

The Moravian missionaries at the Labrador coast and their centuries-long contribution to instrumental meteorological observations

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Abstract The history of instrumental meteorological observations in Labrador/Nunatsiavut, Canada, began in August 1771 when the *Unitas Fratrum*, also known as the “Moravian Brethren”, established a mission among the Inuit on the Labrador coast. The Brethren named this place “Nain” after a city mentioned in the New Testament of the Bible. The missionaries included learned men, trained in the natural sciences, and in October of that same year they began to undertake instrumental meteorological observations. These observations have been continued, in one form or another, to the present day. As will be shown in this paper, the year 1771 thus marks the beginning of a long time series of meteorological observations from Labrador. The authors of this paper are currently researching the climatic history of the Labrador/Nunatsiavut region by tracing the meteorological observations of the Moravian missionaries to be found in scientific publications of the eighteenth, nineteenth and twentieth centuries. As will be demonstrated, the records of these observations in Labrador go through several stages; from being almost completely forgotten, to being published and republished in the main international meteorological journals. In this latter context, it may be said that the channels for the distribution of this knowledge are still being charted; this process involves tracking contacts between the Moravian Church and their sympathisers, as well as between the Church and contemporary scientists. This paper seeks to elucidate knowledge of these old records by placing them in the context of the research field of historical climatology and, at the same time, to honour the Moravian missionary observers for their valuable contribution to knowledge of past variations in climate.

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See Germany send forth
 Her sons, to pour it on the farthest north:
 Fired with zeal peculiar, *they* defy
 The rage and rigour of a Polar sky,
 And plant successfully sweet Sharon's rose
 On icy plains, and in eternal snows.

William Cowper (1802) *Poems*, "Hope", 1, 459–464.

1 Introduction: origins and history of the Moravian Brethren

And it came to pass the day after, that he went into a city called Nain; and many of his disciples went with him, and much people (Luke 7:11)

The Moravian missionaries were a radical Christian group who combined their evangelizing activities with a keen interest in the natural sciences. They were known generally in England as the *Unitas Fratrum*, the "Unity of the Brethren", or more commonly, the "Moravian Brethren". In Czech they were the *Jednota Bratrská*, and in German, the *Evangelische Brüder-Unität*, or the *Herrnhuter Brüdergemeine*. Their history may be said to have begun with pre-Reformation religious movements that originated with the Bohemian reformer Jan Hus (c. 1375–1415). However, it was in the eighteenth century that their missionary work began in earnest. After their virtual extinction in the Thirty Years' War (1618–1648) Bohemian survivors migrated in the early 1700s to Saxony where Count Nicolaus Ludwig von Zinzendorf (1700–1760) gave them refuge. Zinzendorf revitalized the Church in 1722 and a Moravian colony blossomed in the small German town of Herrnhut (*Unter des Herrn Hut* translates as "under the watch of the Lord"—translations into English in this paper are by Gaston Demarée) not far from the Czech and Polish borders (the location of Moravian centres in Europe mentioned here are shown in Fig. 1).

Through the influence of the Count, a vast programme of foreign missions to the "heathen" was launched. These included: the Caribbean (1732); Greenland (1733); Surinam (1735); South Africa (1737); and were followed by many other locations. It was the pioneer of the mission to Greenland, Matthäus Stach (1711–1787) who advocated that missionary work also be undertaken among the Inuit of the Labrador coast (now also known as Nunatsiavut). From the beginning of their activities, the missionaries exhibited a keen interest in observing and recording the weather and climate of the lands they travelled to. They thus took advantage of the burgeoning interest in Europe in the recording of meteorological data which developed in tandem with the refinement of measuring instruments.

An initial journey to Labrador in 1752 under the leadership of Johann Christian Erhardt (1720–1752) established a missionary post at Nisbet Harbour (near present-day Hopedale, see Fig. 2). However, during a trip north, Erhardt and several of his companions were killed by Inuit, and the attempt at a settlement was broken off for the time being. Jens Haven (1724–1796) who had been a Moravian missionary in Greenland during 1758–1760, and who had become convinced of the importance of establishing a mission in Labrador, decided to continue the work which Erhardt had begun (Anonymous 1846). With the consent of the British Governor of Newfoundland, Commodore Hugh Palliser, three exploratory missions took place to the Labrador coast in the years 1764, 1765 and 1770. The journal of Jens Haven and Christian Andreas Schloezer, who explored



Fig. 1 Map showing the locations of Moravian centres and of their scientific correspondents in Europe

the coast of Labrador in the Schooner *Hope*, under the command of Lieutenant Chandler, from 23 July to 3 September 1765, contains a few weather observations (Account of the Voyage of the Four Missionaries 1765; Lysaght 1971) and thus constitutes what may be the earliest Moravian weather accounts for Labrador. (See Appendix 1 for an extract from these accounts.)

By 1769, the Moravians had acquired a grant of 100,000 acres of land from the British government “at His Majesty’s Pleasure” and, during the third reconnaissance journey in 1770, a site was selected for settlement. Finally, in August 1771, the Moravians, under the leadership of the Danish missionary Christopher Brasen (1737–1774) arrived in the location they named “Nain” after the passage in the gospel according to Luke. There they established the first Moravian mission post on the Labrador coast. It is noteworthy that several of the men in the party had worked before in Greenland and were said to be able to speak “West Greenlandic” (Periodical Accounts 1871; Whiteley 1964; Hiller 1971).

The missionaries hoped to establish regular contact with the Inuit in order to proceed with their conversion, and expected them to settle in and around the mission post. However,

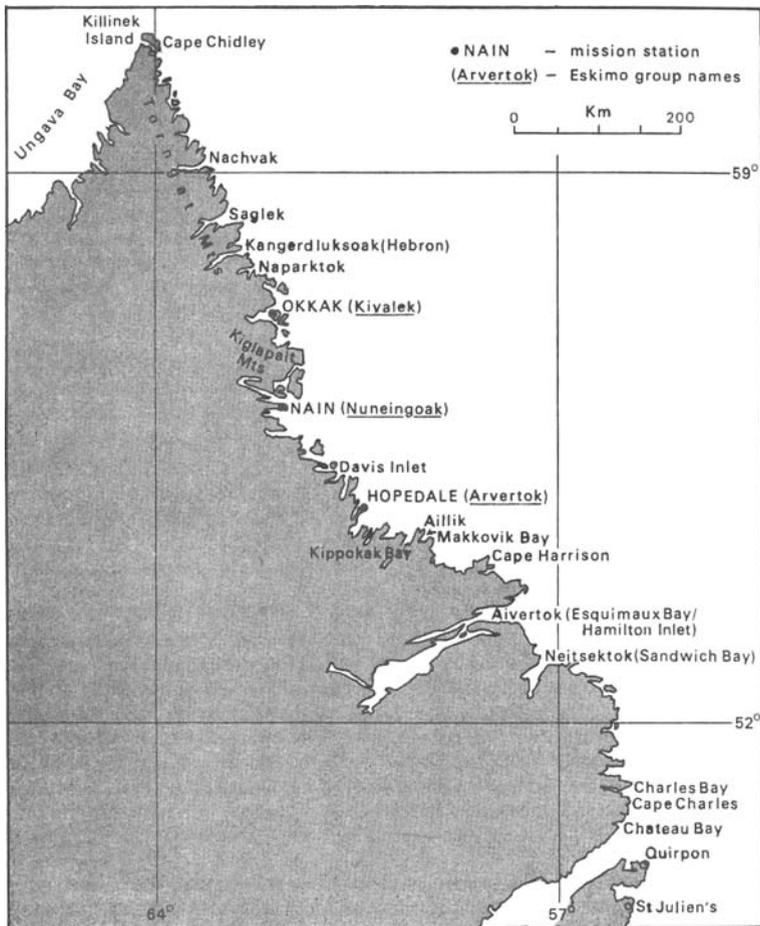


Fig. 2 Map showing the location of the Moravian missionary posts on the coast of Labrador (from Hiller 1971)

it soon became clear that Nain was not an ideal location for a permanent settlement. When the missionaries selected this place for their first station, it was chosen partly because they found several hundred Inuit there. It was not foreseen that this was a summer hunting area which did not provide the Inuit with sufficient hunting possibilities year round (Kleivan 1966, p. 28). The Moravians therefore began to explore further, both to the north and the south, looking for sites for new stations. In the summer of 1776, Jens Haven opened a second post at Okak (sometimes spelled “Okkak”). A third one was opened at Hopedale (the name is a translation of the German “Hoffenthal”) in 1782. Further missions were established at Hebron in 1830, at Zoar in 1865, at Ramah in 1871, at Makkovik in 1895 and finally at Killinek, near Cape Chudley, in 1904. See Fig. 2 for these locations.

The detailed meteorological observations made by the Moravian Brethren in Labrador and elsewhere are to be found in manuscripts kept in libraries and archives in both European and New World locations (see Tables 1 and 2). The data discussed in this paper have been brought to light as a result of numerous searches in these collections. Although this paper concentrates primarily upon instrumental records, it may be noted that there is

Table 1 List of manuscripts of instrumental meteorological observations by Moravian missionaries in the early period known to the authors from the Moravian Archives (M.A.) in Herrnhut, Muswell Hill in London, and in the possession of Cleveland Abbe

Timespan	Location	Observer	Source
Moravian Archives Herrnhut			
Nov 1772–Sept 1773	Wetterbeobachtungen R.15 Ka 8, 1. Nain	Brasen	M.A. Herrnhut Macpherson (1987)
1 Oct 1771–31 Oct 1772	Wetterbeobachtungen in	Brasen, Liebisch &	M.A. Herrnhut
29 Sep 1773–20 Oct 1774	Labrador. Nain	Anonymous	Macpherson (1987)
1 Sep 1775–31 Aug 1781	(M.-Deput.) II.9		
1 Oct 1778–31 July 1781	Okak	Anonymous	M.A. Herrnhut
Moravian Archives Muswell Hill, London			
1 Dec 1775–28 Oct 1779	Nain	Liebisch	Macpherson (1987)
mid Oct 1776–end Aug 1787	Okak	Branagin, Beck, Anonymous	Macpherson (1987)
Manuscripts in possession of Cleveland Abbe in 1873			
1 Oct 1776–31 Aug 1780	Nain	Liebisch	Cleveland Abbe (1873)
1 Sept 1780–31 July 1784	Nain	Krügelstein	Cleveland Abbe (1873)
1 Oct 1778–3 Aug 1782	Okak	Jens Haven	Cleveland Abbe (1873)

also a wealth of qualitative documentary climate data in the Moravian writings and publications. The Moravian climate data have been little used by researchers (however, see e.g. Döll 1937 and Newell 1990) and the sources discussed here not at all. This paper may thus be seen as a contribution to historical climatology; a field of research at the interface of climatology and history that encompasses the tools and methods of these and other related disciplines, but with a primary focus on documentary historical evidence (Brázdil et al. 2005).

2 Timeframe of the meteorological observations

The timeframe of the instrumental meteorological observations made by the Moravian Brethren in Labrador may be divided into four distinct periods. The first covers the period from the earliest observations in 1771 until approximately 1790, and thus corresponds with the time of the *Ancien Régime* in France. For this period, information on the observations is known primarily through two short notes in the *Philosophical Transactions of the Royal Society* (1779, 1781) at London by Benjamin De la Trobe or La Trobe (1726–1786). Monthly extracts of the observations were also published by the natural scientist and astronomer Johann Daniel Tietz or Titius (1729–1796) in a German weekly newspaper, the *Wittenbergisches Wochenblatt*. The notes in the *Philosophical Transactions* remained well known amongst natural scientists in Europe to the mid-nineteenth century, while the publications by Titius were almost completely forgotten. Of relevance here is the fact that the Moravian Bishop and teacher at the theological seminary in Barby, in Saxony-Anhalt, Paul Eugenius Layritz (1707–1788) visited Labrador in the summer of 1773. Layritz held a “visitation” to the Labrador mission, which was said to be “of great benefit to the infant mission” (*Periodical Accounts*, 28, 1871 pp. 1–19; 53–72; Rollmann, s.d.(a) <http://www.mun.ca/rels/morav/texts/brethren.html>). In particular, Layritz recommended the establishment of two missionary stations, one north and one south of Nain, so that the Moravians could reach the Inuit living there. Also, probably as a result of Layritz’s visitation to

Table 2 List of manuscripts of instrumental meteorological observations in Labrador by the Moravian missionaries in the early period located at the Library of the Royal Society, London (Halliwell 1840; Macpherson 1987; and according to the research done by the lead author)

Timespan	Location	Observer or Recorder	Source
Archives of the Royal Society, London			
6 Oct 1776–22 Jul 1777 ^a	Nain		Halliwell (1840) p. 37, XXIX; R.S. MM 10.103
22 Aug 1777–5 Sep 1778	Okak	From M ^f De La Trobe Presented by the President	Halliwell (1840), p. 13 L, LI; R.S. MA 143
22 Aug 1777–10 Sep 1778	Nain	From M ^f De La Trobe Presented by the President	Halliwell (1840), p. 13, L, LI; R.S. MA 143
11 Sep 1778–31 Aug 1780	Nain		R.S. MA 143
11 Sep 1780–31 Aug 1781	Nain	By Mr David Krügelstein to M ^f La Trobe	R.S. MA 143
1 Sep 1781–30 Sep 1782	Nain	Ditto	R.S. MA 143
1 Oct 1782–15 Aug 1783 ^b	Nain	Ditto	R.S. MA 143
1 Aug 1783–31 Jul 1784 ^b	Nain	Presented by the Rev. Mr La Trobe. Feb 3, 1785	R.S. MA 143
1 Aug 1784–31 Jul 1785	Nain	Presented by M ^f Phil Hurlock, F.R.S., 29 March 1787	R.S. MA 143
1 Aug 1785–31 Jul 1786			
Aug 1779–31 Jul 1780	Okkak		R.S. MA 144
1 Aug 1780–31 Jul 1781	Okkak		R.S. MA 144
1 Aug 1781–31 Jul 1783	Okkak		R.S. MA 144
1 Aug 1783–31 Jul 1784	Okkak	Presented by the Rev. Mr La Trobe, 3 Feb 1785	R.S. MA 144
1 Oct 1782–31 Aug 1783	Hoffenthal		R.S. MA 144
1 Sep 1783–31 Jul 1784	Hoffenthal	Presented by the Rev. Mr La Trobe, 3 Feb 1785	R.S. MA 144
1 Sep 1785–16 Aug 1786	Hoffenthal	Ms. in German presented by Mr Phil Hurlock, F.R.S., 29 March 1787	R.S. MA 144

^a This manuscript could not be located during the visit of the lead author to the Library of the Royal Society on 18 October 2006.

^b A short overlap exists between these observations

Labrador, climate-related information for the region is included in a book on the missions of the “Brethren” published in 1774 by Benjamin De la Trobe (under the name La Trobe).

The second period, somewhat less well documented than the first, continues from ca. 1800 to ca. 1882/1883, at which time the first International Polar Year was held. International scientific journals contain fragmented information during this time. However, no clear and complete picture of the observations of the Moravians during this time period is available as yet (see Sections 6.1 to 6.11). However, one manuscript in particular must be mentioned. This is stored at the Moravian Archives in Bethlehem, Pennsylvania, and contains observations on the weather, giving date, barometer and thermometer readings, etc. from May 1872 to July 1873 (Whiteley 1960, s.d.).

The beginning of the third period overlaps with the end of the second, and the information engendered must be seen to a large extent as having its origins and inspirations in the first International Polar Year. Partly as an impetus resulting from this, there was a renewed interest in scientific circles regarding meteorological observations from high latitudes. Thus, for example, the German Polar Commission raised funds for the German

Moravian missionaries in Labrador to equip their six missionary stations with meteorological instruments. During this period, observations were carried out at Nain by Karl Richard Koch (1852–1924) who travelled with the missionary ship and remained during 1882–1883 at the Nain missionary station (see Sections 7.1 and 7.2). Of prime importance during this third period was the work of the *Deutsche Seewarte* or German Naval Observatory (see Section 7.2).

The fourth period begins with the onset of the Second World War when the Canadian Meteorological Service took over observational duties (see Section 7.3).

3 Prelude: Moravian meteorological observations in Greenland

The procedures used in all the early Labrador meteorological observations were based upon those established by Christopher Brasen during his stay in Greenland. These, in turn, originated from the procedures already laid down by Professor Christian Gottlieb Kratzenstein (1723–1795) of Copenhagen, and were carried out with the instruments provided by him. As Brasen was the first Moravian observer in Labrador, the background to his observations, and the procedures used by him, are of interest. Brasen had received training as a physician and surgeon (see *Dienerblatt*, Moravian Archives Herrnhut (Brasen, Christoph [Christopher], 1 p. /Observationes in Grönland A 1767/, *R.15.J.a.No.13q*; contains the meteorological observations carried out in Greenland by Christopher Brasen); Rollmann, *s.d.b*). He travelled as a lay person to Greenland in 1765 and undertook astronomical and meteorological observations in Neu-Herrnhut near Godthåb (present-day Nuuk).

Meteorological observations were carried out at Neu-Herrnhut from 1 September 1767 to 22 July 1768 (with the exception of the period 4 through 24 October 1767—the reason for the gap is not known. Also, no barometric readings were taken in September 1767). During the beginning of June 1768, however, the observations were carried out in Pissiksarbit, located in the mountains approximately 10 miles further inland than Neu-Herrnhut. Brasen's observations are known from several sources: a manuscript catalogued as *R.15.J.a.No.13q* held in the Moravian Archives in Herrnhut (see Fig. 3); a published source by Kratzenstein (1770); the partial publication of the data in the *Historie von Grönland* (1780) of David Cranz, and the nineteenth- and early-twentieth century manuscripts *Afskrift fra Herrnhut i Sachsen 1767–68* (copy from Herrnhut in Saxony 1767–68) and *Afskrift efter Videnskabenes Selskabs Skrifter 1770, 10 Del, Side 373* (copy from the Documents of the Scientific Society 1770, volume 10, p. 373) held in the Archives of the Danish Meteorological Institute (DMI) in Copenhagen. Brasen returned to Copenhagen later in 1768, and subsequently joined the Moravian church in Zeist in the Netherlands in May 1769.

The following sentence, written in German, found at the end of the manuscript noted above, *R.15.J.a.No.13q*, suggests it may be traced to Brasen, or is, at least, a copy of his original manuscript: “This arrangement as well as the weather-glasses I have from Professor Kratzenstein in Copenhagen.” The manuscript also contains the most extensive explanations concerning the procedures for the observations. It may be noted that David Cranz only included a selection of the daily observations; those that reflected large changes in the climatological readings. The Fahrenheit thermometer was read at 8 A.M. in the morning, when the temperature was coldest, and in the afternoon, at 2 P.M., when the temperature was usually warmest. The barometer was expressed in Paris units. The wind direction (given as O, W, S, N, and NO, NW, SO, SW, in other words, East, West, South, North, and Northeast,

Fig. 3 First page of the manuscript R.15.J.a.No.13q containing the meteorological observations carried out in Greenland by Christopher Brasen (courtesy Moravian Archives at Herrnhut, Germany)

R.15.J.a.1 Observations in Greenland 1767
 Aufm 62 Grad 30 Minuten Nord und 52 26 Grad 20 Minuten Längd.

Tag	Zeit	Baro. meter. Fahrenheit	Thermo. meter. Fahrenheit	Wind	Rind	Wetter in Septemb. Monat 1767.
Donst. 4 ^{te}	8 2	Unwetter, Schnee	20 28	N:	0	Wolken, Schnee, Eis.
Mitt. 2 ^{te}	8 2	Falter und Schnee	29 31	N:	2	Falter - Föhn.
Donst. 3 ^{te}	8 2	Sonne.	22 25	N:W:	3	Falter - Föhn.
Freit. 4 ^{te}	8 2		20 25	N:	3	Wolken, Schnee, Eis.
Sonab. 5 ^{te}	8 2		28 22	N:O:	2	Schneeföhn - Föhn.
Sont. 6 ^{te}	8 2		20 25	N:O:	3	Schneeföhn - Föhn.
Mont. 7 ^{te}	8 2		20 25	N:O:	2	Schneeföhn - Föhn.
Donst. 8 ^{te}	8 2		27 22	S:W:	1	Eis - Föhn.
Mitt. 9 ^{te}	8 2		20 25	N:O:	3	Eis - Föhn.
Donst. 10 ^{te}	8 2		20 22	N:O:	2	Eis - Föhn.
Freit. 11 ^{te}	8 2		28 26	N:O:	1	Wolken, Schnee, Eis, Regen, Schnee, Eis, Regen, Schnee, Eis, Regen.
Sonab. 12 ^{te}	8 2		26 22	N:O:	2	Schneeföhn.
Sont. 13 ^{te}	8 2		21 25	N:	2	Schneeföhn - Föhn.
Mont. 14 ^{te}	8 2		22 25	N:O:	1	Schneeföhn - Föhn, Schneeföhn.

R.15.J.a.No.13q.

Northwest, Southeast and Southwest) was also noted, as well as wind strength, and the state of the sky. The strength of the wind was given as a number on a scale ranging from 1 to 6. The definitions are as follows: no. 1 means a very light wind that only ripples the water; no. 2 a topsail breeze, or a light wind in which one may hoist all sails on a ship; no. 3 a marchsail breeze, or a fresh wind where half the sails on a ship must be taken down; no. 4 a strong wind; no. 5 a weak storm; and no. 6 a heavy storm. It may be noted that, just as with the Beaufort scale (defined in 1806) the wind strength corresponding to the numbering scale is given in nautical terms.

4 The early Moravian meteorological observations on the Labrador coast: 1771–ca. 1790

The eighteenth-century instrumental meteorological observations by the Moravian missionaries on the Labrador coast are known from three archival collections: the Moravian Archives in Herrnhut; the Moravian Archives at Muswell Hill, London; the Archives of the Royal Society in London; and, in addition to these, from a nineteenth-century manuscript derived from Cleveland Abbe (1838–1916) an American astronomer and meteorologist (Abbe 1873; Macpherson 1987). The information given in Tables 1 and 2 summarizes the current knowledge regarding the sources; it is possible that other sources may yet be found.

It may be concluded that instrumental meteorological observations were carried out at Nain, Okak and Hopedale from the start of these missions until the 1780s. The thermometric readings were limited to two per day, at 8 A.M. and at 2 P.M., with occasional

readings at odd evening hours, often at 9 PM during the winter months. The station of Nain was the only one where barometric readings were made. In the early period, several thermometers, termed “London”, “Berlin”, and later on, “Barby” were present in the Labrador stations. These names refer to the places of origin of the instruments. Wind strength was given in the six-point scale already used by Brasen and noted above. The state of the sky and the aggregation state of the precipitation was also noted (Macpherson 1987). There is also a statement to the effect that the thermometer, of Fahrenheit scale, was observed at 8 A.M., at noon, at 4 P.M., and at 8 P.M. (De la Trobe 1779). The barometer, whose scale is a French measure known as *pied-du-roi*, was observed at 8 A.M. and at 8 P.M. (see also Cotte 1788, p. 473).

Of these instrumental meteorological observations, two published sources are known. The first one was produced by Benjamin De la Trobe on the basis of the manuscripts, and communicated to the President of the Royal Society in London (De la Trobe 1779, 1781). These extracts were well known in the eighteenth and the early-nineteenth centuries (see, for example, Cotte 1788; Kirwan 1789; Meyer 1830; Kämtz 1832; Dove 1847, 1848).

A second published source is the *Wittenbergsches Wochenblatt*, a weekly newspaper edited in Wittenberg (see Fig. 1) by Johann Daniel Tietz or Titius (Titius 1774 et seq.; Meusel 1815; Poggendorff 1863; Hellmann 1883, 495–496; Folkert 1976). The newspaper is subtitled as follows: *zum Aufnehmen der Naturkunde und das ökonomisches Gewerbes* (“For Use in Natural Sciences and Economic Activities”) thus reflecting the interests of its editor. The existence of the Labrador meteorological observations in the Wittenberg weekly came to the attention of the authors of this paper when searching for evidence of the “great dry fog” of the year 1783 which was caused by the Lakagígar volcanic eruption in Iceland (Demarée et al. 1998; Demarée and Ogilvie 2001).

Table 3 provides a list of the extracts of the instrumental meteorological observations carried out in Nain published in the Wittenberg weekly. In the introduction, Titius mentions that he obtained the weather journal from “learned friends” at the Seminary in Barby, and that Brasen carried out the meteorological observations. He also states that a contact for the information was Johann Jakob Bossart (1721–1789) teacher at the Moravian Seminary in Barby. Regarding the instruments and the procedures, Titius states that the barometer is

Table 3 Inventory of the eighteenth-century meteorological observations at Nain in Labrador carried out by missionaries of the Moravian Brethren as published in the *Wittenbergsches Wochenblatt* by Johann Daniel Titius

Date of Publication	Volume	Pages	Period of the observations	Observer
24 June 1774	25	201–206	October 1771–October 1772 Nov 1772–Sep 1773 Missing in the <i>Wittenbergsches Wochenblatt</i>	Brasen
27 Dec 1776	52	416–420	October 1773–October 1774 Nov 1774–16 Sep 1775 No observations carried out (?)	Brasen (died Sept 1774)
12 Sept 1783	36	281–286	17 September 1775–December 1776	Liebisch
19 Sept 1783	37	289–296	January 1777–December 1778	Liebisch
26 Sept 1783	38	297–302	Corrigendum: March 1777 January 1779–December 1779	Liebisch
24 Oct 1783	42	329–335	January 1780–December 1780	Krügelstein
29 April 1785	17	129–135	January 1781–December 1781	Krügelstein
27 May 1785	21	161–166	January 1782–December 1782	Krügelstein
19 May 1786	20	153–159	January 1783–December 1783	Krügelstein

expressed in Paris inches and lines, the thermometer has a Fahrenheit scale, and that wind strength is expressed in a six-point scale (as described above). Besides the extreme readings of the minimum and the maximum temperature and pressure, a brief monthly weather description is given. The observations began in October 1771 (published in 1774) and continued until December 1783 (published in May 1786). The publication of the series in Titius' newspaper was interrupted during the period November 1774 until September 1775. This resulted from the fact that Christopher Brasen lost his life on 15 September 1774 when his boat was shipwrecked on a reconnaissance trip north of Nain. The exploratory trip had been carried out following the recommendations of the Moravian Bishop, Paul Eugenius Layritz, (see Section 2 above).

Figure 4 shows the monthly maximum and minimum temperatures and atmospheric pressure for the data at the station Nain as published in the *Wittenbergsches Wochenblatt*. It is noted that many of the data published in the Wittenberg weekly correspond to those published in the *Philosophical Transactions* by Benjamin la Trobe. Minor differences occur between the two published series but it is assumed that they are due to errors in the manual selection procedures for the maximum and the minimum or are merely editorial errors. However, in short, the climatological data of Labrador published by the natural scientist

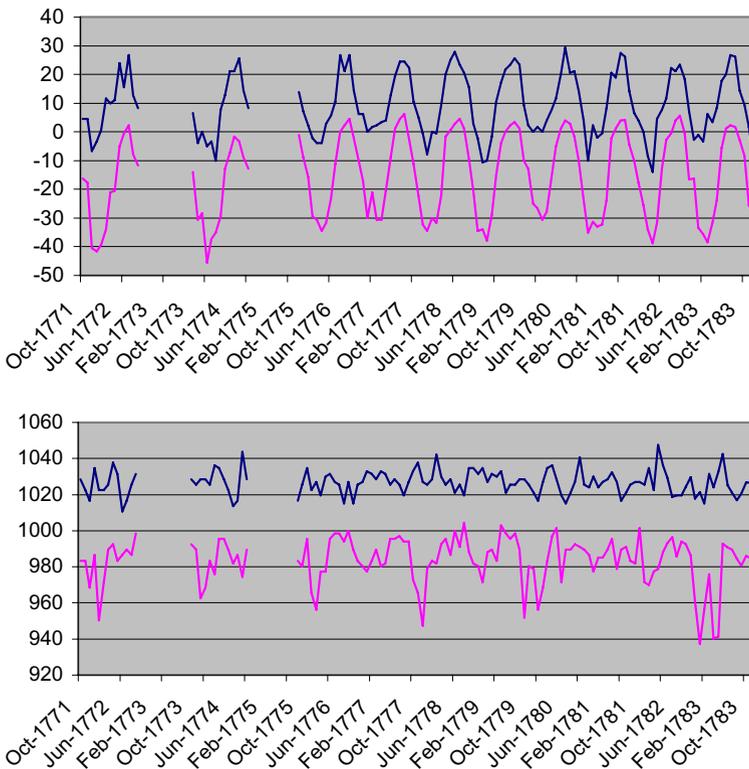


Fig. 4 Monthly maximum and minimum temperature ($^{\circ}\text{C}$) in the upper diagram, and monthly maximum and minimum atmospheric pressure (hPa) in the lower diagram, at Nain in Labrador as published in the extracts in the *Wittenbergsches Wochenblatt* by Titius. The original data have been converted into modern units from the published record. A preliminary comparison with modern data did not reveal any large systematic differences

Titius in his *Wittenbergsches Wochenblatt* are a very valuable source of information which, until now, have hardly been made use of by historical climatologists.

5 Nineteenth-century Labrador meteorological observations in missionary journals

In the early part of the nineteenth century, missionary journals (called *Missionsblätter* in German) began to be published. Figure 5 shows the front cover of such a journal. These had several functions. They provided a means of communication between the Moravian churches in Europe and their missionaries abroad. They also served to inform the public regarding the missionary work. Furthermore, they publicised the raising of funds and the collection of gifts and other goods for the benefit of the overseas missionary endeavours. Such items were shipped with the missionary vessel on its annual journey to the Labrador coast.

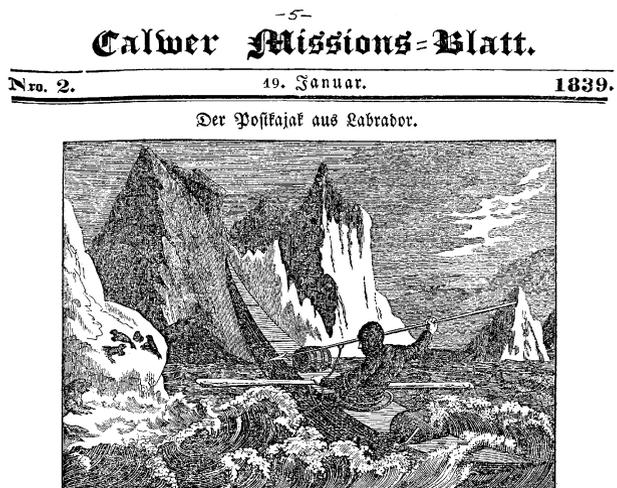
Through the journals, the missionaries were also able to keep their churches in Europe informed of the advances of their work among the “heathen”. Perhaps in an attempt to broaden the content of the journal and thus maintain the interest of readers in the homelands, secular information was also included on topics such as the conditions in the country, and details of climate and weather. At the time, information on climate and environment in northerly countries such as Labrador and Greenland was of great public interest.

The missionary journals were conveyed to Europe by means of the Moravian vessels that visited the Labrador stations in the summer of each year. For this reason, the meteorological manuscripts are organised in “ship-years”; approximately from July of one year to August of the next. The exact day in which this period began or ended each year varied according to a number of conditions, among them the pack ice and the meteorological conditions encountered crossing the Atlantic Ocean.

6 Nineteenth-century Labrador meteorological observations in scientific journals

Throughout the nineteenth century, the Moravian missionaries continued making meteorological observations using both old and new instruments, and the resulting

Fig. 5 The front cover of a missionary journal dated 19 January 1839. The title of the picture is *Der Postkajak aus Labrador* “The Labrador Post Kajak”



information was published in a number of scientific journals. These are listed in Table 4. In the last column of the table, the name of the contact person, usually someone either from, or related to, the *Unitas Fratrum*, is given whenever known. Explicit mention regarding the forwarding of thermometers and barometers to the Moravian missions is to be found in both missionary and scientific journals. Further information on the individual journals may be found below.

6.1 *Annalen der physik* edited by L.W.Gilbert

The journal *Annalen der Physik* (Annals of Physics) was published by Ludwig Wilhelm Gilbert (1769–1824) Professor of Physics and Chemistry at Halle, in Saxony-Anhalt

Table 4 List of instrumental meteorological observations published in scientific journals of the nineteenth century

Timespan	Observer/location	Journal	Editor	Location of editing	Contact person
1790–1801	Hopedale, Okkak, Nain	<i>Annalen der Physik</i> (1803)	L.W. Gilbert	Halle	?
1790–1801	Hopedale, Okak, Nain	<i>Magazin für den neuesten Zustand der Naturkunde</i> (1805)	J.H. Voigt	Weimar	?
1829–1830	Okak, Nain	<i>Archiv für Chemie und Meteorologie</i> (1831)	K.W.G. Kastner	Nürnberg	?
1831–1832	J.S. Meisner (Hopedale) J. Lundberg (Nain)	<i>Neueste Nachrichten aus dem Reiche Gottes</i> (1833)	Elsner, Sam & Nicolai	Berlin	?
1831–1832	J.S. Meisner (Hopedale) C.G. Albrecht (Hopedale) J.P.C. Stock (Hebron)	<i>Archiv für Chemie und Meteorologie</i> (1833)	K.W.G. Kastner	Nürnberg	?
1837–1838	C.B. Henn (Nain)	<i>Bulletin scientifique de l'Académie impériale des Sciences de Saint Pétersbourg</i>	Anonymous	Saint Petersburg	v. Struve
1841–1842	Nain, Hebron, Hopedale	<i>Annalen für Meteorologie, Erdmagnetismus</i> , (1842)	J. Lamont	München	Schubert
1842–1843	C.G. Albrecht (Nain) Hebron	<i>Annalen für Meteorologie, Erdmagnetismus</i> , (1843)	J. Lamont	München	Schubert
1845–1852	Nain, Hebron, Okak	<i>Monatsberichte der Königliche Preussische Akademie der Wissenschaften</i> (1854)	H.W. Dove	Berlin	Lamont (München)
1859–1860	Hopedale ? Hebron ?	<i>Bulletin de la Société de Géographie de Genève</i> (1860 & 1862)	Anonymous	Geneva	Micheli (?)
1866–1867	Okak, Hopedale, Hebron, Nain	<i>Wochenbericht. München königliche Sternwarte</i> (1866–1868)	J. von Lamont	München	Gundert (Calw)

The contact person between the Moravian community and the Editor of the Journal is noted whenever this is known. The dates given in the column to the far left reflect the observational time period covered

(Germany). The volume published in 1803 is of particular interest as it contains weather observations in Greenland and “Terra Labrador” (often used in the eighteenth and nineteenth centuries as an alternative name for Labrador) for the years 1790 to 1801 (Gilbert 1803). In the extracts dealing with Labrador and Greenland, it is not stated who the contact person was, nor where the climate-related material was taken from. However, the text also refers several times to David Cranz’ *Historie von Grönland* (1780) noted in Section 3 above. Weather information from the *Annalen der Physick* may be found in Appendix 2.

6.2 *Magazin für den neusten zustand der naturkunde*

In his *Magazin für den neuesten Zustand der Naturkunde* (Journal for the Latest Information in the Natural Sciences) Johann Heinrich Voigt (1751–1823) Professor of Mathematics and Physics at the University of Jena, Thuringia (Germany) published meteorological extracts from Greenland and Labrador (Voigt 1805). Just as in the case of Gilbert (1803) no further information on the sources used is mentioned. The two texts do not differ significantly in content; however, the German phrasing is slightly different. This suggests the likelihood of an English-based common origin.

6.3 *Archiv für die gesammte naturlehre—archiv für chemie und meteorologie*

The double-titled journal *Archiv für die gesammte Naturlehre—Archiv für Chemie und Meteorologie* or “Archive for the Entire Natural Sciences—Archive for Chemistry and Meteorology” was edited by K.W.G. Kastner in Nürnberg. In 1831, and again in 1833, this scientific journal published meteorological information extracted from letters of Moravian missionaries in Greenland and Labrador (Kastner 1831, 1833). It appears from a brief note that the missionary journal *Neueste Nachrichten aus dem Reiche Gottes* “Latest news from the Kingdom of Heaven” is the source of the information of the published extracts on the winter of 1831/1832. Examples from this journal are given in Appendix 3.

6.4 *Annalen für meteorologie, erdmagnetismus und verwandte gegenstände*

The astronomer Johann von Lamont (1805–1879) also styled Johann Lamont, from Munich, edited the journal *Annalen für Meteorologie, Erdmagnetismus und verwandte Gegenstände* or “Annals of Meteorology, Terrestrial Magnetism and related Subjects” in 1842–1844. Volumes 1842 (no. IV) and 1843 (no. VIII) both contain instrumental meteorological observations from the Moravian stations in Greenland and Labrador. The information was communicated to the Editor of the Journal by “Hofrath Schubert”. This person has been identified as Dr Gotthilf Heinrich von Schubert (1780–1860) *Hofrath* (Counsellor) and Professor in Natural Sciences at the University, first at Erlangen and later in Munich.

In a note, Lamont explains in the Journal that no information is available regarding the instruments used, so that the results, for the time being, cannot be considered as absolute determinations. He is also pleased to announce that, for the coming years, complete observations from Greenland and Labrador may be expected. The following meteorological information is published in the 1842 volume:

At Nain: monthly means of the temperature (°R) in the morning (6, 7 or 8 A.M.), at noon, and in the evening (4, 5, or 6 P.M.), and monthly minimum and maximum barometric readings, for the months September 1841 till July 1842. Some qualitative weather

information is also given. At Hebron: mean monthly air temperature (no mention of the observation hour) from August 1841 till July 1842. The observations were carried out with a Fahrenheit scaled thermometer and reduced to the Réaumur scale. The coldest reading was on 15 February [1842]¹ the thermometer indicating -30.6°R (-38.3°C); the warmest was on 28 August [1841] with 14.6°R (18.3°C). At Hopedale: monthly minimum and maximum readings for temperature and atmospheric pressure from September 1841 to July 1842 are given, as well as some qualitative data.

The volume for 1843 contains similar information. At Nain, with the missionary Carl Gottfried Albrecht as observer, monthly-mean temperature ($^{\circ}\text{R}$) in the morning (5, 6, 7 or 8 A.M.), at noon (only August 1842), and in the evening (4, 5, 6 or 7 P.M.), for the months August 1842 to June 1843. At Hebron, monthly means of temperature (morning, noon and evening), for the months September 1842 to July 1843, followed by a few notes on the weather. The Nain observations, however, also give more detailed information on the wind directions and the weather. From the published information, it seems that the instruments forwarded from the Munich observatory were not yet in use at this time.

6.5 Monatsbericht der königlich-preussischen akademie der wissenschaften zu Berlin

The many search parties for the tragic lost expedition of Sir John Franklin (1786–1847) had the positive result that they considerably augmented the documentation of meteorological observations in Arctic areas. In this context, Heinrich Wilhelm Dove (1803–1879) German meteorologist and head of the Royal Prussian Meteorological Institute, made a presentation in 1854 to the Royal Prussian Academy of Sciences in Berlin on the temperature at the coasts of Greenland, Labrador, and the newly discovered Arctic lands. The data from Dove's presentation were published, also in 1854, in the *Monatsbericht der Königlich-Preussischen Akademie der Wissenschaften zu Berlin* (Monthly Reports of the Royal Prussian Academy of Sciences at Berlin) of which Dove had become a member in 1837. The relevance of Dove's publication is that, for the first time in the nineteenth century, a medium-term temperature time series was published for these regions. The actual originator of the series, Johann Lamont, unfortunately did not publish very many of the Greenland and Labrador data in his possession (see also Sections 6.4 and 6.8).

However, through the courtesy of Lamont, Dove obtained medium-term series from missionaries in Greenland and Labrador that cover the timespan 1841–1852. "Average" monthly values for the reference period 1845–1852 are given for the Moravian Labrador stations Nain, Okak and Hebron (Fig. 6). The averages are based upon the following observations at Nain: 7–8, 12, 4–5 1/2 from July 1841 to July 1852; at Hebron: 6–7, 12, 6–7 from September 1842 to August 1848. It may be assumed that a part of these observations were carried out with the instruments forwarded by Lamont (see also Section 6.4). No clues are provided regarding how the reduction was done. Monthly deviations are given for the stations Nain and Hebron.

6.6 Bulletin scientifique de l'academie imperiale des sciences de Saint Petersburg

The Moravian missionary Christian Benedict Henn (1780–1845) served in Nain and in Okak between 1819 and 1840. Henn communicated with "v. Struve", Russian imperial Minister-Resident in Hamburg and honorary Fellow of the Imperial Academy at Saint

¹ Square brackets are used throughout this paper to denote that a date has been inserted by the authors for clarity, or, in the case of a reference, to indicate an assumption of authorship.

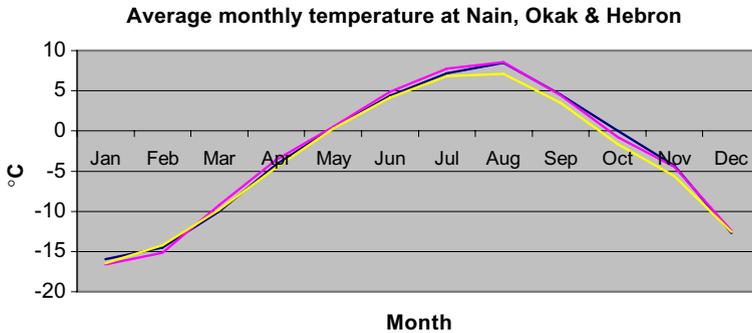


Fig. 6 Average monthly temperature (°C) at the Moravian missionary stations Nain (blue line) Okak (magenta line) and Hebron (yellow line) according to Dove (1847). The reference period is 1845–1852

Petersburg. Documentary climate data including temperature observations concerning the ship-year 1837–1838 were published in the *Bulletin scientifique* of the Academy (Henn 1839; Thomas 1961).

6.7 Bulletin de la société de géographie de Genève

The *Bulletin de la Société de Géographie de Genève*, “Bulletin of the Geographical Society of Geneva” contains two anonymous contributions with fragmentary climatological information on Labrador (Anonymous 1860, 1862). These data must have been provided by an enthusiastic member of the newly created *Société de Géographie de Genève* who was in communication with the missions in Labrador. Based on later evidence (see Section 6.9) the name of J.L. Micheli is suggested (Micheli 1846, 1857, 1869). The articles appear to deal with the ship-year 1859–1860 and are quoted in Appendix 4.

6.8 Wochenbericht königliche sternwarte München

Johann von Lamont (see also Sections 6.4 and 6.5) mentions in the *Wochenbericht Königliche Sternwarte München* (Weekly Reports of the Royal Observatory, Munich) that he obtained climatological data from Greenland and Labrador through the courtesy of a Mr Gundert at Calw in Württemberg (Lamont 1866–1868). This is Hermann Gundert (1814–1893) who had worked as a missionary and linguist in Malabar, south India (Frenz 1998). On his return to Germany, he became a collaborator of the *Calwer Verlagsvereins* (a publishing house in Calw specializing in religious materials) and took charge of it in 1862 (Bautz 1990). Lamont described these observations as a continuation of the previous set and results, and states that new findings will be published shortly. Unfortunately, Lamont published few results. However, according to his notes in the *Wochenbericht Königliche Sternwarte München* observations of atmospheric pressure (inches and lines), temperature (degrees), wind direction, and state of the sky, were undertaken three times per day at the Moravian stations of Nain, Hebron and Hopedale.

Only monthly and seasonal wind information, the eight principal directions and the case of no wind, are printed for the period August/September 1866 to July/August 1867 for the stations Nain, Hebron and Hopedale. Lamont concludes briefly that the peculiarities of the Arctic region, with the modifications that are mainly due to the exposure of the coast, become evident.

Recently, Lamont's vast collection of meteorological manuscripts of the Moravian missionary stations in Labrador (and in Greenland) was re-located and described by Cornelia Lüdecke (2005) and is now at the Technical University of Munich (TUM) at Freising. Lüdecke provides the following inventory of stations in Labrador (Table 5).

6.9 Archives des sciences physiques et naturelles

Jean-Alfred Gautier (1793–1881) mathematician and astronomer at the Geneva observatory, is the author of a group of papers dealing with the Labrador climate. Gautier writes that he obtained climatological information from Jean-Louis Micheli who maintained a long-term correspondence with the Moravian missionaries in Labrador, and even with “christened and civilized” Eskimos (Gautier 1870, p. 135–136; see also 1876, 1877). This channel was used by Gautier to send thermometers made by a Mr Maurer, at the Geneva observatory, to the missions in Labrador. The meteorological records from the Moravian missions in Labrador forwarded to Gautier cover the period from September 1867 through July 1876, spanning a period of 9 years. The condensed meteorological observations were published by Gautier in the scientific journal from Geneva, *Archives des Sciences physiques et naturelles* (Physical and Natural Archives of Science); see Fig. 7.

Gautier's manuscript correspondence contains an entry by Cleveland Abbe on the Labrador meteorological records dated 27 May 1875. He writes that: “He has seconded by purchase of an antiquarian book dealer a manuscript which seems to be the collected duplicate copies of these original observations 1776–1784” and asks Professor Gautier “if he will kindly refer him to the paper and volumes where they are found” (Gautier s.d.). Despite an extensive search, it has not yet been possible by the authors to locate the meteorological manuscripts used by Alfred Gautier. An inventory of the published data is given in Table 6.

6.10 Reports of the meteorological service of the dominion of Canada

The Meteorological Service of Canada was established in 1871 under the Dominion Government (Thomas 1991). Although the Moravian mission stations do not figure in the list of the stations under the responsibility of the Meteorological Service of Canada, several meteorological tables with data from the mission stations are published in the Annual Reports by the Superintendent (Kingston 1879, 1881; Carpmael, 1882, 1884). The only mention of their origin accompanies the first published meteorological tables of a Moravian station—*The Table of this page has been compiled at Toronto from a register kindly furnished by Mr Scott, Secretary of the British Meteorological Office*. The observations were carried out by Samuel Weiz, Moravian missionary in Labrador from 1850 to 1884 (Rollman, s.d. c). It is clear from the comment that the manuscript contained twice daily meteorological observations carried out at 9 A.M. and 9 P.M. at the station Ramah. The extremes of temperature (in Fahrenheit) are the highest and lowest values at the given

Table 5 Inventory of Lamont's collection of meteorological records of Labrador at the Technical University of Munich (TUM) at Freising according to Lüdecke (2005)

Station	Years
Hebron	1842–48, 1856–66, 1871–72
Nain	1841–1865
Okak	1843–1866
Hoffenthal	1852–1872

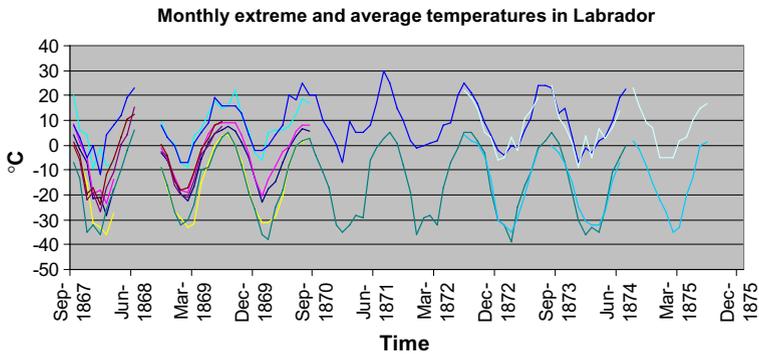


Fig. 7 Reduced meteorological observations of temperature (°C) in the Labrador missionary stations as published by Gautier in Geneva. The *top* and *bottom lines* are the monthly extreme data while the middle curves are the monthly means

observation hours. More detailed meteorological tables are published for the years 1880, 1881 and 1882. Table 7 provides a list of the meteorological tables and the climatological variables at the missionary stations as published in the Reports.

6.11 Smithsonian contributions to knowledge

In 1876, Charles A. Schott from the Smithsonian Institution summarised the meteorological information on temperature at the Hebron, Nain and Okak Moravian missionary stations as known around 1875. This information is almost solely based upon the data provided by De la Trobe (1779, 1781) see Section 2; Dove (1847, 1848 and 1854); and a climatological table in Prout (1845).

7 Labrador meteorological data from the international polar year 1882–1883 to the twentieth century

7.1 The international polar year 1882–1883

A great impetus to the knowledge of Arctic and Antarctic regions was given by the projects of the International Polar Year 1882–1883. At this time, Charles Carpmael, Superintendent of the Meteorological Service of Canada, was requested by the International Polar

Table 6 List of the Moravian meteorological observations published in the *Archives des Sciences physiques et naturelles* in Geneva by Alfred Gautier

Timespan	Observers' location	Year of publication	Editor of journal	Contact person
1867–1869	Hebron Hopedale	1870	Alfred Gautier	J.L. Micheli
1869–1874	Hopedale	1876	Alfred Gautier	J.L. Micheli
1870–1871	Zoar			(died 1876)
1869–1870	Hebron			
1872–1874	Weiz (Ramah)			
1874–1876	Weiz (Ramah)	1877	Alfred Gautier (died 1881)	?

Table 7 List of the meteorological observations at the Moravian mission stations in Labrador as published in the reports of the meteorological service of the dominion of Canada

	Ramah	Ramah	Nain	Okak	Okak	Okak	Hopedale	Hopedale
	Monthly	Monthly	9 A.M. 9 P.M.	9 A.M. 9 P.M.	9 A.M. 9 P.M.	9 A.M. 9 P.M.	Daily at noon	Daily at noon
	1878	1879	1880 I. I–1.II	1880 19. VIII–31.XII	1881	1882	1881 11. IX–31.XII	1882 1. I–29.VIII
Temperature	X	X					X	X
Extremes	X	X						
Amount of cloud	X	X					X	X
Direction wind	X	X	X	X	X	X	X	X
Estimated wind force	X	X	X	X	X	X		
Amount of precipitation	X	X						
No fair days	X	X						
No auroras	X	X						
No fogs	X	X						
Atmospheric pressure			X	X	X	X	X	X

Commission to support the international scientific cooperation by opening posts in the northern region of Canada for 1-year observations, commencing in the autumn of 1882. It was argued that, as Canada had a large territory in northern latitudes, it would benefit directly from the research, furthermore, with relatively small expense (Carpmael 1882, p. xii).

The German Polar Commission contributed to the International Polar Year with two projects in the Arctic. One involved undertaking meteorological and magnetic observations at Kingua Fjord (now Clearwater Fjord) on Baffin Island at the head of Cumberland Sound. This contribution was justified on the grounds that it provided information for the area between Greenland and Canada. The lack of this had previously made it impossible to construct synoptic weather maps for the North Atlantic Ocean and for the Polar area (Neumayer and Børgen 1886; Supan 1887; Neumayer 1890/1891). For the second project, the Commission took advantage of the presence of the German Moravians at the six Labrador mission stations and dispatched Karl Richard Koch (1852–1924) a German scientist, to stay one year on the Labrador coast with the Moravians. Koch travelled in July 1882 with the mission ship *Harmony*, and was able to take advantage of the coastal travel of the ship to the different mission stations. He made use of the opportunity to instruct the missionaries as to how to use the meteorological instruments so that they could carry out observations over the coming ship-year. Koch himself undertook the observations at the station Nain.

It is strange that nowhere in the German reports is any mention made of the previous meteorological observations carried out by the Moravian missionaries, even though there had been publications on the topic in the international literature. Koch reported on his travels, his stay in Labrador, the country and its inhabitants (Koch 1884, 1891a) and on the auroras observed (Koch 1891b, ca. 1884). Samuel Weiz, noted above in Section 6.10, provided a list of the animals (mammals, birds, amphibians, fish) in Labrador (see Neumayer 1891). The German Polar Commission was grateful to the Moravian missionaries for their efforts during the First International Polar Year not least because

the missionaries continued their meteorological observations and forwarded these records to the German Naval Observatory (*Deutsche Seewarte*).

7.2 The German naval observatory (*Deutsche seewarte*)

The *Deutsche Seewarte* or German Naval Observatory was founded in 1874 and was directed from 1876 to 1903 by Georg von Neumayer (1826–1909) who did much to foster research in the regions of both the north and the south poles (Ehlers 1999). He was also one of the initiators of the International Polar Year 1882–1883 (Schröder and Wiederkehr 2001). With further impetus arising from the German contribution to the Polar Year, the *Deutsche Seewarte* fostered long-lasting cooperative research and continued to provide support to the German missionaries at their Labrador stations for their meteorological observations. The information engendered was kept at the *Deutsche Seewarte* in Hamburg and partly published in their publication *Deutsche Überseeische meteorologische Beobachtungen* “German overseas meteorological observations”. As an example, the published meteorological information from the station of Nain is summarised from September 1882 to 1907 (*Deutsche Überseeische meteorologische Beobachtungen*, XVII, p. 1). Renewed interest in the meteorological observations carried out by the German Moravian missionaries resulted in extracts in a variety of geographical and meteorological journals. However, these short notes merely consist of condensed meteorological material (Hann 1883 *et seq.*; Supan 1887, 1889; Brooks 1919; Connor 1938).

More noteworthy, however, are two other studies published by the *Deutsche Seewarte* based upon the observations of the Moravian missionaries in Labrador (and held in their archives). The first one consists of a Ph.D. thesis from the Ludwigs–Universität Giessen (Döll 1937). This publication contains tables of monthly reduced climatological variables of the missionary stations for the reference period starting with the International Polar Year 1882–1883 to 1902. Figure 8 shows the observed extremes of the temperature at the station Nain for the reference period 1882–1902 based upon Döll’s tables.

A second, and final, study published by the *Deutsche Seewarte* deals with the meteorological observations in Labrador during the Second International Polar Year 1932–1933, and immediately after (Baumbach 1940). The publication consists of a text of ten pages with photographs provided by the Moravian Missionaries, as well as monthly meteorological tables for Makkovik (October 1932–July 1934) and Nain (January 1932–July 1933).

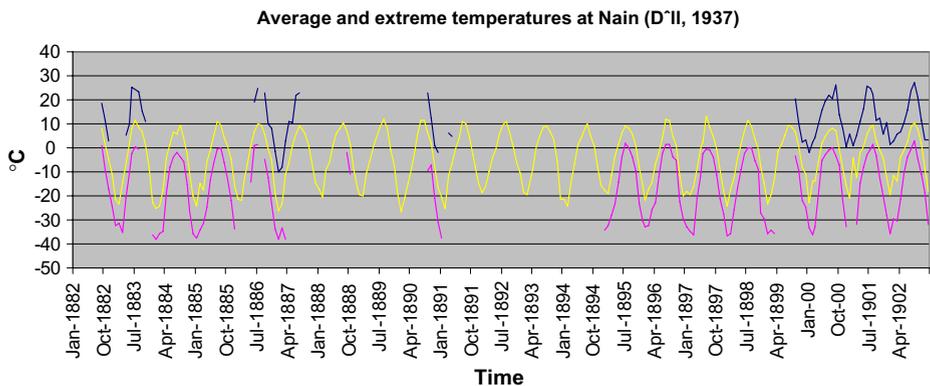


Fig. 8 Fluctuations of the mean (average of the 8 A.M., 2 P.M. and 8 P.M. observations) and extreme (observed at 8 A.M. and 8 P.M.) temperatures (°C) based upon tables by Döll (1937)

7.3 Establishment of the meteorological service of Canada

Baumbach's publication (1940) signals the end of the old and the beginning of the modern era of observations in Labrador. In 1939, in the prelude to the Second World War, the Canadian authorities took over meteorological observations on the Labrador coast for obvious strategic reasons. After the war, significant changes took place in Labrador as well as in the missions of the Moravian Brethren and brought to an end 170 years of the transmission of meteorological information from the Labrador coasts to the Moravian centres in Europe. The last Moravian missionary left Nain in 2005 (*Nunatsiavut*, 10, 3, May–June 2005, p. 19).

The Moravian meteorological data do not appear to have been well known by the Meteorological Service of Canada. Thus, for example, Connor (1938, p. J 334) in his brief history of the meteorological observations in Canada, implies that the observations in Labrador by the Moravian missionaries only began at the time of the First Polar Year 1882–1883 (however, his work does contain tables showing some older temperature data for the Moravian stations). In a more recent work on the history of Canadian meteorological observations by Thomas (1991) it is stated: "The oldest surviving meteorological records from the province of Newfoundland are from observations taken on the Labrador coast at Hebron, Nain, and Okak by Moravian Missionaries beginning in 1777. Abstracts of these data, prepared by Schott, were published in the Smithsonian *Contributions to Knowledge* volumes of 1876 and 1881. These records are generally fragmentary, but a series of these data began during the 1882–1883 International Polar Year and is partially complete for the following thirty years." Both extracts serve to show how little has been known of the efforts of the Moravian missionaries in the field of meteorological observations in Labrador.

8 Conclusions

There can be no doubt that the meteorological observations carried out since the early 1770s on the coast of Labrador/Nunatsiavut by the missionaries of the *Unitas Fratrum* or Moravian Brethren form an extremely important contribution to historical climatology. However, numerous gaps in the observations as well as the frequent and not always well-documented changes in location, procedures, instruments, observation hours, reduction formulas, as well as environmental changes, make it difficult to proceed directly from the data to the construction of long-term homogeneous time-series. A preliminary comparison with present-day climatic observations suggested no systematic differences between the early instrumental observations of the eighteenth and nineteenth centuries and those of the twentieth. Clearly, much further work is required. The purpose of this paper is to highlight the valuable contribution to the meteorological and climatological sciences by the Moravian Brethren and to honour the missionaries who, often under harsh climatic and other difficult conditions, contributed so much to knowledge of changes in climate and environment in Labrador.

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Preußischer Kulturbesitz; Scott Polar Institute, Cambridge; Maurits Sabbebibliotheek, Katholieke Universiteit Leuven, Louvain; Trinity College, Dublin, and the Library of the Royal Society, London. Astrid Ogilvie acknowledges support from the US National Science Foundation grants 0629500 and 0638897. Last, but not least, the authors thank the *Climatic Change* reviewers for their thorough critique.

Appendix 1

Extract of weather observations from the Journal of the Brethren, Jens Haven and Christian Andreas Schloezer (*Account of the Voyage of the four Missionaries 1765*; Lysaght 1971)

July 26th We weighed anchor early in the morning & sailed out of Pitts Harbour with a fair wind.

July 26th We sailed through a multitude of Ice-Islands both to-day & yesterday.

July 28th We met a large Field of Ice through which at length we found a passage but were very much incommoded with small drift Ice, so that we were obliged to lay to in the night.

July 29th We saw Land, but durst not venture too near it on account of the foggy weather.

August 7th It continued Foggy & still more so at Sea....About 9 o'clock in the evening...the Fog continued at Sea, but here it was quite clear.

August 14th We had a strong wind at N.E. with Fog & Rain which continued till the August 17 when at noon it snowed; soon after the wind abated ...

Appendix 2

Weather information from the *Annalen der Physick*

During the winter of the year 1790, there was much snowy weather in Labrador, accompanied by strong frosts, so that the Fahrenheit thermometer often indicated 30 to 36° below zero. At Hopedale, the thermometer showed −40° on January 6th [1790]. The bay of Nain was only free of ice in the beginning of August. On 2 August [1790] there was a lot of lightning in the night. The Eskimos for whom this was somewhat strange awoke the missionaries as they believed that the house was on fire.

At Okkak, at the end of May [1791], the snow in the garden of the missionaries was still packed nine to ten feet high so that they have been forced to shovel it in order, finally, to be able to sow something. At the church, on 17 [May 1791] the snow still lay twenty feet high on one side and pushed so strongly against it that it leaned to one side. On 24 June only [1791], the beach was full of ice, after which it disappeared in one night. Also at Nain, the weather in June [1791] was very wintry, and even on 2 July [1791], the Eskimos caught 5 seals on the ice, and still rode with sledges around on it. The next day, the ice broke up, and on 5 July [1791], the first kayak was launched.

In Okkak the weather was as mild in January [1792] as one could ever remember. The thermometer rose several times above freezing point. The cold began in February [1792]. On the 3rd, the thermometer read −16°, and on the 5th −23°F. Around the middle of July [1792], it was very warm here. The Fahrenheit thermometer rose to 92°.

On 8 February [1793], the Fahrenheit thermometer indicated -34° . The cold was so sharp that the missionaries did not dare to go outside.

In Labrador, the winter months of this year [1794] seem not to have presented anything unusual.

In Labrador it was extraordinary nice weather the whole second half of January [1795]. At Nain, one could not remember having had such good conditions in this season. Everyday there was sunshine, no wind at all, and the cold very moderate. In the night from 4 to 5 August [1795], there was, for this country, a very heavy thunderstorm, with strong downpours, as in Germany.

In Labrador, an extraordinary cold prevailed during the whole month of January [1796], and the Fahrenheit thermometer stood steadily between -15 and -28° . By the end of July [1796], one did not know how to hide from the great heat. The Fahrenheit thermometer showed $+85^{\circ}$. By the end of August, the summer closed at once with a heavy thunderstorm. From this time the winter was changeable in the months September till December.

In Labrador, the cold became so severe in January [1797] that the thermometer in Okkak stood at -36°F and remained as such for the whole month of February. In this most northerly place, the heat this year rose to the highest point, namely $+76^{\circ}\text{F}$.

In Terra Labrador a cold frost persisted in the first months of the year [1798]. The temperature dropped at Okkak to -30°F , and at Nain even on 2 May [1798] to -23° . Once, such a heavy snowfall occurred in Okkak that the snow blown from the mountains lay 20 feet high around the houses and reached the roof of the church. A European woman deceased in this winter, had to be buried in the snow for the time being, and one could only bury her properly in the spring. The summer [1798] was not so hot as the one of the previous year; however, the Fahrenheit thermometer rose at Nain to 70° , and still some degrees higher. Afterwards, a great change followed, in the lapse of half an hour, the thermometer dropped from this elevation some 30 degrees, and on the next days the sea was covered with a thin layer of newly frozen ice between the ice floating around.

The summer [1799] was mostly harsh and like winter. On 10 June [1799], a quarter of an ell (approximately 58 cm) of snow fell, and the bay near Nain became totally free of ice only at the end of this month. Nearly all potatoes froze. In Okkak, the snow started to melt in the country; yet shortly afterwards it snowed again, and on the 24th two sledges with Eskimos arrived on the ice. At the end of June [1799], it froze again so strongly that the whole bay near Okkak was covered in one night by a thin crust of ice. Also many garden plants froze and the largest part that remained have been eaten by mice or birds. On 11 August [1799], the whole coast near Okkak and the sea, as far as one could see from there, was still covered with ice. In the winter months, the weather was mild. On 12 November [1799], one saw at Nain and at Hopedale, a remarkable apparition, which was also dreadful for the Eskimos. Namely, by daybreak, very many *fireballs*, some of them having a diameter of half an ell, flew in all directions to the earth. This phenomenon was noticed, *at the same time*, at Neu-Herrnhut and at Lichtenau in Greenland (at a distance of approximately 100 miles, over the Davis Strait). One can conclude, to some extent, on the height of the region, in which this meteor was produced.

Appendix 3

Weather information from *Archiv für die gesammte Naturlehre*

Archiv für Chemie und Meteorologie or “Archive for the Entire Natural Sciences—Archive for Chemistry and Meteorology”.

Near Okkak, the netfishing from 2 until 30 August appeared to be more favourable than ever; more than 1,100 seals were caught in the same neighbourhood.

At Kangerdluak [Kangirsujjuak], the missionary Ferdinand Kruth [Moravian missionary in Labrador from 1830 to 1863] found at his arrival in the newly opened station of Hebron, the mountainous coast totally free of ice and fog. The weather was nice and remained so, and it only rained a little. At Nain, the summer was wet.

According to Johann Peter Christian Stock [Moravian missionary in Labrador from 1813 to 1843] the thermometer at Hebron from January 1832 until March of the same year continuously showed 23 to 28°R[éamur] below zero” (Kastner 1833, p. 132).

Appendix 4

Weather information from the *Bulletin de la Société de Géographie de Genève*, “Bulletin of the Geographical Society of Geneva”

The country has been very rainy, like ours [Switzerland], even to the point of compromising the harvest of the poor mission’s garden. In December 1859 there was a snowfall of 20 feet....The dominating wind directions are west, north, northwest. The summer solstice and the first half of August are rarely without violent storms. A sign of infallible pleasant weather is when the northerly wind reigns and pushes the clouds southwest. The ice of the sea varies in thickness from 5 to 9 in. It is difficult to know to what depth the soil is frozen, or how deep it would be frozen if the soil layer were less thin than it is. The greatest cold experienced during the past 26 years is -31.5°R and the greatest heat 22°R . In the summer, changes in temperature are rather sudden; it is not rare to experience from 3° to 20°R within the same day. In August [1860?], the maximum temperature was 18°R and the prominent wind direction was north in the most northerly station [Hebron]. In January [1860?], the coldest minimum temperature was 24.5°R and the most frequent wind direction was west.

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