# East Meets West:
# Meteorological observations of the Moravians in Greenland and Labrador since the 18th century

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## Introduction

In the early 18th century Protestants were still not tolerated in many parts of Europe, where mostly Catholics were living. Due to suppressions by the Catholics in Bohemia, a country of the Hapsburgs (today: Czech Republic), one of the few pre-Reformation Protestant sects, the Moravians, had to migrate westward[1]. Finally they were given refuge by Count Nikolaus Ludwig Graf von Zinzendorf (1700-1760) on his estate at Berthelsdorf in Oberlausitz (Saxonia, Germany) close to the boarder of Bohemia. A new village with the name Herrnhut developed in the neighborhood in 1722. Here a "renewed" Moravian Church, the "Herrnhuter Brüdergemeine," was founded under Zinzendorf's pietistic influence in 1727, which represented modest Christianity. In 1732 the Moravians turned west to St. Thomas, one of the Virgin Islands, to start their missionary work. This paper focuses on their settlement and observations in the northern lands of Greenland and Labrador.

## The Moravians in Greenland and in Labrador

At the time, when Vitus Bering (1681-1741) was organizing the "Great Nordic Expedition" (1734-1743) to Kamchatka, the Moravians moved to Greenland as the next region with local non-European inhabitants. Here the Norwegian Hans Egede (1686-1758) had been the first Lutheran pastor to establish the only mission at Godthaab in 1721. Close to his place Matthias Stach (1711-1787) set up the first Moravian mission, Neu-Herrnhut, in 1733. During the following decades, further missions were established along the coastline of southwest Greenland in Lichtenfels, Lichtenau, Friedrichsthal, Umanak, and finally in Idlorpait (Tables 1a, b). When Egede left Godthaab in 1737, the Moravians also continued his mission. In 1771 the Moravians turned further west to Labrador and founded missions on the east coast in Nain, Okak, Hoffenthal, Hebron, Zoar, Rama, Makkovik, and Killinek (Figure 1). Some of these missions are still in use. When the first three missions had been established, either in Greenland or in Labrador, the expansion stopped for the next 50 and 46 years respectively.

**Table 1a.** Moravian Missions founded at Greenland and Labrador in the 18th century[2].

| Period of Function | Greenland | Labrador |
|---|---|---|
| 1733 - 1900 | Neu-Herrnhut | |
| 1748 - 1900 | Lichtenfels | |
| 1771 - present | | Nain |
| 1774 - 1900 | Lichtenau | |
| 1776 - 1919 | | Okak |
| 1782 - present | | Hoffenthal |

**Table 1b.** Moravian Missions founded at Greenland and Labrador in the 19th and 20th century[3].

| Period of Function | Greenland | Labrador |
|---|---|---|
| 1824 - 1900 | Friedrichsthal | |
| 1828 - 1959 | | Hebron |
| 1861 - 1900 | Umanak | |
| 1864 - 1900 | Idlorpait | |
| 1865 - 1894 | | Zoar |
| 1871 - 1907 | | Rama |
| 1896 – present | | Makkovik |
| 1904 - 1924 | | Killinek |

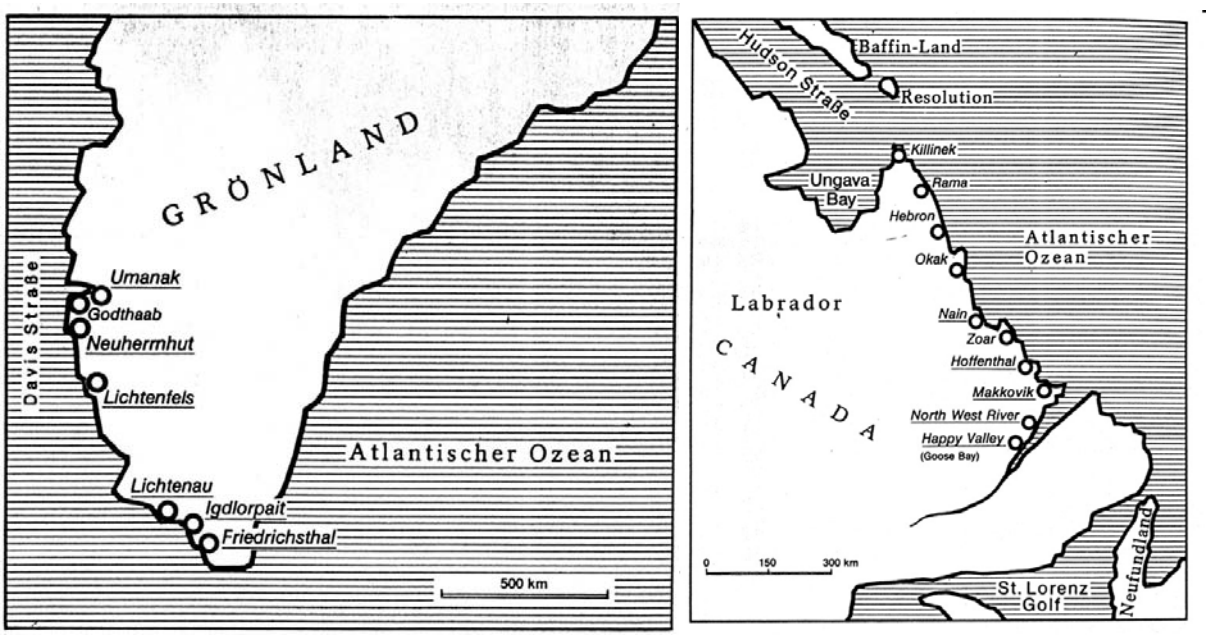


**Fig. 1.** Map of Moravian mission stations in Greenland (left) and Labrador (right)[4].

One of the main tasks of the Moravians had been to translate their Christian concepts into the local Eskimo language[5] and, especially in Labrador, to run a trading store, a workshop and a smithy[6].

**West goes east**

Besides their missionary duties the Moravians not only sent home mission reports each year, but also descriptions of the Eskimo culture illustrated by sketches and pictures. Being interested in the natural sciences, they also observed the weather and made meteorological measurements at each mission, informing the following missionaries about the unknown sub-polar climate[7]. When they returned to their home in Saxonia, they very often brought ethnological souvenirs with them, which filled the attics of their houses, until the Herrnhuter Ethnological Museum was founded in 1878. One of the most interesting items on display is a traditional dog sledge pulled by stuffed dogs from Labrador.

David Cranz (1723-1777) was the first to publish detailed information of the early missionary period in Greenland in the report of his inspection of the missions Neu-Herrnhut and Lichtenfels (1761-1762)[8]. Besides very interesting ethnological descriptions he also gave insight into the climate of Greenland. His book received great attention in Europe and was translated into Dutch, English and Swedish, while a second German edition was already printed in 1770.

Since the establishment of the missions in Labrador, extracts of weather observations made by Christoph Brasen (1738-1774) from October 1771-October 1772, Samuel Liebisch (1739-1809) from September 1775-1781 and 1781-1782 and by his successor from the year 1783 were published in the German weekly newspaper *Wittenberger Wochenblatt* between 1774 and 1786[9].

It had been a big success for the organizer of the first modern and global meteorological network of the Societas Meteorologica Palatina, Johann Jacob Hemmer (1733-1790), to receive some data from Godthaab in Greenland. Pastor Andrea Ginge had send his observations made from October 1786-June 1787 with the ship going to Europe in July. The data were printed in extenso in the *Ephemerides* of the Societas Meteorologica Palatina in Mannheim (Germany)[10]. Close to the sunspot maximum in 1788, they showed a remarkable amount of 54 days with observations of northern lights during from October to April. Another survey of meteorological data from Greenland and Labrador of the period 1790-1801 was made available for the public in *Voigt's Magazin für Naturkunde*[11].

Professor Friedrich Kämtz (1801-1867) from the university in Halle (Germany) included monthly mean values for Nain and Okak (1777-1780) in the climatological description of northern latitudes in first modern textbook on meteorology[12]. Later, data from Nain were used very often to show the temperature difference at the same latitude between North America and Europe[13]. This example contradicted Tobias Mayer's (1723-1762) theory of the solar climate, which was only dependent of the position of the sun[14]. Mayer's theory was published posthumously in 1775 and gave rise to many investigations.

**Lamont's data collection**

At the end of the 1830's, astronomer Johann von Lamont (1805-1879) from the observatory at Munich (Germany) had organized a meteorological network in Bavaria, in which he also wanted to include stations of the Moravian missions. By a mediator he received hand written copies of reports of the annual meteorological observations from Greenland and Labrador. From most missions he received data over many decades (Table 2).

The data consisted mostly of pressure and temperature measurements, as well as wind directions and short descriptions of the weather, observed two or three times a day. Together with the observations, some of Lamont's correspondences also survived in an institute of the Technical University of Munich at Weihenstephan. An example of the measurements is given in figure 2.

**Table 2.** Meteorological data from Greenland and Labrador collected by Lamont[15].

| Period | Greenland | Labrador |
|---|---|---|
| 1841-1865 | | Nain |
| 1842-48, 1856-66, 1871-72 | | Hebron |
| 1843-1844 | Godthaab | |
| 1843-1851 | Lichtenau | |
| 1843-60 / 1862-65 | Neu-Herrnhut / Umanak | |
| 1843-1866 | | Okak |
| 1846-1852 | Lichtenfels | |
| 1852-1872 | | Hoffenthal |

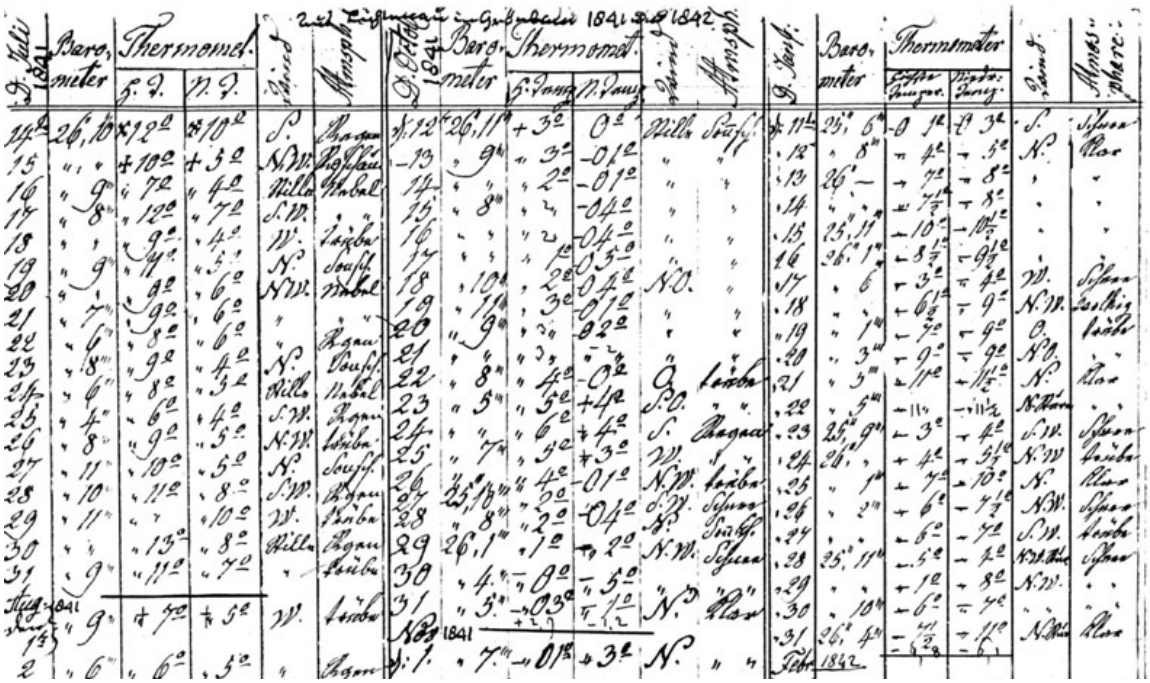

**Fig. 2.** Meteorological observations from Lichtenau (Greenland), 1841-1842[16].
D.: Date (14 July–2 August 1841), (12 October–1 November 1841), (11–31 January 1842)
Barometer: Pressure in Parisian feet
Thermometer: Temperature in °R
H. T. / Temp.: Highest temperature in °R
N. T. / Temp.: Lowest temperature in °R
Wind: Wind direction
Atmosphere: Weather, e.g. dull, clear, cloudy, rain, snow

Lamont had a close look at the data and their accuracy. Among his correspondence we even find calibration tables in °R for five thermometers send to the Moravian stations in Lichtenau, Neu-Herrnhut, Hebron, Hoffenthal, and Nain. He published only mean or extreme values of temperature and pressure of these five stations (September 1841-April 1842) and mean values of temperature as well as wind observations of Friedrichsthal (October 1841-April 1842), Neu-Herrnhut (July 1842-June 1843), and Hebron (September 1842-July 1843) in *his Annalen für Meteorologie und Erdmagnetismus* in the early 1840s[17].

When Adolphe Quetelet (1796-1874) had introduced statistical methods in meteorology to investigate the periodicity of the phenomena[18], Lamont followed his ideas and investigated the implication of arithmetic means in meteorology[19]. He may have used the exotic data set from the sub-Arctic as example to calculate monthly mean values of temperature and pressure[20] as well as counting the number of observations of different wind directions at all stations[21]. After these efforts, it is astonishing that he only published the actual monthly distribution of wind directions of Labrador from 1866/1867 in the *Wochenbericht der Kgl. Sternwarte München*[22]. Besides, he did not give any comment or interpretation of the other data. They may have only served him as a case study for statistical analysis. In his paper on the arithmetic means he said that a mean value did not exist especially for clouds, wind power and direction as well as for precipitation[23]. He also argued that there was no real mean value for temperature and pressure, because both were strongly influenced by clouds, wind and other meteorological parameters. This could be clearly seen at the extreme values of pressure, which showed an unbalanced deviation from the mean value to the minimum, which was twice the deviation to the maximum. In conclusion Lamont only admitted mean values for parameters that followed regular rules, but not for parameters that were dependent of other parameters. Due to this he might have neglected the publication of mean values of temperature and pressure.

**Further weather information from high latitudes**

In the 1850's, many expeditions left England to search for John Franklin's (1786-1847) lost expedition to discover the Northwest Passage. One fascinating report of such a search expedition was written by Johann August Miertsching (1817-1875) describing the Northwest Passage from west to east on sea and on land (1850-1854). He had been asked to act as interpreter for the Eskimos during Sir Robert John Le Mesurier McClure's (1807-1873) expedition aboard the *Investigator*[24]. This offered a very good opportunity for the Moravians to expand the knowledge of Eskimo groups living further to the west. During his journey, Miertsching not only wrote down the local positions, but also he included temperature data and general weather descriptions from the High Arctic. McClure's expedition was the first to prove that the Northwest Passage theoretically existed, but due to the actual heavy ice conditions it could not be sailed by ship.

After all, in the 18$^{th}$ and 19$^{th}$ century, only a few summarizing results of the early meteorological measurements from Greenland and Labrador were made available in various printed media for further scientific investigations.

## First International Polar Year 1882-83

When the director of the Deutsche Seewarte (German Naval Observatory) at Hamburg, Georg von Neumayer (1826-1909), organized the German participation in the International Polar Year (1882-83), he engaged Dr. Karl Richard Koch (1852-1924), Privatdozent for physics at the university in Freiburg, to be in charge of meteorological observations at the six Moravian missions in Labrador (Nain, Okak, Hoffenthal, Zoar, Hebron, and Rama). The Naval Observatory provided the instruments for this international co-operation. Afterwards the meteorological data became part of the official results of the German expeditions during the Polar Year[25].

Being very interested in connecting the European station networks with the polar stations of North America, climatologist Eduard Brückner (1862-1927), calculated daily mean values of the stations in Labrador, which were published in his summary of the results in 1888[26]. These data of the east coast of North America described a cold climate with strong westerly storms (Table 3).

**Table 3.** Mean temperatures (°C) in Labrador during the 1st International Polar Year 1882/83[27].

| | Sept. | Oct. | Nov. | Dec. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rama** | | 0.2 | -4,2 | -10,4 | -20,1 | -22,9 | -16,7 | -7,9 | 1,3 | 5,5 | 7,9 | 7,3 | |
| **Hebron** | | -0,2 | -4,8 | -10,1 | -20,0 | -23,8 | -15,8 | -8,1 | 0,5 | 6,3 | 8,8 | 7,3 | |
| **Okak** | | 0,2 | -5,5 | -10,6 | -21,4 | -24,3 | -15,9 | -7,6 | 0,4 | 6,7 | 9,9 | 8,4 | |
| **Nain** | 7.7 | 0,9 | -5,1 | -11,1 | -21,5 | -23,6 | -15,0 | -7,4 | 1,2 | 7,1 | 10,0 | 7,9 | -4,1 |
| **Zoar** | 7.8 | 0,8 | -5,4 | -11,9 | -22,7 | -23,4 | -15,4 | -6,8 | 1,5 | 7,6 | 11,7 | 8,8 | -4,0 |
| **Hoffenthal** | 7,8 | 1,5 | -4,0 | -9,6 | -21,8 | -22,3 | -14,1 | -5,1 | 1,9 | 8,1 | 12,3 | 9,1 | -3,0 |

Further on, monthly mean values of temperature measurements at Labrador over a period of seven to fourteen years, between 1882 and 1896, were made available by Julius Hann (1839-1921), professor for meteorology in Vienna (Austria), together with sinus equations of the annual course for two regions around 56 °N and 58°N and the mean value (Table 4)[28].

**Table 4.** Temperature conditions on the east coast of Labrador[29].

| | Hoffenthal | Zoar | Nain | Okak | Hebron | Rama | Mittel von je 3 Stationen | | 6 Stationen |
|---|---|---|---|---|---|---|---|---|---|
| N Br. | 55° 27′ | 56° 7′ | 56° 33 | 57° 34 | 58° 12′ | 58° 53 | 56.0° | 58.2° | 57° N |
| W L. | 60° 12′ | 61° 22′ | 61° 40′ | 62° 3′ | 62° 37′ | 63° 21 | 61.0 | 62.7 | 62 W |
| Jahre | 14 | 7 | 12½ | 9½ | 12 | 13½ | 12 | 12 | Jährlicher Gang berechnet[1]) |
| Jan. | —20.2 | —22.6 | —21.8 | —19.6 | —21.4 | —20.0 | —21.3 | —20.3 | —16.1 |
| Febr. | —18.9 | —21.6 | —20.8 | —20.8 | —21.5 | —20.3 | —20.2 | —20.9 | —15.6 |
| März | —12.7 | —14.2 | —14.2 | —14.9 | —15.3 | —15.9 | —13.6 | —15.4 | —10.0 |
| April | — 5.1 | — 5.9 | — 6.1 | — 6.4 | — 7.2 | — 6.6 | — 5.7 | — 6.7 | — 1.9 |
| Mai | 0.6 | 0.8 | 0.1 | 0.1 | 0.2 | 0.3 | 0.5 | 0.2 | 5.4 |
| Juni | 5.5 | 6.1 | 4.5 | 4.7 | 4.5 | 4.4 | 5.2 | 4.5 | 10.3 |
| Juli | 9.8 | 9.8 | 8.1 | 8.3 | 7.6 | 7.7 | 9.1 | 7.9 | 12.7 |
| Aug. | 9.9 | 10.2 | 9.1 | 8.7 | 8.0 | 8.1 | 9.6 | 8.3 | 12.9 |
| Sept. | 6.3 | 6.4 | 5.5 | 4.9 | 4.5 | 4.4 | 6.0 | 4.6 | 10.7 |
| Okt. | 0.8 | 0.5 | — 0.2 | — 0.9 | — 1.0 | — 0.6 | 0.4 | — 0.8 | 5.3 |
| Nov. | — 5.3 | — 7.4 | — 6.2 | — 7.0 | — 6.5 | — 5.8 | — 6.1 | — 6.4 | — 2.7 |
| Dec. | —15.8 | —18.2 | —15.8 | —16.4 | —16.5 | —15.8 | —16.3 | —16.2 | —11.0 |
| Jahr | — 3.8 | — 4.7 | — 4.8 | — 4.9 | — 5.4 | — 5.0 | — 4.4 | — 5.1 | 0.0 |

Jährlicher Gang der Temperatur.

| | |
|---|---|
| 56° N 61° W | $-4.4^\circ + 15.1^\circ \sin(256.3^\circ + x) + 2.0 \sin(259.5^\circ + 2x)$ |
| 58° N 63° W | $-5.1 + 14.6 \sin(255.6 + x) + 1.6 \sin(241.1 + 2x)$ |
| Im Mittel[2]). | $-4.7 + 14.4 \sin(256.0 + x) + 1.8 \sin(251.4 + 2x)$ |

Hann's evaluation showed that the climate of the northern stations Okak, Hebron, and Rama was more moderate and maritime than the climate of the southern stations.

Not until 1937 was the Moravian data set used at the Deutsche Seewarte to calculate monthly mean values for a climatology of Labrador (Table 5)[30]. Absolute and mean extreme values were also added. We do not know whether this was already done with respect to war preparations, which were already under way within the first Four Years Plan.

**Table 5**. Period of meteorological measurements (temperature, pressure, wind and precipitation) at Moravian missions in Labrador[31].

| Station | Geogr. Breite N. | Geogr. Länge von Greenwich W. | Höhe über dem Meere (m) | Temperatur, Luftdruck, Wind, (Richtung und Stärke) Bewölkung: an den Beobachtungsterminen 8, 14, 20 Uhr | 7, 14, 21 Uhr | Niederschlag |
|---|---|---|---|---|---|---|
| Hoffenthal . | 55°27′ | 60°12,5′ | 7,6 | 1882—1898 | — | 1882—1891 |
| Zoar . . . | 56°74′ | 61°22,2′ | 9,5 | 1882—1894 | — | 1882—1891 |
| Nain . . . | 56°33′ | 61°41′ | 4,2 | 1882—1901 | 1902—1913 | 1882—1891, 1907—1913 |
| Okak . . . | 57°34′ | 61°56′ | 7,5 | 1882—1889 | — | 1882—1889 |
| Hebron . . | 58°12′ | 62°21′ | 15,0 | 1882—1900 | 1901—1918 (ohne 1914) | 1882—1891, 1907—1911, 1913, 1915—1917 |
| Rama . . | 58°53′ | 63°15′ | 3,3 | 1882—1889 | — | 1883—1889 |

## Second International Polar Year 1932-33

When the 2nd International Polar Year took place from 1932 to 1933, Germany could not establish a new polar station due to the economy after World War I. Instead, routine measurements were expanded at home. At least the sub-polar stations Makkovik and Nain in Labrador participated. The results of the measurements were published with a delay during the first year of World War II[32]. One of the most interesting observations was made on 9 February 1933, when the passage of a cyclone showed a pressure fall of about 68 hPa[33]. Meteorological parameters between 7th and 11th February were shown in a diagram (see Figure 5). This Labrador storm showed features similar to the cyclone of 2 March 1992, with a pressure fall of 65 hPa, which was observed by modern means of satellite and aircraft (Figure 6).

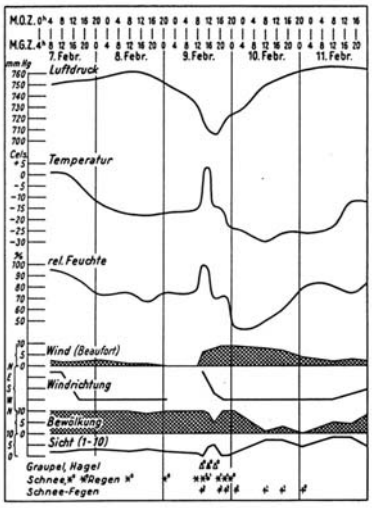


**Fig. 5.** Labrador storm observed at Makkovik during the 2nd International Polar Year on 9 February 1933 [34].


**Fig. 6.** Enhanced infrared imagery of the Labrador cyclone on 2 March 1992, 17:11 UTC [35]

## Importance of the Moravian data set for today

In the meantime, many networks were established for different meteorological investigations. The network of the Arctic Precipitation Data Archive collects data in a large square reaching from Canada to Siberia[36]. In 1900 less that 400 meteorological stations were counted in the area of interest. Due to the Cold War and the growing strategic importance of the Arctic, the number of Arctic stations rose to about 5000 in 1987. After the fall of communism, the number declined rapidly to about 2000 in the year 2000. Until today, the Moravian stations are not included in the network.

Now the historical data, which are kept at the Chair of Ecoclimatology at the Technical University of Munich, are going to be scanned and to be made available for the National Climate Data Centre in Asheville (USA). They will expand the knowledge of the weather of the past for modeling the climate change of the future.

**Endnotes**

[1] Willi Driesen, *Die Herrnhuter Brüdergemeine in Grönland* (Leverkusen, Philathelia, 1986), 39 p.; J. K. Hiller, "The Moravians in Labrador, 1771-1805," *The Polar Record* 15 (1971): 839-54, 835.

[2] After Hartmut Beck (ed.), *Wege in die Welt. Reiseberichte aus 250 Jahre Brüdermission* (Erlangen, Ev.-Luth. Mission, 1992), 300 p., 288, 291.

[3] Ibid.

[4] Ibid.

[5] Samuel Kleinschmidt, *Grammatik der grönländischen Sprache mit theilweisem Einschluss des Labradordialects* (Berlin, Reimers, 1851, 182 p.; 2nd reprint Hildesheim, Olms, 1991).

[6] Hiller, "Moravians," 843, 846.

[7] The meteorological data are included in the annual reports and are not kept in a special file on meteorological measurements at the Archive of the Brüderunität in Herrnhut.

[8] David Cranz, *Historie von Grönland enthaltend die Beschreibung des Landes und der Einwohner u. insbesondere die Geschichte der dortigen Mission der Evangelischen Brüder zu Neu-Herrnhut und Lichtenfels*, 3 vols. (Barby, Heinrich Detlef Ebers, 1765), 1132 p.

[9] Anon., "Auszüge aus den Witterungsbeobachtungen auf der Küste von Labrador Oktober 1771 – Oktober 1772," *Wittenberger Wochenblatt* VII (1774): 202; Anon., "Wetterbeobachtungen aus Labrador Sept. 1775-1781," *Wittenberger Wochenblatt* XVI (1783): 281; Anon., "Wetterbeobachtungen aus Labrador 1781-1782," *Wittenberger Wochenblatt* XVIII (1785): 129; Anon., "Wetterbeobachtungen aus Labrador 1783," *Wittenberger Wochenblatt* XIX (1786): 153.

[10] Andreas Ginge, "Observationes Gotthaabenenses," *Ephemerides Societatis Meteorologicae Palatinae*. Observationes Anni 1787, 42pp, 54pp.

[11] Anon., "Meteorologische Beobachtungen in Grönland und Labrador ausgeführt von den böhmischen Missionären (1790-1801)," *Voigt's Magazin für Naturkunde* IX (1805):

[12] Friedrich Kämtz, *Lehrbuch der Meteorologie*, vol. 2 (Halle, Gebauersche Buchhandlung, 1832), 88.

[13] See for example Julius Hann, "Resultate der meteorologischen Beobachtungen an der Küste von Labrador, Rigolet, Hoffenthal," *Meteorol. Z.* 13 (1896): 117-119.

[14] Karl Schneider-Carius, *Wetterkunde Wetterforschung: Geschichte ihrer Probleme und Erkenntnisse in Dokumenten aus drei Jahrtausenden* (Freiburg/München, Karl Alber, 1955), 99-101.

[15] Grönland file and Labrador file, Archiv Lehrstuhl für Ökologie, TU München , Weihenstephan.

[16] Original in Grönland file, Archiv Lehrstuhl für Ökologie, TU München , Weihenstephan.

[17] Johann Lamont, "Meteorologische Beobachtungen in Labrador und Grönland (1841-1842)," *Annal. f. Meteorol. u. Erdmag.* IV (1842): 69-72; Lamont, "Meteorologische Beobachtungen in Labrador und Grönland (1842-1843)," *Annal. f. Meteorol. u. Erdmag.* VIII, (1843): 185-191; Lamont, "Beobachtungen von Nain und Hebron 1841-1843," *Annal. f. Meteorol. u. Erdmag.* IV (1842-44): 69, VII, 185.

[18] Adolphe Quetelet, "Calcul des probalilités," *Bull. Acad. Roy. Buxelles* 19 (1852). Also see Schneider-Carius, *Wetterkunde*, 171.

[19] Johann Lamont, "Über die Bedeutung arithmetrischer Mittelwerte in der Meteorologie," *Z. Österreichischen Gesellschaft f. Meteorol.* 2 (1867): 241-47.

[20] Lamont calculated all monthly temperature means, but only some monthly pressure means.

[21] You see the results of his calculations written under the columns of the manuscripts. He summarized his results in extra tables with monthly mean values for temperature and the monthly distribution of wind direction (Archiv Lehrstuhl für Ökologie, TU München , Weihenstephan).

[22] Johann Lamont, "Windrichtungen von Nain, Hebron, Lichtenfels und Hoffenthal (Juni 1866-Aug. 1867)," *Wochenbericht der Kgl. Sternwarte München für April*, Nr. 146 (1868).

[23] Lamont, "Bedeutung," 246-247.

[24] Johann August Miertsching, *Reise-Tagebuch des Missionars Joh. Aug. Miertsching, welcher als Dolmetscher die Nordpol-Expedition zur Aufsuchung Sir John Franklins auf dem Schiff Investigator begleitete. In den Jahren 1850 bis 1954.* (Gnadau, Unitätsbuchhandlung, 1855), 196 p.; Beck (ed.), *Wege in die Welt*, 102-133.

[25] K.R. Koch, "Geschichte der supplementären Expedition unter Dr. K.R. Koch nach Labrador," *Die Internationale Polarforschung 1882-1883.* Die Beobachtungs-Ergebnisse der Deutschen Stationen. Band I. Kingua-Fjord und die meteorologischen Stationen II. Ordnung in Labrador: Hebron, Okak, Nain, Hoffenthal, Rama, sowie die magnetischen Observatorien in Breslau und Göttingen. Georg Neumayer und Carl Börgen, ed. (Berlin, A. Asher & Co., 1886),1-181.

[26] Eduard Brückner, "Resultate der meteorologischen Beobachtungen der deutschen Polarstationen 1882/83," *Meteorol. Z.* 5 (1888) :245-59.

[27] Ibid., 256.

[28] Hann, "Resultate," 117-119; Julius Hann, "Zum Klima von Labrador 1 and 2," *Meteorol. Z.* 13 (1896): 359-61 and 420-423. An earlier paper published meteorological data from Rama (1878-1879). See Julius Hann, "Das Klima des nordöstlichen Nordamerika," *Meteorol. Z.* 13 (1896): 70-71.

[29] Julius Hann, "Übersicht über die mittlere Temperatur und den jährlichen Wärmegang an der Küste von Labrador," *Meteorol. Z.* 13 (1896): 422-23.

[30] Ludwig Döll, "Klima und Wetter an der Küste von Labrador," *Aus dem Archiv der Deutschen Seewarte* 57, 2 (1937): 5..

[31] Ibid.

[32] Siegfried Baumbach, "Meteorologische Beobachtungen in Labrador," *Aus dem Archiv der Deutschen Seewarte und des Marineobservatoriums* 60, 8 (1940), 41 p.

[33] Ibid., figs. 2-5.

[34] Ibid., fig. 5.

[35] Zonghui Huo, Da-Lin Zhang and John Gyakum, "The life cycles of the intense IOP-14 storm during CASP II, Part I, Analysis and simulations," *Atmosphere – Ocean* 34, 1 (1996): 51-80.

[36] Personal communication with Bruno Rudolf, 2003.