ceylon).

Of a more meteorological note, the observations made by Dr. Davy took place in what is commonly known as the “Year without a Summer”. The summer of 1816 saw a decline in global surface air temperatures of between 0.4 – 0.7°C (0.7 – 1.3°F). This decline is at least in part attributed to the 1815 eruption of Mt. Tambora in Indonesia (Stothers 1984). As a result, Davy’s temperature observations may contain some influence of this climatic anomaly.

1.3 Structure of this document

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

2 DATA PREPARATION

2.1 Observed Variables

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

Year	Reported as 1816. No conversion needed. Placed in IMMA Element 1 (YR), ASCII Positions 1-4.
Month	Reported and transcribed in alphabetical format, but converted to numerical equivalents (e.g., Feb = 2) during preparation of CSV input file transcription. No conversion needed. Placed in IMMA Element 2 (MO), ASCII Positions 5-6.
Day	Reported in numeric format. No conversion needed. Placed in IMMA Element 3 (DY), ASCII Positions 7-8.
Latitude	Reported in degrees and minutes. Hemisphere only reported where transitioned (N to S, S to N), otherwise omitted. Assumed to be ship’s position at local Noon. Conversion needed to IMMA format latitude in degrees east of 0 to hundredths. Placed in IMMA Element 5 (LAT), ASCII Positions 13-17.
Longitude	Reported in degrees and minutes. Hemisphere only reported where transitioned (E to W, W to E), otherwise omitted. Assumed to be ship’s position at local Noon. Conversion needed to IMMA format latitude in degrees east of 0 to hundredths. Placed in IMMA Element 6 (LON), ASCII Positions 18-23.
Specific Gravity of Sea Water at Temp 80°F	Reported as specific gravity (SG; ratio of substance density relative to distilled fresh water) x 10,000 (reason unsure). Element is not included in IMMA. No translation conducted.
Daily Maximum Air Temperature	Reported in degrees F to tenths. Element is not included in IMMA. No translation conducted.
Daily Minimum Air Temperature	Reported in degrees F to tenths. Element is not included in IMMA. No translation conducted.
Daily Mean Air Temperature	Average of observations made every two hours throughout the day. Reported in degrees F to tenths. Conversion needed to degrees C to tenths. Placed in IMMA Element 29 (AT), ASCII Positions 70-73.

	Note: Observations are specific to a local calendar date, and therefore may differ slightly from what would be computed relative to GMT if the original 2-hr observations were available.
Daily Maximum Sea Surface Temperature	Reported in degrees F to tenths. Element is not included in IMMA. No translation conducted.
Daily Minimum Sea Surface Temperature	Reported in degrees F to tenths. Element is not included in IMMA. No translation conducted.
Daily Mean Sea Surface Temperature	Reported in degrees F to tenths. Conversion needed to degrees C to tenths. Placed in IMMA Element 35 (SST), ASCII Positions 86-89. Note: This element is averaged from observations made every two hours throughout the local calendar date, and therefore may differ slightly from what would be computed relative to GMT if the original 2-hr observations were available.
Barometric Pressure	Reported in Inches of Mercury to tenths. Conversion needed to hectoPascals (hPa) to tenths. Placed in IMMA Element 25 (SLP), ASCII Positions 60-64.
Winds	Wind direction reported in textual format (e.g., South, WNW) based on a 32-point compass. No information is available as to whether the observation is referenced to a magnetic compass heading, or was estimated as true relative to the position of the ship. Conversion needed to whole compass degrees. Placed in IMMA Element 18 (D), ASCII Positions 47-49.
Weather	Prevailing weather conditions for the day, reported in textual format (e.g., Cloudy, wind strong). Conversion to IMMA present weather (WW) or total cloud amount (N) codes necessary where possible, otherwise value ignored. Placed in IMMA Element 23 (WW), ASCII Positions 57-58 and or IMMA Element 36 (N), ASCII Position 90. More detail of translation of this field is provided in section 4.3 .

2.2 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	Pr_Orange	Prince of Orange
16	CI	Country Code	44-45	GB	Great Britain
17	DI	Wind Direction Indicator	46	1	32-pt compass
28	IT	Indicator of All Temperatures	69	4	Degrees F to tenths
34 ‡	SI	SST Measuring Method	84-85	10	Implied Bucket
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)

* *Dr. Davy does not mention the name of the ship on which he sailed from England to Ceylon, but other records indicate the ship which left England bound for Ceylon via Isle of France on 27 January 1816 (approximately when Davy's voyage departed), was named "Prince of Orange".*

‡ *Based on information provided by Davy (1817) and the year in which the observations were made, it is reasonable to conclude that sea water was collected from alongside the ship by a bucket, and once raised to the deck, the water temperature was observed with a mercury-based pocket thermometer of good reliability (most likely a medical grade thermometer).*

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.

2.3 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 2.1, with the addition of the ship's name provided at the beginning of each supplemental record and the textual month provided as its numerical equivalent (e.g., Feb = 2). The data as transcribed are available in the original XLS file ENGLAND TO CEYLON - 1816.xls.

An example of a supplemental data record for 16 March 1816 is formatted as follows:

**Pr_Orange,1816,3,16,4,2,N,18,44,W,10275,82.0,78.5,79.6,83.5,80.0,81.8,29.4,124,97,8,SE by E,
Calms and squalls with thunderstorms and heavy rain in succession.**

[ID, YR, MO, DA, LAT(deg.), LAT(min.), Lat(hem.), LON(deg.), LON(min.) LON(hem.), Specific Gravity of Sea Water, ATmax, ATmin, AT, SSTmax, SSTmin, SST, SLP, D, WW, N, wind remarks, weather including sky and other non-weather remarks]

3 SUMMARY OF TRANSLATION EFFORT

3.1 Preparation of Input Data

Before subjecting the keyed data to the translation program, the original keyed data file was copied and the copy was modified in the following ways:

- Missing Latitude and Longitude positions were added via linear interpolation from previous and subsequent positioning¹.
- Year and month were filled in for every entry of the meteorological register.
- Latitude and Longitude values were separated into separate columns for degrees and minutes to make processing calculations easier.
- A column of hemisphere indicators was added (e.g., N, S, E, and W). Value of "W" noted for 15 June was in error and changed to "E".
- Ship ID was added as first column of data.
- Replaced all commas in the "Weather" column with periods to avoid confusion with field separators.

¹ Although a spherical interpolation is appropriate to interpolation over the Earth's surface, given the small distances covered by a ship under sail during the course of a day or two, and assuming a direct course in open water, the difference in values obtained from spherical versus linear interpolation are negligible (see Renka, 1984).

- A “Weather” remark of “ewel,thefirstobserve.” was removed from the CSV file, as it did not appear in the original data tables (artifact of previous day’s remarks).
- Two transcribed latitudes were corrected².
 - 12 Feb 1816 – Corrected from 9° 0” N to 49° 0” N
 - 16 June 1816 – Corrected from 24° 23” S to 34° 23” S
- Where wind direction is missing, and Weather entry indicates calm, wind is added as “CALM”.
- Where wind direction indicates wind from multiple directions, commas separating the directions are replaced by periods to discriminate from field separators.
- File was converted to CSV (comma separated values) format.
- Input CSV data file given the name: ENG2CEYLON.csv
- A remark of “none reported” was added to the “Weather including sky and other non-weather remarks” column if original was blank.

In addition, several observations were transcribed in red font color in the XLS spreadsheet. Examination of the original data tables (Davy, 1817) reveals that these were estimates provided after the fact to fill in missing data or adjust for data that was deemed erroneous. These values are described as follows:

Month	Day	Element	Davy’s Value	XLS file value	Notes
3	31	SSTmin	77.5	77.5	No rationale for red font, values identical. Value kept in translation.
5	9	Barometer	Missing	29.5	Origin of estimate unknown, removed from translation.
6	10	SSTmax	71.5	61.5	Prior and subsequent observations were 66.0 and 67.5, respectively. Estimated value does not appear realistic. Restoring original value.
6	10	SSTmean	66.9	61.3	Estimated value is (SSTmin + est. SSTmax)/2. Restoring original value for translation.
6	19	Barometer	30 to 31	30.5	Estimate based on mean of what appears to have been a highly variable barometer during the day with remarks “cloudy, tempestuous, showery.” Retaining estimated value in translation.
5	11	Wind dir	SWS	SSW (203°)	Assuming a transpose during typing.

² Positions were adjusted after a plot of the ship track revealed both the error and the most likely correct value.

3	15	Wind dir	S, SE by N	S, SE by E (152°)	Assuming a typo.
3	24	Wind dir	ES by S	SE by S (124°)	Assuming a transpose during typing.

A plot of recorded positions (latitude and longitude) reveals periods of elevated variability in the ship’s track (Figure 5a, b). While these instances may be the result of unfavorable winds or a navigational reason, it is also possible that some of the positional readings/calculations made by the ship’s officers were of less than optimal accuracy (e.g., observer error, excessive overcast, etc.). However, with the two exceptions noted above, the deviations do not appear so substantial as to believe they are in error, nor can the level of locational accuracy be quantifiably determined or attributed. Thus, the observations are carried forward in association with their recorded georeferences, and assumed to be within the normal range of accuracy attributed to the calculation of position using contemporary methods.

3.2 Output

Every input line from the .csv file was read in as a complete line. Daily summary values were parsed into a single output IMMA record for each available date. Supplemental data contain the csv string used in input, which in instances noted in Section 3.1 may differ from data appearing in the original transcribed XLS file.

In instances where wind direction contained multiple entries that span an overall sector of 60 degrees or less, the average direction was output [e.g., E by S (101.25°), E by N (78.75°); range = 22.5°; output = mean = 90]. In cases where the sector span of multiple wind directions exceeded 60 degrees, a code of variable (i.e., 362) was output [e.g., NW (315°), SSW (202.5°); range = 112.5°; output = variable = 362]. The use of 60 degrees is arbitrary, but is in agreement with convention used by the U.S. National Weather Service for a definition of variable winds³.

#	Compass point	Abbrev.	Minimum	Middle	Maximum
1	North	N	354.38°	0.00°	5.62°
2	North by east	NbE	5.63°	11.25°	16.87°
3	North-northeast	NNE	16.88°	22.50°	28.12°
4	Northeast by north	NEbN	28.13°	33.75°	39.37°
5	Northeast	NE	39.38°	45.00°	50.62°
6	Northeast by east	NEbE	50.63°	56.25°	61.87°
7	East-northeast	ENE	61.88°	67.50°	73.12°
8	East by north	EbN	73.13°	78.75°	84.37°
9	East	E	84.38°	90.00°	95.62°
10	East by south	EbS	95.63°	101.25°	106.87°

³ The US NWS defines variable winds as a wind direction that fluctuates by 60° or more during the 2-minute evaluation period when the wind speed exceeds 6 kt.

11	East-southeast	ESE	106.88°	112.50°	118.12°
12	Southeast by east	SEbE	118.13°	123.75°	129.37°
13	Southeast	SE	129.38°	135.00°	140.62°
14	Southeast by south	SEbS	140.63°	146.25°	151.87°
15	South-southeast	SSE	151.88°	157.50°	163.12°
16	South by east	SbE	163.13°	168.75°	174.37°
17	South	S	174.38°	180.00°	185.62°
18	South by west	SbW	185.63°	191.25°	196.87°
19	South-southwest	SSW	196.88°	202.50°	208.12°
20	Southwest by south	SWbS	208.13°	213.75°	219.37°
21	Southwest	SW	219.38°	225.00°	230.62°
22	Southwest by west	SWbW	230.63°	236.25°	241.87°
23	West-southwest	WSW	241.88°	247.50°	253.12°
24	West by south	WbS	253.13°	258.75°	264.37°
25	West	W	264.38°	270.00°	275.62°
26	West by north	WbN	275.63°	281.25°	286.87°
27	West-northwest	WNW	286.88°	292.50°	298.12°
28	Northwest by west	NWbW	298.13°	303.75°	309.37°
29	Northwest	NW	309.38°	315.00°	320.62°
30	Northwest by north	NWbN	320.63°	326.25°	331.87°
31	North-northwest	NNW	331.88°	337.50°	343.12°
32	North by west	NbW	343.13°	348.75°	354.37°

Weather entries contained information that could be translated to the Present Weather (WW), and/or the Total Cloud Amount (N) IMMA fields. Present weather was mapped as closely as possible to Table D3 in Woodruff (2010), and is described in the following table.

Input from Davy (1817)	Interpreted As	IMMA WW Code
Clear/Fine/Pleasant/Very Fine	State of the sky on the whole unchanged	02
Frequent showers	Rain shower(s), moderate to heavy	81
Hazy	Haze	05
Heavy rain / Much rain	Rain [Heavy], not freezing, continuous	65
Improving	Clouds generally dissolving or becoming less developed.	01
Showers	Rain shower(s), slight	80
Rain / Some rain	Rain [Moderate], not freezing, intermittent	62
Squalls / Squalls with rain	Squalls	18
Thunderstorm	Thunderstorm, slight or moderate, without hail but with rain and/or snow at time of observation.	95
Thunderstorms with heavy rain	Thunderstorm, heavy, without hail, but with rain and/or snow at time of observation.	97

Unsettled, frequent showers, lightning	Thunderstorm, slight or moderate, without hail but with rain and/or snow at time of observation.	95
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Total Cloud Amount (Cover) was estimated using the following mapping:

Input from Davy (1817)	Interpreted As	Octas
Clear	Clear	0
Pleasant / Fine	Scattered	2
Fair / Variable	Scattered to Broken	4
Cloudy with occasional sunshine	Broken	6
Tempestuous	Overcast	8
Cloudy	Overcast	8
Thunderstorm/Rain/Showers/Squally	Overcast	8
Gloomy	Overcast	8
Sun Obscured	Overcast	8

In general, any day with rain or storms indicated was given a total cloud amount of 8.

Following IMMA convention, elements for which there were no entries were output as blank fields. All fields are right justified, except for ID, which is left justified.

4 REFERENCES, FIGURES, AND TABLES

4.1 References

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4.2 Figures and Tables

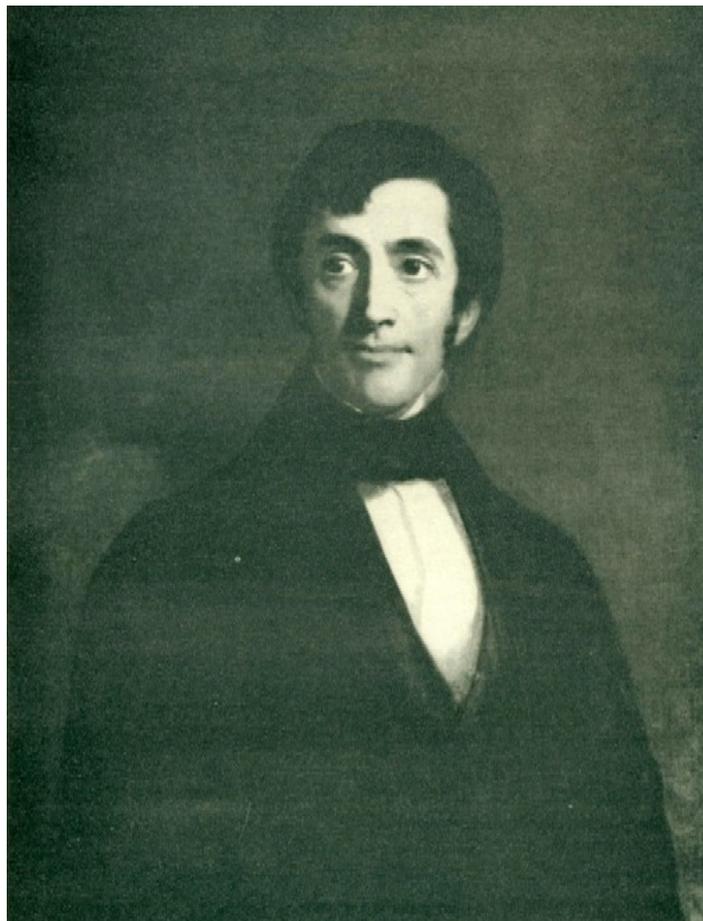


Figure 1. Portrait of Dr. John Davy painted circa 1825, a few years after his return from his travels to Ceylon.



Figure 2. Contemporary painting of the ship-rigged vessel *Melish* in Sydney Harbour in 1830. The *Melish* is of the same type and similar tonnage to the *Prince of Orange* on which Dr. Davy sailed from England to Ceylon.



Figure 3. A pocket-sized medical thermometer circa 1850. This thermometer, with its ivory scale in degrees Fahrenheit, and its bulb projecting approximately one inch from the scale card, is likely very similar to the ones used by Dr. Davy on his 1816 voyage.

Time.	Latitude by Observation	Longitude by Chronometer.	Specific gravity of sea water at temp. 80.	Maximum temp. of the air in the 24 hours.	Minimum.	Mean.	Maximum temp. of the sea in the 24 hours.	Minimum.	Mean.	Barometer.	Winds.	Weather, &c.
June 15	S. 35, 31	W 36, "		65, "	59, "	61, "	64, "	63, "	63, "	30, 3	W by N, SW	Cloudy.
16	24, 23	37, 56		62, "	60, 75	61, 5	65, 5	64, "	65, "	29, 8	SE, NW	A thunder storm.
17	34, 44	40, 7		65, "	58, "	61, 6	65, "	61, "	64, "	30, 3	NW, SE by S	Pleasant.
18	33, 48	42, 3		60, "	58, 5	59, 5	65, "	62, "	63, 4	30, 6	E by S	Cloudy, tempestuous, showery.
19	34, 48	42, 24		63, "	59, 5	61, "	64, "	61, 5	63, "	30 to 31	NE	Incessant rain and thunder and lightning.
20	34, 54	45, 17		63, "	61, "	62, "	64, "	62, "	62, 7	30, 1	N	Improving.
21	35, 7	48, 40		63, "	58, "	61, "	62, "	60, "	60, 9	30, "	WNW	
22	34, 34	51, 35		62, "	57, "	59, 8	62, "	60, "	60, 9	30, 1	W	Moderate.
23	33, 30	55, 16		60, "	57, "	58, 7	62, 25	61, "	61, 5	30, 1	W by S	Pleasant.
24	32, 4	58, 18	10260	60, "	57, 25	58, 3	62, 25	61, 5	62, "	30, 1	SW, SE	Gloomy.
25	31, 2	60, "		59, "	56, 5	57, 3	62, "	60, 75	61, 2	30, 1	NNW	
26	30, 39	60, 33		59, "	57, "	57, 2	63, "	61, "	61, 8	30, 3	E by S, ENE	
27	30, 48	60, 36		61, 5	59, 5	60, 6	61, 5	60, 25	61, 3	30, 3	NE	
28	31, 23	63, 17		63, "	61, 5	62, 5	63, 75	62, "	62, 5	30, 2	N by E	
29	31, 20	64, 34		63, 5	62, "	63, "	63, 75	61, "	62, 5	30, 1		
30	30, 53	65, 38		67, "	62, 5	63, "	65, "	63, 5	64, 5	30, 4	N, W by N	Fair.
July 1	30, 58	65, 45		66, "	61, 5	63, 6	65, "	63, 25	63, 6	30, 2	SW	Gloomy, some rain.
2	29, 23	66, 17		62, "	62, "	60, 7	67, "	64, "	65, 5	30, 3	SE	Fair.
3	27, 18	66, 30		64, "	60, "	62, 4	68, 75	65, 75	67, 3	30, 4	E	
4	24, 45	65, 45		67, "	64, 5	65, 8	70, 75	68, "	69, 4	30, 3	E by S, E by N	
5	21, 45	65, 25	10259	69, "	67, "	68, "	72, "	70, "	71, "	30, 4	SE	Off Rodriguez.
6	19, 53	63, 1		71, "	68, "	69, "	74, "	72, "	72, 5	30, "		At night in sight of the Isle of France.
7	19, 44	62, 50		71, "	69, "	69, 5	73, 5	71, 5	72, 3	30, 2	S by W	Fair, out of sight of land.
17	19, 15	57, 11		72, 75	71, "	71, 6	74, 5	72, "	73, "	30, 1	E by S	
18	18, 14	57, 30		74, 0	72, "	72, 3	74, "	72, 5	74, 7	30, 2	E	
19	17, 6	57, 3		74, 5	72, "	73, 4	75, "	72, 5	74, "	30, 2	E by S	
20	15, 46	58, "		74, 5	72, 5	73, 6	76, 25	75, "	75, 8	30, 2	ESE	Showers.
21	14, 22	58, 48		75, "	74, 5	74, 7	76, 5	75, "	76, "	30, 2	E	Night squally.
22	12, 17	59, 3		76, 5	73, 5	75, 1	77, "	74, 25	75, 6	30, 2	E by S	Fair.
23	10, 12	60, "		77, "	74, 75	75, 1	77, 5	75, "	76, 25	30, "		
24	7, 54	60, 23		77, 5	72, "	74, 6	77, 5	75, "	75, 75	30, "		— night squally.
25	5, 42	60, 51		76, "	75, "	75, 4	77, "	75, 5	76, 2	30, 1	SE	Squalls with rain.
26	4, 6	61, 45		78, "	76, "	77, "	78, 25	75, 75	76, 5			
27	2, 40	62, 51		78, "	76, 25	77, "	79, 5	78, 5	79, "		E by N	Cloudy, squalls with rain.
28	1, 40	63, 35	10253	79, 5	77, 5	78, "	81, "	77, "	79, 1		NE	Improving.
29	1, 14	63, 30		79, "	75, 5	78, "	80, 5	78, "	79, 4			Rainy night.
30	0, 19	65, 11		78, 25	77, "	77, 8	81, "	79, "	80, 2		SE	Pleasant.
31	N 0, 22	66, 30		81, "	73, 5	77, 5	82, 5	78, "	80, 5		W by N	Day calm, night rainy.
Aug. 1	0, 30	67, 52		77, 75	75, "	77, "	80, 5	79, 5	80, "		S by W	Much rain.
2	0, 26	68, 58		78, "	76, "	77, 5	81, "	80, "	80, 4		S by E, S by W	Unsettled, some rain.
3	0, 58	70, 6		81, "	78, 5	79, 9	81, 5	80, "	80, 7		SSW	Fine
4	1, 27	71, 51		80, 5	78, 75	79, 9	81, 75	80, "	80, 7		S by W	
5	1, 17	73, 53		81, "	79, "	79, 5	81, 5	79, 75	81, "		S	
6	1, 37	75, 30		80, 5	78, "	79, 9	81, 75	79, 5	80, 6		SW	
7	2, 10	76, 37		82, "	76, "	78, 8	83, 5	80, "	81, 7		SW by W	Part of the day calm.
8	2, 34	77, 25		81, "	77, 5	79, 6	82, 25	79, 25	80, 7		N by W	Pleasant.
9	2, 30	77, 53		82, "	75, 5	77, "	84, "	78, 5	80, 3			Calm.
10	3, 22	79, 4		79, 75	77, "	77, 6	79, 75	78, 25	79, "		NW	Calm till 4 P. M.
11	5, 17	79, 42		79, 75	76, 25	77, 6	79, "	76, "	77, 5			Frequent squalls.
12	6, 24			77, 75	75, 75	76, 6	78, "	76, "	76, 9		WNW	Pleasant, in sight of Ceylon, in soundings.

Figure 4. Part of the summary data table from Dr. Davy's 1816 letter to his brother, which was published in The Philosophical Transactions of the Royal Society of London (Davy, 1817). Note the erroneous latitude recorded for 16 June. This is likely a typesetting error rather than an observational error and appears to be off by exactly 10 degrees. No reason is provided for the cessation of barometric pressure readings on 26 August.

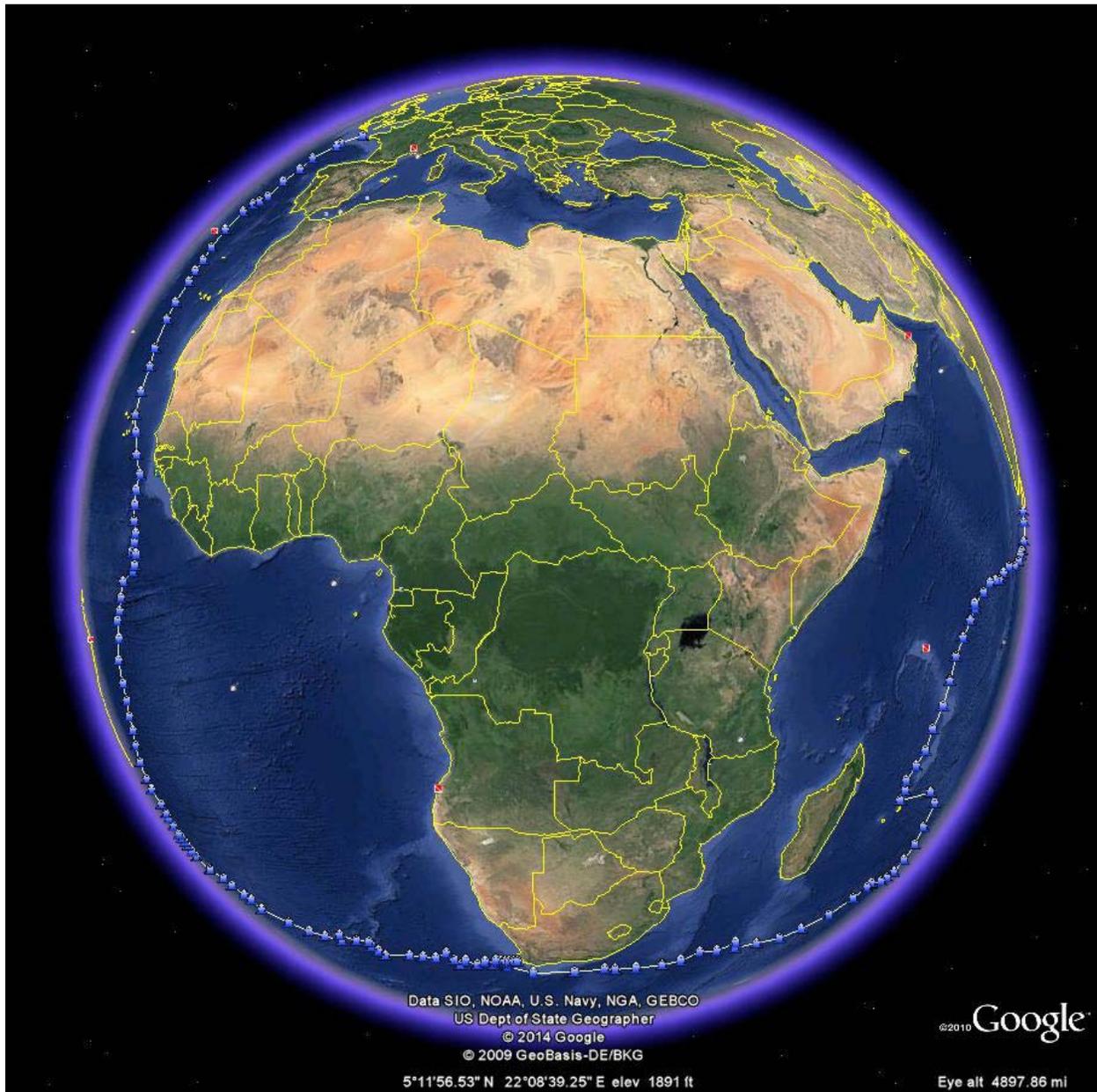


Figure 5a. Ship's path from England to Ceylon, based on coordinates supplied by Davy (1817). Each blue mark represents a day's recorded position.



Figure 5b. Close up of the track of the Prince of Orange in 1816 in the South Atlantic Ocean. Considerable day to day variability is present in the track. It is unknown whether such deviations from a straight track are due to unfavorable winds, storms/rough seas, navigational errors, or the erroneous calculation of position due either to observer error or to excessive cloud cover. However, none of the deviations are of such substantial extent that the environmental observations should be considered invalid relative to the reported position.