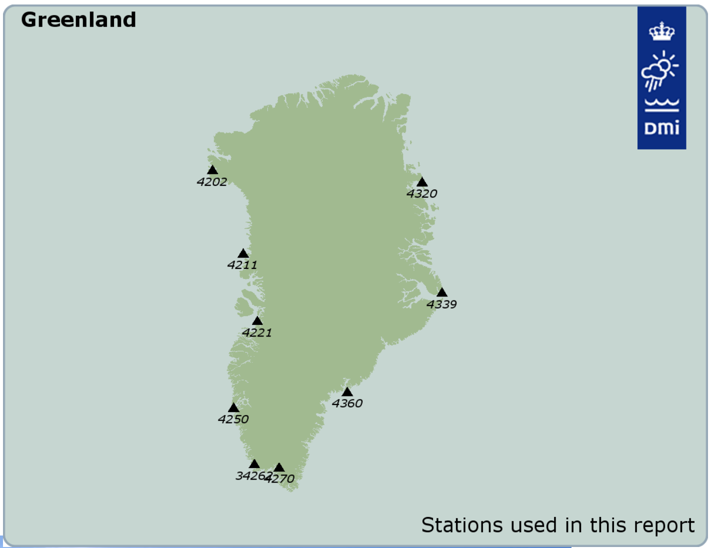
Technical Report 13-04

Greenland - DMI Historical Climate Data Collection 1873-2012

-with Danish Abstracts



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This report is an annual update (2012 data) of the “DMI observational, daily, monthly and annual Greenlandic climate data collection” published for the first time in that form in 1) DMI Technical Report 08-05: DMI Daily Climate Data Collection 1873-2007, Denmark, The Faroe Islands and Greenland - including Air Pressure Observations 1874-2007 (WASA Data Sets). Copenhagen 2008 [8], 2) DMI Technical Report 04-03: DMI Daily Climate Data Collection 1873-2003, Denmark and Greenland. Copenhagen 2004. [24], 3) DMI Monthly Climate Data Collection 1860-2002, Denmark, The Faroe Island and Greenland. An update of: NACD, REWARD, NORDKLIM and NARP datasets, Version 1. DMI Technical Report No. 03-26. Copenhagen 2003. [20] and 4) DMI Technical Report 05-06: DMI annual climate data collection 1873-2004, Denmark, The Faroe Islands and Greenland - with Graphics and Danish Abstracts. Copenhagen 2005 [7].

Front Page:
3 August 2012 - towards SSE, Tugtilik fiord near Tasiilaq. The inscription on the cross is "Gino Watkins Drowned 20 August 1932". He was leading British Arctic Air Route Expedition 1930-31 – mapping the area. The memorial is situated on a south-facing foreland in Tugtilik fiord app. N66.15 W35 degrees. The island in the background is Ailsa Island. Photo: Hans Chr. Florian.

Content:

Abstract

This report contains the available DMI historical data collection 1873-2012 for Greenland, including obervations (atmospheric pressure) and long daily, monthly and annual series of station based data.

Resumé

Denne rapport indeholder tilgængelige historiske DMI datasamlinger 1873-2012 for Grønland. Det drejer sig om observationer af lufttryk samt lange daglige, månedlige og årlige stationsdataserier.

Preface

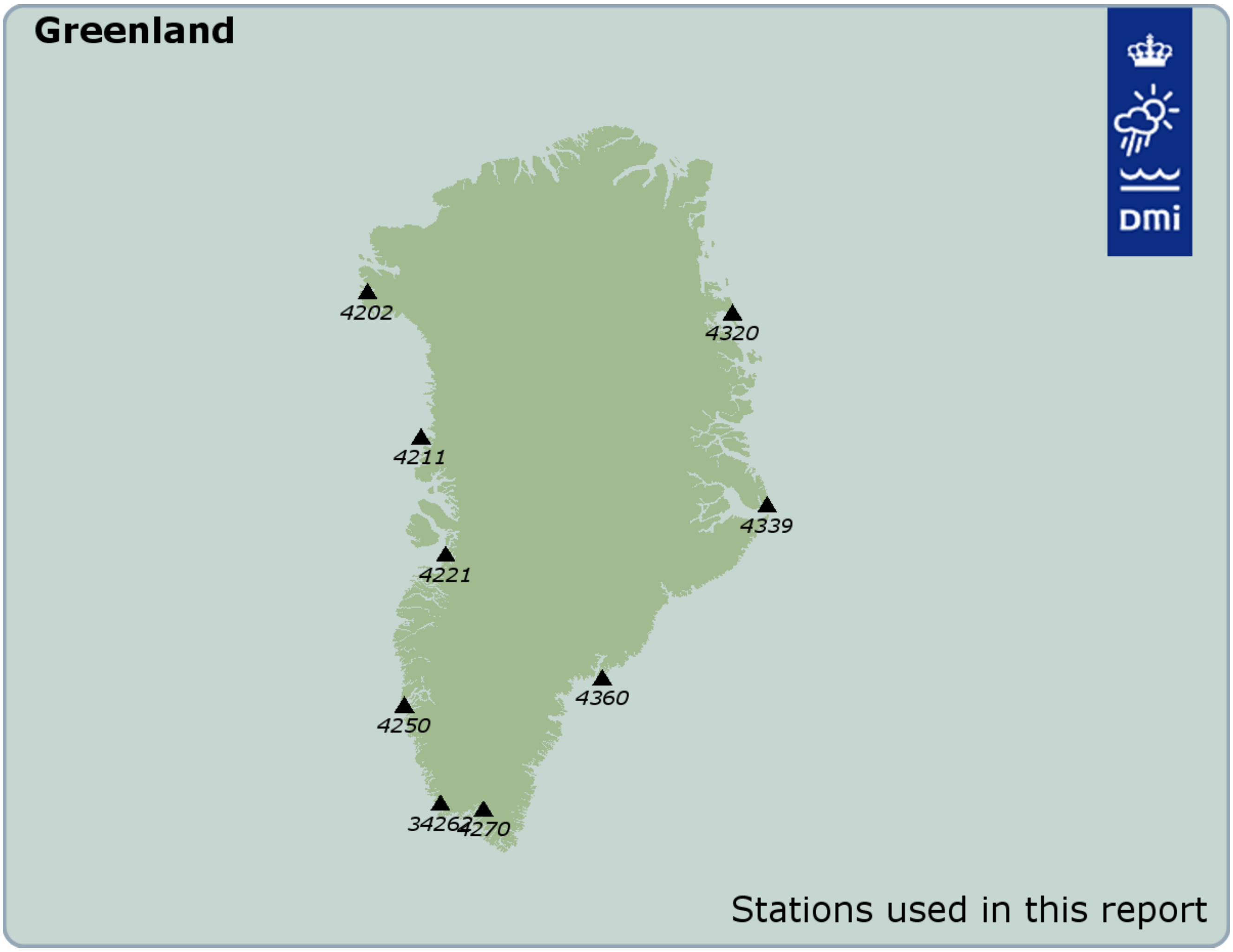
This report contains a DMI historical data collection 1873-2012 for Greenland, including long series of station based data comprising observations of atmospheric pressure plus daily, monthly and annual values of selected parametres. Descriptions of the general weather and climate in Greenland [6] and the weather 2012 are included.

This information has been published earlier in different DMI reports [9], [10], [11] and despite it is now published in one report it will be divided in sections covering the different data types. These sections can for that reason vary slightly in design.

Below is a survey of the information from Greenland you can find in this report and a map showing weather stations (present name and location) from where the data presented in this report comes from.

Data collection	Products in the report	Page
Observation[1]	**Section 1.3. Atmospheric pressure observations**, 1 station: 4360 Tasiilaq (1894-2012)	**27**
Daily	**Section 2.3.1. Accumulated precipitation**, 2 stations: 4221 Ilulissat (1873-1991), 4360 Tasiilaq (1897-2012) **Section 2.3.2 og 2.3.3. Highest/Lowest air temperatures**, 2 stations: 4221 Ilulissat (1877-2012), 4360 Tasiilaq (1897-2012)	**31** **32**
Month	**Section 3.3. Mean air temperature, mean of daily minimum and maximum temperatures and highest/lowest temperature, mean atmospheric pressure, accumulated precipitation, highest 24-hour precipitation, no. of days with snow cover and mean cloud cover**, 10 stations: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund* (1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012)	**41**
Annual	**Section 4.3. Mean air temperature, mean of daily minimum and maximum temperatures and highest/lowest temperature, mean atmospheric pressure, accumulated precipitation, highest 24-hour precipitation, no. of days with snow cover and mean cloud cover**, 10 stations: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund*(1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012) **Section 4.4. Mean air temperature; graph and values** with gauss filtered values, 7 stations: 4202 Pituffik (1948-2012), 4221 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1873-2012), 34262 Ivituut/4270 Narsarsuaq (1873-2012), 4360 Danmarkshavn (1949-2012), 34339 Scoresbysund/4339 Illoqqortoormiut (1924-2012), 4360 Tasiilaq (1895-2012) Greenland poster **with mean air temperatures** for the 7 stations mentioned above is published separately	**69** **69**

[1]**"Greenland observations"**, 81 stations, 10 parametres, hourly observations, 1958 - 2012 are published in a separately report [15]



**34339 Scoresbysund is not marked on the map. The location is nearly similar to 4339 Illooqortoormiut.*

Denne rapport indeholder en DMI historisk dataindsamling 1873-2012 for Grønland. Det drejer sig om tilgængelige lange serier af stationsbaserede data, herunder observationer af lufttryk samt daglige, månedlige og årlige værdier af udvalgte parametre. Beskrivelser af det generelle vejr og klima i Grønland [6] og vejret i 2012 er medtaget.

Datasamlingen er blevet offentliggjort tidligere i forskellige DMI rapporter [9], [10], [11] og på trods af det er nu offentliggjort i én rapport, vil den være opdelt i sektioner, der dækker de forskellige datatyper. Disse afsnit kan af denne grund variere lidt i design.

Nedenfor er en oversigt over tilgængelig klimainformation fra Grønland, du kan finde i denne rapport samt et kort (ovenfor) over danske vejrstationer (nuværende navn og placering), hvorfra denne rapports datamaterale kommer fra.

Datasamling	***Produkter i rapporten***	***Sidetal***
Observation[1]	***Sektion 1.3. Lufttryksobservationer****, 1 station: 4360 Tasiilaq (1894-2012)*	***27***
Døgn	***Sektion 2.3.1. Nedbørsum****, 2 stationer: 4221 Ilulissat (1873-1991), 4360 Tasiilaq (1897-2012)* ***Sektion 2.3.2 og 2.3.3 Højeste og laveste lufttemperatur****, 2 stationer: 4221 Ilulissat (1877-2012), 4360 Tasiilaq (1897-2012)*	***31*** ***32***
Måned	***Sektion 3.3. Middel luft-, max- og min- temperatur samt højeste og laveste temperatur, middellufttryk, nedbørsum, max 24 t nedbørsum, antal snedækkedage og middelskydække****, 10 stationer: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund (1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012)*	***41***
År	***Sektion 4.3. Middel luft-, max- og min- temperatur samt højeste og laveste temperatur, middellufttryk, nedbørsum, max 24 t nedbørsum, antal snedækkedage og middelskydække****, 10 stationer: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund (1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012)* ***Sektion 4.4. Middeltemperatur som data og grafik*** *med gauss-filtrerede værdier, 7 stationer: 4202 Pituffik (1948-2012), 4221 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1873-2012), 34262 Ivituut/4270 Narsarsuaq (1873-2012), 4360 Danmarkshavn (1949-2012), 34339 Scoresbysund/4339 Illoqqor-toormiut (1924-2012), 4360 Tasiilaq (1895-2012)* ***Grønlandsplakat med middeltemperatur*** *for de* ***7*** *ovenstående statio-ner udgives separat*	***69*** ***69***

"Grønlandspakke"*, 81 stationer, 10 parametre, timeobservationer, 1958 - 2012 publiceres i særskilt rapport [15]*

Weather, Greenland 2012

Especially the summer 2012 (JJA) was unusual warm in Greenland. Record breaking and near to record breaking summer and single months occur many places, but also a single record breaking cold June 2012 at Tasiilaq at the east coast were seen!

An analysis of extreme daily maximum temperatures shows new station records in 2012 for the respective months at Ivittuut/Narsarsuaq (24.8°C) in May, and Upernavik (20.3°C) and Ittoqqortoormiit (18.6°C) in July. The 24.8°C at Ivittuut/Narsarsuaq was also a new record for the highest official surface air temperature ever recorded in Greenland in May; it occurred on the 29th of the month.

Rain and several days of thaw have been registered at the ice cap with high temperatures late June and several days in a row in July above 0°C. In mid-July 2012 (July 10 to 12) the Kangerlussuaq area was hit by sudden and violent melt waters, where a bridge in Kangerlussuaq was destroyed by the torrential melt waters.

In 2012, as in recent warm summers since 2007 (2007, 2008, 2010, 2011 and now 2012), a blocking high pressure, associated with negative NAO conditions, was present in the mid-troposphere over Greenland for much of the summer. This circulation pattern advected relatively warm southerly winds mainly along the west coast favouring warmer and drier summers than normal and shifting precipitation towards the north of the ice sheet. The very warm temperatures were followed by a number of unusual melting events. This unusual weather conditions can also be linked to the weather we have experienced in Denmark during the summer 2012. Events in Greenland during the summer 2012 can not be regarded as 'unnatural', but on the other hand there is an indisputably gradual rise in temperature in Greenland and along the way, any 'warm incident' thus will have an increased likelihood of becoming a little bit hotter than the preceding one.

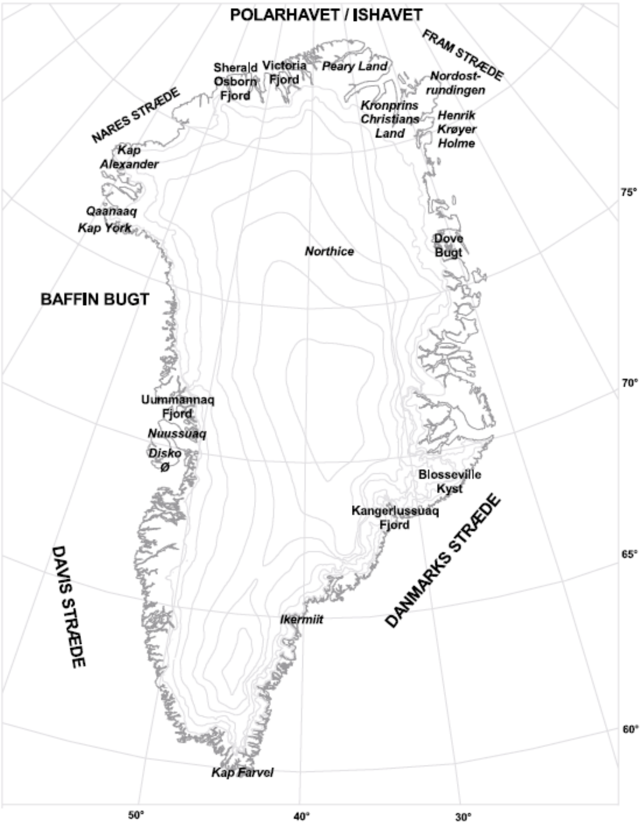
A significant lack of precipitation during summer 2012 in south-east Greenland was also observed (e.g. 0 mm at Tasiilaq, 0.7 mm at Narsarsuaq and 21.6 mm at Qaqortoq in June 2012, and only 1.4 mm at Tasiilaq in July 2012). In Tasiilaq the summer precipitation was the third lowest on record (since 1895). In Danmarkshavn in north-east the summer precipitation was 8.2 mm, the second lowest on record (since 1949) together with summer 2003.

The year 2012 as a whole in Greenland was a rather warm year compared to 1961-90 normal but around 2001-2010 average following the tendency in the temperature development seen in the last decades.

In the capital Nuuk, the annual mean temperature was 0.1°C, which is 1.5°C warmer than normal (normal -1.4°C), but only 0.2°C warmer than the 2001-2010 average. The highest temperature 20.3°C occurred in July and the lowest temperature -22.3°C in March. It was the second wettest year since measurements started in 1890. Precipitation in Nuuk was 1.211 mm against the normal 752 mm, 459 mm or 61% above normal. The wettest year was 2005 with 1.221 mm.

Climate and weather in general; Greenland

The world's largest island (2.2 million square kilometres) stretches almost 24 degrees of latitude from top to bottom. The northern tip is located only 700 km from the North Pole, while Cape Farewell is located 2,600 km further south - at almost the same latitude as Oslo. To the south the altitude of the sun, and consequently the length of nights and days, is almost the same as in Denmark. To the north there is midnight sun in almost one third of the year and winter darkness in another third.

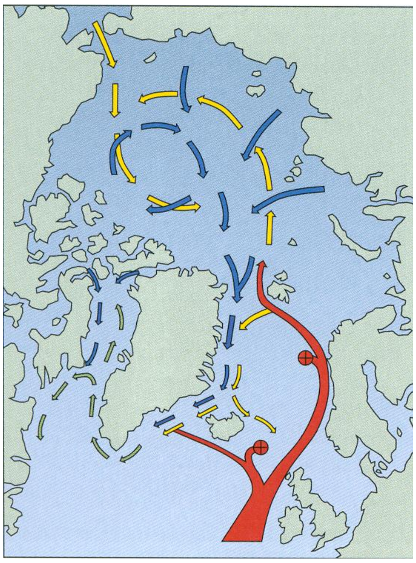


An uninterrupted slightly domed ice cap, the Greenland Ice Sheet, covers 80% of the land. At some places this cap is more than 3 km high. Borings through the central part of the ice cap have shown that the bedrock is located at a depth of 3,030 metres.

The remaining 20% of the island is the habitat of the country's flora and fauna, and this area is also where the human population lives - at the edge of the ice age, as it were - mainly along coasts which give access to open water. The northerly location of the country and the cold, more or less ice-filled sea that surrounds it are the most important factors determining the cold climate in the country.

Sea currents and sea ice

The exchange in the sea of warm and cold water flows between southern and northern latitudes follows patterns illustrated in the figure below. The rotation of the Earth (the coriolis force) makes any movement including sea currents turn to the right. This means that an eastern arm of the warm North Atlantic Sea Current (a branch of the Golf Stream) runs northward along the Norwegian west coast, while a compensatory outflow of cold polar water runs southward along the eastern coast of Greenland.



Sea currents in the Arctic Ocean and the North Atlantic Ocean. The warm North Atlantic Sea Current goes north and passes Norway. Along the way, branches go in the direction of Greenland, and parts of it sink down to the deep sea water (marked with an ⊗). The rest flows into the Arctic Ocean because the higher salt content makes it sink a few hundred metres down before it continues (arrows pointing upwards to the north of Svalbard) under the cold polar water. The polar water flows like a cold, icy current southward along the east coast of Greenland, more or less sharply delimited on the outside by branches of the North Atlantic Current. The two water masses gradually become mixed, and the East Greenland Current continues as a flow of mixed water around Cape Farewell and a bit up along the west coast where the "Storis" it has brought along quickly melts.

A similar pattern of sea currents, though on a smaller scale, is seen between Greenland and Canada. In the winter period, ice is formed within the cold water area, but throughout the year the cold sea currents in addition transport icebergs coming from the glaciers in the area. The East Greenland Sea Current in particular also transports a great deal of “surplus” sea ice from the Arctic Ocean, which is mainly drained through the Fram Strait.
Ice in or from the Arctic Ocean is called polar ice (old ice from the Arctic Ocean). Ice in the East Greenland Sea Current is called “Storis” (general term for the polar ice and thick first year ice from the Arctic Ocean and the Greenland east coast), while ice in the northern and western parts of West Greenland waters is called west ice (first year ice).

Polar ice
Most of the Arctic Ocean is covered by sea ice throughout the year, often appearing as an uninterrupted surface covering an area of several hundred kilometres. Openings and cracks may occur for a few hours, after which they close again or freeze over. From an aeroplane flying at low altitude above the Arctic sea ice it can be seen that the ice is far from smooth and even. Rough banks of ice crisscross the area. Sometimes these banks are almost serrated, indicating that the ice floes are packed together, and sometimes they are rounded, weatherridden and clearly old ridges of ice twisted and frozen together a long time ago, now making the ice thick and unbreakable. Protected by these ridges is the snow, blown together and modelled into hard, parallel snow drifts by the wind. The smooth ice is generally more than three metres thick, while it is not uncommon to see ice packs towering up to 15 metres above the surrounding ice landscape. The ice is typically many years old. It goes without saying that even the largest icebreakers have to give up when faced with such powerful ice formations.

The East Greenland Sea Current and the “Storis”
Almost all water leaving the Arctic Ocean drains through the Fram Strait between Greenland and Svalbard, from where it continues as the sea current called the East Greenland Sea Current all the way down along the east coast of Greenland, around Cape Farewell and a bit up along the west coast. To the east the current is bordered by warmer, saltier (and consequently heavier) Atlantic water floating in a southerly direction after having left the North Atlantic Sea Current. Part of this water flows below the cold polar surface water.

The East Greenland Sea Current brings along huge quantities of polar ice (on average 150,000 m^3 of ice per second) in a band which may be up to several hundred kilometres wide. A few hundred kilometres to the south of the Fram Strait the sea current accelerates, which causes a certain spreading of the ice. In the winter months new ice is quickly formed between the floes of polar ice. This mixture of polar ice and first year ice is called “Storis”. Its floes of polar ice may be as big as the Danish island of Zealand. Drifting down along the coast, however, they are broken into smaller pieces by the wind, the swell of the sea and collision with other floes. To the south of Illoqqortoormiut (Scoresbysund) only a few floes are more than a hundred metres wide and their thickness has been reduced as well. However, even though the smaller dimensions make it easier for (specially designed) vessels to manoeuvre in or sail around the ice, the ice constitutes an extremely big danger to navigation. This is particularly true when the wind brings the ice to areas where ice is not normally expected. It is quite unrealistic to even think of breaking “Storis”.

The total concentration of ice in the ice belt to the north of Illoqqortoormiut is 80% or more (which means that at least 80% of the sea is covered with ice) throughout most of the year. To the south of the ice belt, there are major seasonal variations because of the spreading and melting of the ice. During most of the year the coast is blocked by “Storis” or thick first year ice, but for a few months in late summer the ice may be spread significantly or it may completely disappear. From late winter to early summer it may, on the other hand, spread a few hundred kilometres along the west coast via Cape Farewell.

In addition to currents, the wind has a major impact on the drift of the ice, especially if the ice is not very compact. Winds from the east (on-shore wind) will close the edge of the ice and make it impenetrable for most vessels. If the wind comes from the west there may be bars and belts of ice up to several hundred kilometres from the ice field, while there may be open water areas close to the coast. Such areas may occur more or less permanently in an otherwise uninterrupted ice cover, depending on local winds or sea currents. A permanent open water area within closed sea ice is called a polynya. Well-known is the polynya at the mouth of Scoresbysund, the wildlife of which ensures the survival of the local population.

West Greenland and the west ice

Conditions along the west coast of Greenland differ a great deal from conditions along the east coast. No real polar ice is seen along the west coast – with the exception of "Storis" that travels around Cape Farewell. Polar ice which occasionally drifts towards the south through the Nares Strait between Greenland and Ellesmere Island in northeastern Canada stays close to the Canadian coast when in drifts further south. The vast majority of the ice to the west of Greenland is thus formed in the sea area where it is seen, and it is uncommon to see more than a couple of sea ice types at the same time, for example broken floes of winter ice in a sea covered in dark new, thin ice.

The 3-4 metre thick sea ice which in the winter season covers most of Baffin Bay and closes off Greenland's west coast from Qaanaaq (Thule) in the north and almost all the way down to Sisimiut (Holsteinsborg) in the south is called west ice in Greenland. Varying quantities of west ice is brought with the Labrador Sea Current down along the Canadian east coast where it may sometimes cause interruption of oil drilling activities. Navigation further south is rarely affected to any great extent. Only a small part of the west ice survives the summer.

West ice can generally be broken by ships with sufficient engine power, though it will usually be both unprofitable and hazardous. Consequently it is only possible to sail to and from Qaanaaq (Thule) from July to September, while it is usually possible to sail to and from Aasiaat (Egedes-minde) and Ilulissat (Jakobshavn) from mid-May to mid-December. There is normally no sea ice between the west ice and the "Storis" further south, and 90% of the population therefore live in the four "open sea towns" of Paamiut (Frederikshåb), Nuuk (Godthåb), Maniitsoq (Sukkertoppen) and Sisimiut (Holsteinsborg), where most business enterprises in Greenland are also located.

Icebergs

Glacial outlets from the Greenland ice sheet form icebergs. As opposed to sea ice, icebergs are not made of frozen sea water but of ice which is many thousand years old. This ice was once snow falling on the ice cap. Icebergs may be extremely dangerous for ships, the reason being that icebergs do not follow winds and surface sea currents but go so deep down into the sea (sometimes up to 300 metres below the surface of the sea) that their drifting is primarily determined by deep-sea currents. A ship sailing in the sea ice may easily end up on collision course with an iceberg if there are major differences between surface currents and currents deeper down in the sea. To this should be added that icebergs melt slowly and may therefore drift far away from sea ice areas.

Icebergs are seen along almost all coasts in Greenland, but there are particularly many of them in the Qeqartarsuaq (Disko) area where some of the world's most productive glaciers are located. Many of these icebergs drift to the west, whereupon they are taken south by the Labrador Sea Current. Some icebergs are moved as far south as the transatlantic shipping routes (as was the case in 1912 when the Titanic hit an iceberg).

Climate and weather

The climate in Greenland is an Arctic climate - which means that no forest can grow in the area. The northern part of the country is very close to the North American continent, from which it is separated only by a relatively narrow and more or less ice-filled sea. Southern Greenland on the other hand is something between the continent to the west and the ocean to the east.

Atmospheric flow patterns and cyclone tracks

Because of its height and size Greenland has a great impact on the movement of air in the lower, dense part of the troposphere, causing the wind to blow mainly along the coast. Greenland thus contributes to the exchange of air masses between north and south. In the summer, northerly and southerly winds are almost evenly distributed, while northerly winds are very predominant in the winter in accordance with the fact that the highest air pressure occur in the coldest areas to the west or north west.

The picture changes in the upper troposphere. Within a cold and dense air mass pressure necessarily drops faster with altitude than in a warm air mass. Consequently there is generally low pressure at an altitude of, for example, 5 kilometres (the 500-hPa level) where the atmosphere is coldest (to the north) and high pressure where it is warmest (to the south). This pattern is less regular in winter when the pole area is not the coldest area, the coldest areas being the eastern parts of the continents (where the impact from the oceans is lowest). The Figure below shows the mean pattern in January. The low pressure area over Baffin Island is often named “the Canadian cold vortex”.

The flow at the 500-hPa level is interesting because it to a great extent governs the migrating weather systems (highs and lows) and the weather associated with them. Lows in particular are associated with “bad weather” - strong winds and precipitation. As shown, Greenland is mainly “supplied” from the southwest (where winters are cold) in the winter and mainly from the west in the summer.

Most lows develop as “waves” at the polar front (the border between cold air to the north and warmer, more humid air to the south). The waves propagate along the front, the cold being on their left hand side. This means that the preferred cyclone tracks in the winter are from the east coast of the United States at the edge of the Gulf Stream towards the northeast, passing south of Greenland and continuing to Iceland and the Norwegian Sea. In a scenario like that, the southern and eastern parts of Greenland will be particularly affected. However, very different patterns occur. Sometimes cyclones move northwards through the Davis Strait and the Baffin Bay, and sometimes a cyclone will move directly towards Cape Farewell, subsequently splitting into two centres, one of which follows the west coast, while the other follows the east coast. When this happens, most of Greenland may be affected during the passage, depending on local conditions.

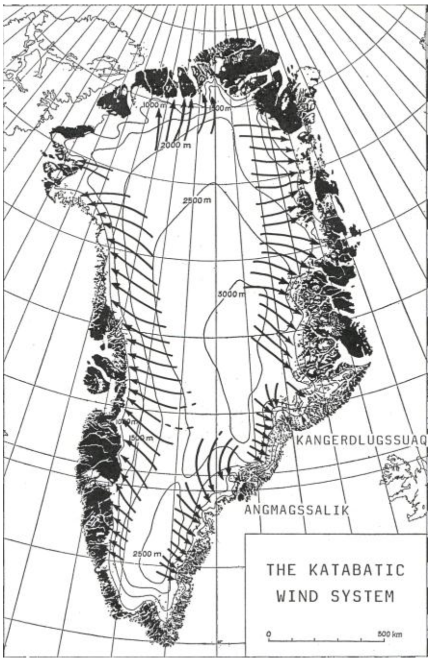
In the summer, lows are less intense, but their tracks tend to be displaced northward, often straight towards West Greenland, where the weather may therefore be rather unsettled.

Other types of lows - of a more local nature and on a smaller scale - occur. Here only the polar lows are mentioned. They develop over ice-free sea areas when the atmosphere is very cold, typically between Labrador and West Greenland, but sometimes even near the southeastern coast of Greenland. The occurrence is always relatively far to the north of the polar front. The diameter of a polar low is generally 200-300 km, and the system may be quite intense. Its lifetime is normally one or two days. At some point in the cycle the system may feature a cloud structure similar to that of a tropical hurricane. This is no coincident. Just like tropical hurricanes, these lows get their energy from the heat and humidity brought to the air from the surface of the sea, being essentially warmer than the air.

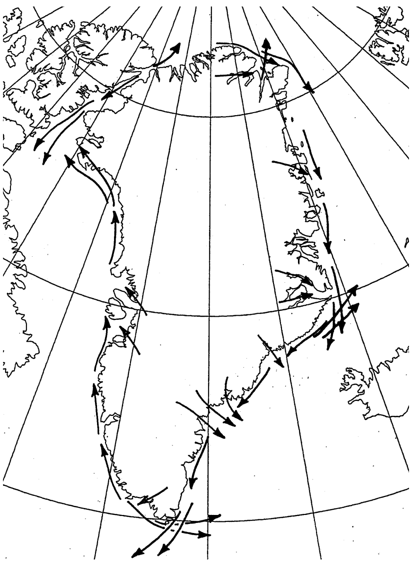
Wind

As mentioned above, strong winds will typically be connected with passing cyclones. Between such events there will be short or long periods of calm throughout the year, in which the wind regimes are determined by local conditions.

One example of this is the katabatic wind system of the ice cap (see figure below). Katabatic means downward going, and the winds move from the central and highest part of the ice cap towards the edge of the ice. They are governed by the difference in density between the cooled, heavy air closest to the surface of the ice and the warmer, lighter air in the free atmosphere at the same level. The outflow accelerates as and when the slope of the surface increases, and the topography may cause canalisation with extremely high wind velocities at the edge of the ice. Because of the change in altitude, the outgoing air is compressed and thereby heated (this is called an adiabatic process if it takes place without being affected by external factors (ie heating or cooling, addition or release of humidity)). The heating (which is named a Foehn effect) will then be 1°C for each 100 metre the altitude changes. Whether the fast-moving wind will reach the fjords in the coastal area will depend on its temperature on arrival. If it is warmer (lighter) that the fjord air it will only be able to replace the fjord air locally, mainly at the head of the fjords, where it will be felt like a warm Foehn wind. If it is colder (heavier) it will as an icy fall wind easily go all the way through the fjord eventually reaching the open sea. The best known example of this is the 60 km long, unpopulated and very windy Kangerlussuaq fjord on the east coast. From a position in a protected side fjord it would be possible both to hear and see the gales because of their noise and the snow drift or foam they generate. Its continued, more subdued passage over the Denmark Strait can be seen on satellite pictures, from which appears that the flow may continue more than 200 km out over the sea.



However, "undisturbed weather" in the fjords is often calm, though characterised by sea breezes in summer and land breezes in winter, governed by local temperature differences in the ordinary manner. This pattern is so predominant that it can be compared to a monsoon system (ie seasonally determined winds caused by differences in the heating of sea and land) in several places.



Predominant wind directions in situations with strong winds in the coastal area. The winds coming from the land may be warm Foehn winds or cold fall winds. Winds blowing along the costs are mainly "barrier winds" blowing clockwise in relation to the land. However, at "the corners of the land" there are two wind regimes. Thus, at Cape Farewell, which is often affected by very strong winds, both northeasterly and westerly gales occur. The latter is part of a "lee whirl" typically formed on the east coast with a prevailing westerly flow in the area.

Local wind regimes may be affected, eventually destroyed under the influence of passing cyclones. The strong winds connected with such cyclones have their own patterns which are very dependent on the topography and on the wind direction in relation to the coast. If they blow towards the coast they will partly be lifted up and cause precipitation and partly be deflected along the coast in the direction of lower pressure (a westerly wind will thus be deflected towards the north, while an easterly wind will be deflected towards the south). In this process the wind will accelerate - we have a so-called barrier wind which may become very strong. If the wind blows away from the coast it will be either a warm Foehn wind (especially in West Greenland) or a cold fall wind (especially in East Greenland). Both types of winds may blow at very high speeds.

A special feature in Greenland is that the change from calm to gale force may take place very suddenly. A Greenlandic word for this phenomenon is “piteraq”, which is mainly used about strong northwesterly fall winds on the east coast. These winds will typically occur when cold air of Canadian origin reaches the coast via the ice cap behind a northeast moving low. The topography of the ice cap will canalise the cold outflow towards parts of the coastland. Most exposed is the wide sea bay to the south of Tasiilaq (Ammassalik).

Temperature

The long period of midnight sun in North Greenland is the reason why the mean summer temperature (July) is only about two degrees lower in Peary Land than in the southernmost part of the country. More important is the difference between the outer coasts where drifting ice or cold water makes the air cold and humid, and the ice free inland where the weather is warmer and often sunny. Differences of up to about 5°C may be registered. The proximity of the ice cap does not have any major effect in the form of low temperatures, one reason being that air coming from the ice cap will be Foehn winds, as described above.

In winter the difference between mean temperatures in the north and in the south is much greater, in excess of 30°C. While the annual fluctuation at Cape Farewell - which is affected by the sea - is less than 10°C, the same difference in the northwestern part of Greenland may be in excess of 40°C. As in summer there are temperature differences between coastal and inland areas, though ordinarily with opposite signs and mainly in places where the sea is completely or partly free of ice. Foehn winds inside the fjords may bring temperatures above zero even in the middle of the winter, sometimes even up to 10°C or more. This is frequently seen in the southern part of the country but rarely in the northernmost part of Greenland. An outbreak of Foehn winds may make the snow disappear and the ice break, which is not always a welcome change in the life patterns of animals and human beings.

An important element in the temperature description is its vertical distribution. Normally temperature will decrease with altitude by 6.5°C per kilometre on average. In the Arctic area this drop in temperature generally is lower, and over the first hundred metres the temperature will often increase with altitude - sometimes even considerably. A temperature distribution like that is called an inversion. In the winter the occurrence of such a “cold bottom layer” is due to radiation cooling of the snow surface and thereby of the lowest layer of air. In the summer the cooling caused by melting ice is the crucial factor. While summer inversions are thus related to the coastal climate, winter inversions occur in places located far away from open sea areas.

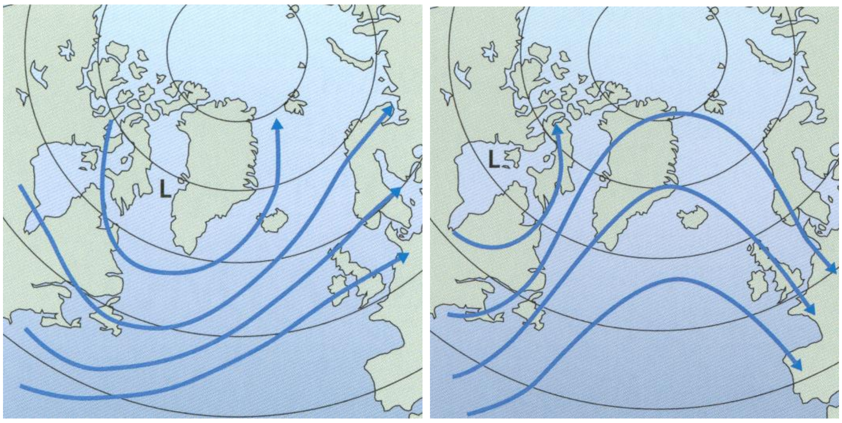
In winter, the increase in temperature up through the inversion layer may be more than 20°C over just a few hundred metres. An inversion like that is possible only in calm, cloud-free weather. The onset of strong winds will result in a dramatic almost instant temperature increase followed by a more moderate drop in temperature if the wind calms down again.

One result of the frequent inversions is that in the spring snow starts melting in the mountains rather than at sea level and that the most vigorous vegetation is often found at an altitude of a few hundred metres. If a temperature measuring station is moved from a low to a slightly higher position it may result in loss of continuity in measurements.

Cold and mild winters - the temperature seesaw

The Canadian cold vortex is not stationary but fluctuates from day to day around its normal position. In certain periods there are more significant fluctuations of longer duration, which may have a significant impact on the winter weather not only in Greenland but also in the northwestern part of Europe and elsewhere.

There are two types of deviation. In the first type the vortex is displaced eastwards to Greenland where it may intensify. This causes a change in the behaviour of Atlantic cyclones: the preferred tracks are pushed southwards, which implies an increase in the supply of Atlantic air to northwestern Europe where the winter will be very mild. In contrast, Greenland will have a very cold winter, undisturbed by "Atlantic weather" but with a great likelihood of polar lows to develop.



"The Temperature Seesaw" - sketch illustration of the two deviating 500 hPa patterns in NAO (North Atlantic Oscillation). The arrows represent contour lines as in the figure on page 14 and thus illustrate the air flow.

In the other type of deviation the vortex is displaced towards the southwest, typically to the Hudson Bay area, and weakened. In this scenario, Atlantic cyclones will follow a northward track towards Greenland, where the weather will be very changeable with frequent temperature increases to several degrees above zero, especially in the southern part of the country. Further to the east over the Atlantic Ocean high pressure will prevail, thus blocking the usual supply of maritime air to northwestern Europe where the winter may be very cold.

These fluctuations are popularly called the temperature Seesaw. Another designation is NAO (North Atlantic Oscillation). About 60% of all winters can be characterised as one of the two types of winters described. NAO patterns are also seen in the summer, though they are not as manifest. There is, of course, great interest in the possibility of predicting patterns like this.

Fog - summer and winter

Greenland is known for its clear air. When there is no precipitation or drifting snow, the curvature of the Earth rather than fog and mist limits people's field of vision. An exception to this is experienced in the surrounding waters in the summer period. The water will remain cold as compared with the air above it because of the ice, which is only melting very slowly, as described above. The lowest layer of air will be cooled and its content of water vapour may condense, leading to the formation of advection fog. Fog and drifting ice constitute a very unpleasant cocktail for navigation.

The sea fog season begins in May, peaks in July and fades out in September. In coastal waters there will be fog for about 20% of the time in July. Fog is also very common in the central part of the Greenland ice cap in the summer.

Summer sea breezes lead the sea fog into the fjords, where it is generally dissolved quickly by the sunheated land. The further into the fjords, the less frequent is the occurrence of fog. Seen in this perspective, the airports in Kangerlussuaq and Narsarsuaq are ideally located.

In winter the air is generally dry and very clear, unless snow is falling or drifting. However, in areas where cold air flows out over open water, sea smoke may be formed. Low radiation fog may sometimes be seen in areas with vast snow surfaces. However, a radiation-cooled snow surface will generally have a drying effect on the lowest layer of air since the humidity contained in this layer will be sublimated into white frost on the cold surface.

Precipitation

The amount of precipitation is generally higher at the coasts than inside the country. It is very high in the southern part of the country, especially on the east coast, while it is low in North Greenland, which has a number of “Arctic deserts”, ie areas nearly snow free in the winter, and where evaporation may exceed precipitation in the summer.

At sea level, precipitation takes the form of rain in the summer and mainly of snow in the winter in the southern part of the country. In the northernmost part of the country it may sometimes snow in July, while rain is extremely rare in the winter. Precipitation in the form of showers is common in the winter at locations close to open sea. In the summer there may be showers inland as a result of sun warming. Thunder occurs in unstable weather, though only very rarely and generally for very short periods of time. In the winter time heavy showers over the sea may be accompanied by thunder. Precipitation measurements carried out during the winter are unreliable because of frequent snow drifting.

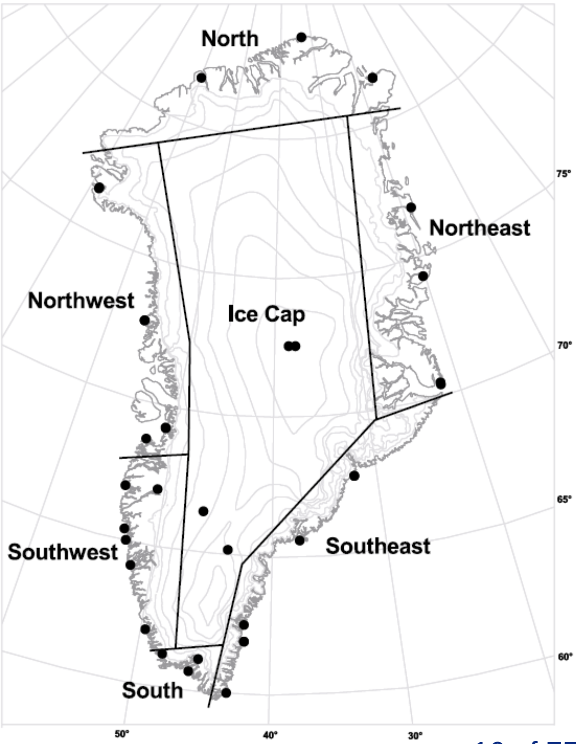
Weather and climate regions in Greenland

Greenland can be divided into seven weather and climate regions. Each region has certain special characteristics, which will be described below. The figure shows location of regions and stations from where data can be found in [6].

South Greenland

The large temperature differences in the area - between the cold sea and the warm inland area in the summer and between the warm sea and the cold inland area in the winter - give rise to a local but dominant monsoon system in the fjords, featuring sea breezes in the summer and equally dominant land breezes in the winter. This pattern is disturbed in times of unstable weather.

The winter weather is generally changeable, but differs a great deal from year to year. Lows crossing South Greenland from the southwest to the northeast will make the weather change between easterly winds accompanied by rising temperature and precipitation in the form of snow or rain, and northwesterly winds with clearing and colder weather. Sometimes, with a stationary low pressure area to the south of Greenland, strong, warm and dry Foehn



winds from an easterly direction may blow in the fjords for relatively long periods of time, in rare cases for weeks. The temperature of such winds will be in the region of 10°C or more. The winds may reach gale force with gusts of hurricane scale. Locally these winds are referred to as a “sydost” (“southeaster”) even though the wind direction is typically northeast. In such scenarios the snow cover will disappear and the ice in the fjords will break. In contrast, a stationary low pressure area near Iceland may be characterised by a long period of northwesterly winds with hard frost and in the coastal area frequent snow showers. Inside the country clear sky will prevail.

Summers are warm inside the country. In certain locations the mean temperature for July is a little above 10°C. Temperatures are lower near the coast because of the cold sea, where fog is frequent (above 20% of time). The sea breeze brings the fog into the sun-heated fjord areas where it is dissolved.

The amount of precipitation is large. In the summer, precipitation will always be in the form of rain, while snow is most common in the winter. The snow layer can occasionally be reduced by melting.

Southwest Greenland

This area is the part of the country where ships can navigate almost unimpeded in relation to sea ice allyear round. The open sea means that the coastal zone, where the population is concentrated, has relatively mild winters, while the summers are characterised by relatively cool and often unsettled weather. Inside the fjords winters are cold, while summers are warmer. However, just as in South Greenland, there are major fluctuations in the weather from year to year. The amount of precipitation is generally large in the southern part of the area but decreases further to the north and especially in the direction going from the coast and inwards. While winters in Sisimiut are characterised by relatively much snow, there is generally only a thin layer of snow in Kangerlussuaq/Sdr. Strømfjord.

In winter, winds from northerly directions are predominant. They are typically connected with clear, cold weather in the coast land, though there are many snow showers over the sea, which occasionally affect the coast. Unstable, rough weather accompanies lows passing through the Davis Strait from the south or the southwest. During the passage temperatures will rise, and there will be abundant precipitation and strong wind from the south, often reaching gale force and occasionally even hurricane force in the coastal area. The best known of these winds is the “sydvesten” (“the southwester”) at Nuuk (called “nigersuaq” in Greenlandic). When combined with a Foehn effect, this southerly wind may bring temperatures up to 10-15°C even in the middle of winter, though this is relatively rare. The high temperatures will only last for a short period of time.

In the event of major outbreaks of cold air from Canada, polar lows will often develop over the sea. If they reach the coast they will be very manifest in the form of strong winds combined with blinding drifting snow and hard frost.

In summer lows passing from the south and southwest through the Davis Strait are relatively frequent. Just as in winter, these lows may cause rather abundant precipitation in coastal areas with strong winds from the south. In June precipitation may still be in the form of snow, but otherwise it will be rain. Inside the fjords, the winds generally are more moderate, though local outbreaks of strong Foehn winds or mountain gusts may occur.

Stable summer weather is seen in periods with high pressure over the central part of Greenland. In such conditions there may be “midsummer weather” even in May, with day temperatures of up to 20°C in the inner part of the fjords, but with frequent fog and temperatures only slightly above 0°C at the outer coast.

The midnight sun line goes through Maniitsoq, while the limit for polar nights is located a little to the north of Sisimiut.

Northwest Greenland

Since the ice cover is almost uninterrupted in Baffin Bay in the winter, winters are less unstable but colder than in southwest Greenland. The area has the same storm patterns: strong winds from the southeast or south bringing large amounts of precipitation both summer and winter accompany cyclones moving towards Baffin Bay from directions between south and west. On the lee side of the Cap York peninsula, southeasterly winds appear as extremely turbulent Foehn winds at Pituffik/Thule Air Base. Also in the inner parts of the Disko Bay and Uummannaq Fjord occasional strong Foehn winds from the southeast occur, while the strait between Disko and Nuussuaq, the Vaigat, is known for its changeable winds. Generally the mean wind velocity peaks in the autumn and falls again in December when the sea freezes over.

The amount of precipitation is relatively large in the southern part of the area, but lower in the northern part. In winter precipitation is almost always in the form of snow, while rain is most common in the summer, though it may sometimes snow in the northern part. Fog is very frequent at sea and in coastal areas in the summer.

The duration of the midnight sun/polar night periods in the northern part of the area is 127 and 110 days respectively, in the southern part 52 an 24 days.

North Greenland

In the winter the mean air pressure is highest in this part of the country, the core of the high pressure being located in the large northwest facing fjords - Sherard Osborn Fjord, Victoria Fjord, etc. The weather is often clear and calm, and the temperature is the lowest found at sea level anywhere in Greenland, the mean temperature probably being close to -40°C. The cold snow surface results in a very persistent and strong low level inversion. Because of relatively low air pressure (and relatively warm air) in Baffin Bay, the cold surface air is drained like a winter monsoon to the southwest down through the Nares Strait. The resulting strong wind causes strong ice drifting in the Strait, peaking in early winter. Later in the winter fast ice is formed down to a line slightly north of Cape Alexander, connecting Greenland and Ellesmere Land. To the south of this line a polynya will form, called the “North Water”, the fauna of which ensures the survival of the local population.

A similar drainage pattern is seen to the east of the high pressure area where the air flows along the north coast towards Nordostrundingen, where a marked wind maximum exists. It is best registered by the automatic weather station on Krøyers Holme, a small group of flat islets. Around these is another polynya called the “North East Water”, which at least partly is kept open by the wind.

Summers are short. The snow covering the area disappears in July and returns in September, though passing cyclones may cause occasional snowfalls, sometimes even blizzards in this period as well. However, summers are generally sunny and relatively warm inland, while coastal areas are often affected by fog or low clouds, which are characteristic of the ice-filled Arctic Ocean.

Precipitation is generally sparse, though unevenly spread. In many areas the wind moves considerable quantities of snow and several areas are almost free of snow in the winter because of the wind. A maximum of precipitation is seen around Station Nord on the wind side of Kronprins Christian Land. This precipitation contributes to preserving the ice cap on the peninsula.

The duration of the midnight sun/polar night periods at Cape Morris Jesup is 154 days and 143 days respectively.

Northeast Greenland

Winters are generally very cold since there is no open sea in the area. The weather is often clear with strong radiation cooling. Northerly wind directions are predominant. Strong winds and precipitation are usually connected with cyclonic activities over the Greenland Sea, and may sometimes last for relatively long periods of time. Maximum winds occur in the coastal area, though winds coming from the ice cap may be very strong in certain fjords, taking the form of northwesterly and westerly Foehn or fall winds. One example of this is the inner fjord complex in Scoresbysund, another the northwestern part of Dove Bay, where the wind moves considerable quantities of snow.

In the summer period the coastal zone is often affected by fog from the ice-filled sea, the mean temperature of the fog being only a little above zero degrees Celsius. Inside the fjords summers are relatively warm and sunny, though there may be periods of cold and unsettled weather when lows pass the area. The highest temperatures are registered a few hundred metres above sea level where there is no sea breeze.

For the year as a whole, the largest amounts of precipitation are seen in the southern part of the area. However, inside the fjords the precipitation is sparse, which is the reason why there is a wide zone of ice-free land to the south. A snow cover is formed in September, and the snow disappears again in the period from May to July. Sometimes snow falls locally in July and August, but it always melts away very quickly.

Fast ice in the fjords breaks in July in the southern part of the area, but in the northern part it may last all summer. The formation of new ice begins in September.

The duration of the midnight sun/polar night periods in the northern part of the area is 137 days and 121 days respectively and 72 days and 52 days in the southern part.

Southeast Greenland

Winds and precipitation in this area are strongly affected by cyclonic activities around Iceland. The track of the lows typically goes from southwest to northeast. In front of such a low there will be a barrier wind from the northeast along the coast (Greenlandic: “neqajaq”), accompanied by precipitation. The wind has its maximum where the coastline is protruding and may here quite often reach hurricane force. Tasiilaq (Ammassalik) and the Aputiteeq weather station are located close to the coastline but are often without the reach of the neqajaq, while Ikermiuarsuq and Prins Chr. Sund are more exposed to it. Behind the low there may be strong winds from directions between north and west (the hurricane-like piteraq). In most cases the piteraq is a rather local wind, the occurence of which is determined by the topography of the coastal area and the ice cap. It blows frequently in the wide sea bay to the south of Tasiilaq (see figure page 15) where the Ikermiit weather station is located. Tasiilaq itself is rarely affected by the piteraq, but the large Kangerlussuaq fjord (about 68°N) is very exposed to it. The piteraq may be a warm Foehn wind with local temperatures of more than 20°C, but in the winter it is usually a cold fall wind. During a destructive piteraq in Tasiilaq in February 1970 the temperature was about -20°C and the peak wind velocity was estimated to be near 90 m/s.

The precipitation in the area is abundant, the largest amounts falling to the south (2,000-3,000 mm a year). Coastal mountains appear half covered in snow, and at the Blosseville Coast in the northeast the glaciation line is close to sea level at certain locations. The amount of precipitation is particularly high within the regime of relatively warm easterly (on-shore) winds blowing to the north of a major low pressure area being stationary over South Greenland or over the sea to the south of Greenland. In such cases, precipitation may be in the form of rain even in winter. Snow in the summer is rare.

In terms of temperature the area is affected by the East Greenland Polar Sea Current which has a surface temperature close to zero degrees throughout the year and which brings along drift ice most of the time. Winters are therefore cold with only short periods of thaw. Summers are cool with frequent fog at the outer coast, but relatively warm and sunny in the fjords.

The midnight sun line passes through Tasiilaq, while the polar night line is located about 200 km further north.

The Greenland Ice Sheet

The ice cap in Greenland is one of the most arid areas in the world. Along the edge, melting takes place in the summer, but in the central part air temperatures hardly rise above 0°C. The reason for this is partly the altitude, partly the high albedo (reflection of light) of the snow surface, which means that the surface is only to a limited extent warmed by the sun. Temperatures are extremely low in the winter, sometimes below -60°C in the central and northern part of the area. The British research station Northice registered a temperature of -70°C in the 1950s. The cold surface “drains” heat from the lowest layer of air, the result being an almost permanent inversion, which may be very strong in the winter. The inversion layer is the cause of the katabatic winds mentioned earlier. They are strongest and most persistent in winter, while in the summer they are mostly felt at night and in the early morning hours. Passing cyclones may affect the inversion layer and break down the wind pattern. However, the pattern will quickly be re-established after the passage.

The southern part of the ice cap is partly maintained by abundant precipitation, while the central and northern parts exist because the melting is rather modest. The surface of the snow bear witness to the wind conditions. It is relatively even and loose in the central part of the area, where it is not affected to any great extent by the wind. Along the edges, the snow is hard blown with clear-cut snow drifts (“sastrugi”) lying parallel to the predominant wind direction.

History of stations used in the report

By convention a time series is named after the most recent primary station delivering the data. Here is presented an overview back in time of the positions and relocations and starting and (if any) closing dates of the stations used in this report. Also presented are any positions or relocations and starting and closing dates of other stations forming part of the series and therefore referred to in the description of the different data series in the report. More metadata on the series/station may be found in [22]. The information can also be found in a text file attached to this report, see page 23.

4202 Pituffik (Thule Air Base)

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
4200	Dundas	01-JAN-1961	23-JUN-1981	synop_gr				-684800	763400	21
4200	Dundas	02-NOV-1981	30-DEC-1981	synop_gr				-684800	763400	21
4200	Dundas	01-MAR-1982	29-MAY-1982	synop_gr				-684800	763400	21
4200	Dundas	01-JUL-1982	31-AUG-1983	synop_gr				-684800	763400	21
4202	Pituffik*)	01-JAN-1974	27-NOV-2006	synop_gr				-684500	773200	77

*) From Nov 2006 the monthly data are obtained from Thule AB (Pituffik), personal communication.

4211 Mittarfik Upernavik (Airport)

The station 4209 Upernavik AWS was an automatic station, which explains the lack of manually observations in the period, where 4210 Upernavik was closed.

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
34210	Upernavik	01-SEP-1873	31-DEC-1960	clima_man				-560700*)	724700*)	19*)
4210	Upernavik	01-JAN-1958	31-JAN-1987	synop_gr				-561000	724700	63
4209	Upernavik AWS	30-AUG-1984	26-SEP-1995	synop_gr				-561000	724700	63
4210	Upernavik	08-SEP-1995	16-AUG-2004	synop_gr				-561000	724700	120
4211	Mittarfik Upernavik	23-OCT-2000		synop_gr				-560800	724700	126
4202	Pituffik	01-JAN-1974	27-NOV-2006	synop_gr				-684500	763200	77
4216	Ilulissat	01-JAN-1961	30-SEP-1991	synop_gr				-510300	691300	39
4216	Ilulissat	01-OCT-1991	31-AUG-1992	synop_gr				-510300	691300	39
4221	Mittarfik Ilulissat	14-AUG-1991		synop_gr				-510400	691400	29

*) The number and positions of relocations during the period are not certain.

4221 Mittarfik Ilulissat (Airport) (Danish name: Jakobshavn Lufthavn/Airport)

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
34216	Jakobshavn	01-JUL-1873	28-FEB-1962	clima_man				-510300	691300	39
4216	Ilulissat	01-JAN-1961	30-SEP-1991	synop_gr				-510300	691300	39
4216	Ilulissat	01-OCT-1991	31-AUG-1992	synop_gr				-510300	691300	39
4221	Mittarfik Ilulissat	01-JAN-1984	13-AUG-1991	metar				-510358	691425	29
4221	Mittarfik Ilulissat	14-AUG-1991		metar				-510358	691425	29
4221	Mittarfik Ilulissat	14-AUG-1991		synop_gr				-510358	691425	29
4220	Aasiaat	01-JAN-1958		synop_gr				-525106	684229	43

4250 Nuuk (Danish name: Godthåb)

In the late 1990's the manual precipitation measurement at 4250 Nuuk was replaced with an automatic rain gauge. This arrangement did not function satisfactory for climatic purposes at that time and therefore a supplementary manual measurement was started 2 February 1999 as station 34250 Nuuk. At this manual precipitation station 34250 Nuuk the precipitation was observed every day at 21 UTC for the previous 24 hours. The manual station 34250 was closed 1 September 2012.

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
34250	Nuuk	01-JAN-1874	31-DEC-1960	clima_man				-514330*)	641030*)	20*)
4250	Nuuk	01-JAN-1958	31-AUG-1991	synop_gr				-514500	641000	54
4250	Nuuk	01-SEP-1991		synop_gr				-514500	641000	80
34250	Nuuk	02-FEB-1999	01-SEP-2012	precip_man				-514500	641000	54
4221	Mittarfik Ilulissat	14-AUG-1991		synop_gr				-510400	691400	29
4254	Mittarfik Nuuk	01-AUG-1985		metar				-514100	641200	86
4254	Mittarfik Nuuk	01-NOV-2000		synop_gr				-514100	641200	86
4270	Mittarfik Narsarsuaq	01-JAN-1961		synop_gr				-452500	611000	34

*) The number and positions of relocations during the period are not certain.

34262 Ivittuut (Danish name: Ivigtut)

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
34262	Ivittuut	01-JAN-1875	31-DEC-1966	clima_man				-481100*)	611200*)	30*)

*) The number and positions of relocations during the period are not certain.

4270 Narsarsuaq Lufthavn/Airport

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
4270	Mittarfik Narsarsuaq	01-JAN-1961		synop_gr				-452500	611000	34
34270	Mittarfik Narsarsuaq	22-JAN-2009		precip_man				-452600	610900	4

A manual measurement was started in January 2009 as station 34270 Mittarfik Narsarsuaq. At this manual precipitation station 34270 Mittarfik Narsarsuaq the precipitation is observed every day at 12 UTC for the previous 24 hours.

4320 Danmarkshavn

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
4320	Danmarkshavn	05-NOV-1948	31-DEC-1957	synop_gr				-184000	764600	14
4320	Danmarkshavn	01-JAN-1958		synop_gr				-184005	764610	11
34320	Danmarkshavn	01-JAN-2009		precip_man				-184000	764600	11

A manual measurement was started in January 2009 as station 34320 Danmarkshavn. At this manual precipitation station 34320 Danmarkshavn the precipitation is observed every day at 12 UTC for the previous 24 hours.

34339 Scoresbysund

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
34339	Scoresbysund*)	01-NOV-1923	31-DEC-1946	clima_man				-215800	702900	17
34339	Scoresbysund*)	01-JAN-1947	30-APR-1948	clima_man				-215800	702900	24
34339	Scoresbysund*)	01-MAY-1948	31-OCT-1948	clima_man				-215800	702900	41
34339	Scoresbysund*)	01-NOV-1948	30-SEP-1949	clima_man				-215800	702900	51

*) Also called Ittoqqortoormiit. The relocations during the period are not certain.

4339 Illoqqortoormiut (Danish name: Scoresbysund. Previous name: Ittoqqortoomiit)

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
34340	Uunarteq (Kap Tobin)	01-OCT-1948	31-DEC-1960	project				-215800	702500	42
4340	Uunarteq (Kap Tobin)	01-OCT-1949	31-OCT-1980	synop_gr				-215800	702500	42
4340	Uunarteq (Kap Tobin)	05-SEP-1985	10-JUN-1990	synop_gr				-215800	702500	41
4339	Illoqqortoormiut (Scoresbysund)	01-NOV-1980	16_AUG-2005	synop_gr				-215700	702900	65
4339	Illoqqortoormiut (Scoresbysund)	17_AUG-2005		synop_gr				-220000	703000	70
4341	Mittarfik Nerlerit Inaat	01-NOV-2000		synop_gr				-223900	704500	14

4360 Tasiilaq (Danish name: Ammassalik. Previous name: Angmagssalik)

No.	Name	Start	End	Type	UTM	Northings	Eastings	Longitude	Latitude	Elev.
34360	Tasiilaq (Ammassalik)	13-OCT-1894	31-SEP-1959	clima_man				-373800*)	653600*)	50*)
4360	Tasiilaq (Ammassalik)	01-JAN-1958	31-MAR-1982	synop_gr				-373800	653600	36
4360	Tasiilaq (Ammassalik)	01-APR-1982	14-AUG-2005	synop_gr				-373800	653600	50
4360	Tasiilaq (Ammassalik)	15-AUG-2005		synop_gr				-373812	653640	54
4361	Mittarfik Kulusuk	28-NOV-2000		synop_gr				-370900	653500	35

*) The number and positions of relocations during the period are not certain.

File formats; Station position file

A station file included in this report contains the digitised information on the station positions and thereby on any removals of the stations during the operation period.

The file name is:

gr_station_position.dat

Format of the station position fixed format text file:

Position	Format	Description
1-5	F5.0	Station number
6-35	A30	Station name
36-45	A10	Station type (synop_gr = part of WMO synoptic net, clima_man = manual climate station, clima_aut = automatic climate station, precip_man = manual precipitation station, metar = part of WMO meteorological airport net)
46-56	Date11	Start date (dd-mmm-yyyy)
57-67	Date11	End date (dd-mmm-yyyy)
68-70	A3	UTM zone
71-81	F11.0	Eastings
82-92	F11.0	Northings
93-98	F6.0	Elevation (metres above mean sea level)
99-109	F11.0	Latitude, degrees N (dddmmss)
110-120	F11.0	Longitude, degrees E (dddmmss)

Data are only to be used with proper reference to the accompanying report:
Cappelen, J. (ed) (2013): Greenland - DMI Historical Climate Data Collection 1873-2012 - with Danish Abstracts. DMI Technical Report 13-04. Copenhagen.

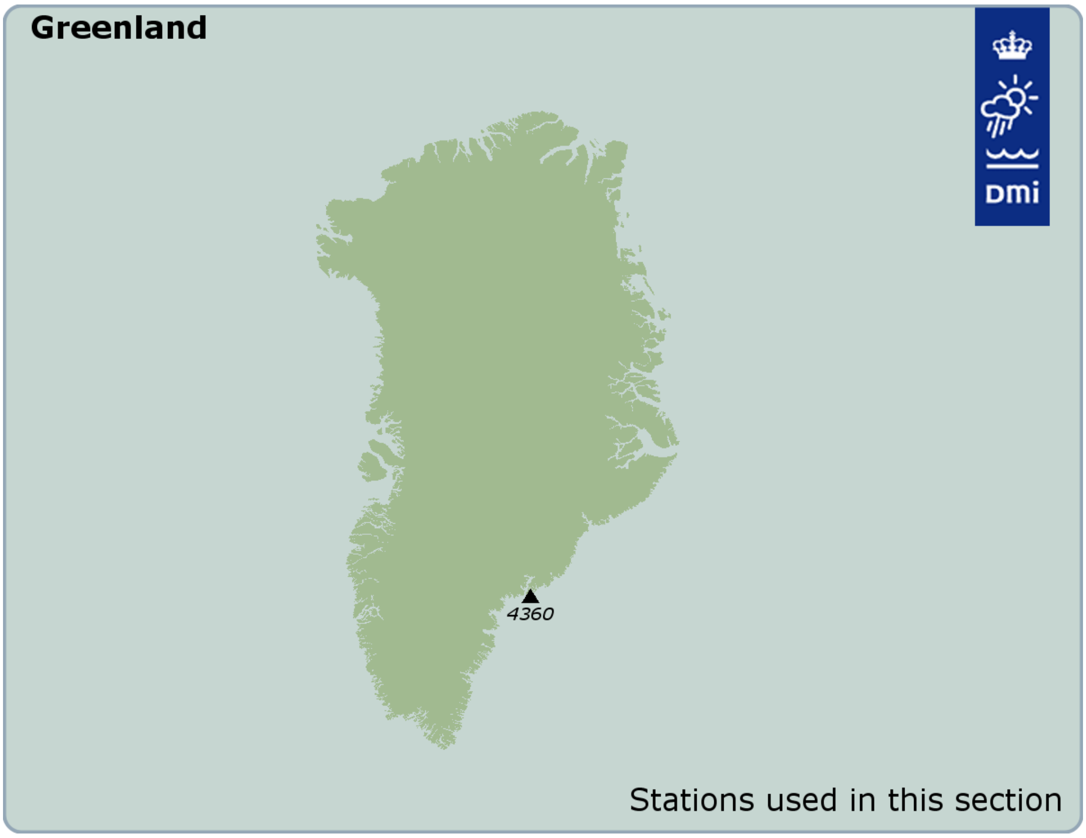
1. Observational Section: Historical DMI Data Collection

Data collection	Products in the report	Page
Observation[1]	**Section 1.3. Atmospheric pressure observations**, 1 station: 4360 Tasiilaq (1894-2012)	**27**

[1] **"Greenland observations"**, 81 stations, 10 parametres, hourly obs. 1958-2012 are published separately [15]

Datasamling	*Produkter i rapporten*	*Sidetal*
Observation[1]	***Sektion 1.3. Lufttryksobservationer**, 1 station: 4360 Tasiilaq (1894-2012)*	***27***

*[1] **"Grønlandspakke"**, 81 stationer, 10 parametre, timeobservationer, 1958-2012 publiceres i særskilt rapport [15]*



Latest earlier report:
[12] Cappelen, J. (ed), 2012: Greenland - DMI Historical Climate Data Collection 1768-2011. DMI Technical Report No. 12-04.

1.1. Introduction

The purpose of this chapter is to publish one mean sea level atmospheric pressure data series from Tasiilaq, Greenland (*observations)* covering the period 1894-2012 as shown as can be seen in table 1.2.1.

According to the intensions to update regularly, preferably every year, this section contains an update (2012 data) of the one greenlandic mean sea level atmospheric pressure series from Tasiilaq originally published in DMI technical Report 97-3: North Atlantic-European pressure observations 1868-1995 - WASA dataset version 1.0 [27].

As part of a former project called WASA, selected DMI series of atmospheric pressure observations from Denmark, Greenland and the Faroe Islands 1874-1970 on paper were digitised. The pressure observations were digitised from the meteorological yearbooks, which means that the observations were station level data corrected for index error, temperature and, since 1893, gravity. From 1971 the pressure data were taken from the DMI Climate Database. The WASA project was originally titled: "The impact of storms on waves and surges: Changing climate in the past 100 years and perpectives for the future" [28].

Figure 1.1.1. Location of the stations that originally provided atmospheric pressure observations to the WASA pressure data set [27]. In this chapter the updated greenlandic series Ammassalik/Tasiilaq is presented. The station representing this site is listed in the table 1.2.1. For station co-ordinates confer with the station position file in the data files included in this report. Pressure data sets from Denmark (three sites) and Tórshavn, The Faroe Islands are presented in the representative historical Climate Data Collection; DMI Technical Report 13-02 [13]) and DMI Technical Report 13-05 [14]).

Climate change studies and the related analysis of observed climatic data call for long time series of climate data on all scales, but please note that the digitisation of the observations of atmospheric pressure only can be considered as the first step towards sensible utilisation of the observations for climate change studies. Next follows testing for homogeneity of the series, ensuring that any discovered trend are natural.

During the WASA project the data have been homogenised. The updated series presented in this chapter has been tested and corrected carefully, mainly based on visual tests. Thus it must be stressed that the updated atmospheric pressure data after the WASA project consist of the values *as observed*, and that no final testing for homogeneity has been performed on these observations for the whole period up to now. They are therefore not necessarily homogenized as such and this should be considered before applying the data series for climate research purposes.

For the benefit of scientists that may wish to conduct such testing various results and remarks concerning observational pressure data have been included in the report. For supplementary metadata, see also [27].

The mean sea level atmospheric pressure data set from 4360 Tasiilaq, Greenland can be downloaded from the publication part of DMI web pages.

Formålet med denne sektion er at publicere en tilgængelig dataserie af observationer af lufttryk (msl) fra Tasiilaq, Grønland 1894-2012. Dataseriens detaljer kan ses i tabel 1.3.1 i afsnit 1.3 og filformat af den medfølgende fil kan ses i afsnit 1.4.

1.2. Stations and parametres

1.2.1. Station Overview

	Country	Station	Station number	First year
1	GR	Tasiilaq	4360[1)]	1894

Table 1.2.1 Primary stations used in this report.

[1)] Before 1958 the observations were taken from 34360 Angmagssalik, see table 1.3.1.

The stations have been relocated several times since the start, new station numbers and names have been attached, new instruments and new observers have been introduced. The latter have obviously been replaced many times. See the station history in the chapter "History of stations used in the report".

1.2.2. Data Dictionary

Abbr.	Element	Method	Unit
Pppp	Atmospheric pressure (MSL)	Obs	0,1 hPa

Table 1.2.2. Elements used in this section. 'Method' specifies that the element is an observation. The units of the observation values in the data files are specified in 'Unit'.

1.3. Atmospheric pressure observations; Tasiilaq – 4360; 1894-2012

The atmospheric pressure measurements started 1894 at a national climate station Angmagssalik. Measurements of atmospheric pressure were stopped at this manually operated climate stations in the 1950's. Therefore the atmospheric pressure series had to be continued from a nearby synoptic station measuring atmospheric pressure. In the WASA project the data were merged into a long homogeneous series and the table 1.3.1 indicates how the stations were merged and how many observations the series contains in the different parts.

Site and period	Station	Start	End	Obs. hours (utc)
Tasiilaq 1894-2012	34360 Angmagssalik	01 November 1894	31 November 1956	8,11,17
	4360 Tasiilaq	01 January 1958	05 August 2005	0,3,6,9,12,15,18,21
	4360 Tasiilaq	05 August 2005	31 December 2012	0 – 23 every hour

Table 1.3.1. The Tasiilaq series of atmospheric pressure observations (at MSL, mean sea level).

1.4. File Formats; Observation data files

An observation file included in this report contains mean sea level (MSL) atmospheric pressure observations from 4360 Tasiilaq, Greenland.

The file name is determined as follows:

gr_obs_<station number>_pppp_<period>.dat

More specifically in this report:

gr_obs_pppp_4360_1894_2012.dat

There **can** be missing dates/records/values between the start and the end date.

Format and units of the atmospheric pressure observation fixed format text file:

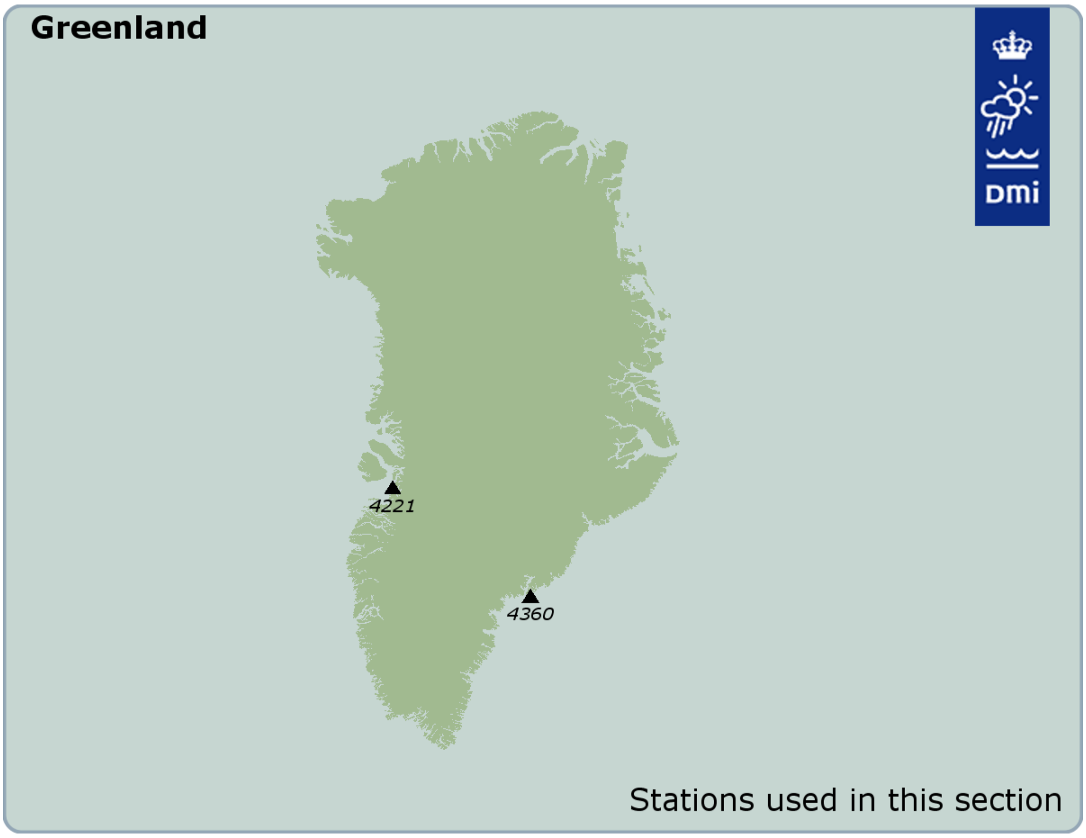
Position	Format	Description
1-5	F5.0	Station number
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour (UTC)
16-20	F5.0	Atmospheric pressure reduced to MSL (0.1 hPa)

Data are only to be used with proper reference to the accompanying report: Cappelen, J. (ed), 2013: Greenland - DMI Historical Climate Data Collection 1873-2012 – with Danish Abstracts. DMI Technical Report 13-04. Copenhagen.

2. Daily Section: Historical DMI Data Collection

Data collection	Products in the report	Page
Daily	**Section 2.3.1. Accumulated precipitation**, 2 stations: 4221 Ilulissat (1873-1991), 4360 Tasiilaq (1897-2012) **Section 2.3.2 og 2.3.3. Highest/Lowest air temperatures**, 2 stations: 4221 Ilulissat (1877-2012), 4360 Tasiilaq (1897-2012)	**31** **32**

Datasamling	*Produkter i rapporten*	*Sidetal*
Døgn	***Sektion 2.3.1. Nedbørsum**, 2 stationer: 4221 Ilulissat (1873-1991), 4360 Tasiilaq (1897-2012)* ***Sektion 2.3.2 og 2.3.3 Højeste og laveste lufttemperatur**, 2 stationer: 4221 Ilulissat (1877-2012), 4360 Tasiilaq (1897-2012)*	***31*** ***32***



Latest earlier report:
[12] Cappelen, J. (ed), 2012: Greenland - DMI Historical Climate Data Collection 1768-2011. DMI Technical Report No. 12-04.

2.1 Introduction

The purpose of this chapter is to publish available long *daily* DMI data series 1873-2012 for Greenland. The data parameters include minimum and maximum temperature and accumulated precipitation.

According to the intensions to update regularly, preferably every year, this particular report contains an update (2012 data) of the "DMI Daily Climate Data Collection" for the first time published in that form in DMI Technical Report 04-03 [24]. A similar collection of long DMI *monthly* and *annual* Greenlandic climate data series can be found in section 3 and 4 in this report.

The digitisation of a great part of the data presented in this chapter and also much of the station history presented are results of various projects. The WASA project[1], the ACCORD[2] project and the NACD[3] project have all contributed regarding the data from Greenland together with a digitisation during spring 1999 funded by the Danish Climate Centre [16], situated at the DMI. The old daily series of maximum temperature, minimum temperature and precipitation from 34360 Tasiilaq on the east coast of Greenland were digitised thanks to KVUG[4].

Climate change studies and the related analysis of observed climatic data call for long time series of daily climate data. In this context the report also serves as the DMI contribution of daily values to the European Climate Assessment & Dataset (ECA&D)[5]. ECA&D was initiated by the European Climate Support Network (ECSN[6]) which is a project within the Network of European Meteorological Services (EUMETNET[7]).

Please note that the digitisation of the observations only can be considered as the first step towards sensible utilisation of the observations for climate change studies. Next follows testing for homogeneity of the series, ensuring that any discovered trend are natural. Thus it must be stressed that the series presented here mostly consist of the values *as observed*, and that no testing for homogeneity has been performed on these daily observations. They are therefore not necessarily homogenized as such, and the report description of each series should therefore be read carefully before applying the data series for climate research purposes.

For the benefit of scientists that may wish to conduct such testing some metadata have been included in the report. For supplementary metadata see also DMI Technical Report 03-24 [22].

The historical daily data sets can be downloaded from the publication part of DMI web pages.

Formålet med denne sektion er at publicere tilgængelige lange daglige dataserier 1873-2012 fra Grønland. Det omfatter højeste og laveste temperaturer og nedbørsum. I afsnit 2.2 kan ses hvilke stationer og parametre, det drejer sig om. Stationshistorien kan ses i afsnittet "History of stations used in the report". I afsnit 2.3 er de enkelte seriers sammensætning beskrevet, afsnit 2.4 omhandler metadata og endelig er filformatet af de medfølgende filer beskrevet i afsnit 2.5.

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[1] WASA: 'The impact of storms on waves and surges: Changing climate in the past 100 years and perpectives for the future'. See [27].
[2] EU project number ENV-4-CT97-0530: Atmospheric Circulation Classification and Regional Downscaling. [1]
[3] EU project number EV5V CT93-0277: North Atlantic Climatological Dataset. See [18].
[4] The Commission for Scientific Research in Greenland: 'Kommissionen for Videnskabelige Undersøgelser i Grønland'
[5] Project homepage: http://eca.knmi.nl/
[6] http://www.eumetnet.eu/ecsn
[7] http://www.eumetnet.eu/

2.2. Stations and parameters

2.2.1 Station Overview

	Country	Station	Station number	First year
1	GR	Ilulissat	4221[1)]	1873
2	GR	Tasiilaq	4360[2)]	1895

Table 2.2.1 Primary stations used in this report.

[1)] Before 1961 the observations were taken from 34216 Jacobshavn, see tables in chapter 2.3.
[2)] Before 1958 the observations were taken from 34360 Angmagssalik, see tables in chapter 2.3.

The stations have been relocated several times since the start, new station numbers and names have been attached, new instruments and new observers have been introduced. The latter have obviously been replaced many times. See the station history in the chapter "History of stations used in the report".

2.2.2 Data Dictionary

Abbr.	Element	Method	Unit
Tx	Highest temperature	max	0,1°C
tn	Lowest temperature	min	0,1°C
p	Accumulated precipitation	sum	0,1 mm

Table 2.2.2. Elements used in this report. 'Method' specifies whether the element is a sum or an extreme. The units of the daily values in the data files are specified in 'Unit'.

2.3. Description of the daily data series

2.3.1 Accumulated precipitation

Two Greenlandic sites have long digitised daily series of accumulated precipitation and lowest/highest temperatures. The tables 2.3.1 to 2.3.3 present an overview of the station data series (identified by the station name and number) making up the long series. Overlap periods have been included when available. For station co-ordinates confer with the station position file in the data files included.

Site and period	Station	Start	End
Ilulissat, 1873-1991	34216 Ilulissat (Jacobshavn) 4216 Ilulissat	1 July 1873 2 January 1961	31 December 1960 12 October 1991
Tasiilaq 1897-2012	34360 Tasiilaq (Angmagssalik) 4360 Tasiilaq	1 October 1897 1 January 1958	30 September 1959 31 December 2012

Table 2.3.1. Greenlandic series of daily accumulated precipitation.

2.3.2 Lowest temperature

Site and period	Station	Start	End
Ilulissat, 1873-2012	34216 Ilulissat (Jacobshavn) 4216 Ilulissat 4221 Ilulissat Mittarfik	1 July 1873 1 January 1961 16 August 1991	31 December 1960 31 August 1992 31 December 2012
Tasiilaq 1894-2012	34360 Tasiilaq (Angmagsalik) 4360 Tasiilaq	15 October 1894 1 January 1958	30 September 1959 31 December 2012

Table 2.3.2. Greenlandic series of daily lowest temperature.

2.3.3 Highest temperature

Site and period	Station	Start	End
Ilulissat, 1877-2012	34216 Ilulissat (Jacobshavn) 4216 Ilulissat 4221 Ilulissat Mittarfik	1 January 1877 2 January 1961 16 August 1991	31 December 1960 1 September 1992 31 December 2012
Tasiilaq 1897-2012	34360 Tasiilaq (Angmagssalik) 4360 Tasiilaq	1 October 1897 1 January 1958	30 September 1959 31 December 2012

*Table 2.3.3. Greenlandic series of daily highest temperature***.**

2.4. Metadata

Changes in station position, measuring procedures or observer may all significantly bias a time series of observations. For that reason metadata (“data on data”) are important.

All available information on station positions regarding the data published in this chapter is included in a data file attached to this publication, please see please see the chapter “History of stations” and chapter 2.5.4.

In Appendix additionally metadata can be found. In Appendix 2.1 dates for the introduction of the Hellmann rain gauge and for the introduction of Stevenson screens (thermometer screen) are listed if available.

Finally a compiled set of various metadata, covering aspects such as station position and relocations, change of instrumentation and observation units etc., that is essential to know when homogenizing time series of climate data can be found in DMI Technical Report 03-24 [22]. This publication contains information concerning a major part of the stations included in this report.

2.5. File formats; Daily data files

The daily files included in this report contain daily DMI data series 1873 - 2012 comprising different parameters for selected meteorological stations in Greenland.

The file names are determined as follows:

gr_daily_<element abbr><station number>_<period>

More specifically following fixed format text files in this report:

4 fixed ASCII format data files named gr_daily_p<station number_period>.dat
5 fixed ASCII format data files named gr_daily_tn<station number_period >.dat
5 fixed ASCII format data files named gr_daily_tx<station number_period >.dat

Formats and units can be seen in the sections 2.5.1 to section 2.5.3.

Data are only to be used with proper reference to the accompanying report: Cappelen, J. (ed), 2013: Greenland - DMI Historical Climate Data Collection 1873-2012 – with Danish Abstracts. DMI Technical Report 13-04. Copenhagen.

2.5.1 Daily accumulated precipitation files

p<station number_period>.dat

gr_daily_p<station number_<period>.dat

The observation files contain daily accumulated precipitation. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

gr_daily_p4216_1961_1991.dat
gr_daily_p4360_1958_2012.dat
gr_daily_p34216_1873_1960.dat
gr_daily_p34360_1897_1959.dat

Format and units of all precipitation observation files:

Position	**Format**	**Description**
1-5	F5.0	Station number
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour (Local time or UTC (since 2001 (4216 and 4360, whole period))
16-20	F5.0	Accumalated precipitation previous 24 hours (0.1 mm) -1 means more than 0 mm, but less than 0.1 mm, -2 means accumulation for several days up to the day where precipitation differs from 0, -9999 means missing value. **Please note:** For **station 34216** and **station 34360** the ‘daily precipitation’ may in some cases be the precipitation accumulated for several days.

2.5.2 Daily lowest temperature files

gr_daily_tn<station number_period>.dat

The observation files contain observed daily lowest temperature. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

gr_daily_tn4216_1961_1992.dat
gr_daily_tn4221_1991_2012.dat
gr_daily_tn4360_1958_2012.dat
gr_daily_tn34216_1873_1960.dat
gr_daily_tn34360_1894_1959.dat

Format and units of all minimum temperature observation files:

Position	**Format**	**Description**
1-5	F5.0	Station number
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour DNT or UTC (since 2001 or if station number starts with 6)
16-20	F5.0	Lowest temperature previous 24 hours (0.1°C).

2.5.3 Daily maximum temperature files

tx<station number_period>.dat

gr_daily_tx<station number_<period>.dat

The files contain daily highest temperatures. There are no missing dates between the start and the end date. Any missing observations are filled in by -9999.

gr_daily_tx4216_1961_1992.dat
gr_daily_tx4221_1991_2012.dat
gr_daily_tx4360_1958_2012.dat
gr_daily_tx34216_1877_1960.dat
gr_daily_tx34360_1897_1959.dat

Format and units of all maximum temperature observation files:

Position	**Format**	**Description**
1-5	F5.0	Station number
6-9	F4.0	Year
10-11	F2.0	Month
12-13	F2.0	Day
14-15	F2.0	Hour DNT or UTC (since 2001 or if station number starts with 4)
16-20	F5.0	Highest temperature (0.1°C). The highest temperature, covering the previous 24 hours, is read in the morning (the same as the lowest temperature). For the manual climate stations (34216 and 34360) **please note:** During the periods 1 Jan 1874 - 31 Dec 1912 and 2 Jan 1971 - 31 Dec 2000 the highest temperature is listed on the date it has been read. During the period 1 Jan 1913 - 1

Jan 1971 the highest temperature is listed on the previous day (where it most often occurs). This change in practice was only regarding the highest temperature, not the lowest temperature. The result is repeated here in the data files as listed above. Because of the change back and forth in practise the data files (and DMI annals) hold no highest temperature for the 24-hours period starting in the morning 31 Dec 1912 and ending in the morning 1 Jan 1913. And conversely the highest temperature of the 24-hours that starts in the morning 1 Jan 1971 and ends in the morning 2 Jan 1971 is listed TWO times in the data files: With time stamp 1 Jan 1971 at 8 hours AND with time stamp 2 Jan 1971 at 8 hours, just as the change of practice dictates for those dates.

Appendix 2.1. Introduction of the Hellmann rain gauge and Stevenson screens

Some events like replacement of rain gauges and thermometer screens can sometimes cause serious “break points” in the time series. In table A2.1.1 is listed relevant information on dates (it took place from app. 1910 – 1925) for introduction of the Hellmann rain gauge and for introduction of Stevenson screens (if available) concerning the stations in this report. The information originates from DMI Technical Report 94-20 [3].

Station No.	**Name**	**Fjord gauge replaced by Hellmann**	**Stevenson screen mounted**
34216	Ilulissat (Jacobshavn)	1923.08	N/A
34360	Tasiilaq (Angmagsalik)	1920.10	N/A

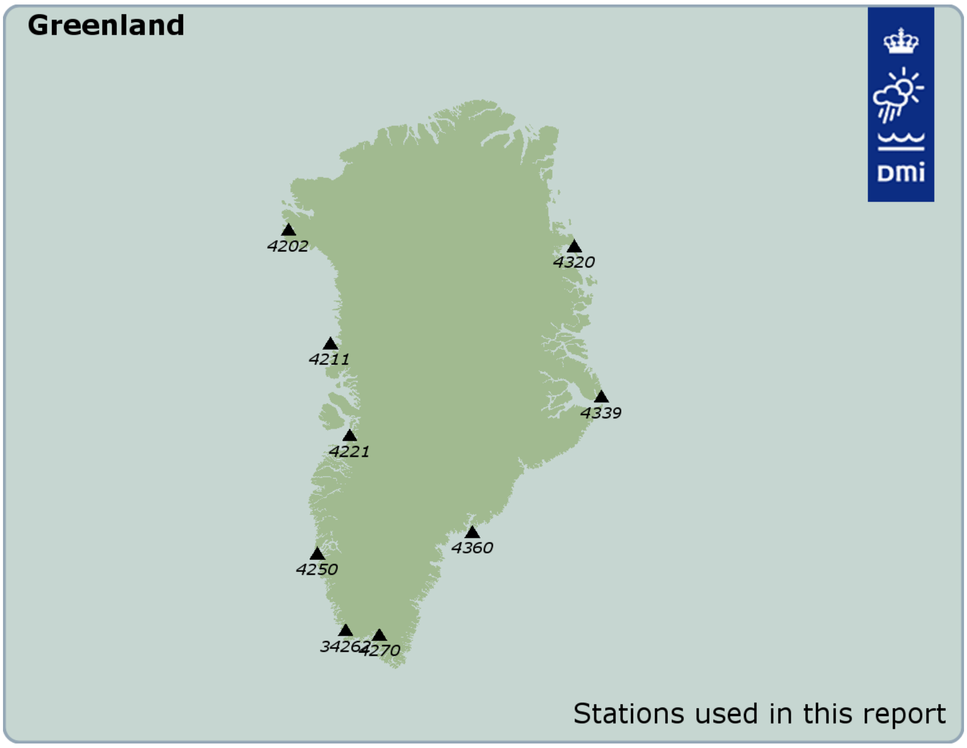
Table A2.1.1. Information on station instrumentation concerning rain gauge and Stevenson screen (thermometer screen). From ’table 6’ in [3].

3. Monthly Section: Historical DMI Data Collection

Data collection	Products in the report	Page
Month	**Section 3.3. Mean air temperature, mean of daily minimum and maximum temperatures and highest/lowest temperature, mean atmospheric pressure, accumulated precipitation, highest 24-hour precipitation, no. of days with snow cover and mean cloud cover**, 10 stations: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund* (1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012)	41

Datasamling	*Produkter i rapporten*	*Sidetal*
Måned	***Sektion 3.3. Middel luft-, max- og min- temperatur samt højeste og laveste temperatur, middellufttryk, nedbørsum, max 24 t nedbørsum, antal snedækkedage og middelskydække**, 10 stationer: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund* (1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012)*	*41*

**34339 Scoresbysund is not marked on the map. The location is nearly similar to 4339 Illoqqortoormiut.*



Latest earlier report: [12] Cappelen, J. (ed), 2012: Greenland - DMI Historical Climate Data Collection 1768-2011. DMI Technical Report No. 12-04.

3.1 Introduction

The purpose of this chapter is to publish available long *monthly* DMI data series 1873-2012 for Greenland. The data parameters include mean temperature, minimum temperature, maximum temperature, atmospheric pressure, precipitation, highest 24-hour precipitation, number of days with snow and cloud cover.

According to the intensions to update regularly, preferably every year, this particular report contains an update (2012 data) of the “DMI Monthly Climate Data Collection” published for the first time in that form in DMI Technical Report 03-26: DMI Monthly Climate Data Collection 1860-2002, Denmark, The Faroe Island and Greenland. An update of: NACD, REWARD, NORDKLIM and NARP datasets, Version 1, Copenhagen 2003 [20]. A similar collection of long DMI *daily* and *annual* greenlandic climate data series can be found in section 2 and 4 in this report.

Some of the monthly data have over the years been published in connection with different Nordic climate projects like NACD (North Atlantic Climatological Dataset, see [18]), REWARD (Relating Extreme Weather to Atmospheric circulation using a Regionalised Dataset, see [17]), NORDKLIM (Nordic Co-operation within Climate activities, see NORDKLIM project homepage: http://www.smhi.se/hfa_coord/nordklim/) and NARP (Nordic Arctic Research Programme).

The original DMI Monthly Climate Data Collection published in DMI Technical Report 03-26 [20]) was for that reason, besides a publication of a collection of recommended DMI long monthly data series 1860-2002, also an revision/update of the NACD, REWARD, NORDKLIM and NARP datasets with a clarification on what has been done with the data previously. The method used in this clarification was based on 3 different datasets:

1) **Recommended -** a collection of DMI recommended well-documented data series.

2) **Observed -** based strictly on raw observations, which have to fulfil certain criteria in terms of frequency etc., in order for arithmetic means, maximums, minimums etc. to be calculated depending on the parameter. These dataset acts as a baseline, since many of the time-series previously published represent adjusted data, which are not very well documented.

3) **Previous -** represents the time-series generated earlier primarily in connection with NACD and REWARD. These time-series are quite complete for the period 1890 – 1995 and many holes have been filled compared to the observed dataset.

The revision/update of those datasets is considered done with the DMI Technical Report 03-26 [20].

Therefore only already published recommended DMI monthly data series with relevant updates/corrections have been included since and will be included in this and the coming reports comprising DMI Monthly Data Collections.

The monthly data sets can be downloaded from the publication part of DMI web pages.

Special remarks:

In the following chapters the reference “NARP1” refers to the “NARP dataset version 1”, see [20].

The time series referred to in this report have been constructed by a number of persons. Their names and initials/abbreviations are: Poul Frich (PF), John Cappelen (JC), Ellen Vaarby Laursen (EVL), Rikke Sjølin Thomsen (RST), Bent Vraae Jørgensen (BVJ) and Lotte Sligting Stannius (LSS).

Time series are referred to by their creator (abbreviations seen above) and the number they have in the internal DMI time series classification.

Therefore, time series “, JC-TS1474” means a time series created by John Cappelen with number 1474 in the time series classification.

“Monthly_db” refers to an internal DMI monthly database with monthly values of various weather parameters.

In this report months are referred to by year/month number (ex. 2000/03 = March 2000) and the minimum criteria used here for calculating a valid monthly value is that measurements from more than 21 days are present in that month, so the number of daily values are ranging 22-31.

During some of the former data projects (i.e. NACD) the data have been homogenised based on tests against neighbouring stations.

The updated series presented in this report have been tested and corrected carefully, mainly based on visual tests. Otherwise it is indicated if care should be taken when using the series.

Special care should be taken concerning most of the series with mean cloud cover. There are still problems to be solved in the data sets mainly due to the difficult character of the observation (visual) and the shift to automatic detection with a ceilometer starting approximately in the beginning of the new millennium. Care should also be taken in the case of series with number of days with snow cover, another visual parameter.

Formålet med denne sektion er at publicere tilgængelige lange anbefalede månedlige DMI dataserier 1873-2012 fra Grønland. Det omfatter middeltemperatur, minimumtemperatur, maksimumtemperatur, atmosfærisk tryk, nedbørsum, maksimal 24t nedbørsum, antallet af dage med sne og skydække. I afsnit 3.2 kan ses hvilke stationer og parametre, det drejer sig. Stationshistorien kan ses i afsnittet “History of stations used in the report”. I afsnit 3.3 er de enkelte seriers sammensætning beskrevet og endelig er filformatet af de medfølgende filer beskrevet i afsnit 3.4.

3.2. Stations and parameters

3.2.1 Station Overview

	Country	Station	Station number	First year
1	GR	Pituffik	4202[1)]	1948
2	GR	Upernavik	4211[2)]	1873
3	GR	Ilulissat	4221[3)]	1873
4	GR	Nuuk	4250[4)]	1873
5	GR	Ivittuut	34262	1873
6	GR	Narsarsuaq	4270	1961
7	GR	Danmarkshavn	4320	1949
8	GR	Scoresbysund	34339	1924
7	GR	Illoqqortoormiut	4339[5)]	1949
8	GR	Tasiilaq	4360[6)]	1895

Table 3.2.1 Primary stations used in this report.

1) The series are a combination of 4202 Pituffik and before that 4200 Dundas. From Nov 2006 the monthly data are obtained from Thule AB, personal communication.

2) The series are a combination of 4211 Upernavik, 4210 Upernavik, 4209 Upernavik AWS and before that 34210 Upernavik.

3) The series are a combination of 4221 Ilulissat, 4216 Ilulissat and before that 34216 Jacobshavn. New monthly values in the period 1936-1948 have been applied in connection with the 2010 update, see details in Appendix 3.3. The corrections are not applied in earlier reports.

4) The series are a combination of 4250 Nuuk and before that 34250 Godthåb.

5) The series are a combination of 4339 Illoqqortoormiut, 4340 Kap Tobin and before that 34340 Kap Tobin.

6) The series are a combination of 4360 Tasiilaq and before that 34360 Angmagssalik.

3.2.2 Data Dictionary

Number	Abbr.	Element	Method	Unit
101	T	Mean temperature	Mean	0,1°C
111	Tx	Mean of daily maximum temperature	Mean	0,1°C
112	Th	Highest temperature	Max	0,1°C
121	Tn	Mean of daily minimum temperature	Mean	0,1°C
122	Tl	Lowest temperature	Min	0,1°C
401	P	Mean atmospheric pressure	Mean	0,1 hPa
601	R	Accumulated precipitation	Sum	0,1 mm
602	Rx	Highest 24-hour precipitation	Max	0,1 mm
701	DSC	No. of days with snow cover (> 50 % covered)	Sum	days
801	N	Mean cloud cover	Mean	%

Table 3.2.2. Elements used in this report. 'Method' specifies whether the element is a sum, a mean or an extreme. The units of the monthly values in the data files are specified in 'Unit'. The DMI system of element numbers contains more than the shown elements. At the moment (2012) there are about 250 entries.

3.3. Description of monthly data series

3.3.1. Pittufik (PITU) - 4202

Element No. 101 (Mean Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1948 – 2012	PF-TS1+JC-TS1423+Monthly-db PITU4202+pers. comm.	780	0
Details: Created using PF-TS1: 1948-1996, JC-TS1423: 1997-1999, monthly-db PITU 4202: 2000-2006/10 and personal communication /Thule AB) 2006/11-2012. From 2000-2006/10 data occasionally have been changed due to personal communication (Thule AB) and too many missing observations.				

3.3.2. Upernavik (UPER) - 4211

Element No. 101 (Mean Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1873 – 2012	NARP1 + LSS-TS1425 + Monthly-db UPER 4210/4209/4211	1680	0

Details:
Created using NARP1: 1873-1957, LSS-TS1425: 1958-1999, monthly-db UPER 4210/4209: 2000-2001 and monthly-db UPER 4211: 2002-2012. Missing months were filled using multiple regressions with 4216 Ilulissat (ILUL) and 4202 Pituffik (PITU), one regression for each month January-December, see Appendix 3.1. Months with inserted values: 1977/08, 1982/01-12, 1983/01-07, 1983/09-11, 1984/01+02+04+05+06+07, 1986/02-10, 1988/09+10+11+12, 1989/01, 1990/10+11, 1991/08. For one month 1982/03, 4202 Pituffik (PITU) was not available so the regression was done with 4216 Ilulissat (ILUL) alone (UPER = 0.843 * ILUL – 70.3 = -204, r^2=0.876).

Element No. 111 (Mean of Daily Maximum Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1+ LSS-TS1451 + Monthly-db UPER 4210/4209/4211	1476	244

Details:
Created using NARP1: 1890-1957, LSS-TS1451: 1958-1999, monthly-db UPER 4210/4209: 2000-2001 and monthly-db UPER 4211: 2002-2012. LSS-TS1451 has missing values from 1981/07 - 1995/09, because the number of days per month for 4209 were low in this period (15-25 pr. month). Missing months: 244 (not listed here).

Element No. 112 (Highest Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + JC-TS1474 + Monthly-db UPER 4210/4209/4211	1476	248

Details:
Created using NARP1: 1890-1957, JC-TS1474: 1958-1999, monthly-db UPER 4210/4209: 2000-2001 and monthly-db UPER 4211: 2002-2012. LSS-TS1474 has missing values from 1981/07 - 1995/09, because the number of days per month for 4209 were low in this period (15-25 pr. month). Missing months: 248 (not listed here).

Element No. 121 (Mean of Daily Minimum Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + JC-TS1495 + Monthly-db UPER 4210/4209/4211	1476	226

Details:
Created using NARP1: 1890-1957, JC-TS1495: 1958-1999, monthly-db UPER 4210/4209: 2000-2001 and monthly-db UPER 4211: 2002-2012. LSS-TS1495 has missing values from 1981/07 - 1995/09, because the number of days per month for 4209 were low in this period (15-25 pr. month). Missing months: 226 (not listed here).

Element No. 122 (Lowest Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS1516 + Monthly-db UPER 4210/4209/4211	1476	229

Details:
Created using NARP1: 1890-1957, LSS-TS1516: 1958-1999, monthly-db UPER 4210/4209: 2000-2001 and monthly-db UPER 4211: 2002-2012. LSS-TS1516 has missing values from 1981/07 - 1995/09, because the number of days per month for 4209 were low in this period (15-25 pr. month). Missing months: 229 (not listed here).

Upernavik (UPER) – 4211 (continued)

Element No. 401 (Mean Atmospheric Pressure)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + JC-TS1606 + Monthly-db UPER 4210/4209/4211	1476	145
Details: Created using NARP1: 1890-1957 (34210) reduced to mean sea level (see appendix 3.3), JC-TS1606: 1958-1999, monthly-db UPER 4210/4209: 2000-2001 and monthly-db UPER 4211: 2002-2012. The missing values are concentrated in the periods 1940-1945 and 1981-1988. Missing months: 145 (not listed here).				

Element No. 601 (Accumulated Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1980	NARP1 + BVJ-TS1909	1092	119
Details: Created using NARP1: 1890-1957, BVJ-TS1909: 1958-1980. The missing values are concentrated in the period 1938-1950. Missing months: 119 (not listed here).				

Element No. 602 (Highest 24-hour Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1950 – 1980	NARP1 + BVJ-TS1930	372	1
Details: Created using NARP1: 1950-1957, BVJ-TS1930: 1958-1980. Missing: 1977/8.				

Element No. 701 (Number of days with Snow Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1938 – 1980	NARP1 + LSS-TS2030	516	0
Details: Created using NARP1: 1950-1957, LSS-TS2030: 1958-1980. Missing: None.				

Element No. 801 (Cloud Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1980	NARP1 + LSS-TS2087	1092	46
Details: Created using NARP1: 1890-1957, LSS-TS2087: 1958-1980. Missing: 46 (not listed here).				

3.3.3. Ilulissat (ILUL) - 4221

Element No. 101 (Mean Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1873 – 2012	PF-TS14 +LSS-TS1428 + Monthly-db ILUL 4221	1680	0

Details:
Created using PF-TS14: 1873/1-1991/10, LSS-TS1428: 1991/11-1999, monthly-db ILUL 4221: 2000-2012. Missing months 1976/7, 1993/5+6 and 2000/4 were filled using monthly correlations with Aasiaat (4220): 1976/07: ILUL = 0.948 * AASI + 23.7 (r^2=0.829), 1993/05: ILUL = 1.081 * AASI + 21.0 (r^2=0.987), 1993/06: ILUL = 1.080 * AASI + 20.0 (r^2=0.968) and 2000/04: ILUL = 1.063 * AASI + 19.2 (r^2=0.989). Missing months 2005/08 and 2005/9 were filled using monthly correlations with Aasiaat (4220): 2005/08: ILUL = 1.021 * AASI + 6.341 (r^2=0.8) and 2005/09: ILUL = 1.3 * AASI – 8.995 (r^2=0.849). Months 2006/2, 2006/4-2006/10 were calculated using the METAR code. The former published series (latest 1873-2002 and earlier) has been changed, because the use of JC-TS1426 in that series for the period 1961/1 – 1979/3 wasn't appropriate. New corrections to PF-TS14 in the period 1936/11-1946/8, se appendix 3.4.

Element No. 111 (Mean of Daily Maximum Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1895 – 2012	NARP1 + LSS-TS1452 +LSS-TS1454 + Monthly-db ILUL 4221/4216	1416	104

Details:
Created using NARP1: 1895-1960, LSS-TS1452: 1961-1991, LSS-TS1454: 1992-1999, monthly-db ILUL 4221: 2000-2012. Missing: 104 months, not listed here, especially during years 1916-1918 and 1982-1988. Missing months 2005/08 and 2005/9 were filled using monthly correlations with Aasiaat (4220): 2005/08: ILUL = 1.309 * AASI – 8,832 (r^2=0.931) and 2005/09: ILUL = 1.477 * AASI – 13.849 (r^2=0.849). Months 2006/2, 2006/4-2006/10 were calculated using the METAR code.

Element No. 112 (Highest Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS1475 +LSS-TS1477 + Monthly-db ILUL 4221/4216	1476	120

Details:
Created using NARP1: 1890-1960, LSS-TS1475: 1961-1991, LSS-TS1477: 1992-1999, monthly-db ILUL 4221: 2000-2012. Missing: 120 months, not listed here, especially during years 1893, 1916-1918 and 1982-1988. Months 2006/4-2006/10 were calculated using the METAR code.

Element No. 121 (Mean of Daily Minimum Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + JC-TS1496 +LSS-TS1498 + Monthly-db ILUL 4221/4216	1476	111

Details:
Created using NARP1: 1890-1960, LSS-TS1496: 1961-1991, LSS-TS1498: 1992-1999, monthly-db ILUL 4221: 2000-2012. Missing: 111 months, not listed here, especially during years 1916-1917, 1935-1936 and 1982-1988. Missing months 2005/08 was filled with Aasiaat (4220). 2005/9 was filled using a monthly correlation with Aasiaat (4220): ILUL = 1.026 * AASI – 33.316 (r^2=0.634). Months 2006/2, 2006/4-2006/10 were calculated using the METAR code.

Element No. 122 (Lowest Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS1517 +LSS-TS1519 + Monthly-db ILUL 4221/4216	1476	125

Details: Created using NARP1: 1890-1960, LSS-TS1517: 1961-1991, LSS-TS1519: 1992 – 1999, monthly-db ILUL 4221: 2000-2012. Missing: 125 months, not listed here, especially during years 1916-1917, 1935-1937 and 1982-1988. Months 2006/4-2006/10 were calculated using the METAR code.

Ilulissat (ILUL) – 4221 (continued)

Element No. 401 (Mean Atmospheric Pressure)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + JC-TS1607 +JC-TS1609 + Monthly-db ILUL 4221/4216	1476	70

Details:
Created using NARP1: 1890-1960 (34216) reduced to mean sea level (see appendix 3.3), JC-TS1607: 1961-1991, JC-TS1609: 1992 – 1999, monthly-db ILUL 4221: 2000-2012. Missing: 70 months, not listed here, especially during years 1987-1991. Months 2006/2, 2006/4-2006/10 were calculated using the METAR code.

Element No. 601 (Accumulated Precipitation)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1984	NARP1 + BVJ-TS1910	1140	14

Details:
Created using NARP1: 1890-1960, BVJ-TS1910: 1961-1984. Missing: 14 months, not listed here.

Element No. 602 (Highest 24-hour Precipitation)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1984	NARP1 + BVJ-TS1931	1140	10

Details:
Created using NARP1: 1890-1960, BVJ-TS1931: 1961-1984. Missing: 10 months, not listed here.

Element No. 701 (Number of days with Snow Cover)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1938 – 1981	NARP1 + LSS-TS2031	528	1

Details:
Created using NARP1: 1890-1960, LSS-TS2031: 1961-1981. Missing: 1976/7.

Element No. 801 (Cloud Cover)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1978	NARP1 + LSS-TS2088	1068	4

Details:
Created using NARP1: 1890-1960, LSS-TS2088: 1961-1978. Missing: 1921/3, 1929/7, 1936/10 and 1976/7. From 23 August 1991 observations of cloud cover are available from 4221 Ilulissat Airport, but observations to scattered. From medio September 2004 a ceilometer for automatic detection of cloud cover are used at 4211 Ilulissat Airport as the only way of observation the clock around, but up to date erroneous data. The data after 1991 are therefore not recommended for use.

3.3.4. Nuuk (NUUK) - 4250

Element No. 101 (Mean Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1873 – 2012	PF-TS24+NARP1+LSS-TS1433+Monthly-db NUUK4250	1680	9

Details:
Created using PF-TS24 1873-1889, NARP1: 1890-1957, LSS-TS1433: 1958-1999, monthly-db NUUK 4250: 2000-2012. Missing: 1896/6, 1899/4+5, 1900/10, 1901/1+2, 1920/9+10 & 2000/3. 2000/12 value has been changed by EVL in the dataset 1890-2006 compared to previous datasets. 2003/2 was filled using a monthly regression with NUUK AIRPORT (4254). 2003/2: NUUK(4250) = 1.050 * NUUK AIRPORT(4254) + 6.603 (r^2=0.999). 2000/12, 2005/5, 2007/1 – 2008/12, 2009/9 and 2011/1-2012/12 were filled with the values from Nuuk Airport 4254.

Element No. 111 (Mean of Daily Maximum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS1458 + Monthly-db NUUK 4250	1476	31

Details:
Created using NARP1: 1890-1957, LSS-TS1458: 1958-1999, monthly-db NUUK 4250: 2000-2012. Missing: 31 months (not listed here), particularly during year 1894, 1898 & 1912. 2003/2 was filled using a monthly regression with NUUK AIRPORT (4254). 2003/2: NUUK(4250) = 1.014 * NUUK AIRPORT (4254) -3.782 (r^2=0.999). 2005/5, 2007/1 – 2008/12, 2009/9 and 2011/1-2012/12were filled with the values from Nuuk Airport 4254.

Element No. 112 (Highest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS1481 + Monthly-db NUUK 4250	1476	35

Details:
Created using NARP1: 1890-1957, LSS-TS1481: 1958-1999, monthly-db NUUK 4250: 2000-2012. Missing: 35 months (not listed here), particularly during year 1894, 1898, 1912 and 1999. 2003/1, 2005/5, 2007/1 – 2008/12, 2009/9 and 2011/1-2012/12 were filled with the values from Nuuk Airport 4254.

Element No. 121 (Mean of Daily Minimum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS1502 + Monthly-db NUUK 4250	1476	50

Details:
Created using NARP1: 1890-1957, LSS-TS1502: 1958-1999, monthly-db NUUK 4250: 2000-2012. Missing: 50 months (not listed here), particularly during years 1941 and 1943-1945. 2003/2 was filled using a monthly regression with NUUK AIRPORT (4254). 2003/2: NUUK(4250) = 1.080 * NUUK AIRPORT (4254) +18.282 (r^2=0.997). 2005/5, 2007/1 – 2008/12, 2009/9 and 2011/1-2012/12 were filled with the value from Nuuk Airport 4254.

Element No. 122 (Lowest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS1523 + Monthly-db NUUK 4250	1476	63

Details:
Created using NARP1: 1890-1957, LSS-TS1523: 1958-1999, monthly-db NUUK 4250: 2000-2012. Missing: 63 months (not listed here), particularly during years 1941, 1943-1945 and 1999. 2003/1, 2007/1 – 2008/12, 2009/9 and 2011/1-2012/12 were filled with the value from Nuuk Airport 4254.

Nuuk (NUUK) – 4250 (continued)

Element No. 401 (Mean Atmospheric Pressure)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + JC-TS1614 + Monthly-db NUUK 4250	1476	262

Details:
Created using NARP1: 1890-1957 (34250) reduced to mean sea level (see appendix 3.3), JC-TS1614: 1958-1999, monthly-db NUUK 4250: 2000-2012. Missing: 262 months (not listed here), particularly during years 1926-1946. 2003/1+2, 2005/5, 2007/1-2008/12, 2011/1, 2012/1-3 and 2012/7-8 were filled using the values from 4254 Nuuk Airport.

Element No. 601 (Accumulated Precipitation) – Not necessarily homogenous

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + BVJ-TS1915 + Monthly-db NUUK 34250/4250	1476	78

Details:
Created using NARP1: 1890-1957, BVJ-TS1915: 1958-1998, monthly-db 34250 Nuuk: 1999/2-2012/8, monthly-db 4250 Nuuk: 2012/9-2012. Missing: 78 months (not listed here), particularly during years 1893, 1899, 1918-1921. Not necessarily homogenous, possible break in the early 1950s based on a visual check. Not necessarily homogenous, because of the different ways of detection – from 1 September 2012 an automatic raingauge.

Element No. 602 (Highest 24-hour Precipitation) - – Not necessarily homogenous

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1922 – 2012	NARP1 + BVJ-TS1936 + Monthly-db NUUK 34250/4250	1092	2

Details:
Created using NARP1: 1890-1957, BVJ-TS1936: 1958-1998, monthly-db 34250 Nuuk: 1999/2-2012/8, monthly-db 4250 Nuuk: 2012/9-2012. Missing: 1992/7, 1999/1. Not necessarily homogenous, because of the different ways of detection – from 1 September 2012 an automatic raingauge.

Element No. 701 (Number of Days with Snow Cover)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1942 – 1981	NARP1 + LSS-TS2036	480	0

Details:
Created using NARP1: 1942-1957, LSS-TS2036: 1958-1981.

Element No. 801 (Mean Cloud Cover) – Not necessarily homogenous

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 2012	NARP1 + LSS-TS2093 + Monthly-db NUUK 4250	1476	44

Details:
Created using NARP1: 1890-1957, LSS-TS2093: 1958-1999, monthly-db 4250 Nuuk: 2000-2012. Missing: 41 months (not listed here), particularly during years 1893-1894, 1999-2005 and 2010-2012. From 1 February 1999 a ceilometer for automatic detection of cloud cover are used at 4250 Nuuk as the only way of observation the clock around. Not necessarily homogenous, because of the different ways of detection.

3.3.5. Ivittuut – (IVIT) - 34262 (Previous part of Narsarsuaq series)

Element No. 101 (Mean Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1873 – 1960	NARP1	1056	0
Details: Created using NARP1: 1873-1960. Missing: None.				

Element No. 111 (Mean of Daily Maximum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	50
Details: Created using NARP1: 1890-1960. Missing: 50 months (not listed here), particularly during years 1916-1919 & 1927-1928.				

Element No. 112 (Highest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	50
Details: Created using NARP1: 1890-1960. Missing: 50 months (not listed here), particularly during years 1916-1919 & 1927-1928.				

Element No. 121 (Mean of Daily Minimum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	25
Details: Created using NARP1: 1890-1960. Missing: 25 months (not listed here), particularly during years 1918-1919 & 1927-1928.				

Element No. 122 (Lowest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	25
Details: Created using NARP1: 1890-1960. Missing: 25 months (not listed here), particularly during years 1918-1919 & 1927-1928.				

Ivittuut – (IVIT) - 34262 (continued) (Previous part of Narsarsuaq series)

Element No. 401 (Mean Atmospheric Pressure)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	26
Details: Created using NARP1: 1890-1960 (34262) reduced to mean sea level (see appendix 3.3). Missing: 26 months (not listed here), particularly during years 1918-1919 & 1927-1928.				

Element No. 601 (Accumulated Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	27
Details: Created using NARP1: 1890-1960. Missing: 27 months (not listed here), particularly during years 1918-1919 & 1927-1928.				

Element No. 602 (Highest 24-hour Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	15
Details: Created using NARP1: 1890-1960. Missing: 15 months (not listed here), particularly during years 1927-1928.				

Element No. 701 (Number of Days with Snow Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1938 – 1960	NARP1	276	12
Details: Created using NARP1: 1938-1960. Missing: 12 months 1942/1-1942/12.				

Element No. 801 (Mean Cloud Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1890 – 1960	NARP1	852	26
Details: Created using NARP1: 1890-1960. Missing: 26 months (not listed here), particularly during years 1918-1919 & 1927-1928.				

3.3.6. Narsarsuaq (NARS) - 4270

Element No. 101 (Mean Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	LSS-TS1435 + Monthly-db NARS 4270	624	2
Details: Created using: LSS-TS1435: 1961-1999, monthly-db NARS 4270: 2000-2012. Missing: 1985/5+6. 2007/7 was filled using a monthly regression with Qaqortoq (4272): Narsarsuaq (4270) = 0.796 * Qaqortoq (4272) + 45.601 (r^2=0.724), period 1961-2006. 2007/8 was filled using a monthly regression with Qaqortoq (4272): Narsarsuaq (4270) = 0.806 * Qaqortoq (4272) + 33.383 (r^2=0.793), period 1961-2006.				

Element No. 111 (Mean of Daily Maximum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	LSS-TS1460 + Monthly-db NARS 4270	624	0
Details: Created using: LSS-TS1460: 1961-1999, monthly-db NARS 4270: 2000-2012. Missing: None. 2007/7 was filled using a monthly regression with Qaqortoq (4272): Narsarsuaq (4270) = 0.846 * Qaqortoq (4272) + 50.301 (r^2=0.666), period 1961-2006. 2007/8 was filled using a monthly regression with Qaqortoq (4272): Narsarsuaq (4270) = 0.968 * Qaqortoq (4272) + 26.709 (r^2=0.758), period 1961-2006.				

Element No. 112 (Highest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	LSS-TS1483 + Monthly-db NARS 4270	624	4
Details: Created using: LSS-TS1483: 1961-1999, monthly-db NARS 4270: 2000-2012. Missing: 4 months (1967/12, 1985/6, 2007/7, 2007/8).				

Element No. 121 (Mean of Daily Minimum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	LSS-TS1504 + Monthly-db NARS 4270	624	0
Details: Created using: LSS-TS1504: 1961-1999, monthly-db NARS 4270: 2000-2012. Missing: None. 2007/7 was filled using a monthly regression with Qaqortoq (4272): Narsarsuaq (4270) = 0.415 * Qaqortoq (4272) + 49.310 (r^2=0.302), period 1961-2006. 2007/8 was filled using a monthly regression with Qaqortoq (4272): Narsarsuaq (4270) = 0.380 * Qaqortoq (4272) + 40.323 (r^2=0.406), period 1961-2006.				

Element No. 122 (Lowest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	LSS-TS1525 + Monthly-db NARS 4270	624	5
Details: Created using: LSS-TS1525: 1961-1999, monthly-db NARS 4270: 2000-2012. Missing: 5 months (1962/3, 1963/1, 1967/12, 2007/7, 2007/8).				

Narsarsuaq (NARS) – 4270 (continued)

Element No. 401 (Mean Atmospheric Pressure)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	JC-TS1616 + Monthly-db NARS 4270	624	0
Details: Created using: JC-TS1616: 1961-1999, monthly-db NARS 4270: 2000-2012. Missing: None.				

Element No. 601 (Accumulated Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	BVJ-TS1918 + Monthly-db NARS 4270 + monthly-db NARS 34270	624	1
Details: Created using: BVJ-TS1918: 1961-1999, monthly-db NARS 4270: 2000-2008, monthly-db NARS 34270: 2009-2012. Missing: 2009/1. 34270 Narsarsuaq started 22/1 – 2009.				

Element No. 602 (Highest 24-hour Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	BVJ-TS1939 + Monthly-db NARS 4270 + monthly-db NARS 34270	624	1
Details: Created using: BVJ-TS1939: 1961-1999, monthly-db NARS 4270: 2000-2008, monthly-db NARS 34270: 2009-2012. Missing: 2009/1. 34270 Narsarsuaq started 22/1 – 2009.				

Element No. 701 (Number of Days with Snow Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 1999	LSS-TS2038 + Monthly-db NARS 4270	468	41
Details: Created using: LSS-TS2038: 1961-1981, monthly-db NARS 4270: 1982-1999. Missing: 41 months (not listed here), particularly during years 1985 & 1996-1998. After 1999, data becomes very sparse.				

Element No. 801 (Mean Cloud Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1961 – 2012	LSS-TS2095 + Monthly-db NARS 4270	624	38
Details: Created using: LSS-TS2095: 1961-1999, monthly-db NARS 4270: 2000-2012. Missing: 38 months (1985/5+6, 2009-2012 (erroneous data, not recommended for use)).				

3.3.7. Danmarkshavn (DANM) - 4320

Element No. 101 (Mean Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1439 + Monthly-db DANM 4320	768	6
Details: Created using NARP1: 1949-1957, LSS-TS1439: 1958-1999, monthly-db DANM 4320: 2000-2012. Missing: 6 months (1954/11, 1977/8, 1981/7-10 (due to labour strike)).				

Element No. 111 (Mean of Daily Maximum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1463 + Monthly-db DANM 4320	768	6
Details: Created using NARP1: 1949-1957, LSS-TS1463: 1958-1999, monthly-db DANM 4320: 2000-2012. Missing: 6 months (1954/11, 1977/8, 1981/7-10 (due to labour strike)).				

Element No. 112 (Highest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1483 + Monthly-db DANM 4320	768	6
Details: Created using NARP1: 1949-1957, LSS-TS1483: 1958-1999, monthly-db DANM 4320: 2000-2012. Missing: 6 months (1977/8, 1981/6-10 (due to labour strike)).				

Element No. 121 (Mean of Daily Minimum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1507 + Monthly-db DANM 4320	768	14
Details: Created using NARP1: 1949-1957, LSS-TS1507: 1958-1999, monthly-db DANM 4320: 2000-2012. Missing: 14 months (1977/8, 1981/7-10 (due to labour strike), 2009/1-2009/9 (erroneous data).				

Element No. 122 (Lowest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1528 + Monthly-db DANM 4320	768	15
Details: Created using NARP1: 1949-1957, LSS-TS1528: 1958-1999, monthly-db DANM 4320: 2000-2012. Missing: 15 months (1977/8, 1981/6-10 (due to labour strike), 2009/1-2009/9 (erroneous data)).				

Danmarkshavn (DANM) – 4320 (continued)

Element No. 401 (Mean Atmospheric Pressure)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + JC-TS1621 + Monthly-db DANM 4320	768	6
Details: Created using PF-TS49: 1949-1957, JC-TS1621: 1958-1999, monthly-db DANM 4320: 2000-2012. Missing: 6 months (1954/11, 1977/8, 1981/7-10 (due to labour strike)).				

Element No. 601 (Accumulated Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + BVJ-TS1921 + Monthly-db DANM 4320 + Monthly-db DANM 34320	768	7
Details: Created using NARP1: 1949-1957, BVJ-TS1921: 1958-1999, monthly-db DANM 4320: 2000-2008, monthly-db DANM 34320: 2009-2012. Missing: 7 months (1949/9, 1954/11, 1977/8, 1981/7-10 (due to labour strike)).				

Element No. 602 (Highest 24-hour Precipitation)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + BVJ-TS1942 + Monthly-db DANM 4320 + Monthly-db DANM 34320	768	5
Details: Created using NARP1: 1949-1957, BVJ-TS1942: 1958-1999, monthly-db DANM 4320: 2000-2008, monthly-db DANM 34320: 2009-2012. Missing: 5 months (1977/8, 1981/7-10 (due to labour strike)).				

Element No. 701 (Number of Days with Snow Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1958 – 1981	LSS-TS2041	288	5
Details: Created using LSS-TS2041: 1958-1981. Missing: 5 months (1977/8, 1981/7-10 (due to labour strike)). Since 1981 most winter months are missing a few days, which means that the number of days with snow cover at 4320 Danmarkshavn is not accurate. The data after 1981 are therefore not recommended for use.				

Element No. 801 (Mean Cloud Cover) – Not necessarily homogenous				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS2098 + Monthly-db DANM 4320	768	46
Details: Created using NARP1: 1949-1957, LSS-TS2098: 1958-1999, monthly-db DANM 4320: 2000-2012. Missing: 46 months (1954/11, 1977/8, 1981/7-10 (due to labour strike), 2009-2012/4 (erroneous data, not recommended for use)). From 13 August 2001 a ceilometer for automatic detection of cloud cover are used at 4320 Danmarkshavn as the only way of observation the clock around. 27 April 2012 14 UTC a new ceilometer was installed. Not necessarily homogenous, because of the new way of detection.				

3.3.8. Scoresbysund (SCOR) – 34339 (Previous part of Illoqqortoormiut series)

Element No. 101 (Mean Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1924 – 1949	NARP1	309	37
Details: Created using parts of NARP1: 1924/1-1949/9. Missing: 37 months: 1924/7-10, 1927/8, 1929/8, 1931/9, 1932/8, 1933/8, 1934/8, 1936/8, 1938/7-1939/1, 1939/-8, 1940/9, 1941/8-10, 1942/8-9, 1943/8-10, 1944/8, 1945/7-8, 1946/8.				

Element No. 111 (Mean of Daily Maximum Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1925 – 1949	NARP1	297	47
Details: Created using parts of NARP1: 1925/1-1949/9. Missing: 47 months: 1938/7-1939/1, 1939/7-8, 1946/8-1949/9.				

Element No. 112 (Highest Temperature)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1925 – 1949	NARP1	297	45
Details: Created using parts of NARP1: 1925/1-1949/9. Missing: 45 months 1938/7-1939/1, 1946/8-1949/9.				

Element No. 401 (Mean Atmospheric Pressure)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1924 – 1949	NARP1	309	69
Details: Created using parts of NARP1: 1924/1-1949/9 (34339) reduced to mean sea level (see appendix 3.3). Missing: 69 months (not listed here), primarily during 1938-1943.				

Element No. 801 (Mean Cloud Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1924 – 1949	NARP1	309	39
Details: Created using parts of NARP1: 1924/1-1949/9. Missing: 39 months (not listed here).				

3.3.9. Illoqqortoormiut (ILLO) - 4339

Element No. 101 (Mean Temperature) - Inhomogenous based on a visual test				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1441 + Monthly-db ILLO 4339/4340	759	5
Details: Created using parts of NARP1: 1949/10-1957/12 (34340 Kap Tobin), LSS-TS1441: 1958-1999 (4340: 1958/1-1980/10 and 4339:1980/11-1999/12), monthly-db ILLO 4339: 2000-2012. 2009/9 was filled using a monthly regression with Mittarfik Nerlerit Inaat (4341): Illoqqortoormiut (4339) = 0.867 * Mittarfik Nerlerit Inaat (4341) + 6.726 (r^2=0.992), period 2002-2008. Missing: 5 months 1977/8, 1981/7-10 (due to labour strike). Inhomogenous based on a visual test, possible break 1980/10.				

Element No. 111 (Mean of Daily Maximum Temperature) - Inhomogenous based on a visual test				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1465 + Monthly-db ILLO 4339	759	146
Details: Created using parts of NARP1: 1949/10-1957/12 (34340 Kap Tobin), LSS-TS1465: 1958-1999 (4340/4339), monthly-db ILLO 4339: 2000-2012. 2009/9 was filled using a monthly regression with Mittarfik Nerlerit Inaat (4341): Illoqqor-toormiut (4339) = 0.868 * Mittarfik Nerlerit Inaat (4341) + 7.577 (r^2=0.991), period 2002-2008. Missing: 146 months 1977/8, 1981/6-10 (due to labour strike) and 1982/1-1993/8. Inhomogenous based on a visual test, possible break 1980/10.				

Element No. 112 (Highest Temperature) - Inhomogenous based on a visual test				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS1488 + Monthly-db ILLO 4339	759	145
Details: Created using parts of NARP1: 1949/10-1957/12 (34340 Kap Tobin), LSS-TS1488: 1958-1999 (4340/4339), monthly-db ILLO 4339: 2000-2012. 2009/9 was filled with Mittarfik Nerlerit Inaat (4341). Missing: 145 months 1977/8, 1981/6-10 (due to labour strike) and 1982/2-1993/8. Inhomogenous based on a visual test, possible break 1980/10.				

Element No. 121 (Mean of Daily Minimum Temperature) - Inhomogenous based on a visual test				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1950 – 2012	NARP1 + LSS-TS1509 + Monthly-db ILLO 4339/4340	756	146
Details: Created using NARP1: 1950-1957 (34340 Kap Tobin), LSS-TS1509: 1958-1999 (4340/4339), monthly-db ILLO 4339: 2000-2012. 2009/9 was filled using a monthly regression with Mittarfik Nerlerit Inaat (4341): Illoqqortoormiut (4339) = 0.771 * Mittarfik Nerlerit Inaat (4341) + 6.377 (r^2=0.98), period 2002-2008. Missing: 146 months (not listed here), particularly during 1981-1993. Inhomogenous based on a visual test, possible break 1980/10.				

Element No. 122 (Lowest Temperature) - Inhomogenous based on a visual test				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1950 – 2012	NARP1 + LSS-TS1530 + Monthly-db ILLO 4339/4340	756	147
Details: Created using NARP1: 1950-1957 (34340 Kap Tobin), LSS-TS1530: 1958-1999 (4340/4339), monthly-db ILLO 4339: 2000-2012. Missing: 147 months (not listed here), particularly during 1981-1993. Inhomogenous based on a visual test, possible break 1980/10.				

Illoqqortoormiut (ILLO) – 4339 (continued)

Element No. 401 (Mean Atmospheric Pressure)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + JC-TS1623 + Monthly-db ILLO 4339	759	5
Details: *Recommended:* Created using parts of NARP1: 1949/10-1957/12 (34340 Kap Tobin) reduced to mean sea level (see appendix 3.3), JC-TS1623: 1958-1999 (4340/4339), monthly-db ILLO 4339: 2000-2012. Missing: 5 months 1977/8 and 1981/7-10 (due to labour strike).				

Element No. 601 (Accumulated Precipitation) - Not necessarily homogenous				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1950 – 2012	NARP1 + Monthly-db ILLO 4339/4340	756	34
Details: Created using NARP1: 1950-1999 (4340/4339), monthly-db ILLO 4339: 2000-2012. Missing: 34 months (1957/6, 1981/7, 2008/1-2, 2008/10-2009/9, 2011/7-2012/12). 17 August 2005 an automatic raingauge was installed at 4339 Illoqqortoormiut. Not necessarily homogenous, because of new ways of detection.				

Element No. 602 (Highest 24-hour Precipitation) - Not necessarily homogenous				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1950 – 2012	NARP1 + Monthly-db ILLO 4339/4340	756	29
Details: Created using NARP1: 1950-1957 (34340 Kap Tobin), monthly-db ILLO 4339/4340: 1958-2012. Missing: 29 months (2008/10-2009/9, 2011/7-2012/12). 17 August 2005 an automatic raingauge was installed at 4339 Illoqqortoormiut. Not necessarily homogenous, because of new ways of detection.				

Element No. 701 (Number of Days with Snow Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1958 – 1980	LSS-TS2043	274	1
Details: Created using LSS-TS2043: 1958/1-1980/10 (4340 Kap Tobin). Missing: 1 month (1977/8). After 1981 observations are available from 4339 Illoqqortoormiut. Observations of snow cover exist from August 1993. However, most winter months are missing a few days, which means that the number of days with snow cover at Illoqqortoormiut not can be considered as accurate. The data after 1980/10 are therefore not recommended for use.				

Element No. 801 (Mean Cloud Cover) – Not necessarily homogenous				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1949 – 2012	NARP1 + LSS-TS2100 + Monthly-db ILLO 4339	759	42
Details: Created using parts of NARP1: 1949/10-1957/12 (34340 Kap Tobin), LSS-TS2100: 1958-1999 (4340/4339), monthly-db ILLO 4339: 2000-2012. From 1949/10 observations came from 4340 Kap Tobin in octas. The former published series of cloud cover from Scoresbysund (Jørgensen, P. V. and Ellen Vaarby Laursen (2003) [20]) have been multiplied by a factor 1,25 from 1953/1, indicating that observations in octas were started from that year. This was indeed wrong. There are observations in octas from 1949/10. Therefore the former monthly values of cloud cover have been multiplied by the factor 1,25 in the period 1949/10-1952/12. Missing: 42 months 1977/8, 1981/7-10 (due to labour strike). 2009/6-2011/7, 2011/10-2012/8 are missing or erroneous data. From 17 August 2005 a ceilometer for automatic detection of cloud cover are used at 4339 Illoqqortoormiut as the only way of observation the clock around. Not necessarily homogenous, mostly because of the new way of detection but also because of different locations involved.				

3.3.10. Tasiilaq (TASI) - 4360

Element No. 101 (Mean Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1895 – 2012	NARP1 + LSS-TS1443 + Monthly-db TASI 4360	1416	14

Details:
Created using NARP1: 1895-1957, LSS-TS1443: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/4 was filled using both a monthly average value (-2,6°C) from a professional private weather station and a corrected (+0,8°C) monthly average value (-2,6°C) from Mitt. Kulusuk (4361). 2010/9 was filled using a corrected (-0,5°C) monthly average value (6,3°C), 2012/2 using a monthly average value (6,7°C), 2012/8 using a corrected (-1°C) monthly average value (7,4°C), 2012/11 using a corrected (-0,4°C) monthly average value (-3,0°C) and 2012/12 using a corrected (-0,1°C) monthly average value (-3,5°C) all from a professional private weather station. Missing: 14 months (1910/9 – 1911/8, 1924/8, 1937/7).

Element No. 111 (Mean of Daily Maximum Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1898 – 2012	NARP1 + LSS-TS1457 + Monthly-db TASI 4360	1380	12

Details:
Created using NARP1: 1898-1957, LSS-TS1457: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/4 was filled using a monthly average value (1,5°C), 2010/9 using a corrected (-0,5°C) monthly average value (8,2°C), 2012/2 using a monthly average value (-3,9°C), 2012/8 using a corrected (-1°C) monthly average value (10,9°C), 2012/11 using a corrected (-0,4°C) monthly average value (-0,8°C) and 2012/12 using a corrected (-0,1°C) monthly average value (-1,3°C) all from a professional private weather station. Missing: 12 months (1910/9-1911/8).

Element No. 112 (Highest Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1895 – 2012	NARP1 + LSS-TS1457 + Monthly-db TASI 4360	1416	17

Details:
Created using NARP1: 1895-1957, LSS-TS1457: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/9 was filled using the highest value from September 2010 (14,6°C), 2012/2 using the highest value from Feb 2012 (4,1°C), 2012/8 using the highest value from Aug 2012 (17,2°C) and 2012/12 using the highest value from Dec 2012 (6,9°C) all from a professional private weather station. Missing: 17 months (1910/9 – 1911/8, 1977/11, 1982/11-1983/2).

Element No. 121 (Mean of Daily Minimum Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1895 – 2012	NARP1 + LSS-TS1511 + Monthly-db TASI 4360	1416	24

Details:
Created using NARP1: 1895-1957, LSS-TS1511: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/4 was filled using a monthly average value (-6,6°C), 2010/9 using a corrected (-0,5°C) monthly average value (4,4°C), 2012/2 using a monthly average value (-9,4°C), 2012/8 using a corrected (-1°C) monthly average value (3,9°C), 2012/11 using a corrected (-0,4°C) monthly average value (-5,2°C) and 2012/12 using a corrected (-0,1°C) monthly average value (-5,8°C) all from a professional private weather station. Missing: 24 months (not listed here), mainly during years 1910-1911 & 1937-1938.

Element No. 122 (Lowest Temperature)

Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1895 – 2012	NARP1 + LSS-TS1532 + Monthly-db TASI 4360	1416	25

Details:
Created using NARP1: 1895-1957, LSS-TS1532: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/4 was filled using the lowest value from Apr 2010 (-13,4°C) and 2012/2 was filled using the lowest value from Feb 2012 (-20,2°C) both from a professional private weather station. Missing: 25 months (not listed here), mainly during years 1910-1911 & 1937-1938.

Tasiilaq (TASI) – 4360 (continued)

Element No. 401 (Mean Atmospheric Pressure)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1895 – 2012	NARP1 + JC-TS1625 + Monthly-db TASI 4360	1416	57

Details:
Created using NARP1: 1895-1957 (34360) reduced to mean sea level (see appendix 3.3), JC-TS1625: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/4, 2010/9, 2012/2, 2012/8 and 2012/12 were filled using monthly average values from Mittarfik Kulusuk (4361). Missing: 57 months (not listed here), mainly during years 1910-1911 & 1940-1943.

Element No. 601 (Accumulated Precipitation) - Not necessarily homogenous				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1898 – 2012	NARP1 + BVJ-TS1926 + Monthly-db TASI 4360	1380	24

Details:
Created using NARP1: 1898-1957, BVJ-TS1946: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/4 (34,4 mm), 2010/9 (131,6 mm) and 2012/5-9 (33,6mm;0,0mm;1,4mm;42,8mm;30,4mm) were filled using values from a professional private weather station. 2012/3 was reduced (minus 165mm in the period 17-21 March) due to errors. Missing: 24 months (not listed here), mainly during years 1910-1911 and 1980. 15 August 2005 an automatic raingauge was installed at 4360 Tasiilaq. Not necessarily homogenous, because of new ways of detection.

Element No. 602 (Highest 24-hour Precipitation) - Not necessarily homogenous				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1898 – 2012	NARP1 + BVJ-TS1926 + Monthly-db TASI 4360	1380	19

Details:
Created using NARP1: 1898-1957, BVJ-TS1946: 1958-1999, monthly-db TASI 4360: 2000-2012. 2010/4 (16,2 mm), 2010/9 (29,4 mm) and 2012/5-9 (8,0mm;0,0mm;0,8mm;21,2mm;9,4mm) were filled using values from a professional private weather station. 2012/3 was reduced (minus 165mm in the period 17-21 March) due to errors. Missing: 19 months (not listed here), mainly during years 1910-1911 and 1980. 15 August 2005 an automatic raingauge was installed at 4360 Tasiilaq. Not necessarily homogenous, because of new ways of detection.

Element No. 701 (Number of Days with Snow Cover)				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1958 – 1978	LSS-TS2045	252	0

Details:
Created using LSS-TS2045: 1958-1978. Since 1978 most winter months are missing a number of days, which means that the number of days with snow cover at Tasiilaq not can be considered as accurate. The data after 1978 are therefore not recommended for use.

Element No. 801 (Mean Cloud Cover) – Not necessarily homogenous				
Dataset	*Period*	*Content*	*Total months*	*Missing months*
Recommended	1895 – 2012	NARP1 + LSS-TS1926 + Monthly-db TASI 4360	1416	23

Details:
Created using NARP1: 1898-1957, LSS-TS1946: 1958-1999, monthly-db TASI 4360: 2000-2012. Missing: 23 months (1910/9-1911/8, 1924/8, 1937/7, 2006/10, 2010/4. 2010/9, 2011/10-2012/2 and 2012/12). From 18 August 2005 a ceilometer for automatic detection of cloud cover are used at 4360 Tasiilaq as the only way of observation the clock around. Not necessarily homogenous, mostly because of new ways of detection.

3.4. File formats; Monthly data files

The monthly files included in this report contain monthly DMI data series 1873-2012 comprising different parameters from selected stations in Greenland.

The files are provided for each station, for each element, named by the 4-letter station abbreviation plus station number, element number and period.

The file names are determined as follows:
gr_monthly_<station abbreviation>_<station number>_>element number>_<period>.dat
ex. *gr_monthly_nuuk_4250_101_1873_2012.dat (all files are not listed here)*

The fixed format text files consist of 3 columns: YEAR, MONTH, "VALUE".
The units of "VALUE" can be seen in the data dictionary table 3.2.2, in chapter 3.2.

Special Remarks:
1) Months are referred to by year/month number (ex. 1981/03 = March 1981).

2) The minimum criteria used here for calculating a valid monthly value is that **measurements from more than 21 days** are present in that month, so the number of daily values are ranging 22-31.

In addition a dataset containing all monthly data series is also available as both a fixed format text file, a Excel file and a csv file (; seperated) named: gr_monthly_all

In the fixed format text file g**r_monthly_all.dat** each record contains:

Variable	Start	End	Format	Description
STAT_NO	1	5	F5.0	Station number (see section 3.2.1)
ELEM_NO	6	8	F3.0	Element number (see section 3.2.2)
YEAR	9	12	F4.0	Year
JAN	13	17	F5.0	Jan. value (units described in section 3.2.2)
FEB	18	22	F5.0	Feb. value (units described in section 3.2.2)
MAR	23	27	F5.0	March value (units described in section 3.2.2)
APR	28	32	F5.0	April value (units described in section 3.2.2)
MAY	33	37	F5.0	May value (units described in section 3.2.2)
JUN	38	42	F5.0	June value (units described in section 3.2.2)
JUL	43	47	F5.0	July value (units described in section 3.2.2)
AUG	48	52	F5.0	Aug. value (units described in section 3.2.2)
SEP	53	57	F5.0	Sep. value (units described in section 3.2.2)
OCT	58	62	F5.0	Oct. value (units described in section 3.2.2)
NOV	63	67	F5.0	Nov. value (units described in section 3.2.2)
ANNUAL	73	77	F5.0	Ann. value (units described in section 3.2.2)
CO_CODE	78	80	A3	Country code (GR= Greenland).

In the files **gr_monthly_all** data are sorted according to element and station number. Furthermore all missing values have been replaced with the dummy value -9999 and a calculated annual value and a country code have been included.

Data are only to be used with proper reference to the accompanying report: Cappelen, J. (ed), 2013: Greenland - DMI Historical Climate Data Collection 1873-2012 – with Danish Abstracts. DMI Technical Report 13-04. Copenhagen.

Appendix 3.1. Note on multiple regressions used in monthly temperature series; Upernavik

Multiple Regressions used to fill 46 months in UPERNAVIK(4209/4210) - ELEMENT101

Month	Regression Formula	Corr. Coeff.
January	UPER = 0.607 * ILUL + 0.542 * PITU + 32.3	$r^2 = 0.867$
February	UPER = 0.480 * ILUL + 0.575 * PITU + 12.6	$r^2 = 0.902$
March	UPER = 0.386 * ILUL + 0.600 * PITU - 0.2	$r^2 = 0.954$
April	UPER = 0.432 * ILUL + 0.524 * PITU - 11.2	$r^2 = 0.979$
May	UPER = 0.520 * ILUL + 0.437 * PITU - 16.6	$r^2 = 0.982$
June	UPER = 0.647 * ILUL + 0.384 * PITU - 19.9	$r^2 = 0.966$
July	UPER = 0.748 * ILUL + 0.407 * PITU - 24.2	$r^2 = 0.842$
August	UPER = 0.574 * ILUL + 0.249 * PITU - 2.2	$r^2 = 0.897$
September	UPER = 0.513 * ILUL + 0.283 * PITU - 2.5	$r^2 = 0.968$
October	UPER = 0.431 * ILUL + 0.351 * PITU + 5.6	$r^2 = 0.963$
November	UPER = 0.599 * ILUL + 0.412 * PITU + 20.9	$r^2 = 0.917$
December	UPER = 0.513 * ILUL + 0.283 * PITU + 2.5	$r^2 = 0.889$

UPER = Upernavik, ILUL = Ilulissat and PITU = Pituffik. For more information see also chapter 3.3.2, element number 101.

Appendix 3.2. Additional notes on monthly series, Upernavik and Ilulissat

For Upernavik and Ilulissat, the original NACD series, the NORDKLIM, NARP and REWARD series, the present series in the time-series database and observed values in the DMI internalmonthly database has been studied in further details. These details are found in the tables below:

UPERNAVIK – (UPER)
Element No. 101 Details: note that this Poul Frich series is rather new and not identical to the NACD series (only 1890-1981). NACD had many holes (1891/10, 1934/4, 1932/8+9, 1939/8+9+10+11, 1940/2, 1943/9, 1944/4 – 1945/10, 1981/7-12). The JC series 1425, 1958 – 1999 (here from 1961 - 1990 published in [6]) is basically an extension of the NACD series to 1999. They are equal from 1958 - 1981 except in a few cases (1968/10, 1970/5, 1971/12, 1977/8, 1979/1 and 1981/3), where JC corrects small NACD mistakes by comparisons with "monthly". After the restart of 4210 instead of 4209 in 1995/09 the data in PF, JC, NACD and *monthly* are exactly the same. The JC series has "introduced" holes in for example in 1977/08 due to a very low number of elements used for the monthly calculations. Other holes: 1981/07-1984/08, 1986/02-10, 1988/09 - 1989/01, 1990/10+11 & 1991/08.
Element No. 111 Details: no info about PF series number. JC series (Series 1451: 1958/01 - 1999/12) and REWARD/NARP are equal for long periods 1961/01 - 1981/06 (except in a few cases: 1966/12, 1967/05, 1968/10, 1970/05, 1971/02, 1971/12, 1977/08 and 1981/03. The JC-series 1451 has missing values from 1981/07 - 1995/09. Oct.1995/10 the values are again the same except in some few cases (1995/11, 1997/09 and 1997/12). Before 1961/01 (e.g. 1958/01 - 1960/12) values are different). REWARD holes: 1914/01 - 12, 1925/03 - 1927/07, 1943/04 - 1945/10. The data in monthly are the same as in JC from 1958 - 1961. From 1961 - 1981 monthly/JC/NARP are equal except in a few cases (typing errors?). Also the data in monthly are the same as NARP and JC from 1995 - 2000. In the period with 4209 the number of elements were often low (15-25 pr. month), which caused JC to insert "missing values". In the 4209 period the REWARD series is often equal to monthly for 4209, but many months are different. Corrected?
Element No. 112 Details: the PF (Series 4) consist of st34210 from 1890 - 1954, st4210 from 1955 - 1986, st4209 from 1987 - 1995/09 and st4210 from 1995/10 - 12. The PF data and the JC (Series 1474: 1958/01 – 1999/12) are the same during most of the period (1958-1996). The main difference is introduced holes in the JC series due to low number of elements in some periods. These holes are 1958/05 - 07, 1977/07 and 1981/07 - 1995/09. A part from these values are different in 1968/10, 1970/05, 1971/12 and 1981/03. As with elem.111, the REWARD/NARP series has holes 1914/01 - 12, 1925/03 - 1927/07, 1943/04 - 1945/10. The data in monthly (starting 1958/01) are the same as NARP, except in a few cases (1968/10, 1970/05, 1971/12, 1981/03, 1983/06, 1987/01 and 1995/09). Station 4210 used for most of period, except 4209 is used from 1987/03 - 1995/09.
Element No. 121 Details: the PF data consists of st34210 from 1890/01 - 1960/12, st4210 from 1961/01 – 1985/12, st4209 from 1986/01 - 1995/10 and st4210 1995/10 - 1995/12. The PF and JC data (Series 1495: 1958/01 – 1999/12) are the same during most of the period (1958-1996). The main difference is introduced holes in the JC series due to low number of elements in some periods. These are primarily 1977/08 and the period 1981/07 - 1995/09. Different values are found in 1958/01 - 1961/01, 1976/02 and 1981/06. The NARP/REWARD series is the same as PF, except for the three months (1932/08+09 and 1950/07). Two large holes are found 1925/01 - 1927/07 and 1944/04 - 1946/02. The data in monthly are the same as NARP from 1961/02 - 1981/09 and again from 1995/10 except in a few cases (1976/02, 1978/08 and 1998/01+02). Before 1961/02 they are equal to JC series. There is one hole from 1982/01-08. From 1987-1995 the data in NARP are from monthly for 4209.
Element No. 122 Details: The JC (Series 1516: 1958/01 – 1999/12) and PF data are the same from 1960/12 - 1981/06 and 1995/10-12, except for a few months (1973/03, 1973/05 & 1977/08). Before 1960/12 (1958/01 – 1960/11) they are different, with JC values the same as in monthly. The JC data has holes: one major hole: 1981/07 - 1995/09, a minor holes: 1973/05, 1977/08, 1998/01 & 1999/05. The NARP/REWARD series is the same as the PF series except for 1932/09, 1989/11 & 1993/11. The REWARD series has holes from 1925/01 - 1927/07 and 1944/04 - 1946/02.
Element 401 Details: The JC (Series 1606: 1958/01 – 1999/12) and PF data are the same for most of the overlapping period, except 1981/03+08+12, 1991/02+04+05, 1992/09, 1994/07+12, 1995/02+05-09. But the JC data actually has more values than the PF series, including 1984/09 – 1985/12, 1986/11 – 1988/08, 1989/02 - 1990/12. The PF and NACD are identical in the overlapping period (until 1981/12). The NACD has extensive holes: 1891/10, 1899/08, 1900/08, 1927/01 -07, 1931/04, 1932/08+09, 1939/08-11, 1940/02 - 1945/12, 1949/01-06, 1981/07, 1982/01 – 1984/08, 1986/01-10, 1988/09 – 1989/01.

Element 601

Details: Data in PF and JC (Series 1909: 1958/06 - 1981/05) series are the same in the overlap period except only 1963/11 and 1977/08 (JC no data). The same data are found in NARP and NACD. NACD has big holes with missing data before 1950: 1891/09, 1908/02, 1923/08, 1927/02+03, 1931/04, 1932/08+09, 1933/01+03, 1934/07, 1936/01, 1937/08, 1937/12 – 1938/05, 1938/10-12, 1939/02-04+08-12, 1940/02+03+05+11, 1941/02+03, 1941/11 – 1942/05, 1942/10 – 1943/05, 1943/10, 1943/12 – 1946/06, 1946/11 – 1947/05, 1947/08, 1947/10 – 1948/05, 1948/10 – 1949/06, 1949/10-1950/05, 1950/10+12. Station 4209 did not measure precipitation.

Element No. 602

Details: the JC (Series 1930: 1958/01 - 1981/12), PF, NARP, REWARD data are exactly the same except JC has introduced holes due to low number of elements for certain months/periods. Data in "monthly" are also the same (starting in January 1958). No information about stations or adjustments. Remark: Station 4209 did not measure precipitation

Element No. 701

Details: the JC (Series 2030: 1958/01 - 1981/05), PF, NARP and NACD data are exactly the same in the overlap period, except JC does not include the second half of 1981 due to low number of elements. Data in "monthly" are also the same (starting in January 1958).

Element No. 801

Details: the PF, NARP and NACD data are exactly the same. The JC (Series 2087: 1958/01 - 1981/06) data is also the same for the overlap period, except in the following months (1959/07, 1959/08, 1961/07+12, 1962/06, 1963/01, 1964/03+05+08+09+12, 1965/05, 1969/11, 1972/02, 1975/06, 1977/08+12, 1979/01+04. The data in monthly are the same as in the JC series except for 1977/08.

ILULISAAT – (ILUL)

Element 101

Details: The PF (series 14) and JC (series 1426: 1961/01 – 1979/03) data are not identical. A correction of the months June, July and august by -0.1°C from 1873/01 – 1982/12 in the PF series (because of significant “break”) are the main difference. The PF-TS14 series is not the same as the NACD, but rather a corrected version of it, with corrections on a monthly basis for different periods. PF-TS14 has no holes, while NACD had several missing months including (1916/10-12, 1917/02, 1921/03, 1929/07, 1936/10 & 1937/07). From 1982 - 1990 PF-TS14 and NACD are the same. Monthly for 4216 is almost the same as NACD but 54 of 396 months have slightly different values.

Appendix 3.3. Regarding monthly data of atmospheric pressure

The reading of a mercury barometer is proportional to the length of a mercury column in the barometer, which is balanced against the weight of the entire atmospheric column of air above the open surface of the mercury. The mercury barometer was therefore calibrated to “standard conditions” (0ºC and a certain standard gravity). At other conditions corrections must be used.

The formula used to correct old barometer readings for the stations presented in this publication is given below. The formula simply corrects for gravity (part 1) and reduces the pressure to mean sea level (part 2):

P * (1 – 0,00259 * cos (2* φ * π/180)) * (1 + 9.82/287.04 * h/(T/10+273.15))

P is atmospheric pressure (0.1 hPa) at station level, φ is the latitude in degrees, h is the height of the barometer in metres above sea level and T is the air temperature at station level (0.1 ºC)

For the calculation are used monthly means of P and T. This introduces an error compared to a reduction performed on the actual observations. The error is proportional to the difference between ‘the average P to T ratio’ and ‘the ratio of average P to average T’ (T in Kelvin). This means the error is zero if T is constant within the period. Within a month the maximum T-range would normally be within 30 degrees. And a numerical variation of 30 is small when compared to the temperature in Kelvin and the atmospheric pressure in 0.1 hPa. Therefore the error introduced by using monthly values may be considered small.

The different station specific corrections, which have been used in the construction of the pressure series in this report, can be seen in the following DMI publication:

DMI Technical Report 03-24: Metadata, selected climatological and synoptic stations, 1750-1996, Copenhagen 2003 [22].

This publication can be downloaded from the publication part of DMI’s web site:
http://www.dmi.dk/dmi/dmi-publikationer.htm

Appendix 3.4. Note on new corrections in monthly temperature series; Ilulissat

ILULISSAT 4221. Instruments at 34216 moved 1 November 1936 and again 1 September 1946 leads to new corrections in ELEMENT101 Mean Temperature in time series PF-TS14, not dealt with earlier. Comparison between (tmax+tmin)/2 and tmean clearly shows the need for corrections. The mean of the difference in a period before 1895/1-1936/10 and a period after 1946/9-1956/12 compared to the period in question 1936/11-1946/8 give the monthly corrections. The corrections have been applied in connection with the 2010 update in DMI Technical Report 11-05 [10]. The corrections are not applied in earlier reports.

Month	Corrections
January	0,7
February	0,7
March	0,7
April	0,7
May	0,6
June	0,5
July	0,4
August	0,5
September	0,6
October	0,9
November	0,9
December	0,9

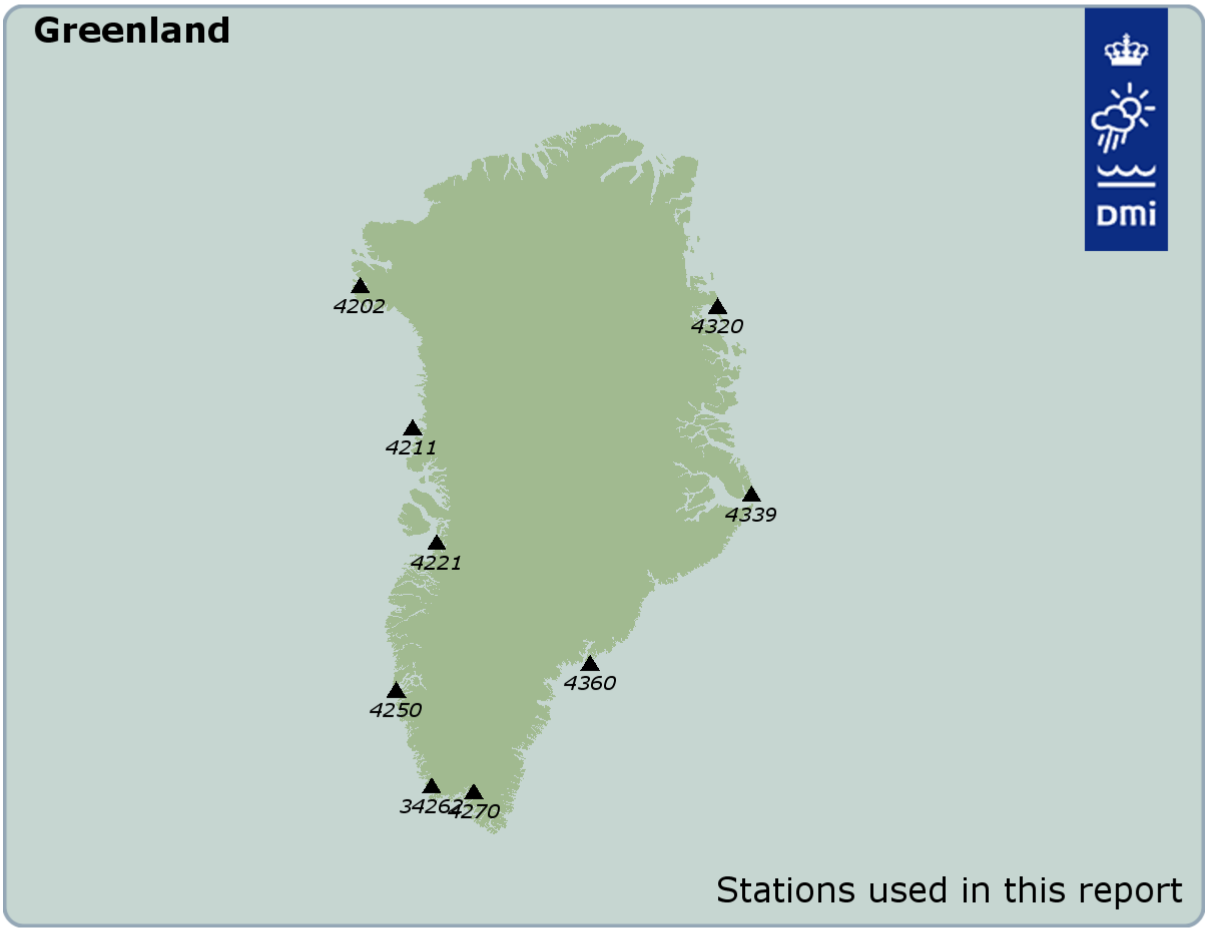
For more information see also chapter 3.3.3, station ILULISSAT 4221, element number 101.

4. Annual Section: Historical DMI Data Collection

Data collection	Products in the report	Page
Annual	**Section 4.3. Mean air temperature, mean of daily minimum and maximum temperatures and highest/lowest temperature, mean atmospheric pressure, accumulated precipitation, highest 24-hour precipitation, no. of days with snow cover and mean cloud cover**, 10 stations: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund* (1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012) **Section 4.4. Mean air temperature; graph and values** with gauss filtered values, 7 stations: 4202 Pituffik (1948-2012), 4221 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1873-2012), 34262 Ivituut/4270 Narsarsuaq (1873-2012), 4360 Danmarkshavn (1949-2012), 34339 Scoresbysund*/4339 Illoqqortoormiut (1924-2012), 4360 Tasiilaq (1895-2012) Greenland poster **with mean air temperatures** for the 7 stations mentioned above is published separately	**69** **69**

Datasamling	*Produkter i rapporten*	*Sidetal*
År	***Sektion 4.3. Middel luft-, max- og min- temperatur samt højeste og laveste temperatur, middellufttryk, nedbørsum, max 24 t nedbørsum, antal snedækkedage og middelskydække****, 10 stationer: 4202 Pituffik (1948-2012), 4211 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1890-2012), 34262 Ivituut (1873-1960), 4270 Narsarsuaq (1961-2012), 4320 Danmarkshavn (1949-2012), 34339 Scoresbysund* (1924-1949), 4339 Illoqqortoormiut (1950-2012), 4360 Tasiilaq (1895-2012)* ***Sektion 4.4. Middeltemperatur som data og grafik*** *med gauss-filtrerede værdier, 7 stationer: 4202 Pituffik (1948-2012), 4221 Upernavik (1873-2012), 4221 Ilulissat (1873-2012), 4250 Nuuk (1873-2012), 34262 Ivituut/4270 Narsarsuaq (1873-2012), 4360 Danmarkshavn (1949-2012), 34339 Scoresbysund*/4339 Illoqqortoormiut (1924-2012), 4360 Tasiilaq (1895-2012)* ***Grønlandsplakat med middeltemperatur*** *for de* ***7*** *ovenstående stationer udgives separat*	***69*** ***69***

**34339 Scoresbysund is not marked on the map. The location is nearly similar to 4339 Illooqortoormiut.*



Latest earlier report:

[12] Cappelen, J. (ed), 2012: Greenland - DMI Historical Climate Data Collection 1873-2011 – with Danish Abstracts. DMI Technical Report No. 12-04.

4.1. Introduction

The purpose of this chapter is to publish different *annual* climate data from Greenland together with relevant graphics. That is:

- Annual values within the period 1873-2012 for Greenland. The data parameters include mean temperature, minimum temperature, maximum temperature, atmospheric pressure, precipitation, highest 24-hour precipitation, number of days with snow and cloud cover.
- Annual mean temperatures and filtered values for selected meteorological stations in Greenland; 1873-2012, both as data and graphics.

Annual values of mean temperatures also regularly forms part of other similar publications [13,14].

The greenlandic annual data are partly an annual update (with 2012 data) of the "DMI Annual Climate Data Collection" published for the first time in that form in DMI Technical Report 05-06: DMI Annual Climate Data Collection 1873-2004, Denmark, The Faroe Islands and Greenland - with Graphics and Danish Abstracts. Copenhagen 2005 [7].

The annual data sets can be downloaded from the publication part of DMI web pages.

Formålet med denne sektion er at publicere forskellige årlige klimaværdier indenfor perioden 1873-2012 samt tilhørende grafik. Det drejer sig om henholdsvis:

- *Årsmiddelværdier for udvalgte meteorologiske stationer i Grønland. Det omfatter middeltemperatur, minimumtemperatur, maksimumtemperatur, atmosfærisk tryk, nedbørsum, maksimal 24t nedbørsum, antallet af dage med sne og skydække.*
- *Årsmiddeltemperaturer og gauss filtrerede værdier for udvalgte meteorologiske stationer i Grønland, både som data og grafik.*

I afsnit 4.2 kan ses hvilke stationer og parametre, det drejer sig om. Årsmiddelværdierne af de forskellige parametre kan findes sammen med de månedlige data, se sektion 3. I afsnit 4.4 er årsmiddeltemperaturer for forskellige stationer i Vest- og Østgrønland grafisk vist sammen med København, Danmark og Tórshavn, Færøerne. Endelig er filformatet af de medfølgende filer og grafik beskrevet i afsnit 4.5 og 4.6.

4.2. Stations and parameters

4.2.1. Station Overview

Seven meteorological stations with a long record have been operated in Greenland, five of them since the 19th century. They have digitised records back to the start of 1870's (the Danish Meteorological Institute (DMI) was established 1872. In table 4.2.1 stations used in this chapter are listed together with a start year.

The stations have been relocated several times since the start, new station numbers and names have been attached, new instruments and new observers have been introduced. The latter have obviously been replaced many times. See the station history in the chapter "History of stations used in the report".

It is also obvious that the quality and homogeneity of the series have been affected in various degrees. The series have been corrected in the best possible way i.e. in connection with the development of the North Atlantic Climatological Dataset: DMI Scientific Report 96-1: North Atlantic Climatological Dataset (NACD Version 1) - Final report. Copenhagen 1996 [18] and the regularly publication of the DMI historical monthly data collection in section 3.

The station numbers and names in the table 4.2.1 refer to the present situation.

Number	Country	Station number	Name	First year
1	GR	4202[1]	Pituffik	1948
2	GR	4211[2]	Upernavik	1873
3	GR	4221[3]	Ilulissat	1873
4	GR	4250[4]	Nuuk	1873
5	GR	4270[5]	Narsarsuaq	1873
6	GR	4320	Danmarkshavn	1949
7	GR	4360[6]	Tasiilaq	1895

1) The series are a combination of 4202 Pituffik and before that 4200 Dundas. From Nov 2006 the monthly data are obtained from Thule AB, personal communication.

2) The series are a combination of 4211 Upernavik, 4210 Upernavik, 4209 Upernavik AWS and before that 34210 Upernavik.

3) The series are a combination of 4221 Ilulissat, 4216 Ilulissat and before that 34216 Jacobshavn. New monthly values in the period 1936-1948 have been applied in connection with the 2010 update, see details in Appendix 3.3. The corrections are not applied in earlier reports.

4) The series are a combination of 4250 Nuuk and before that 34250 Godthåb.

5) The series are a combination of 4270 Narsarsuaq and before that 34262 Ivittuut.

6) The series are a combination of 4360 Tasiilaq and before that 34360 Angmagssalik.

Table 4.2.1. The meteorological stations and year of first appearance.

4.2.2 Data Dictionary

Number	Abbr.	Element	Method	Unit
101	T	Mean temperature	mean	0,1°C
111	Tx	Mean of daily maximum temperature	mean	0,1°C
112	Th	Highest temperature	max	0,1°C
121	Tn	Mean of daily minimum temperature	mean	0,1°C
122	Tl	Lowest temperature	min	0,1°C
401	P	Mean atmospheric pressure	mean	0,1 hPa
601	R	Accumulated precipitation	sum	0,1 mm
602	Rx	Highest 24-hour precipitation	max	0,1 mm
701	DSC	No. of days with snow cover (> 50 % covered)	sum	days
801	N	Mean cloud cover	mean	%

Table 4.2.2. Parameters used in this report. 'Method' specifies whether the element is a sum, a mean or an extreme. The units of the monthly values in the data files are specified in 'Unit'. The DMI system of element numbers contains more than 10 elements; in 2012 about 250 entries.

4.3. Annual values 1873-2012; Greenland

Calculated annual values for the different stations in table 4.2.1 and the different parameters in table 4.2.2 can be found together with the monthly data (see section 3).

4.4. Annual mean temperatures and filtered values for seven meteorological stations in Greenland; 1873-2012

Annual mean temperatures 1873-2012 and filtered values for seven stations in Greenland are available as a data series and a graph. The graphs in this section show the annual mean temperatures from selected stations from West and East Greenland together with København, Denmark and Tórshavn, the Faroe Islands and West Greenland.

The annual mean temperature data within the period 1873-2012 for the seven meteorological stations are the same as the annual values for parameter 101 Mean Temperature mentioned in section 4.3. There can be annual values (interpolated) for certain years in the annual data files, despite they are missing in the calculation (due to missing months) described in chapter 4.3.

A Gauss filter with filter width (standard deviation) 9 years has been used to create the “bold” smooth curves. A Gauss filter with standard deviation 9 years is comparable to a 30-years running mean. However, the filter gives a smoother curve than a running mean, as temperatures from central years are given larger weight than temperatures from periferal years. Filter values are also calculated for the years at either end of the series. It should be noted that these values are computed from one-sided Gauss filters, and that values from later years will change, when the series is updated.

Important note: 2010 in West Greenland was extremely record breaking warm many places and the usual graphics are not tuned to deal with such extreme values. A better graphic presentation can be seen in a poster showing “Annual mean temperatures 1873-2012, Greenland” (Tr13-04_gr_temperatur_1873_2012_plakat.pdf); se section 4.6. The following record breaking annual 2010 average temperatures (normal 1961-90) can also help in the interpretation: Pituffik -7.9°C, Upernavik -3.1°C, Ilulissat -0.1°C, Nuuk 2.6°C, Narsarsuaq 5.4°C. Tasiilaq 1.1°C was the second warmest in 2010 and Danmarkshavn with -11.3°C in northeast Greenland, ended in the warm end of the scale, but not near the record.

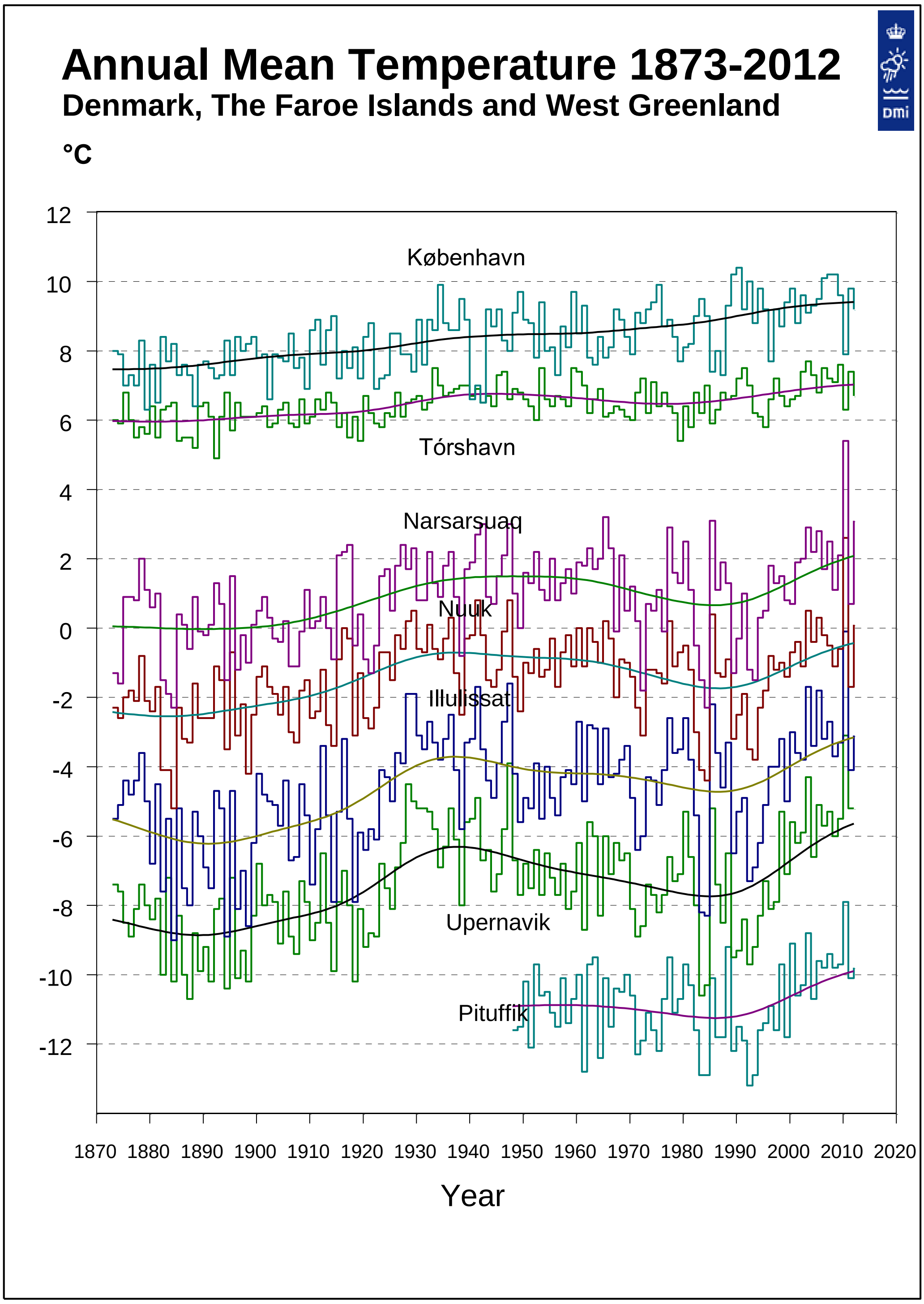


Figure 4.4.1. Annual mean temperatures 1873-2012, Denmark, The Faroes and West Greenland.

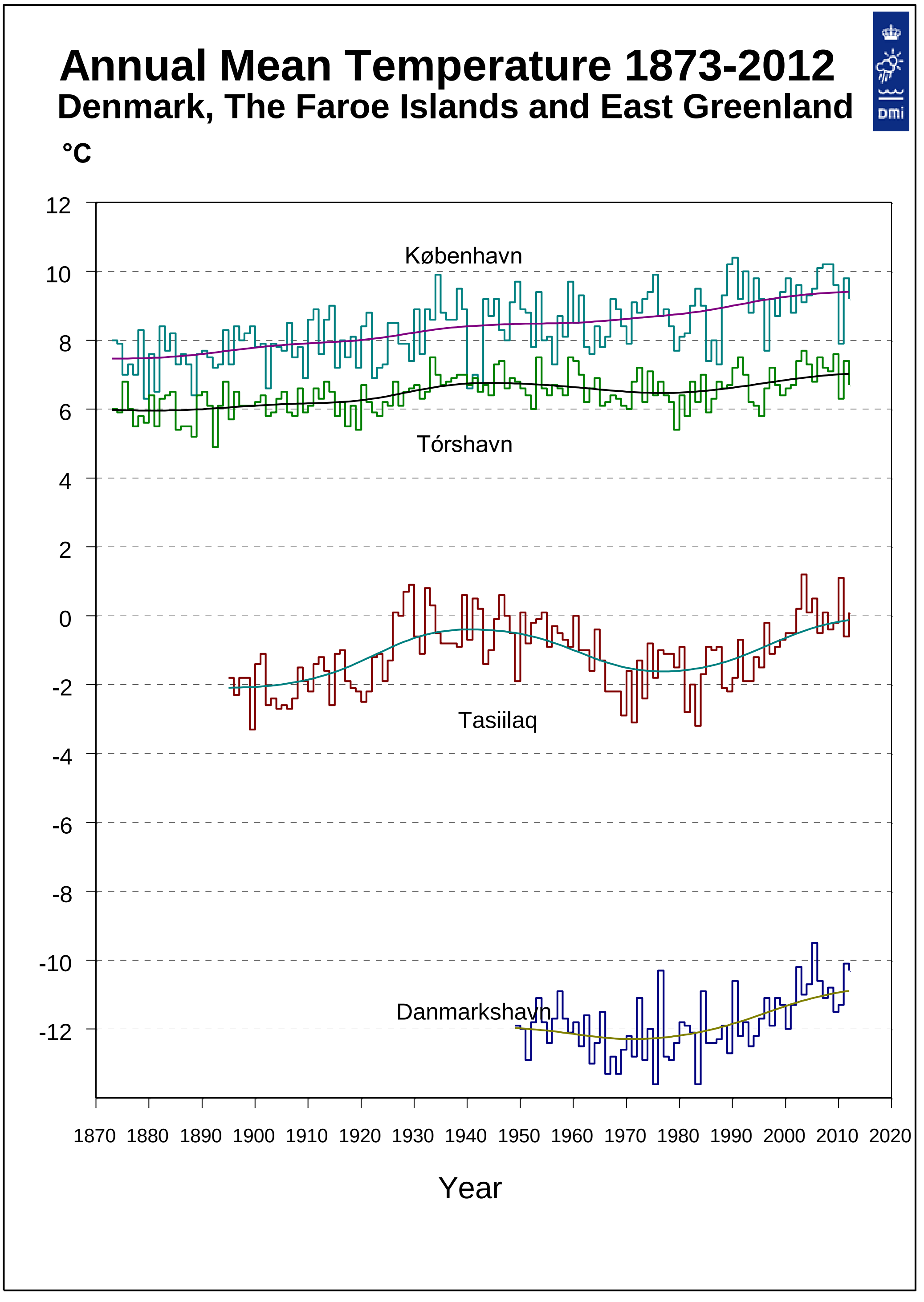


Figure 4.4.2. Annual mean temperatures 1873-2012, Denmark, The Faroes and East Greenland.

4.5. File formats; Annual data files

The annual files included in this report contain annual mean temperature 1873 - 2012 for selected meteorological stations in Denmark, The Faroe Islands and Greenland.

The file names are determined as follows:

gr_annual_temperature_dkfrgr_<period>

More specifically a fixed format text file and an Excel file in this report:

gr_annual_temperature_dkfrgr_1873_2012.dat
gr_annual_temperature_dkfrgr_1873_2012.xlsx

Besides years the files contains the annual mean temperatures in degrees Celsius to one decimal place (the variable is specified with a “T” followed by a station number) and a Gaussian filtered value to 2 decimal places (the variable is specified with a “F” followed by a station number).

Description of the data format for the fixed format text file:

Variable	Type	Start	End	Format
YEAR	YEAR	1	4	F4.0
T04202	TEMP	5	12	F8.1
F04202	FILTER	13	20	F8.2
T04211	TEMP	21	28	F8.1
F04211	FILTER	29	36	F8.2
T04221	TEMP	37	44	F8.1
F04221	FILTER	45	52	F8.2
T04250	TEMP	53	60	F8.1
F04250	FILTER	61	68	F8.2
T04270	TEMP	69	76	F8.1
F04270	FILTER	77	84	F8.2
T04320	TEMP	85	92	F8.1
F04320	FILTER	93	100	F8.2
T04360	TEMP	101	108	F8.1
F04360	FILTER	109	116	F8.2
T06011	TEMP	117	124	F8.1
F06011	FILTER	125	132	F8.2
T06186	TEMP	133	140	F8.1
F06186	FILTER	141	148	F8.2

Note that the annual values of the different stations in table 4.2.1 and parameters in table 4.2.2 can be found together with the monthly data (see file formats; monthly data files chapter 3.4).

Data are only to be used with proper reference to the accompanying report: Cappelen, J. (ed), 2013: Greenland - DMI Historical Climate Data Collection 1873-2012 – with Danish Abstracts. DMI Technical Report 13-04. Copenhagen.

4.6. File formats; Annual graphics

Annual graphics included in this report contain graphs showing annual mean temperatures 1873-2012 for selected stations from West and East Greenland together with Tórshavn at The Faroe Islands and København, Denmark. The graphs are available in a Danish and English version and also in a larger version as a poster (only Danish version).

The file names are determined as follows:

gr_annual_temperatur_side_<sidetal>_<periode>_<sprog>.pdf
gr_annual_temperature_page_<page number>_<period>_<language.pdf

More specifically a number of pdf files (Danish and English versions) in this report:

gr_annual_temperatur_side1_1873_2012_dk.pdf:
Annual mean temperatures 1873-2012 Denmark, The Faroe Islands and West Greenland (Danish version)

gr_annual_temperatur_side2_1873_2012_dk.pdf:
Annual mean temperatures 1873-2012 Denmark, The Faroe Islands and East Greenland (Danish version)

gr_annual_temperature_page1_1873_2012_eng.pdf:
Annual mean temperatures 1873-2012 Denmark, The Faroe Islands and West Greenland (English version)

gr_annual_temperature_page2_1873_2012_eng.pdf:
Annual mean temperatures 1873-2012 Denmark, The Faroe Islands and East Greenland (English version)

gr_annual_temperatur_side1_1873_2012_plakat.pdf:
Annual mean temperatures 1873-2012 Denmark, The Faroe Islands and West Greenland (Danish poster)

gr_annual_temperatur_side2_1873_2012_plakat.pdf:
Annual mean temperatures 1873-2012 Denmark, The Faroe Islands and East Greenland (Danish poster)

gr_annual_temperatur_1873_2012_plakat.pdf:
Annual mean temperatures 1873-2012, Greenland (Danish poster)

Data are only to be used with proper reference to the accompanying report: Cappelen, J. (ed), 2013: The Faroe Islands - DMI Historical Climate Data Collection 1873-2012 – with Danish Abstracts. DMI Technical Report 13-04. Copenhagen.

References

[1] ACCORD, Atmospheric Circulation Classification and Regional Downscaling. See the Internet site http://www.cru.uea.ac.uk/cru/projects/accord/ for particulars.

[2] Brandt, M. L. (1994): The North Atlantic Climatological Dataset (NACD). Instrumenter og rekonstruktioner. En illustreret gennemgang af arkivmateriale. DMI Technical Report 94-19. København.

[3] Brandt, M. L. (1994): Summary of Meta data from NACD-stations in Denmark, Greenland and the Faroe Islands 1872-1994. DMI Technical Report 94-20. Copenhagen.

[4] Brandt, M. L. and T. Schmith (1994): Correction, reduction and Homogenization of Barometer Records. DMI Technical Report 94-22. Copenhagen.

[5] Brødsgaard, B. (1992): Stationshistorie i Grønland: dokumenteret for 5 klimastationer. DMI Technical Report 92-02. Copenhagen.

[6] Cappelen, J. et al. (2000): The Observed Climate of Greenland, 1958-99 – with Climatological Standard Normals, 1961-1990/Klimaobservationer i Grønland, 1958-99 – med klimanormaler 1961-90. DMI Technical Report 00-18. Copenhagen.

[7] Cappelen, J. (2005): DMI annual climate data collection 1873-2004, Denmark, The Faroe Islands and Greenland - with Graphics and Danish Abstracts. DMI Technical Report 05-06: Copenhagen.

[8] Cappelen, J., Laursen E. V., Kern-Hansen, C. (2008): DMI Daily Climate Data Collection 1873-2007, Denmark, The Faroe Islands and Greenland - including Air Pressure Observations 1874-2007 (WASA Data Sets). DMI Technical Report 08-05. Copenhagen.

[9] Cappelen, J., 2011: DMI Annual Climate Data Collection 1873-2010, Denmark, The Faroe Islands and Greenland - with graphics and Danish summary. DMI Technical Report 11-04. Copenhagen.

[10] Cappelen, J. (ed), 2011: DMI monthly Climate Data Collection 1768-2010, Denmark, The Faroe Islands and Greenland. DMI Technical Report 11-05. Copenhagen.

[11] Cappelen, J. (ed), 2011: DMI Daily Climate Data Collection 1873-2010, Denmark, The Faroe Islands and Greenland - including Air Pressure Observations 1874-2010 (WASA Data Sets). DMI Technical Report 11-06. Copenhagen.

[12] Cappelen, J. (ed), 2012: Greenland - DMI Historical Climate Data Collection 1768-2011. DMI Technical Report No. 12-04.

[13] Cappelen, J. (ed) (2013): Denmark - DMI Historical Climate Data Collection 1768-2012 - with Danish Abstracts. DMI Technical Report 13-02. Copenhagen.

[14] Cappelen, J. (ed) (2013): The Faroe Islands - DMI Historical Climate Data Collection 1873-2012 - with Danish Abstracts. DMI Technical Report 13-05. Copenhagen.

[15] Cappelen, J. (ed) (2013): Weather observations from Greenland 1958-2012.

Observation data with description. DMI Technical Report 13-11. Copenhagen.

[16] Danish Climate Centre, see http://www.dmi.dk/dmi/en/index/klima/danish_climate_centre.htm.

[17] Drebs A., Hans Alexandersson, Povl Frich, Eirik J. Førland, Trausti Jónsson, Heikki Tuomenvirta (1998): REWARD: -Relating Extreme Weather to Atmospheric Circulation using a Regionalised Dataset. Description of REWARD data set, Version 1.0. Det Norske Meteorologiske Institutt KLIMA Report no: 16/98. Oslo.

[18] Frich, P. (Co-ordinator), H. Alexandersson, J. Ashcroft, B. Dahlström, G. Demarée, A. Drebs, A. van Engelen, E.J. Førland, I. Hanssen-Bauer, R. Heino, T. Jónsson, K. Jonasson, L. Keegan, P.Ø. Nordli, Schmith, T. Steffensen, H. Tuomenvirta, O.E. Tveito, (1996): NACD, North Atlantic Climatological Dataset (NACD Version 1) - Final Report. DMI Scientific Report 96-1. Copenhagen.

[19] Jørgensen, P. V. (2002): Nordic Climate Data Collection 2001. An update of: NACD, REWARD, NORDKLIM and NARP datasets, 1873-2000. Version 0. DMI Technical Report 01-20. Copenhagen.

[20] Jørgensen, P. V. and Laursen, E.V. (2003): DMI Monthly Climate Data Collection 1860-2002, Denmark, The Faroe Island and Greenland. An update of: NACD, REWARD, NORDKLIM and NARP datasets, Version 1. DMI Technical Report 03-26. Copenhagen.

[21] Laursen, E. V. (2002): Observed daily precipitation, maximum temperature and minimum temperature from Ilulissat and Tasiilaq, 1873-2000. DMI Technical Report 02-15. Copenhagen.

[22] Laursen, E. V. (2003): Metadata, Selected Climatological and Synoptic Stations, 1750-1996. DMI Technical Report 03-24. Copenhagen.

[23] Laursen, E. V. (2003): DMI Monthly Climate Data, 1873-2002, contribution to Nordic Arctic Research Programme (NARP). DMI Technical Report 03-25. Copenhagen.

[24] Laursen, E. V. (2004): DMI Daily Climate Data Collection, 1873-2003, Denmark and Greenland. DMI Technical Report 04-03. Copenhagen.

[25] Lysgaard, L., 1969: Foreløbig oversigt over Grønlands klima i perioderne 1921-50, 1951-60 og 1961-65. Det Danske Meteorologiske Institut, Meddelelser nr. 21. København.

[26] NACD, North Atlantic Climatological Dataset. See (Frich et al. 1996 [18]).

[27] Schmith, T., H. Alexandersson, K. Iden and H. Tuomenvirta (1997). North Atlantic-European pressure observations 1868-1995 (WASA dataset version 1.0). DMI Technical report 97-3. Copenhagen.

[28] WASA: 'The impact of storms on waves and surges: Changing climate in the past 100 years and perpectives for the future'. See the project report: Schmith et al. 1997 [27].

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