TITLE OF PROJECT/DATA SET:

Understanding Climate-Driven Phenological Change - Observations, Adaptations and Cultural Implications in Northeastern Siberia and Labrador/Nunatsiavut (PHENARC)

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DATASET OVERVIEW

Introduction/Abstract: In Labrador (the coastal regions of which are now known as Nunatsiavut in the Inuktitutut language) instrumental and qualitative meterological observations began in August 1771 when the *Unitas Fratrum*, or Unity of the Brethren, established its first mission among the Inuit on the Labrador coast. The Moravian Brethren, as they are more commonly known, comprise a Christian church that has pre-reformation origins that go back to the Bohemian reformer Jan Hus (c. 1375-1415). Matthäus Stach (1711-1787) was the pioneer of the Moravian Greenland missionaries, and it was he who advocated missionary work among the Inuit of the Labrador coast. The photograph (taken by Astrid Ogilvie in May 2011) shows the Moravian church in Nain harbor. There are some data for all the missionary stations in Labrador: Nain, Okak, Hopedale, Hebron, Ramah and Makkovik. However, the station with the greatest data coverage is Nain, and it is primarily data from this location that are included here. The observations of the missionaries lasted until 1939 when they were taken over by the Canadian Meteorological Service. After World War II, the missionaries lost their ties with the Inuit population and their missionary stations were regrouped. The last missionary left Nain in 2005. However, the Moravian church is still strong in many parts of Labrador. The records of these observations in Labrador have gone 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 sympathizers, as well as between the Church and contemporary scientists. The data deposited here have been collected, analyzed and processed by our project affiliate Gaston Demarée working closely with Astrid Ogilvie (project PI). See Demarée and Ogilvie (2013) and Demarée *et al*. (2010; 2011).

Time period covered: The data included here are: i) a temperature and pressure series from Nain for the period 1771 to 1783; and ii) a Nain temperature series for 1882 to 1902.

Physical location of the measurement or platform (latitude/longitude/elevation): The geographical location of the data sets is known (e.g., the various missionary sites in Labrador and, in this regard, primarily Nain at 56°32'32"N 61°41'34"W). However, the precise location of the instruments is not known.

Data sources, descriptions, collection and processing:

Eighteenth-Century Data

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 I and II summarizes the current knowledge regarding the sources.

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

Moravian Archives Herrnhut

Timespan	**Location**	**Observer**	**Source**
Nov 1772 - Sept 1773	Wetterbeobachtungen R.15 Ka 8, 1. Nain	Brasen	M.A. Herrnhut Macpherson (1987)
1 Oct 1771–31 Oct 1772 29 Sep 1773-20 Oct 1774 1 Sep 1775-31 Aug 1781	Wetterbeobachtungen in Labrador. Nain (M.-Deput.) II.9	Brasen, Liebisch & Anonymous	M.A. Herrnhut Macpherson (1987)
1 Oct 1778-31 July 1781	Okak	Anonymous	M.A. Herrnhut

Moravian Archives Muswell Hill, London

Timespan	**Location**	**Observer**	**Source**
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

Timespan	**Location**	**Observer**	**Source**
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)

The thermometric readings were generally made twice per day, at 8 am and at 2 pm and occasionally more frequently (as represented in Figure 2; see also De La Trobe, 1779). 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. The barometer, whose scale is a French measure known as *pied-du-roi*, was generally observed at 8 am and at 8 pm. However, the station of Nain was the only one where barometric readings were made.

Table II 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 research done by Gaston Demarée). This manuscript (*) could not be located during the visit of Demarée to the Library of the Royal Society. A short overlap exists between these observations (**)

Archives of the Royal Society, London

Timespan	Location	Observer or Recorder	Source
6 Oct 1776–22 Jul 1777 (*)	Nain		Halliwell (1840) p. 37, XXIX; R.S. MM 10.103
22 Aug 1777–5 Sep 1778	Okak	From M^{r} 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^{r} 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^{r} La Trobe	R.S. MA 143
1 Sep 1781-30 Sep 1782	Nain	Ditto	R.S. MA 143
1 Oct 1782-15 Aug 1783 (**)	Nain	Ditto	R.S. MA 143
1 Aug 1783-31 Jul 1784 (**)	Nain	Presented by the Rev. M^{r} La Trobe. Feb 3, 1785	R.S. MA 143
1 Aug 1784-31 Jul 1785 1 Aug 1785-31 Jul 1786	Nain	Presented by M^{r} Phil Hurlock, F.R.S., 29 March 1787	R.S. MA 143
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. M^{r} La Trobe, 3Feb 1785	R.S. MA 144
1 Oct 1782-31 Aug 1783	Hopedale		R.S. MA 144
1 Sep 1783-31 Jul 1784	Hopedale	Presented by the Rev. M^{r} La Trobe, 3 Feb 1785	R.S. MA 144
1 Sep 1785-16 Aug 1786	Hopedale	Ms. in German presented by M^{r} Phil Hurlock, F.R.S., 29 March 1787	R.S. MA 144

Of these observations, two published sources are also 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). A second published source is the *Wittenbergsches Wochenblatt* (the "Wittenberg Weekly") a weekly newspaper edited in Wittenberg by Johann Daniel Tietz or Titius (Titius, 1774 et seq., and also by others. Table III provides a list of the extracts of the instrumental meteorological observations carried out in Nain published in the Wittenberg weekly. 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 reason for the lack of observations after that time and until the nineteenth century is not yet known. Figure 1ab shows the monthly maximum and minimum temperatures and atmospheric pressure for the data at the station Nain as published in the *Wittenbergsches Wochenblatt*.

Table III 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	Vol.	Pages	Period of the Observations	Observer
24 June 1774	25	201-206	October 1771 - October 1772	Brasen
			Nov 1772 – Sep 1773 Missing in the *Wittenbergsches Wochenblatt*	
27 Dec 1776	52	416-420	October 1773 – October 1774	Brasen († Sept 1774)
			Nov 1774 – 16 Sep 1775 No observations carried out (?)	
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

Nineteenth-Century Data

In the early part of the nineteenth century, missionary journals (called *Missionsblätter* in German) began to be published. 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 publicized the raising of funds and the collection of gifts and other goods for the benefit of the overseas missionary endeavors. 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. Throughout the nineteenth century, the Moravian missionaries continued making meteorological observations using both old and new instruments, and the resulting information was published in a number of scientific journals.

Table IV List of instrumental meteorological observations published in scientific journals of the 19th century. 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

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

A further source of data derives from the *Deutsche Seewarte* or German Naval Observatory that was founded in 1874. Renewed interest on the part of the Observatory in the observations from Labrador resulted in contributions to a variety of geographical

and meteorological journals. Of particular value is a Ph.D. thesis from the Ludwigs-Universität Giessen (Döll, 1937). This 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 2 shows the observed extremes of temperature at Nain for the reference period 1882-1902 based upon Döll's tables.

Data format: Excel files.

Data remarks: As with all early instrumental data there are many uncertainties with regard to the instruments used, their location, and the accuracy of the data. They must therefore be used with extreme caution and suitable disclaimers. There are also many gaps in the data. Thus for example, 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.

Data Calculations: The barometric measurements were converted in the following way: In Europe the measurement called "pied du roi" was much used. 1 *pied du roi* = 32.48 cm; 1 *pied du roi* also = 12 "pouces". 1 *pouce* = 27.07 mm ; 1 *pouce* also = 12 "lignes" ; 1 *ligne* = 2.256 mm. (NB - sometimes the decimal system is used for the *lignes* (lines) depending on the instrument.) Thus, the measurement of the barometer at Nain in August 1777: The observation of 28,3 is converted thus: 28 x 27.07 mm + 3 x 2.256 mm = 757.96 mm + 6.768 mm = 764.728 mm Hg (in modern units). Then mmHg is converted into mbar: 1 mm Hg = 1,333224 hPa or mbar (764.728 mm Hg = 1019.55 hPa or mbar (1 hPa = 1 mbar). The temperature measurements were calculated by converting the Fahrenheit scale used in the observations to the Celsius scale. These calculations were undertaken by Gaston Demarée.

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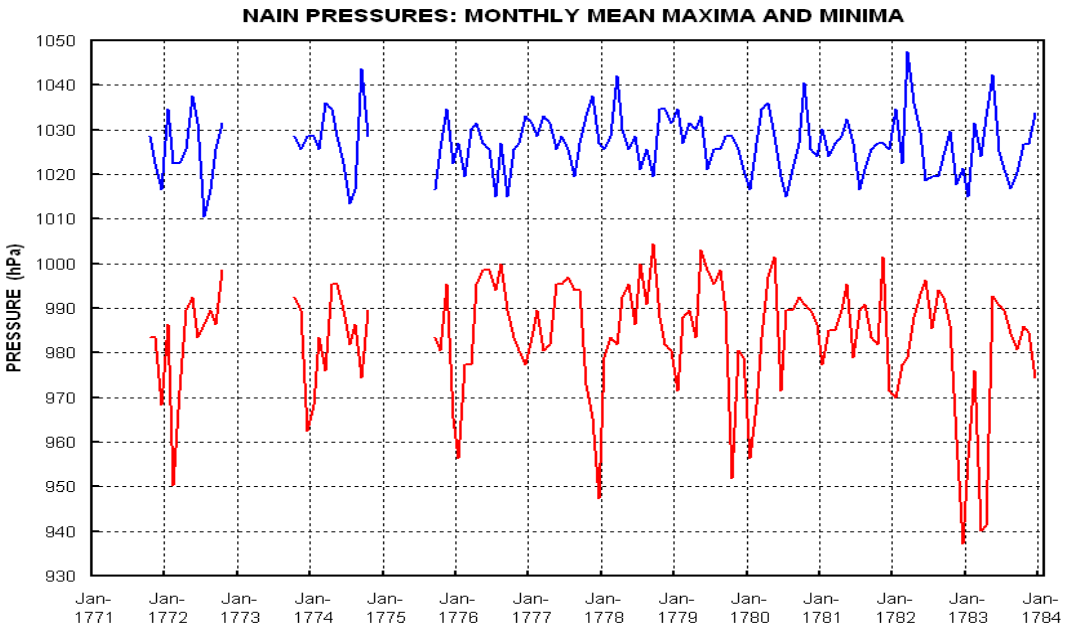

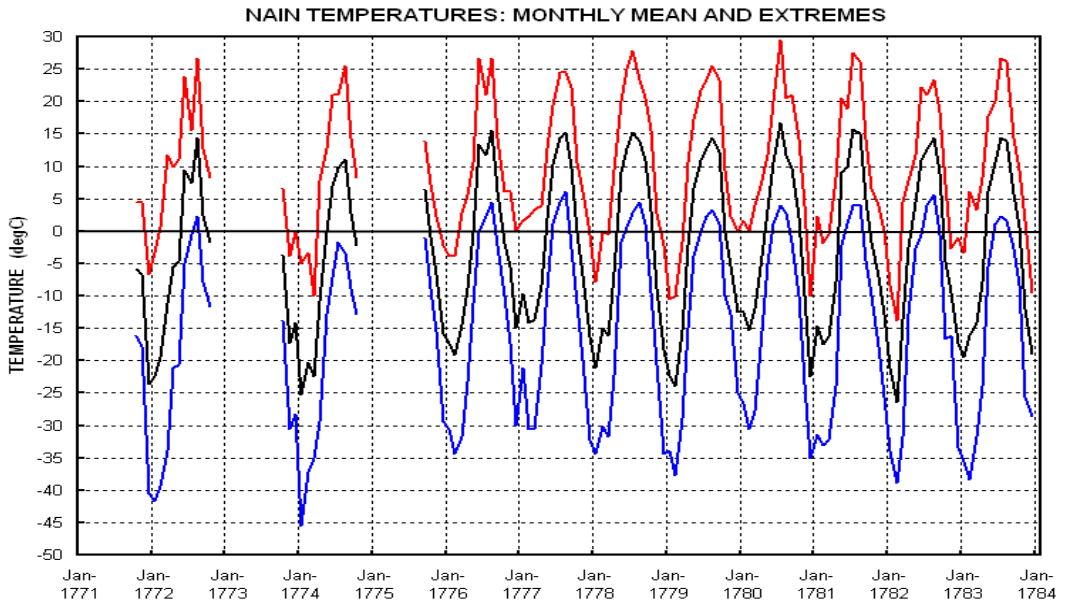

Figure 1a. Upper diagram: monthly maximum and minimum atmospheric pressure (hPa) at Nain in Labrador. Figure 1b. Lower diagram: monthly maximum and minimum temperatures (°C). Both records derived from data contained in the *Wittenbergisches Wochenblatt* as published by Titius. The original data have been converted into modern units by our affiliate Gaston Demarée.

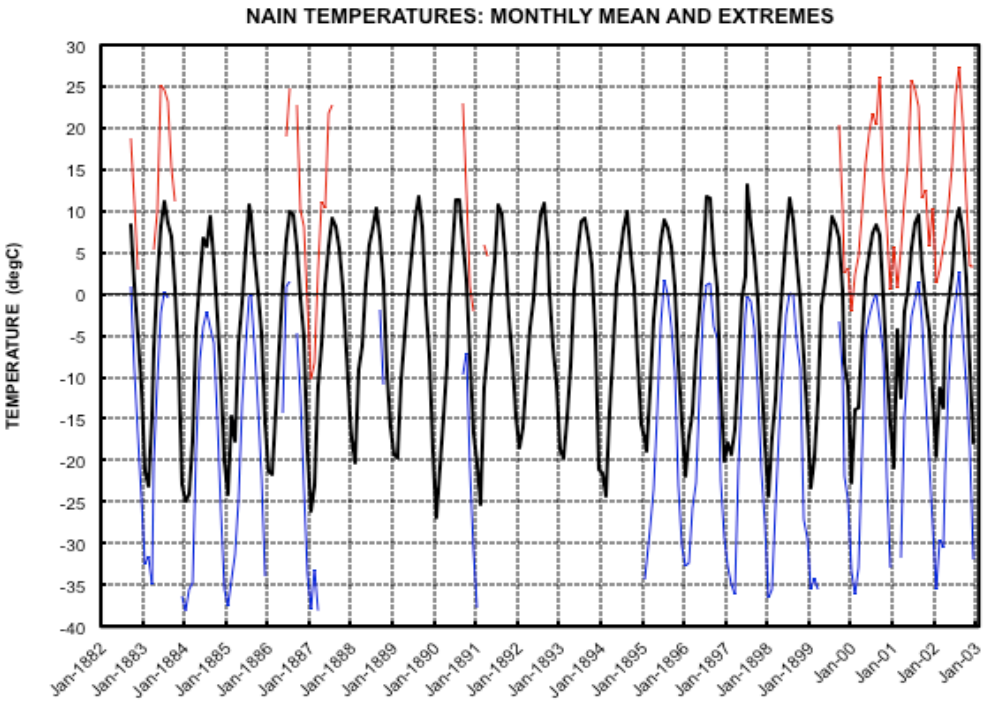

Figure 2. Nain temperatures 1882- 1902 in (°C). Fluctuations of the mean (average of the 8 am, 2 pm and 8 pm observations) and extreme (observed at 8 am and 8 pm) based upon tables by Döll (1937).