

A meteorological manuscript for Labrador/Nunatsiavut concerning May 1872-June 1873 found in Moravian Missionary Records

Gaston R. DEMARÉE¹, Thea OLSTHOORN², Pascal MAILIER¹ and Astrid E. J. OGILVIE^{3,4}

¹Royal Meteorological Institute of Belgium, Brussels, Belgium

²Nijmegen, The Netherlands

³Stefansson Arctic Institute, Akureyri, Iceland

⁴Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado, U.S.A.

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Abstract

A manuscript contained in the Moravian Archives, Bethlehem, PA, USA, entitled *Observations on the weather, giving date, barometer and thermometer readings, etc., Erscheinungsjahr, May 1872 - June 1873* provides daily instrumental meteorological observations and weather observations in a non-specified missionary station of the Moravian Brethren in Labrador. The daily observations cover the time period from 29 May 1872 to 3 July 1873 with an 8-day break in December 1872. According to these data, the temperature in this area was, on the average, about 2.6 °C lower than in present.

Key words: Moravian Brethren, meteorological observations, Labrador, Hopedale

1. Historical introduction

The Moravian Brethren are a pre-Reformation Christian group with its origins in the early 15th century Hussite movement in Bohemia and Moravia. After the "Battle of the White Mountain" in 1620 near Prague, the Moravian Brethren, also named the *Unitas Fratrum*, began to be persecuted by the forces of the Counter-Reformation in the Czech Lands. In the early 1700s, Bohemian survivors migrated to the estate of Count von Zinzendorf in Saxony. They took refuge there and founded the town of Herrnhut. Driven by the incitement of the Count, a vast programme of foreign missions to the "heathen" was launched. This included Greenland in 1733 (Demarée *et al.*, 2020; Demarée and Ogilvie, 2021). An attempt to establish a missionary post at Nisbet Harbour (near present-day Hopedale) in 1752 was aborted due to the fact that the trade agent, John Christian Erhardt, and six further members of the ship's crew were killed during trading activities with Inuit (Hiller, 1966; Rollmann, 2009). However, further exploratory voyages took place subsequently, and by 1769 a grant of 100.000 acres was acquired from the British government. The Moravian Brethren then settled finally at Nain in August 1771 under the leadership of the Danish missionary Christopher Brasen (1737-1774) (Dienerblatt Brasen).

In the context of the spirit of the Enlightenment, at their seminaries the Moravian missionaries were taught *the natural, social and religious circumstances of a country; geography, knowledge of the earth and sky, and knowledge of the calendar*. This was extremely useful for their travel and missionary work (Uttendörfer, 1916; Macpherson, 1987, p. 31). Within this framework,

instrumental meteorological observations were carried out by the Moravian Brethren at their missionary stations. Christopher Brasen travelled to Greenland where he undertook daily meteorological observations at Neu-Herrnhut [near present-day Nuuk] during 1767-1768 (Demarée and Ogilvie, 2021). Later he began to undertake daily meteorological observations at the missionary station of Nain. These observations were continued for some 200 years. However, because of gaps in this record the series has some limitations. Nevertheless, they still provide a valuable source of early instrumental historical climatic information (Demarée and Ogilvie, 2008; Demarée *et al.*, 2020; Ouellet-Bernier *et al.*, 2020). A detailed chronology of the observations is provided in Demarée and Ogilvie (2008).

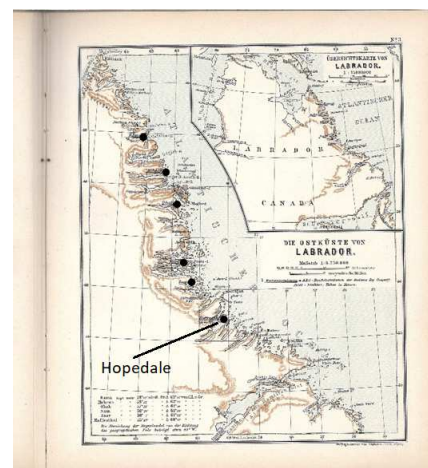


Fig. 1. Map of Labrador with the location of the mission stations of the Moravian Brethren.

Figure 1 shows the location of the Moravian Brethren's missionary stations on the east coast of Labrador (Missions-Atlas, 1895, N° 3). The mission stations existing in the 1890s are indicated by a black dot and are, from north to south, Rama, Hebron, Okak, Nain, Zoar and the most southerly station Hopedale.

2. Description of the meteorological manuscript

This paper focuses on a specific manuscript contained in the Moravian Archives in Bethlehem, USA, entitled *Observations on the weather, giving date, barometer and thermometer readings, etc., Erscheinungsjahr; May 1872 - June 1873*. The manuscript comprises 45 pages, numbered from 38684 to 38728. The first page has the title *Wetterbeobachtungen von früheren Jahren* ("Weather Observations from Previous Years"). The manuscript is divided into two sets, the first one from 38685 to 38704, on grey-blueish paper covering the period 14 December 1872 to 3 July 1873 and the second one from 38705 to 38728, on yellowish paper covering the period 29 May [1872] to 5 December [1872]. The manuscript is written in German *Kurrentschrift* ("cursive script"). The instrumental and non-instrumental meteorological observations are ranged as follows in columns: *Datum*, *Barom.*, *Therm.*, *Wind*, *Wetter*, *Naturerscheinungen* ("date, barometer, thermometer, wind, weather, natural phenomena"). The instrumental observations are carried out 3-times a day (Fig. 2).

Datum	Barom.	Therm.	Wind	Wetter	Naturerscheinungen
28. 6. 1	+6	18.8	Wind	stille	
28. 6. 2	+10	18.8	Wind	stille	
28. 6. 3	+11	18.8	Wind	stille	
29. 6. 1	+7	18.8	Wind	stille	
29. 6. 2	+20	18.8	Wind	stille	
29. 6. 3	+10	18.8	Wind	stille	
30. 6. 1	+5	18.8	Wind	stille	
30. 6. 2	+10	18.8	Wind	stille	
30. 6. 3	+10	18.8	Wind	stille	
1. 7. 1	+5	18.8	Wind	stille	
1. 7. 2	+10	18.8	Wind	stille	
1. 7. 3	+10	18.8	Wind	stille	
2. 7. 1	+5	18.8	Wind	stille	
2. 7. 2	+10	18.8	Wind	stille	
2. 7. 3	+10	18.8	Wind	stille	
3. 7. 1	+4	18.8	Wind	stille	
3. 7. 2	+10	18.8	Wind	stille	
3. 7. 3	+9	18.8	Wind	stille	
4. 7. 1	+7	18.8	Wind	stille	
4. 7. 2	+10	18.8	Wind	stille	
4. 7. 3	+10	18.8	Wind	stille	
5. 7. 1	+7	18.8	Wind	stille	
5. 7. 2	+12	18.8	Wind	stille	

Fig. 2. The Bethlehem manuscript, page 38709, data from 28 June [1872] to 5 August [1872].

The name of the missionary station was not specified in the Moravian Brethren Archive manuscript as doubts remain about the year of the observations of the second part of the manuscript. Therefore, some research to further identify the manuscript was undertaken. It is known that missionary societies and missionary journals in the homeland were instrumental in the development of a number of scientific fields, in particular meteorology (Demarée and Ogilvie, 2008; Demarée *et al.*, 2010). In this context, Jean-Alfred

Gautier¹ published monthly climatological data from Labrador in the late 1860s and the 1870s (Gauthier, 1870, 1876, 1877). Unfortunately, the original meteorological manuscripts have not been located at Geneva, nor at the Geneva Library (known as the Public and University Library from 1907 to 2006) nor at the Geneva Observatory (private correspondence Marcel Golay², 2006).

Comparing the monthly values derived from the manuscript of the Moravian Archives, Bethlehem, with the monthly printed values in Gautier's published paper (Gautier, 1876, p. 42), it was firmly established that the location of the missionary station in the Moravian Archives Bethlehem manuscript was Hopedale³ (named *Hoffenthal* in German) (Fig. 3). Furthermore, the year was 1872 for the second part of the manuscript and that was in accordance with the name of the manuscript given by the Moravian Archive at Bethlehem. Gautier's published papers specify the hours of the 3-times-a-day instrumental meteorological observations at 7 a.m., noon, and in the evening, most probably at 7 p.m.



Fig. 3. View of Hopedale by "M.K.," ca. 1890. Pencil Drawing, Courtesy Unity Archives, Herrnhut (Hans Rollmann, 2002, p. 24).

3. The instrumental meteorological observations

3.1 The atmospheric pressure observations

The instrumental meteorological observations are analyzed on a daily and consequently on a monthly time basis. The incomplete month of December 1872 is taken into the analysis. Unfortunately, the manuscript does not provide any information specifically on the instruments, how the measurements were carried out, the observational procedures nor where the instruments were located at the missionary settlement.

The atmospheric pressure observations were

¹ Jean-Alfred Gautier (1793-1881), Swiss mathematician, astronomer and director of the Observatory of Geneva.

² Marcel Golay (1927-2015), Swiss astronomer, professor at Geneva University and director of Geneva Observatory.

³ Hopedale located at 55° 29' N, 60° 12' W.

undertaken with a barometer expressed in English inches and tenths of inches. The monthly minimum, maximum and average values of the atmospheric pressure are based upon the 3 daily observations. The Roman numerals represent the months in the years 1872 and 1873 (Fig. 4). Nearly all monthly average values (except the month of July 1872) are above the standard atmospheric pressure of 1013,25 hPa. The yearly average equals 1019,49 hPa.

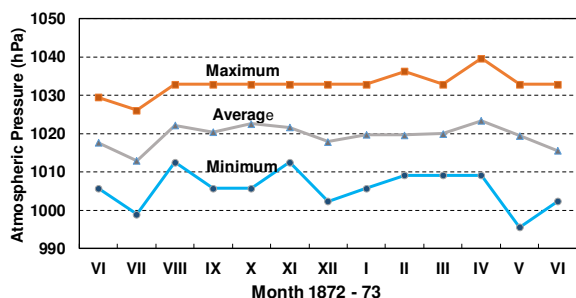


Fig. 4. Monthly atmospheric pressure expressed in hPa at Hopedale for the months June 1872 through June 1873. The three lines show the monthly maximum value, monthly average value, and minimum value in order from the top.

3.2 The air temperature

The air temperature observations were carried out with a Celsius-scaled thermometer. The average air temperature generally becomes negative between the months October and November 1872 and starts to become positive again only in May 1873 as shown in Fig. 5.

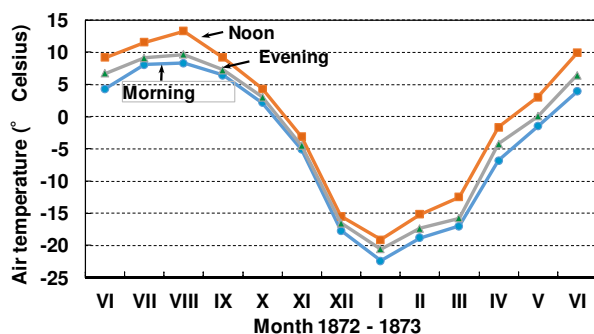


Fig.5. Average monthly air temperature in °C at Hopedale for the months June 1872 through June 1873. The three lines show monthly average temperature in the morning at 7 a.m., at noon, and in the evening at 7 p.m.

In the months of December 1872 and January and February 1873 the minimum temperature is below -30 °C. The difference between the monthly daily maximum and minimum temperature reaches -40 °C in February 1873 (Fig. 6). The difference between the midday temperature and the morning and evening temperatures is larger in summer and spring. The difference becomes small in autumn months due to the

reigning cold, lack of sunshine and shorter daylight.

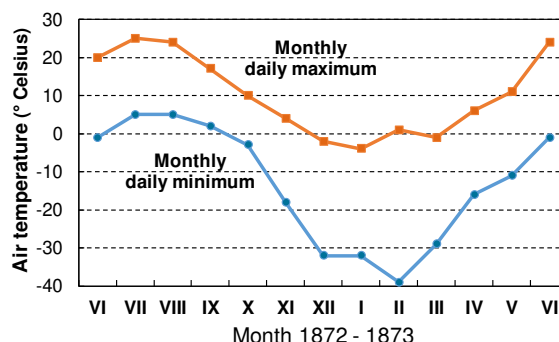


Fig. 6. Monthly daily maximum and minimum air temperature in °C at Hopedale for the months June 1872 through June 1873.

How does the temperature record of 1872-1873 compare in relation to the present temperature at Hopedale? The proceedings and instruments of 19th century meteorological observations have been modified and standardized. Furthermore, the Bethlehem manuscript contains only one year of observations.

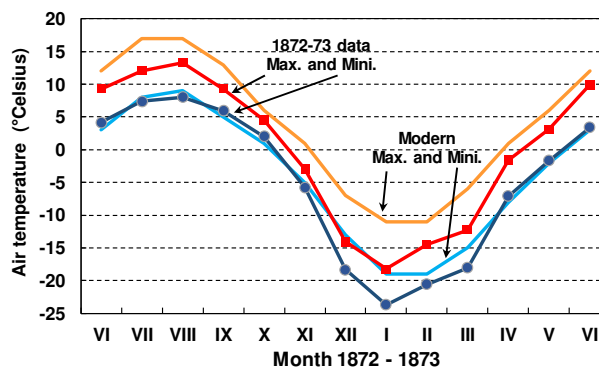


Fig. 7. Monthly high and low air temperature averages at Hopedale. The lines with markers represent the 1872-1873 data set while the lines without marker represent the modern 2000-2015 data set.

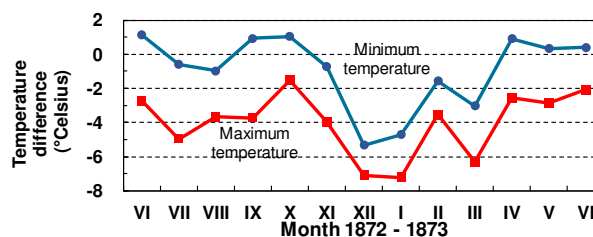


Fig. 8. Temperature difference from the modern data to the 1872-1873 data obtained from the data in Fig. 7.

Figure 7 compares the monthly high and low temperature averages in the period 1872-1873 with the data based on weather reports at Hopedale collected during 2005-2015. The modern data set monthly maximum average is significantly higher than the one of the 1872-1873 data set (<https://... Hopedale, climate>).

Figure 8 is the temperature difference from the modern data to the 1872-1873 data obtained from the

data sets in Fig. 7. The monthly maxima average in 1872-1873 was lower than in the present-day set in a whole year. The average of the difference was $-4.2\text{ }^{\circ}\text{C}$.

The monthly minima averages are approximately equal in the summer months for both data sets, but the average in 1872-1873 was significantly lower than the present. The average of the difference was $-1.1\text{ }^{\circ}\text{C}$ in a year. The mean of the both averages was $-2.6\text{ }^{\circ}\text{C}$. This suggests a very cold winter 1872-1873 and/or an increase in winter temperatures in the present. This cold record is representative of the Little Ice Age climate of this region (Fig. 8).

3.3 Wind direction and wind strength

Figure 9 represents wind directions on a wind rose with 16 cardinal directions. The strength of the wind is represented in the manuscript according to a number of different adjectives in German. These have been translated into English to give the following 6-grade scale: 1 (light); 2 (moderate); 3 (fresh); 4 (strong); 5 (heavy); and 6 (violent). Converting the descriptions into the 12-grade Beaufort scale provides very similar results. Given the numerous missing values for the wind direction, a Bayesian technique had to be used. The most frequent wind directions are in the quarter from West to North with North dominant.

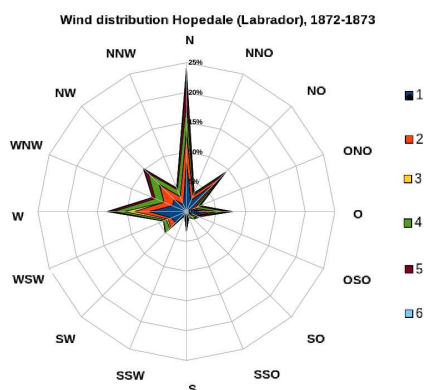


Fig. 9. The wind rose for Hopedale, 1872-1873. The strength is expressed in a 6-grade scale.

4. The non-instrumental observations

4.1 The state of the sky

The observer describes the sky as: hazy; foggy; cloudy; overcast; fog; ice fog; sunshine; bright and beautiful; clear; red sunset; lightning; moonlight; lamb clouds; starry sky; rainy or rain-swept. Snowy and precipitation events are described as: rain; snow; snowfall; snow drifting; snow shower; dew, drizzle. observations are analysed on a daily and consequently on a monthly time basis.

4.2 Natural phenomena

The first of the potato plants in the Moravian

Brethren's 'garden of Eden' blossomed on the 9th of July 1872. Gautier (1876, pp. 52-53) provides a table of aurora borealis observations at the Labrador mission stations Hopedale, Zoar, Hebron and Rama for the years 1869 to 1872. Gautier refers to a letter of Cleveland Abbe⁴ in which Cleveland Abbe refers to *the thermometer observations made in Labrador by the Moravian Missionaries* published in *Memoirs de la Société de Physique*. Cleveland Abbe published a catalogue of aurorae borealis in Labrador, at Nain, from October 1776 to August 1784, and at Okak, from October 1778 to August 1782 (Cleveland Abbe, 1873).

The Bethlehem manuscript mentions the following aurorae at Hopedale: 17 July; 3, 4, 5 and 30 August; 16 and 28 September; 15, 16, 28, 29 and 30 October; 5, 6, 9, 13, 16, 24 November; 3, 17, 20, 22 and 31 December 1872; 5, 8, 11, 13, 18, 20, 24, 25, 26 and 27 January; 2 February; 10, 24, 26 and 29 March; 28 and 29 April 1873. A few of these aurorae were also noted at Rama (Gautier, 1876, p. 53).

The bay of Hopedale was free of ice on 14 June 1872 and on 9 June 1873 while drift ice was noted in the sea on 26 June 1872 and 17 June 1873. Dry fog (*Höhenrauch* in German) was noticed on 7, 9 and 10 July 1872 and on 25 October 1872 as well as on 16 June 1873. Dry fog might be associated with a volcano eruption. However, only the two following confirmed eruptions took place in Iceland in the period of the weather observations: Bárðarbunga in 1872 and Grímsvötn on 8 January 1873 (Smithsonian Institution; Elín Margrét Magnúsdóttir, 2017).

After January 13th, the eruption was weaker, but from Sida and Medalland in clear weather, a steam column could be seen rising above the Jøklerne in NE the entire Spring to mid-June month. In Ytri-Hreppur, ash falls are also mentioned at the end of July (Thoroddsen, 1915, pp. 127-128).

It is unclear when the eruption ended but probably the intensive part was finished at the end of January 1873. Therefore, it seems unlikely that the appearance of the dry fog can be attributed to the Icelandic volcano eruption. Besides the natural phenomenon of lightning in the summer, the dry fog was attributed to the Inuit in the *Diaria* of the Moravians (Olsthoorn, 2017) but more possibly to Amerindians setting the bush afire in hunting caribou. Fires do occur in Labrador as shown by the comments: 'a fire has been raging in the forests in Ugjuktok-Bay. It is not known how it originated' (*Periodical Accounts ...*, 1853(21), pp. 14-15) and 'the fog increased by being mixed with smoke caused by great fires of the bush at a considerable distance inland' (*Periodical Accounts ...*, 1868(27), pp. 1-5).

⁴ Cleveland Abbe (1838-1916), American meteorologist, weather forecaster at the U.S. Weather Bureau of the U.S. Army Signal Corps.

5. Climate-related information on the year 1872-1873 from missionary journals

The missionary journals were instrumental in the communication between the Moravian missionaries in the far-away settlements and the flock of Moravian communities and their sympathizers in Europe. These journals informed the communities of the advances of the missionaries among the ‘heathen’ and of the difficulties encountered, among them the harsh conditions in which the missionaries had to work. Interest is given here to the climate-related documentary information of the years 1872-1873 in the missionary journals in order to relate it to the manuscript under discussion.

Towards the end of September 1872, the cold weather set in; we were therefore obliged to gather in the produce of our gardens, which furnished us with plentiful provisions for the winter. The potatoes, turnips, and other vegetables were abundant. [...] In January and February 1873, the cold was intense, at one time the thermometer stood at about 40° below zero of Fahrenheit [also -40.0 °C] (Letters from Hopedale, July 1873, *Periodical Accounts ...*, 1873 (29), pp. 3-4).

On February 1st, 1873, the cold was intense and we had to fight against a strong westerly wind that lasted all day. Never, in any of my travels, have I suffered so much from the cold. I was not surprised when I learned on my return that the thermometer had gone down that day to -36 °C (Correspondence from Labrador, Hopedale 12th July 1873. *Journal de l'Unité des Frères*, 39^e Année, 1874, p. 148).

In the Passion week of 1873, and Easter on April 13th, 1873, the weather at Hopedale was registered ‘clear, very beautiful and brilliant, splendid, dazzling’.

During the whole of the Passion-week we had delightful weather, which was no small blessing, as it was the means of increasing the number who were thus enabled to attend the meeting, not only from Nain itself, but also from the different outposts (Extract from the diary of Nain, from August 1872 to August 1873. *Periodical Accounts ...*, 1874 (29), p. 61).

On the 13th of December 1872 the sea was frozen over (Extract from the diary of Okak, from August 1872 to August 1873. *Periodical Accounts ...*, 1874(29), p. 62).

The sea froze on the 15th of December 1872. [...] On the evening of the 6th of January 1873, a terrible snow-storm arose. [...] The cold during the months of January and February 1873 was very great, the thermometer sinking to 37° below zero of Fahrenheit [-38,3 °C] (Extract from the diary of Hopedale, from August 1872 to July 1873. *Periodical Accounts ...*, 1874(29), pp. 53-54).

On the 11th of December 1872 we had a very strong north wind accompanied by a heavy fall of snow;

towards evening it blew a perfect gale, and during the night our house creaked and shook from the fury of the storm’ (Extract from the diary of Nain, from August 1872 to August 1873. *Periodical Accounts ...*, 1874 (29), p. 60).

In the beginning of February 1873, I set out upon a visit to Ramah, to see our brethren and sisters in their solitude at that place. The cold was now less severe than it had been in January, the thermometer indicating about 13° below zero of Fahrenheit [-25.0 °C], and the wind, which had been very high, had abated (From Br. Guenther, Hebron, August, 1873. *Periodical Accounts ...*, 1874 (29), p. 69).

6. Conclusion

The Bethlehem manuscript provides detailed daily instrumental and non-instrumental meteorological observations at the Moravian Brethren mission station Hopedale in Labrador of for the years 1872-1873. It is highly valuable, not least because it provides the only significant meteorological data available for the Labrador coast for the 1860s and 1870s. Furthermore, this meteorological time series, a result of the cooperation between Gautier at Geneva and the Moravian Brethren in Labrador, is an important contribution to the historical knowledge of world climate also because it provides information from an area of relatively poor coverage of climate data.

Author contributions

GD designed and wrote the paper with contributions from all co-authors. TO deciphered the *Kurrentschrift* script and contributed to the understanding of the German language. PM produced the wind rose and AO did the all-over editing.

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Summary in Japanese

和文要約

モラヴィア宣教師記録に記載された
1872年5月から1873年6月の
ラブラドル/ヌナツィアブト地方の気象データ

Gaston R. DEMARÉE¹, Thea OLSTHOORN², Pascal MAILIER¹, Astrid E.J. OGILVIE^{3,4}

¹ベルギー王立気象研究所, ²ナイメーヘン市(オランダ), ³ステファンソン北極研究所, ⁴コロラド大学ボルダー校

米国ベツレヘムのモラヴィアアーカイブに収録されている「1872年5月～1873年6月天候、日付、気圧計・温度計の測定値の観測, Erscheinungsjahr」という表題の資料は、カナダ・ラブラドル(ヌナツィアブト)地方のモラヴィア宣教師拠点における毎日の測器による気象観測と天候観測データが記録されている。12月に8日間の中断があるが、観測は1872年5月29日から1873年7月3日までの毎日の記録がある。その記録によれば、この地域の平均月最高気温は現在より4.2℃低く、平均月最低気温は1.1℃低かった。

Correspondence to: G.R. Demarée, gdemaree@meteo.be

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