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Station history and metadata of meteorological observations from Ny- Ålesund, Svalbard

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Keywords Svalbard, Ny-Ålesund, climate data, metadata	

Disciplinary signature

Responsible signature

Abstract

Ny-Ålesund weather station was established in 1950, and regular observations of all common parameters required for an official surface synoptic network station started in 1969. During its long history, the station was moved and upgraded several times. For some periods, parallel measurements exist for several parameters.

This report describes the metadata of the observations which are currently found in the open access database of the Norwegian Meteorological Institute. We give detailed information on the different locations of the weather station as well as instruments and observation methods for each parameter. Information on data quality is provided, and a selection of the long time series is also presented. Finally, information on how to access the time series is provided.

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Introduction

The meteorological data series from Ny-Ålesund is one of the most frequently downloaded and used datasets from the Norwegian Meteorological Institute's climate database, illustrating its importance as a unique climate data record for the scientific community.

Ny-Ålesund weather station was established in 1950, and regular observations of all common elements required for an official surface synoptic network station started in 1969. The station is run as a cooperation between the Norwegian Meteorological institute (MET Norway), the Norwegian Polar institute and the Alfred Wegener Institute in Germany.

MET Norway is responsible for data transfer, quality control and long-term storage, and the data are distributed worldwide by WMO's Global Telecommunication System (GTS) in near real-time. The long-term data series is publicly available and easily accessible through various download services due to MET Norway's free and open data policy.

The weather station in Ny-Ålesund has been moved and upgraded several times since its establishment, and there are parallel measurements for some parameters. For any scientifically sound analysis of the long-term data series, especially when assessing climate variability and change in the high-Arctic, metadata describing these changes are indispensable. Until now, this kind of information has not been as easily accessible as the data itself.

Extensive work on data series and station history from Svalbard and Ny-Ålesund were conducted at MET Norway in the 1990s by Hanssen-Bauer et al. (1990), Nordli (1990), Steffensen et al. (1996) and Nordli et al. (1996). This report aims to update and supplement this work and describes the station history and metadata for Ny-Ålesund weather station. The information has been gathered from the paper archives and the digital station history database (Stinfosys) at MET Norway.

In the *Site description* chapter, we give information on the different locations of the weather station, while information on instruments and observation methods is described in detail for each parameter in the following *Data description* chapter. Quality information is given in a separate *Data quality* chapter, before information on how to access the time series and metadata is provided in the *Data access* chapter. Finally, we present a selection of long climate series.

1 Site description

Ny-Ålesund is located on the northwestern coast of Spitsbergen, the largest island in Svalbard. It is located on Brøggerhalvøya, a peninsula on the southwestern side of Kongsfjorden. Kongsfjorden is encircled by steep mountains, and in the inner parts tide water glaciers flow into the fjord.

The meteorological station in Ny-Ålesund has been located in several places since the first measurements started, see Fig. 1, Fig. 2, Fig. 3 and Table 1. More details follow below and in the chapters for each meteorological parameter.

The weather station has been located within the village centre of Ny-Ålesund since 1974 (site 1 in Fig. 1), however, it has been relocated several times within the village. The following names of the different locations within main site 1 in the village centre will be used throughout the report, and are also shown and used in Fig. 2:

1-A - Village square

1-B - Telegraph station

1-C - Old telegraph station

1-D - Measurement field I

1-E - Ungkarsheimen

1-F - Measurement field II

1-G - Sverdrup station (the current Norwegian Polar Institute station)

TABLE 1 | Overview of the different placements of the meteorological station. Station number, WMO station number, coordinates in decimal degrees, site (corresponding to sites 1, 2 and 3 in Fig.1), and elevation in meters above sea level. The coordinates are those of the precipitation gauge.

Time period	Station number	WMO number	Coordinates	Site	m.a.s.l.
1950 - 1952	Not applicable, no data in database		78.9281 N : 11.9184 E	1	10 m
1952 - 1953			78.9239 N : 11.9268 E	2	4 m
1961 - 1967			78.9281 N : 11.9184 E	1	10 m
1967 - 1974	99900	1004	78.9293 N : 11.8667 E	3	42 m
1974 →	99910	1007	78.9243 N : 11.9312 E	1	8 m



FIGURE 1 | The three main sites of the weather station in Ny-Ålesund. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

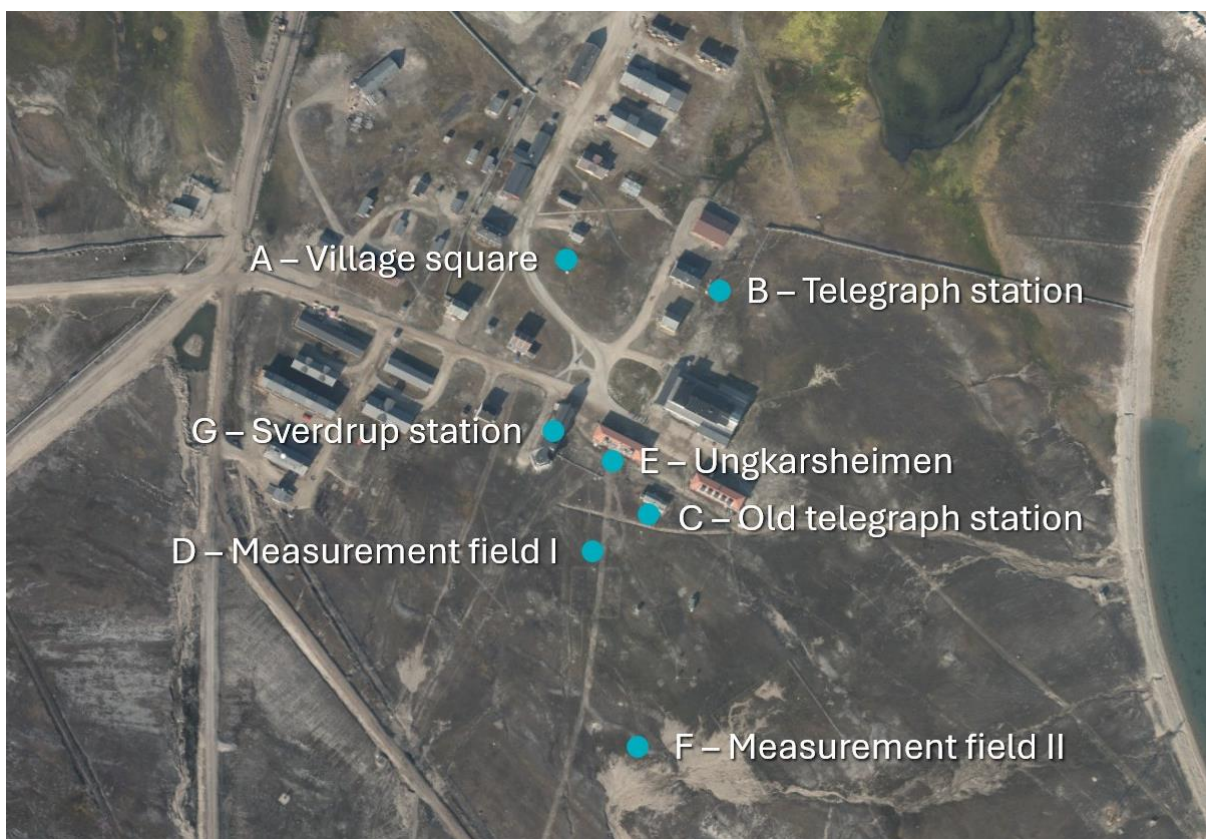


FIGURE 2 | The different locations within main site 1 in the centre of Ny-Ålesund. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

1.1 1950-1953 and 1961-1967

Ny-Ålesund was originally established as a mining settlement, and the first meteorological measurements were taken in Ny-Ålesund (site 1 and 2 in Fig. 1) by employees at the Kings Bay A/S in the periods 1950-1953 and 1961-1967. The measurements from these two periods were irregular and of poor quality and are therefore not included in the database of the Norwegian Meteorological Institute (MET Norway). Some (but not all) of these observations are stored in paper form at the National Archives of Norway. A short summary of the station history for 1950-1967 can be found in Appendix E.

1.2 1967-1974

The meteorological station was re-established on 17 August 1967 at the ESRO station (European Space Research Organization) at Hamnerabben (site 3 in Fig. 1). Hamnerabben is located 1.6 km west-northwest of Ny-Ålesund village (site 1 in Fig. 1). The station was run by The Research Council of Norway. The precipitation gauge, temperature screen and wind sensors were placed 20 m south of the ESRO station building. The observations were irregular in the first couple of years, so the data record in the database of MET Norway begins in January 1969 with observation hours 00, 06, 12, 18 UTC until June 1969 and 06, 12, 18 UTC from July 1969.

1.3 1974-present

1.3.1 *Manual measurements*

The meteorological station was relocated back to Ny-Ålesund village (site 1 in Fig.1) in the end of July 1974 and was from then on operated by the Norwegian Polar Institute. The old station was kept operative until the end of the month, so data from the new location was officially available from 1 August 1974. The instruments have been moved several times within the village since then. See the *Data description* chapter for details. The station number was changed from 99900 to 99910 with the relocation.

1.3.2 *Automatic measurements*

An automatic weather station (AWS) was installed 28 July 1994 at Measurement Field I (1-D) and AWS data were available in the MET Norway database from 4 September 1994. The automatic precipitation gauge was moved 1 August 1997 from the village square (1-A) to Measurement field I (1-D). The whole AWS was moved 100 m west on 15 July 2000 to Measurement field II (1-F) because of several reports of errors in the period 1998-2000.

The weather station at
Hamnerabben in 1967



The weather station in
Ny-Ålesund in 1974



The automatic weather
station in 2023



FIGURE 3 | The Ny-Ålesund weather station in 1967, 1974 and 2023. Photo: MET Norway.

2 Data description

Information about instruments, locations and observation methods are described in detail for each parameter.

2.1 Air temperature

2.1.1 1967-1974

When the station was re-established at Hamnerabben (site 3 in Fig.1) in 1967, the free-standing screen was placed 20 m south of the station building. The observations were irregular in the beginning, but from January 1969, air temperature was measured four times a day at 00, 06, 12, 18 UTC until June 1969, and then three times a day at 06, 12, 18 UTC from July 1969. Maximum and minimum temperature were registered twice a day (06 and 18 UTC).

2.1.2 1974 – present

The station was moved back to Ny-Ålesund village (site 1 in Fig.1) at the end of July 1974. The temperature screen with new thermometers was placed in the village square (1-A). Table 3 lists the known thermometer changes for the weather station.

The observation hours were the same as before (06,12,18 UTC) with extreme temperature registrations twice a day (06 and 18 UTC).

The old wooden temperature screen (MI-33) was replaced with a new one (MI-46) 24 July 1982, see Fig. 6. The new screen was placed 4 m northwest of the old screen. In addition, a temperature sensor and hygrometer for MITEF (automatic measurements that were displayed on a screen in the MET room) were installed at the same time, see Fig. 5. Parallel manual measurements were carried out in the two screens for a few years.

2.1.3 Automatic measurements

An automatic weather station (AWS) was installed 28 July 1994 at Measurement Field I (1-D) and data was available in the MET Norway database from 4 September 1994. A PT-100 thermometer in a cylindrical plastic screen of the type MI-74 was used for temperature measurements and placed 2 m above ground level, see Fig. 7.

A PT-100 thermometer was also installed in the MI-46 screen in the village square (1-A) at the same time. In addition, the manual observations done by the Polar Institute were still performed. So at this point there were actually three parallel temperature measurements: One in the AWS and two in the MI-46 (automatic PT-100 and manual mercury thermometer).

In 2000 the AWS was moved about 100 m from Measurement field I (1-D) to its current position at Measurement Field II (1-F) on July 15th.

TABLE 2 | Metadata for measurements of **temperature**. Site and location correspond to locations in Fig. 1 and Fig. 2.

Site and location	Sensor and screen	Operational period	Height (m.a.g.l.)
3	Mercury thermometer (<i>manual</i>) Radiation screen: MI-33*	1967.08 ⁺ -1974.07	1.9 m
1-A	Mercury thermometer (<i>manual</i>) MITEF (<i>automatic</i> , 27 July 1982-1997.07) Radiation screens: MI-33* (1974.08-1982.07) MI-46* (24 July 1982-1997.07)	1974.08-1997.07	MI-33: 1.8 m MI-46: 2.1 m
1-A	PT100 in MI-46*	1994.09-1998.07	2.1 m
1-D	PT100 in MI-74* PT100	1994.09-2000.07	1.8 m
1-F	Radiation screens: MI-74* (2000.07-2013.07) MI-2001B* (2013.08 →)	15 July 2000 →	2 m

⁺Data in database from 1969.

*See figure text of Fig. 6 and Fig. 7 for descriptions of the screen types.

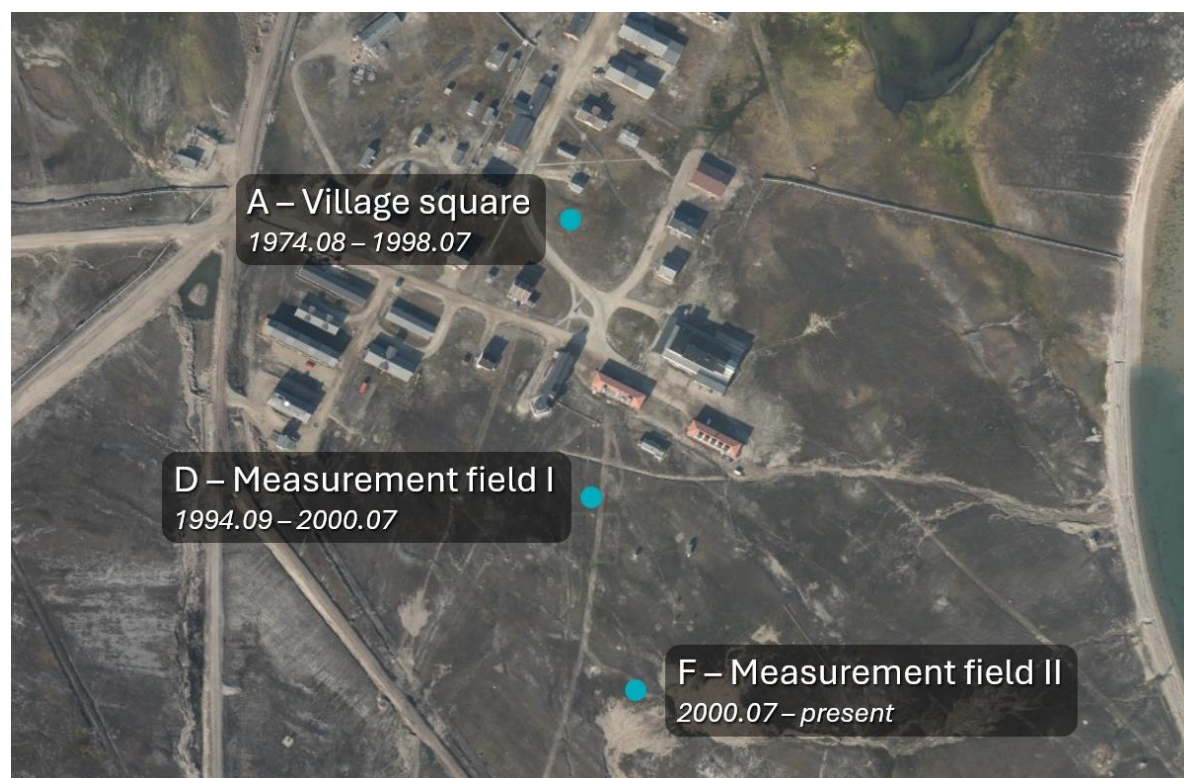


FIGURE 4 | Locations of the **temperature** measurements from 1974 to present. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

2.1.4 Parallel measurements

The automatic measurements from the AWS were used as the official (primary) temperature series (which means it was used for synoptic data and used in calculation of daily and monthly mean temperatures, please see the *Data access* chapter) from 4 September 1994. However, for maximum and minimum temperature, the manual measurements from the mercury thermometer in the MI-46 were still used as the official (primary) series until 31 July 1997. From 1 August 1997 06 UTC the measurements from the AWS became the official measurements for maximum and minimum temperature as well.

The measurements from the PT100 thermometer in the MI-46 were stored as secondary temperature in the MET database from 4 September 1994 to 31 July 1998. After that, all measurements from the MI-46 screen stopped.

Temperature measurements from the relative humidity sensor from the AWS were stored as secondary temperature from 1 December 2000 to 31 May 2005.

2.1.5 Other temperature measurements

There are notes suggesting that there have been measurements of grass minimum temperature and sea surface temperature in Ny-Ålesund. However, there is no data stored in the database of MET Norway, except for four days in 2007.

Dew point temperature is a derived parameter. Daily values are available from 1 December 2004 and hourly values from 1 July 2005. There are many gaps in the beginning of the series.

Homogenised temperature series are available for Ny-Ålesund with a monthly time resolution from September 1934 (this series is extrapolated to start in 1934). See Nordli et al. (2014) for details.

TABLE 3 | Known replacements of thermometers.

Manual thermometers	
16 January 1970	New minimum thermometer
26 January 1977	New main, maximum and minimum thermometers
24 July 1982	New main, maximum and minimum thermometers
7 July 1988	New main thermometer
AWS	
7 August 1995	New PT-100 element in a new cylindrical plastic screen
15 September 2007	New PT-100
14 October 2009	New PT-100

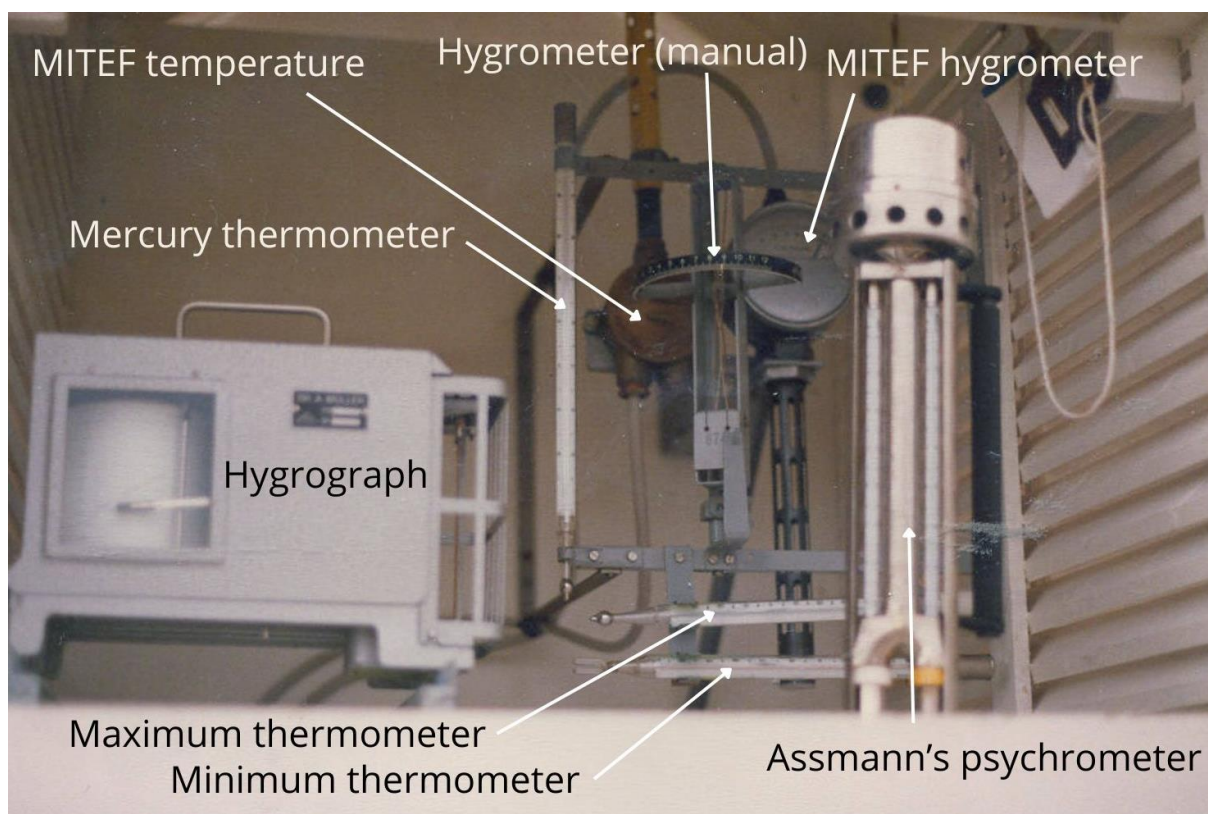


FIGURE 5 | Inside the MI-46 temperature screen in 1988. The Assman psychrometer was probably only used for control purposes during the inspection when the photo was taken. The MITEF sensors were used for automatic measurements. Photo: MET Norway.



FIGURE 6 | The two temperature screens MI-33 (left) and MI-46 (right) in 1994. The MI-33 has double-boarded walls and floor and was to be used at sites in harsh climates. The MI-46 has double-boarded floor and walls to the north and south, while the eastern and western walls are double-louvered. Of the precipitation gauges in the picture, the gauge to the left is the Geonor T-200 (automatic gauge). The gauge in the middle is a Russian type (used for test purposes). To the right is the manual Norwegian gauge. Photo: MET Norway.



FIGURE 7 | Cylindrical temperature screens. Left: Photo from 2000 of with temperature and humidity sensors in separate screens. The smaller screen to the right is the MI-74, a circular double louvered plastic screen. The one on the left was used for the humidity sensor before both temperature and humidity sensor were placed in the same screen in 2013. Right: The MI-2001B, a circular double louvered plastic screen with co-located temperature and humidity sensor, photo taken in 2013. Photo: MET Norway.

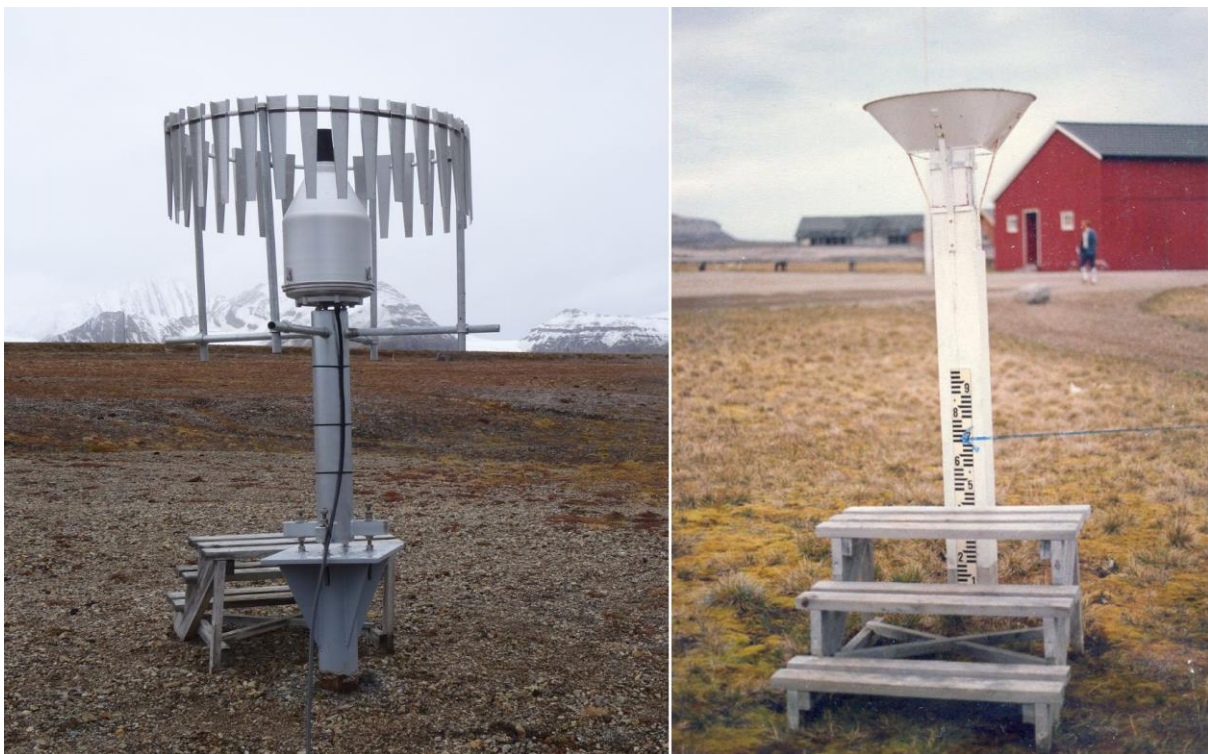


FIGURE 8 | Precipitation gauges. Left: Geonor T-200 with a single Alter windshield in 2020. Right: Photograph from 1988 of the manual measurement gauge (Norwegian type) in the Village square (1-A). The scale on the pole was used for the manual measurement of snow depth. Photo: MET Norway.

2.2 Precipitation

2.2.1 1967-present

From August 1967 until July 1974, the precipitation gauge was placed at the ESRO station at Hamnerabben (site 3 in Fig. 1). Precipitation measurements from Ny-Ålesund are available in the database from 1969.

The station was relocated to the centre of Ny-Ålesund (site 1 in Fig. 1) in July 1974. Since then, the manual precipitation measurements have been performed in the village square (1-A).

In both sites, the manual precipitation measurements were measured with a Norwegian Gauge, see Fig. 8, and performed twice a day at 06 and 18 UTC.

2.2.2 Automatic measurements

In September 1994, additional automated measurements were started. A Geonor T-200 with a single Alter windshield was mounted close (5 m distance) to the manual precipitation gauge in the Village square (1-A). In 1997, the Geonor gauge was moved to the tundra area south of the settlement to be closer to the rest of the automated measurements in Measurement Field I (1-D) on August 1st. In 2000, the gauge and the rest of the AWS was moved again on July 15th to its current position, about 100 m westwards to Measurement field II (1-F).

2.2.3 Parallel measurements

Both datasets (manual and automatic) exist in parallel from 1994 and are available in the MET database (see the *Data access* chapter for more info on parallel series).

Because of poor data quality and numerous data transfer problems in the automatic data set from the Geonor gauge, the manual precipitation measurements are kept as the official (primary) precipitation series for Ny-Ålesund and are used for calculation of daily and monthly precipitation sums. However, the data from the Geonor gauge have been used for gap filling when there has been missing data in the manual series, see Table C2 in Appendix C.

There are plans of ending the manual series in the near future, having the automatic measurements take over as the official precipitation series.

TABLE 4 | Metadata for measurements of **precipitation**. Site and location correspond to locations in Fig. 1 and Fig. 2.

Site and location	Sensor and wind screen type	Operational period	Height (m.a.g.l.)
3	Norwegian gauge (manual)	1967.08 ⁺ -1974.07	1.9 m
1-A	Norwegian gauge (manual)	1974.08 →	2 m
1-A	Geonor T-200, Alter wind shield	1994.09-1997.07	2 m
1-D	Geonor T-200, Alter wind shield	1997.08-2000.07	2 m
1-F	Geonor T-200, Alter wind shield	2000.07 →	2 m

⁺Data in database from 1969.

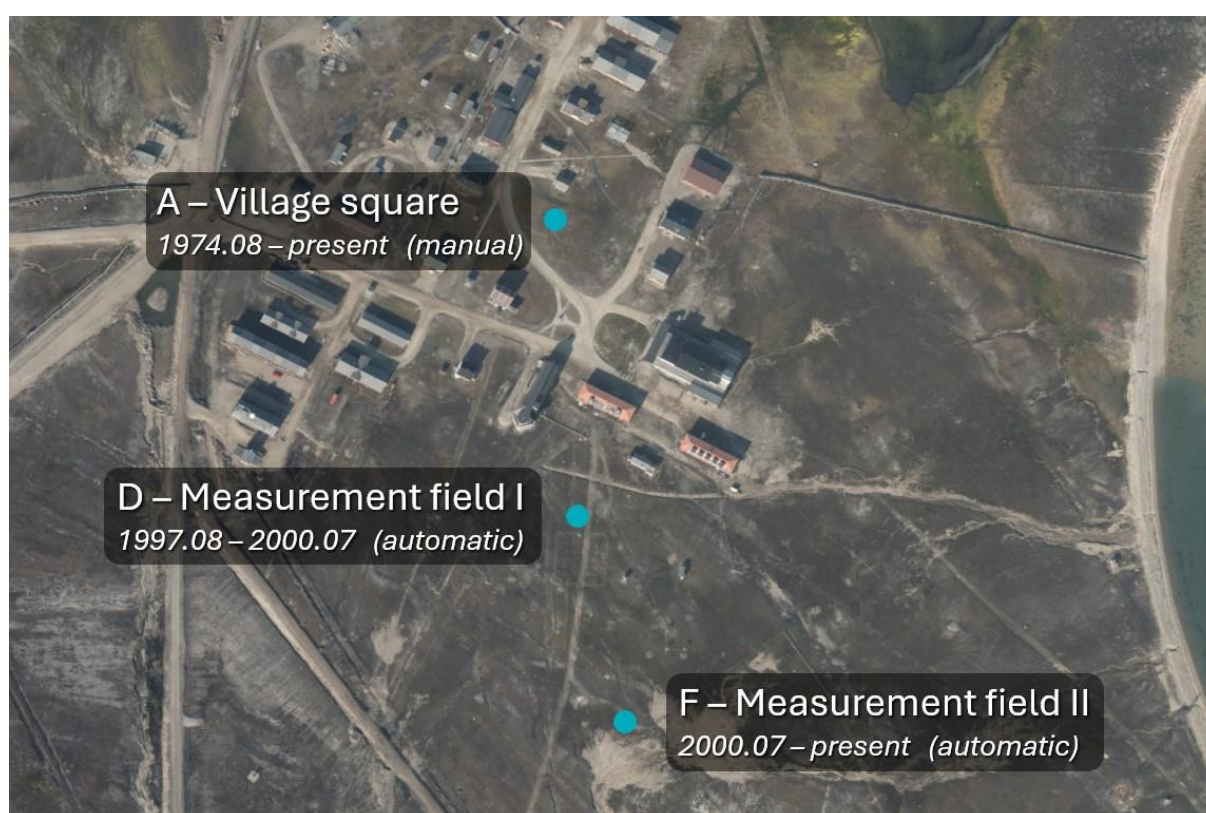


FIGURE 9 | Locations of the **precipitation** gauge from 1974 to present. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

2.3 Snow cover and state of the ground

Measurements of snow cover started in September 1974. The manual observations were done once a day at 6 UTC. There are several large gaps in the time series, see Table 5.

Snow cover has been observed in two periods using different codes, see Table B1 and Table B2 in Appendix B. The oldest code used in the period 1974 to 1979 is called «snow cover». When measurements resumed in 2009, the parameter «state of ground» was used and from 2013 an updated version of this was taken into use. The «state of ground» is also converted to the old «snow cover» code.

2.4 Snow depth

Measurements of snow depth started in September 1974. The manual observations were done once a day at 6 UTC. There are several large gaps in the time series, see Table 6.

2.4.1 Manual measurements

Snow depth was measured manually in two shorter periods in the 1970s, as listed in Table 6. The snow measure was mounted on the precipitation gauge pole, see Fig. 8, which was located in the Village square (1-A).

After a long break, the manual snow depth measurements were resumed in November 2008 in the same location. Measurements were performed only occasionally in the last two months of 2008, but from January 2009 until now, daily manual snow depth measurements are performed.

2.4.2 Automatic measurements

In 1997, the station was equipped with an automatic snow depth sensor and hourly measurements started in October 1997. The automatic snow depth sensor was mounted close to the wind mast, which at that time was located in Measurement Field I (1-D). In August 2000, the snow depth sensor was moved with the rest of the automatic weather station to its current location in Measurement Field II (1-F) site F.

At the new location, problems with the sensor and data transfer occurred, and the dataset between 1997 and 2017 is of varying quality and content, see the *Data quality* chapter. Table C1 in Appendix C lists the available automatic snow depth data per year from 1997.

2.4.3 Parallel measurements

Currently, the daily manual measurements are distributed as the official (primary) snow depth measurements in Ny-Ålesund. The automatic hourly snow depth data are also available in the MET database from 1997, but then as a secondary series (see the *Data access* chapter).

There are plans of ending the manual series in the near future, having the automatic measurements take over as the official series.

TABLE 5 | Metadata for observations of **snow cover**. Site and location correspond to locations in Fig. 1 and 2.

Site and location	Sensor	Operational period
1-A	Manual observations	1974.09-1976.12
		1978.09-1979.04
		2009.01→

TABLE 6 | Metadata for measurements of **snow depth**. Site and location correspond to locations in Fig. 1 and Fig. 2.

Site and location	Sensor	Operational period
1-A	Manual measurements	1974.09-1976.12
		1978.09-1979.04
		2008.11→
1-D	Aanderaa ultrasonic snow depth sensor	1997.10-2000.07
1-F	Aanderaa ultrasonic snow depth sensor	2000.08-2003.08
1-F	Campbell SR50	2003.09-2008.08
1-F	Campbell SR50A	2008.09-2021.05*
1-F	Lufft SHM31	2021.09 →

*Between 2010 and September 2017, no automatic snow depth measurements exist because of unstable data connection between logger and instrument.

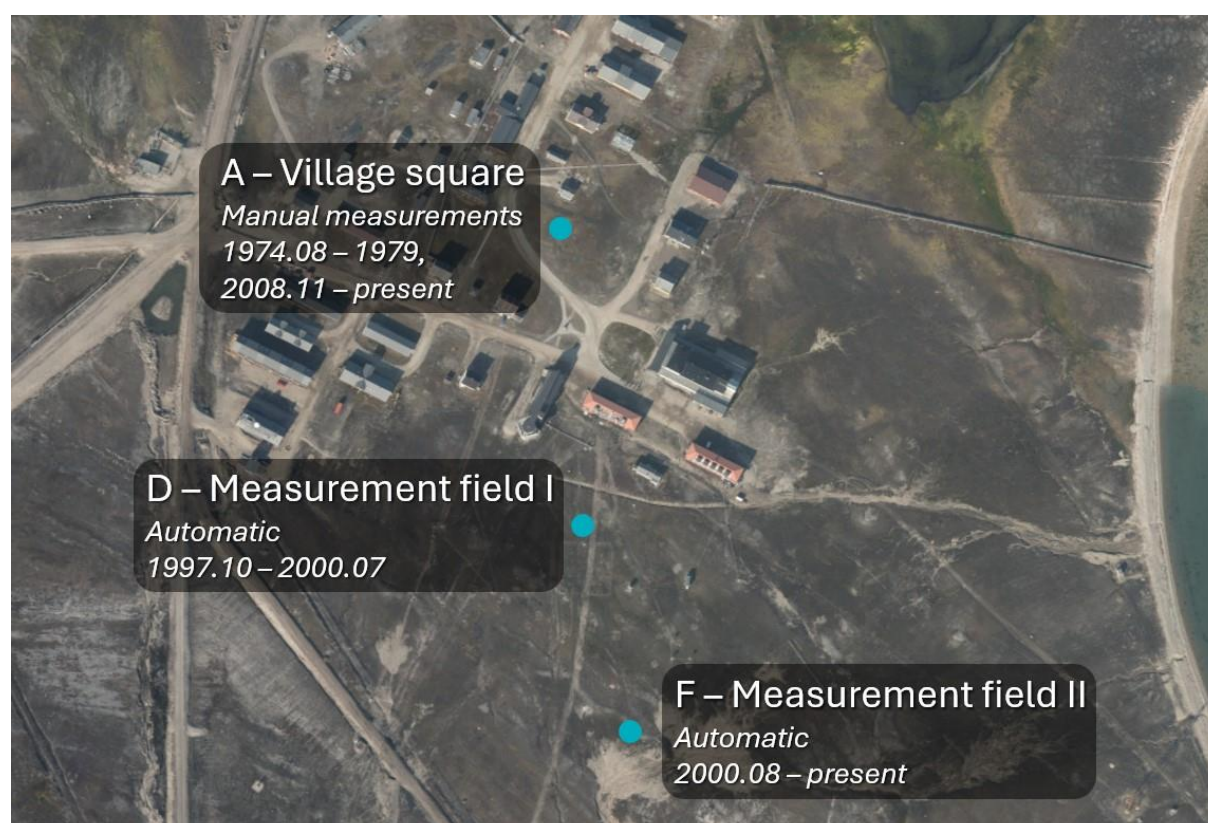


FIGURE 10 | Locations for **snow depth** measurements from 1974 to present. Manual measurements have been conducted in location A, and automatic measurements in locations D and F. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

2.5 Wind

Wind instruments were located at the ESRO station at Hamnerabben (site 3 in Fig. 1) between 1961 and 1974, and regular wind observations have been available since 1969. Measurements were performed with a wind vane and cup anemometer. Data were recorded with an anemograph (paper recorder for wind speed and direction), and the observer manually read the average wind speed and direction of the last 10 minutes four times a day at 00, 06, 12, 18 UTC until June 1969, and then three times a day at 06, 12, 18 UTC from July 1969.

In July 1974 the wind measurements were moved into Ny-Ålesund village centre, with the anemometer mounted at 10 m height in an existing antenna mast belonging to the telegraph station (1-B) and the wind vane at 8.5 m height in a lamppost close to the Village square (1-A).

Both anemometer and wind vane were moved again and mounted together in a mast by Ungkarsheimen (1-E) in July 1982. There was a significant height difference between the sensors in the mast: the anemometer was mounted at 10 m above ground, while the wind vane was mounted at 20 m above ground. Both the height difference and the proximity to the closest building were not ideal for wind measurements, thus a small relocation to a new mast by the Old telegraph station (1-C) and change of instrument type happened in 1984, see Table 8. The introduction of this new sensor type made it possible to also record the highest wind gust value (3-5 second average) in the measurement interval (6 hour).

2.5.1 Automatic measurements

In 1994, new wind sensors and a fully automated weather station were mounted at Measurement field I (1-D). The new mast for the wind sensors (wind vane and cup anemometer) was located about 30 m SW from the last location. From then on hourly measurements are available, including wind speed and direction averaged over the last 10 minutes. Additionally, maximum wind gust speed during the last hour and maximum 10-minute average wind speed during the last hour and corresponding wind direction values are available.

In 2000, all automated sensors were moved about 100 m to Measurement field II (1-F) on July 15th. In 2021, the wind sensors were replaced with an ultrasonic anemometer.

2.5.2 Parallel measurements

The official (primary) series from September 1994 were the data from the AWS. There are also wind speed and wind direction data in secondary time series from 1994 until 2005. This data lacks documentation. The observation hours for the data in the secondary time series are 6,12,18 UTC from September 1994 to July 1997, and 0, 3, 6, 9, 12, 15, 18, 21 UTC from August 1997 to May 2005. See the *Data Access* chapter for info about primary and secondary series.

TABLE 7 | Metadata for measurements of **wind speed**. Site & location correspond to Fig. 1 and 2.

Site and location	Sensor	Operational period	Height (m.a.g.l.)
3	MI 48/250*	1969.01-1974.07	9 m
1-B	MI 48/250*	1974.08-1982.07	10 m
1-E	MI 48/250*	1982.07-1984.08	10 m
1-C	Fuess 90z	1984.09-1994.08	10 m
1-D	Vaisala WAA 151**	1994.09-2000.07	10 m
1-F	Vaisala WAA 151** (2000.07-2021.09) Gill windobserver 75 (2021.09 →)	2000.07 →	10 m

TABLE 8 | Metadata for measurements of **wind direction**. Site & location correspond to Fig. 1 and 2.

Site and location	Sensor	Operational period	Height (m.a.g.l.)
3	MI 65*	1969.01-1974.07	9.5 m
1-A	MI 65*	1974.08-1982.07	8.5 m
1-E	MI 65*	1982.07-1984.08	20 m
1-C	Fuess 90z	1984.09-1994.08	10 m
1-D	Vaisala WAV 151**	1994.09-2000.07	10 m
1-F	Vaisala WAA 151** (2000.07-2021.09) Gill windobserver 75 (2021.09 →)	2000.07 →	10 m

* Produced by the instrumental service at MET Norway.

** The earlier models of these Vaisala sensors were called WAV/WAA 15A.

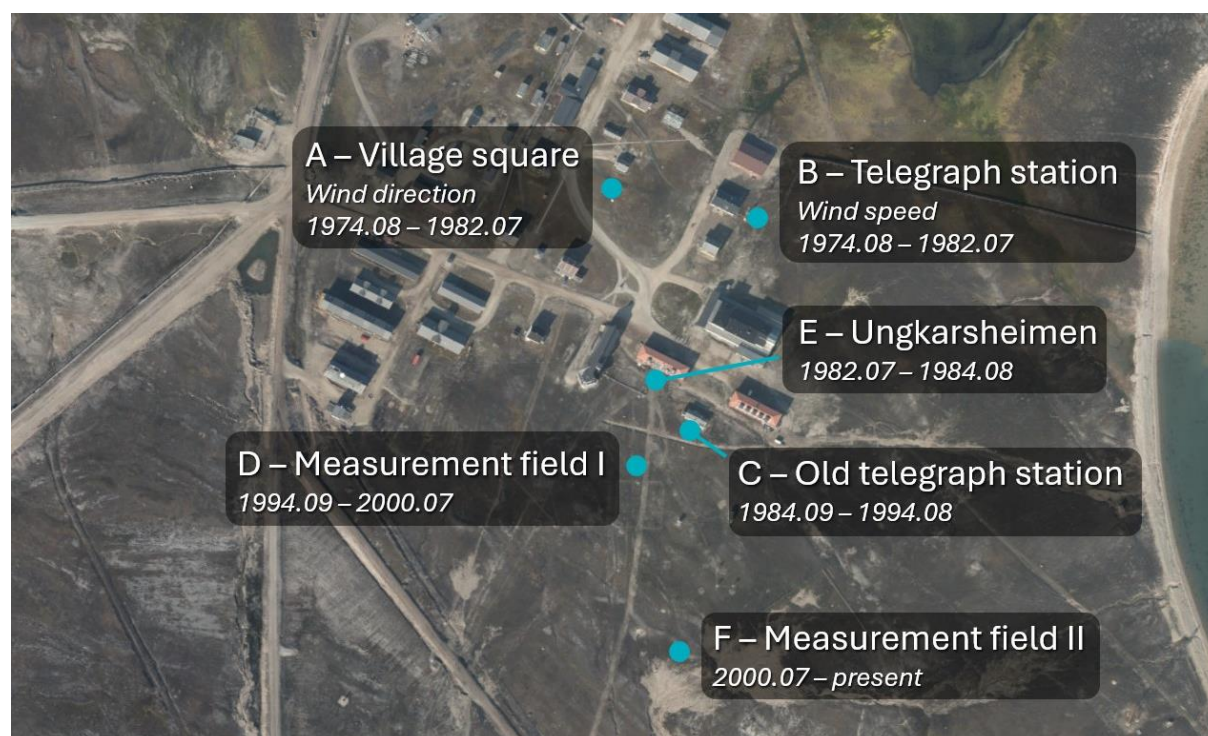


FIGURE 11 | Locations for measurements of **wind speed and direction** from 1974 to present. For 1974.08-1982.07, the speed and direction instruments were not located in the same place. From 1982.07, both instruments were placed in the *same* location. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

2.6 Air Pressure

Air pressure measurements started in August 1967, but the observations were irregular in the beginning, so data are only available from January 1969. Air pressure was measured four times a day at 00, 06, 12, 18 UTC until June 1969, and then three times at 06, 12, 18 UTC from July 1969. The barometer and barograph were placed in the office building at the ESRO station at Hamnerabben (site 3 in Fig.1). The station was relocated to the Telegraph station in Ny-Ålesund (1-B) at the end of July 1974.

The instruments were moved 24 July 1982 from the Telegraph station (1-B) to the research station in Ungkarsheimen (1-E), ca. 150 m southwards. The barometer was placed on a stable wall and was placed 219.7 cm higher than at the old placement.

As usual for meteorological stations, the measured pressure at the barometer is reduced to a well-defined reference point on the ground, which gives the surface pressure at the station, also known as QFE in aviation applications. If available, both heights are given in Table 9.

2.6.1 Automatic measurements

Automatic measurements started in July 1994. The automatic pressure sensor was placed with the AWS logger unit in the same building as before, Ungkarsheimen (1-E).

There was a relocation of the automatic pressure sensor in July 1999 to Sverdrup Station (1-G), together with the logger unit. In 2021, the pressure sensor was relocated again and placed together with the rest of the automatic weather station at Measurement field II (1-F).

2.6.2 Parallel measurements

Hourly air pressure data from the AWS are available in the database from 4 September 1994 and were the official (primary) air pressure data from then on. Manual observations continued in parallel until 30 May 2005 and are stored as a secondary series in the MET database. See the *Data Access* chapter for info about primary and secondary series.

TABLE 9 | Metadata for measurements of **air pressure**. Site and location correspond to locations in Fig. 1 and Fig. 2. When available, two heights are stated: The height of a station reference point to which the measured pressure is reduced and (if available or different) the height of the barometer itself.

Site and location	Sensor	Operational period	Reference height Hp and barometer height Hb (m.a.s.l.)
3	Mercury barometer (Fuess 3217), barograph (Fuess 11049)	1967.08 ⁺ -1974.07	Hp=43.3 m
1-B	Mercury barometer (Fuess 3217), barograph (Fuess 11049)	1974.08-1982.07	Hp=7.7 m Hb=10.5 m
1-E	Mercury barometer (Fuess 3217), barograph (Fuess 11049 until 1988.07, Fuess 1226572 from 26 July 1988)	1982.07-2005.05	Hp=7.7 m Hb=12.7 m
1-E	Digiquartz 1016B 52269 (automatic)	1994.09-1999.05	Hp=7.7 m Hb=10.7 m
1-G	Digiquartz 1016B 52269, Vaisala PTB220 from 2007.09	1999.05-2021.08	Hp=7.7 m Hb=17.5 m
1-F	Vaisala PTB330A	2021.09 →	Hp=7.7 m Hb=15.7 m

⁺ No data in database until 1969.01.

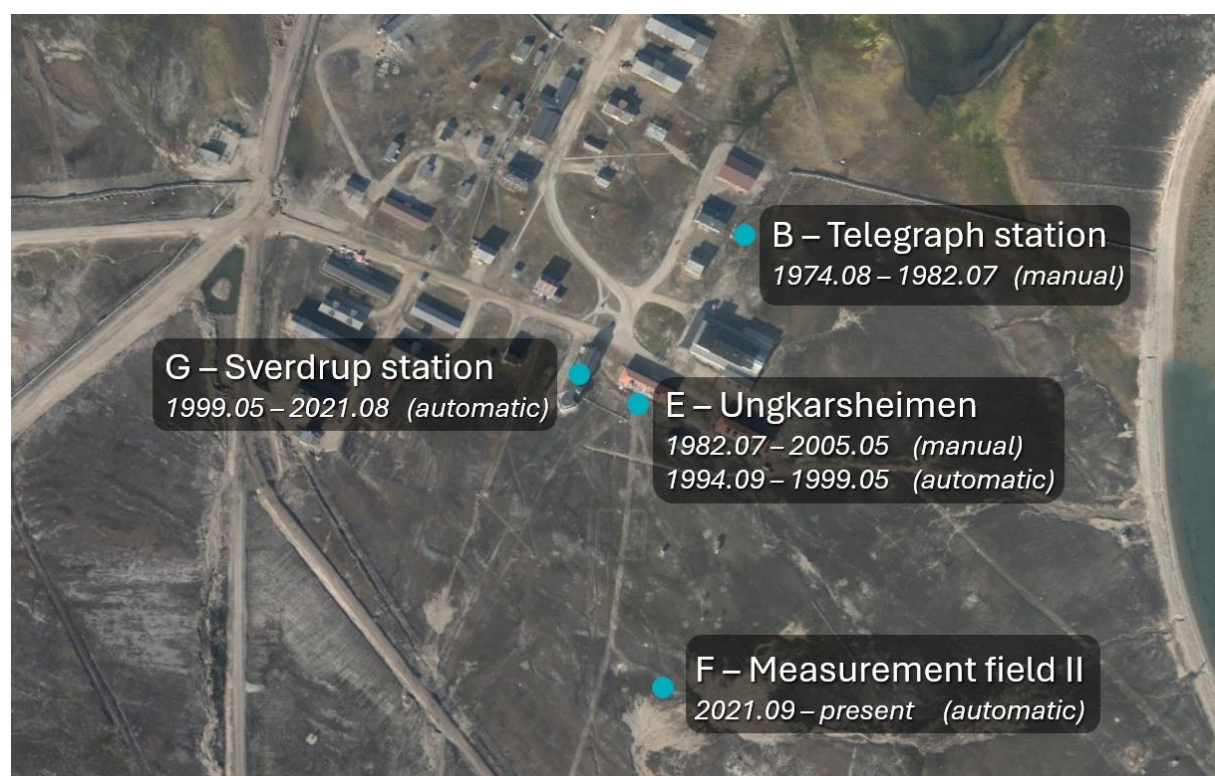


FIGURE 12 | Locations of the **air pressure** measurements from 1974 to present. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

2.7 Relative humidity

Relative humidity measurements started in August 1967. Because the observations were irregular in the beginning, there is only data available in the database from January 1969.

Relative humidity was registered manually four times at 00, 06, 12, 18 UTC until June 1969, and then three times a day at 06, 12, 18 UTC from July 1969.

Automatic measurements started in July 1994. Hourly relative humidity data from the AWS are available in the database from 4 September 1994 and were the official (primary) relative humidity data series from then on.

The hygrometer is placed together with thermometers in the radiation screen, so we refer to the air temperature section for details about placement and relocations, which are also summed up in Table 10.

2.7.1 *Parallel measurements*

The official (primary) series from September 1994 were the data from the AWS. There are also relative humidity data in a secondary time series from 1994 until 2005. This data lacks documentation. The observation hours for the data in the secondary time series are 6,12,18 UTC from September 1994 to July 1997, and 0, 3, 6, 9, 12, 15, 18, 21 UTC from August 1997 to May 2005. See the *Data Access* chapter for info about primary and secondary series.

2.8 Visual observations

The visual weather observations, encompassing cloud type, cloud height and cloud cover, visibility, and the dominant weather phenomena, are performed by the staff of the Norwegian Sverdrup station, operated by the Norwegian Polar Institute. A list of observed parameters can be found in Table A8 in Appendix A. The table also lists the WMO code table that is used for the parameters, and those code tables can be found in WMO (2019).

Observations were performed four times at 00, 06, 12, 18 UTC until June 1969, and then three times a day at 06, 12, 18 UTC from July 1969. The observers also register the parameter state of ground, described in the *Snow depth, snow cover and state of ground* subsection.

TABLE 10 | Metadata for measurements of **humidity**. Site & location correspond to locations in Fig. 1 & Fig. 2.

Site and location	Sensor	Operational period	Height (m.a.g.l.)
3	Hygrometer (T478) <i>Radiation screen: MI-33*</i>	1967.08 ⁺ -1974.07	1.9 m
1-A	- Hygrometer (T478) - Hygrograph (F124/306 until 1988.07, M-H5548 from 26 July 1988, F-H9377 from 8 July 1993) - MITEF (Lambrecht, 27 July 1982 - 1997.07) <i>Radiation screens:</i> MI-33* (1974.08-1982.07) MI-46* (24 July 1982-1997.07)	1974.08-1997.07	MI-33: 1.8 m MI-46: 2.1 m
1-D	Lambrecht L-800** (2 Aug 1998: new sensor, same type) <i>Radiation screen: MI-74*</i> Vaisala HMP45D** (2000.07-2013.07) HMP155** (2013.08 →)	1994.09-2000.07	2 m
1-F	<i>Radiation screens:</i> Circular louvered screen* (2000.07-2013.07) MI-2001B* (2013.08 →)	2000.07 →	2 m

⁺ No data in database until 1969.01. * See figure text of Fig. 6 and Fig. 7 in the temperature section for descriptions of the screen types. ** Parts of sensor changed routinely at every inspection, but sensor type still the same

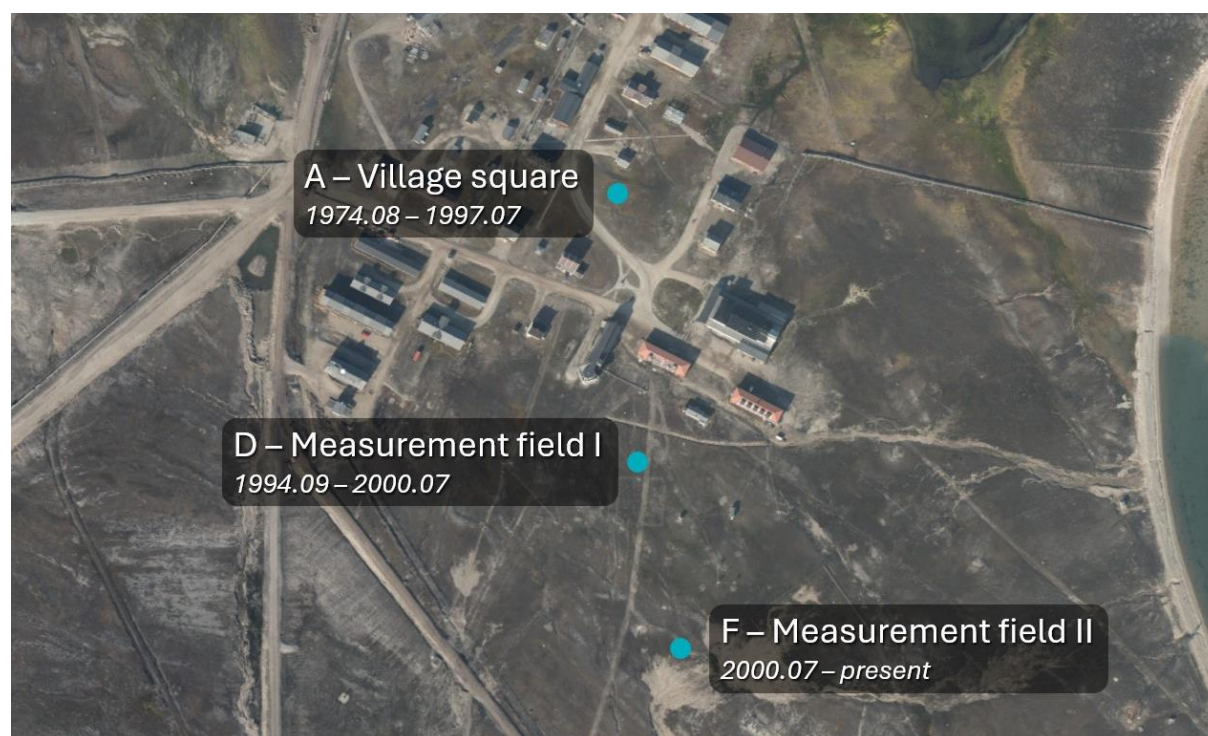


FIGURE 13 | Locations of **humidity** measurements from 1974 to present. Aerial photo from TopoSvalbard © Norwegian Polar Institute.

3 Data quality

All data from MET Norway is quality controlled. Before 2005, the quality control was manually performed. Since 2005, a combination of automatic quality control and manual quality control has been applied to the data available in the database. Data is automatically controlled in near real-time where suspicious data are flagged and manually inspected.

A note on observation hours for manual measurements: In general, the measurements are performed within ± 15 minutes of the hour at 06, 12 and 18 UTC, but deviations might occur due to weekend days and varying duty schedules.

3.1 Temperature

The AWS had unstable temperature measurements in some periods. This was the case from August 1998 until 8 May 1999 when a new cable for the AWS was installed.

Reports of possible errors (cases of discrete false temperature jumps) were again issued from the end of April 2000. As a result, the AWS was moved 100 m westwards 15 July 2000 to Measurement Field II (1-F) and the electronics in the PT-100 were fixed.

In April 2007, new reports of frequent errors in the temperature measurements from the AWS were issued. Because of this, temperature measurements from the secondary thermometer were used as official temperatures from Ny-Ålesund until September the same year. During an inspection 15 September 2007 it was discovered that the errors were due to corrosion in the PT-100 sensor. A new PT-100 was then installed.

3.2 Precipitation

Dyngeseth (2004) compared the manual and automatic gauge measurements from the first three years of parallel measurements when the two gauges were both located in the Village square (1-A, September 1994 - July 1997). In general, there was quite good agreement between the two gauges and deviations seldom exceeded ± 0.25 mm for 12-hour periods.

On average, the automated Geonor gauge measured higher precipitation amounts than the manual gauge: Over the entire study period, the relative difference in total accumulation was 7 % in summer (April- September, 940 days) and 12 % in winter (October - March, 1022 days).

However, a few individual 12-hour periods had a difference of several millimetres in the measured total. Dyngeseth & Brækkan (2004) studied those events in more detail and concluded as follows:

- Most of those differences could be explained by noise in the Geonor measurements, erroneously interpreted as accumulation. This problem is handled by an algorithm (see Dramstad 2021) in the local logger system that was implemented in Ny-Ålesund 7 September 2021.

- Some of the differences occurred during relatively large precipitation events. The differences can be explained by not quite synchronous measurements: The manual measurement is usually taken in a time window of ± 15 minutes of the hour, while the automatic measurements occur exactly on the hour.

During winter 2021/2022, the automatic heating on the Geonor gauge did not work, thus some capping may have occurred in this period. The heating was fixed 6 September 2022.

There are instances where the observer measured precipitation but did not report any precipitation type. This is especially true for the period before the automatic quality control started (which includes consistency checks to avoid this issue).

3.3 Snow depth

Generally, snow depth is one of the parameters that are most affected by the exposure of the measuring site. Significant differences between measurements from different locations must therefore be expected.

In August 2000, the snow depth sensor was moved with the rest of the automatic weather station to its current location in Measurement Field II (1-F). At the new location, problems with the sensor and data transfer occurred and the time series was interrupted until autumn 2003 when a new sensor (Campbell SR50) was installed. However, some technical problems with the data transfer remained, resulting in varying data coverage.

Because of the remaining problems with establishing a stable data connection, the manual snow depth measurements resumed in autumn 2008. From 2010 to September 2017 there are no automatic snow depth measurements. The data collection system was updated on 28 June 2017, and a new snow depth sensor was installed (Campbell SR50A). This gave a more stable dataflow.

Because of the sensor and dataflow problems, the dataset between 1997 and 2017 is of varying quality and content. The available data were quality controlled, both automatically and manually, and the largest outliers as well as periods with corrupt data were removed. The entire time series has gaps of various lengths, and the data may still include some non-realistic values. A quality check of this period is therefore recommended when using the data. Table C1 in Appendix C lists the availability of automatic data per year for the period 1997-2017.

3.4 Wind speed

The wind speed in the period 1969-1994 was recorded with an anemograph (paper recorder), which the observer manually read. It is likely that the wind scale used on the paper recorder was the Beaufort wind force scale, and that the data was then converted into wind speed in meters per second. Therefore, the data only took discrete values in this period.

With the automatization of the wind measurements in 1994, wind speed was directly measured in meters per second. The data was also converted to Beaufort wind force and stored under a separate parameter name until March 2005.

Until the change of sensor and location in 1984, up to 30% of all observations each year were reported as zero, representing a calm wind situation, see Table 11. After 1984, the amount of calm wind situations was always lower than 5 % of the observations.

Generally, older systems require a higher wind speed to register any wind. Furthermore - mechanical sensors, like cup anemometers, have a higher onset speed than ultrasonic wind sensors. However, given the significant difference in the occurrence of calm situations, one cannot exclude the possibility that some wind observations were simply not performed by the observers and wrongly annotated as 0 in the records.

The variety of wind speed sensors may also have an impact on the highest recorded wind speeds in a similar manner. The highest recorded wind speeds may at times have been limited by the sensor's capability.

TABLE 11 | Fraction of wind speed observations categorized as calm wind situations (where the wind speed is 0.0-0.2 m/s) for different time periods corresponding to the different locations of the wind speed sensor.

Time period	Fraction of calm wind situations	Location	Sensor
01.1969-07.1974	17.8 %	Hamnerabben (site 3)	MI 48/250
08.1974-06.1982	28.1 %	Telegraph station (1-B)	MI 48/250
08.1982-08.1984	27.9 %	Ungkarsheimen (1-E)	MI 48/250
09.1984-07.1994	10.2 %	Old telegraph station (1-C)	Fuess 90z
09.1994-05.2000	4 %	Measurement field I (1-D)	Vaisala WAA 151
08.2000-12.2024	3.5 %	Measurement field II (1-F)	Vaisala WAA 151, Gill windobserver 75 (from 2021)

4 Data access

Since the weather station in Ny-Ålesund had a large relocation in 1974, the data from the station can be found under two station numbers:

- 99900 Ny-Ålesund I (1969-1974)
- 99910 Ny-Ålesund (1974 to present)

Updated versions of time series

During the work with collecting and processing the metadata of the Ny-Ålesund weather station, we have applied some additional checks and recalculated some of the aggregated time series to ensure a consistent and sound data set.

Therefore, please be aware that differences between earlier and more recently downloaded time series may occur.

Parallel series – primary (official) series and secondary series

When there are parallel measurements for a parameter, one of the series is categorized as the official series and stored as what we call the official or primary series in the database.

The official (primary) series is used for the calculation of aggregated values (hourly, daily, monthly etc.). The series is also used for synoptic data, see also the subsection *GTS data* below.

The other parallel series are then stored as secondary series in the database.

4.1 Where to find data

An extensive overview of available data download services can be found via the website of the Norwegian Meteorological Institute: www.met.no

We mention two of the data download services here: Seklima and Frost.

Seklima.met.no is an easy to use, GUI-based data portal that is well suited when you only need smaller data sets and also want the possibility to visualise the data directly.

Frost.met.no is an interface that is convenient when you need to extract larger data sets and need data for scripts and applications. You can also find metadata about the weather stations here. Frost and its backend are still under development, and updated versions will be released.

4.1.1 GTS data

Data from Ny-Ålesund weather station is also shared every hour via GTS (Global Telecommunication System by World Meteorological Organization for real-time exchange of meteorological data).

Please note that for **precipitation**, the real time data set that was shared via GTS every hour contained the hourly automated precipitation measurements and not the manual measurements until 2018. Since then, the real-time messages contain the manual precipitation measurements from 6 and 18 UTC and no automatic measurements. This means that the GTS data set may differ from the data set in the MET Norway database, which is solely based on manual precipitation measurements.

For climate purposes, it is recommended to download the quality-controlled data series from MET Norway's database instead of using the GTS-data.

4.2 Parallel series and how to find them

To find the secondary series, one must currently use Frost. In seKlima, only the official (primary) series is available. Since Frost is in constant development at the moment, we only briefly mention how to find secondary series in the different versions below. Please note that this information may be outdated for updated Frost versions.

In Frost v.0 the secondary series can be found using :1 or :2 after the station number. So, 99910:0 (and also just 99910) will retrieve the official (primary) series, while 99910:1 and 99910:2 will retrieve data stored as secondary series. In Frost v.1 (at the moment called beta-frost) one must use the advanced settings and documentation to find the secondary series (using the path currently named «kvkafka» rather than the one named «filter»).

5 Time series and trends

We present some of the climate series from Ny-Ålesund. Figure 14 shows the climate standard normals for temperature and precipitation for Ny-Ålesund. Standard normals are averages of climatological data over a 30-year period (Tveito 2021).

Temperatures in Ny-Ålesund, and Svalbard in general, are relatively high considering its latitude, and have large variability in the winter half year. The relatively warm North Atlantic Current is the cause of this together with a high frequency of southerly winds.

The normal period 1991-2020 has higher temperatures in all months, and especially in the winter months, compared to the 1961-1990 normal period. The warmest month is June for both periods, while the coldest month is February for 1961-1990 and March for 1991-2020.

Precipitation sums in the Arctic are generally low due to cold air masses that have stable stratification and small amounts of water vapor. But the topography causes local differences, and Ny-Ålesund has an annual precipitation amount twice that of Svalbard Airport for instance. It is generally difficult to measure precipitation in Svalbard because of strong winds and drifting snow.

For precipitation, the normal period 1991-2020 has more precipitation than the 1961-1990 period during winter, while April to August shows both more and less precipitation. The difference between the two periods is especially large for January, where very large monthly sums in 1996, 2006, 2008, 2010 and 2012 contributed to this large difference.

See the sections below for more information on each parameter.

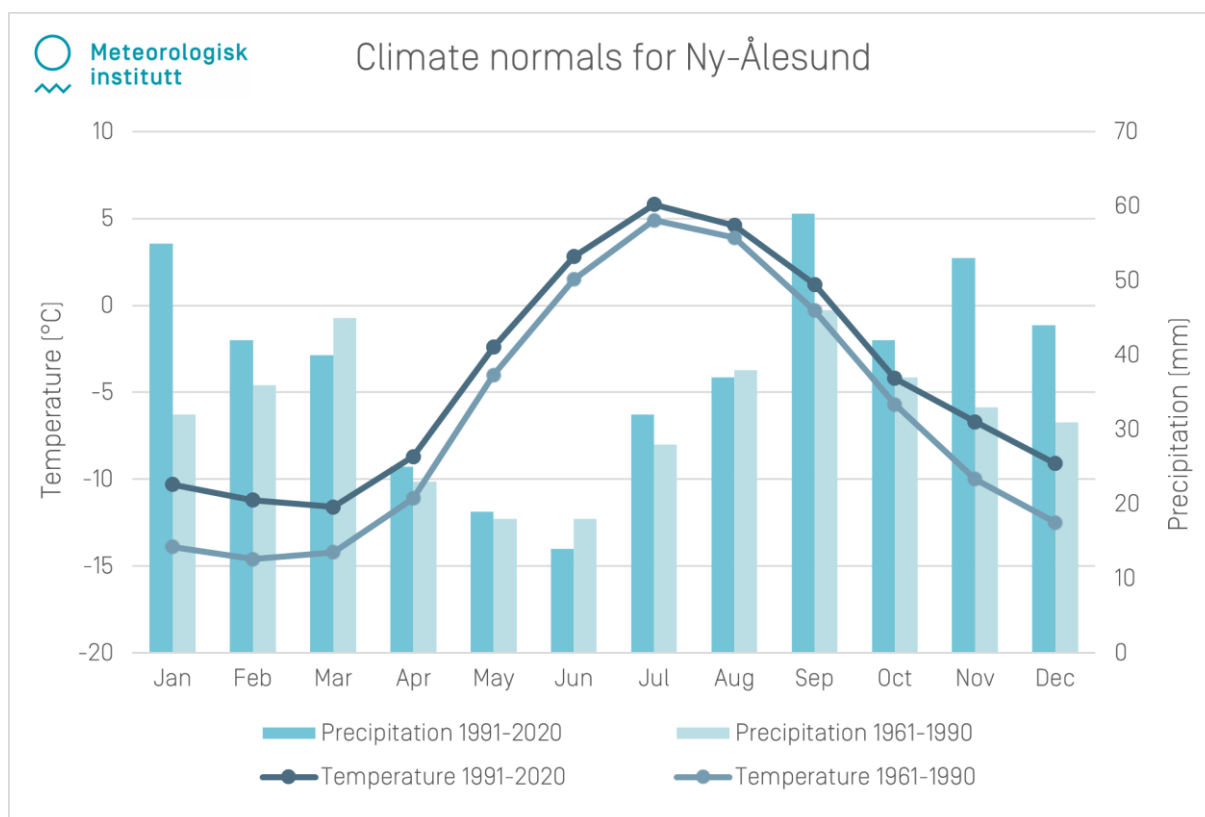


FIGURE 14 | Monthly climate normals for air temperature and precipitation for the two periods 1961-1990 and 1991-2020.

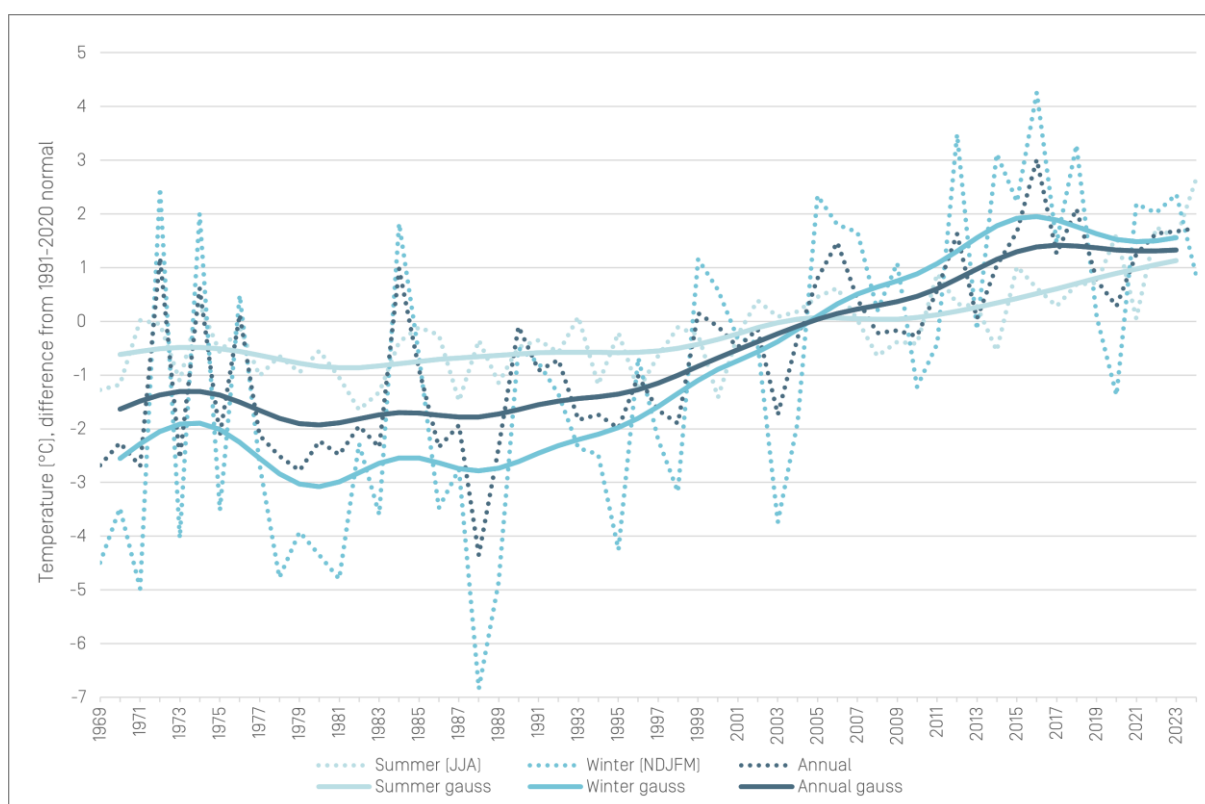


FIGURE 15 | Annual, summer and winter mean temperature for the period 1969-2024 relative to the 1991-2020 normal period (observed-normal value). The series are also smoothed by Gaussian weighting coefficients that show variability on a decadal time scale.

5.1 Temperature

The temperature series from Ny-Ålesund shows a clear increase from 1969 to 2023, both in the annual and seasonal series, with a stronger increase in winter than in summer, see Fig. 15 and Table 12.

The linear trend for the mean annual temperature shows a warming of 0.7 °C per decade for the full period 1969-2024. Isaksen et al. (2022) calculated trends for Ny-Ålesund for the periods 1981-2020, 1991-2020 and 2001-2020 with trends 1.0, 1.1 and 1.1 °C per decade respectively, showing a larger trend over the more recent decades.

For the temperature measurements performed by the Alfred Wegener Institute in Ny-Ålesund, Maturilli et al. (2013) found a linear trend of 1.35 °C per decade in the shorter period 1994-2010. Using the same period for the annual temperature data set from MET Norway, the linear trend equals 1.31 °C per decade and corresponds nicely with Maturilli et al. (2013).

Figure 16 shows the daily median air temperature and percentiles from Ny-Ålesund in the period 1969-2024. The figure clearly shows a larger variability in temperature in the winter half year and a smaller variability in the summer half year.

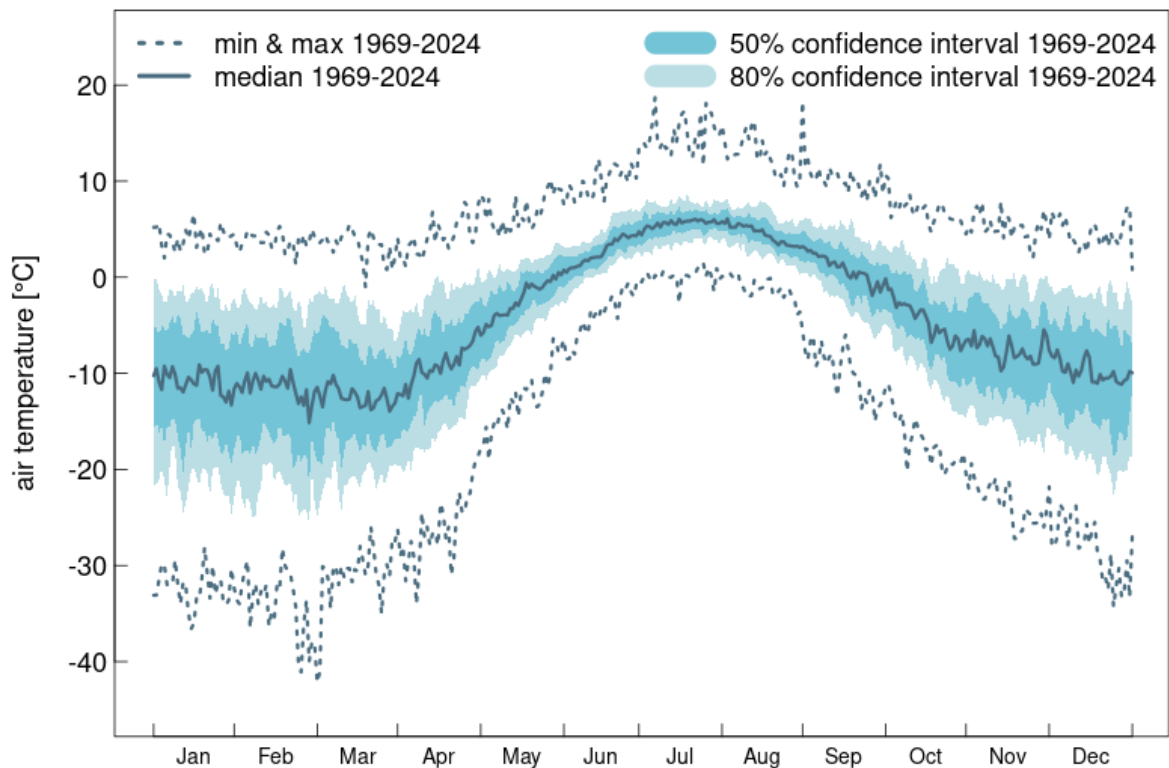


FIGURE 16 | Daily air temperature from Ny-Ålesund in the period 1969-2024. The figure shows the median for the entire period (dark blue line) and the 50 % and 80 % confidence interval (medium and light blue shaded area, respectively). In addition, the recorded minimum and maximum values for the entire observational period of the station are shown (dotted lines).

TABLE 12 | Linear trends for mean temperature as °C per decade for the period 1969-2024. All the trends are statistically significant on a 1 % level.

	Annual	Summer (JJA)	Winter (NDJFM)
Linear trend [°C/decade]	0.71 °C	0.33 °C	1.05 °C

5.2 Precipitation

The annual precipitation series (Fig. 17) shows a statistically significant increase of 7 % per decade relative to the 1991-2020 normal period (statistically significant on a 1 % level).

Part of this increase is attributed to the larger catchment ratio of rain compared to snow, see Champagne et al. (2024), Førland et al. (2020), Førland & Hanssen-Bauer (2000, 2002), Hanssen-Bauer et al. (1996), Wolff et al. (2015). When the temperature increases, more of the precipitation falls as rain, see Fig. 18, and more of the precipitation is actually landing in the rain gauge, resulting in more precipitation being measured.

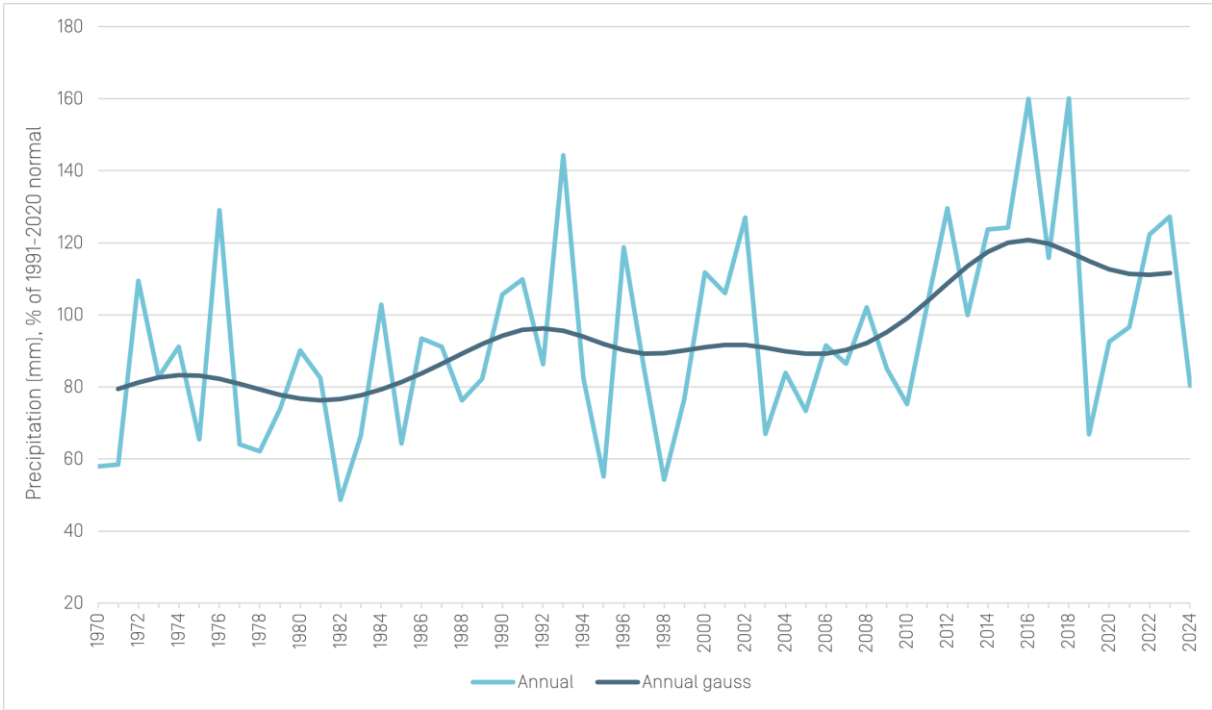


FIGURE 17 | Annual precipitation sums (light blue) for the period 1970-2024 in percent of the 1991-2020 normal period. The series is also smoothed by Gaussian weighting coefficients that show variability on a decadal time scale (dark blue).

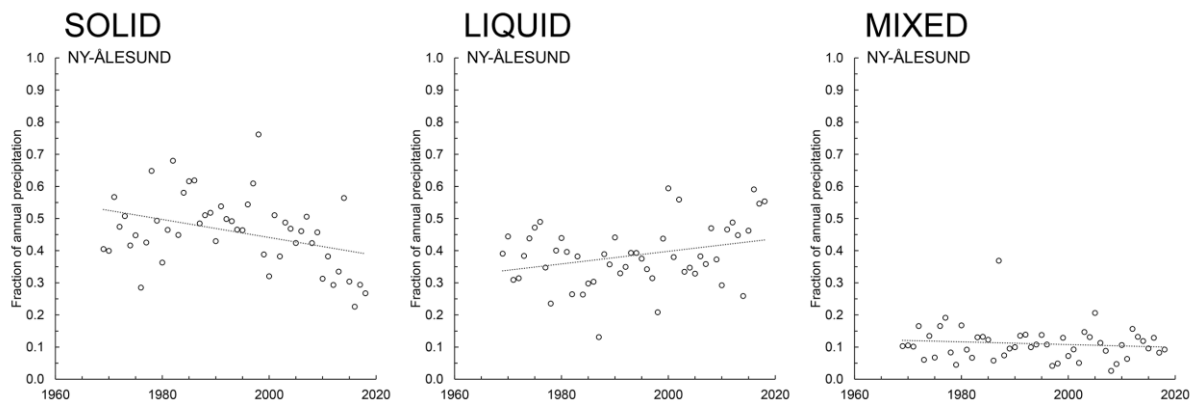


FIGURE 18 | The fraction of the annual precipitation of solid, liquid and mixed precipitation for the period 1969-2018. Figure from Førland et al. (2020) © American Meteorological Society. © American Meteorological Society. Used with permission.

5.3 Snow cover

Figure 19 shows the number of days per year with snow or ice on the ground for Ny-Ålesund. The large data gap between 1979 and 2010 as well as the series being short makes it difficult to say anything about trends in the data.

The years 2012, 2016, 2018 and 2019 have a larger number of days with ice covered ground, due to prominent rain on snow-events. Please note that there is no information about ice on the ground for the years 1975, 1976 and 1979.

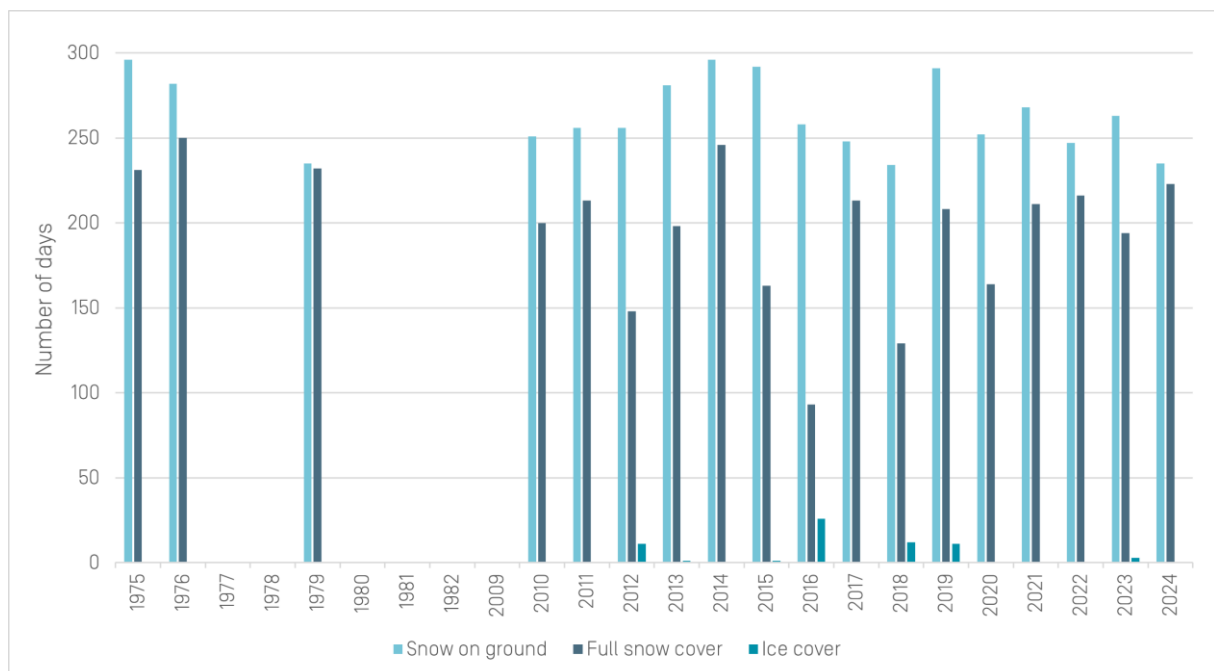


FIGURE 19 | Number of days per year with snow or ice on the ground, and also number of days with full snow cover and days with ice covered ground.

5.4 Snow depth

Figure 20 shows snow depth for Ny-Ålesund from 1974 to 2024, but please note that there is a large data gap in the period 1979-2008.

There are large year-to-year variations in snow depth. The snowmelt typically starts in May or June, leaving July and August free of snow. The maximum measured snow depth in Ny-Ålesund was 131 cm in March 2014.

Snow depth measurements in Svalbard are challenging due to high and varying wind speeds and drifting snow and may therefore not be representative for the mean snow depth and precipitation amount over larger areas.

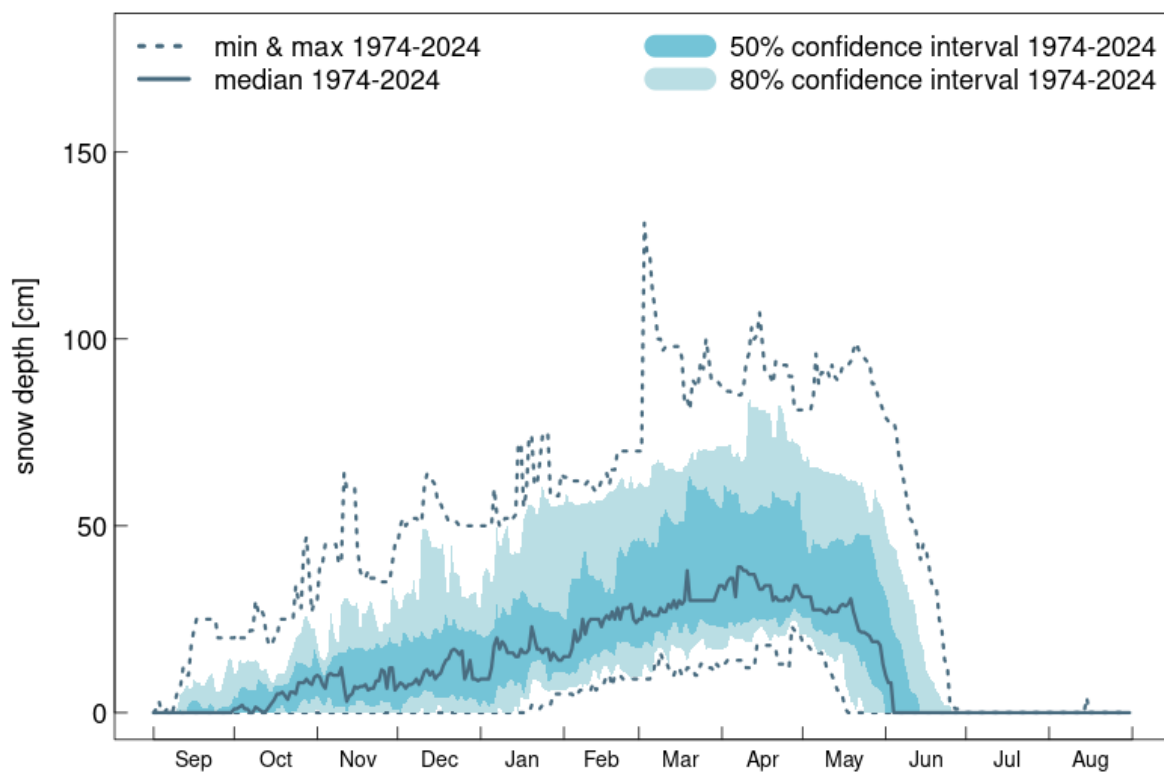


FIGURE 20 | Snow depth from Ny-Ålesund in the period 1974-2024. The x-axis uses the hydrological year. The figure shows the median for the entire period (dark blue line) and the 50 % and 80 % confidence interval (medium and light blue shaded area, respectively). In addition, the minimum and maximum of the recorded snow depths for the entire observational period of the station are shown (dotted lines). A version of this figure is available operational at cryo.met.no - a web portal by MET Norway.

5.5 Wind

Wind roses for Ny-Ålesund are shown in Fig. 21 for the location at Hamnerabben (site 3 in Fig. 1) for the period 1969–1973 and for the current location in Measurement field II (1-F) of the weather station for the period 2001–2024. At both places, the dominant wind direction is between east and southeast. At the earliest station at Hamnerabben, a second main wind direction from south and south-southwest can be seen.

The dominant wind directions are along the fjord from the inland to the coast. This is, as pointed out by Hanssen-Bauer et al. (1990), partly caused by the topography's channelling effect on the large-scale wind field, and partly by drainage winds transporting cold, heavy air from the inland glaciers to the warmer sea.

There is a large difference in the number of calm situations between the two locations, with 18.4 % at Hamnerabben and 3.6 % in the measurement field. Please see the *Data quality* chapter for more details.

Wind roses for all the different locations of the wind instruments in Ny-Ålesund can be found in Appendix D.

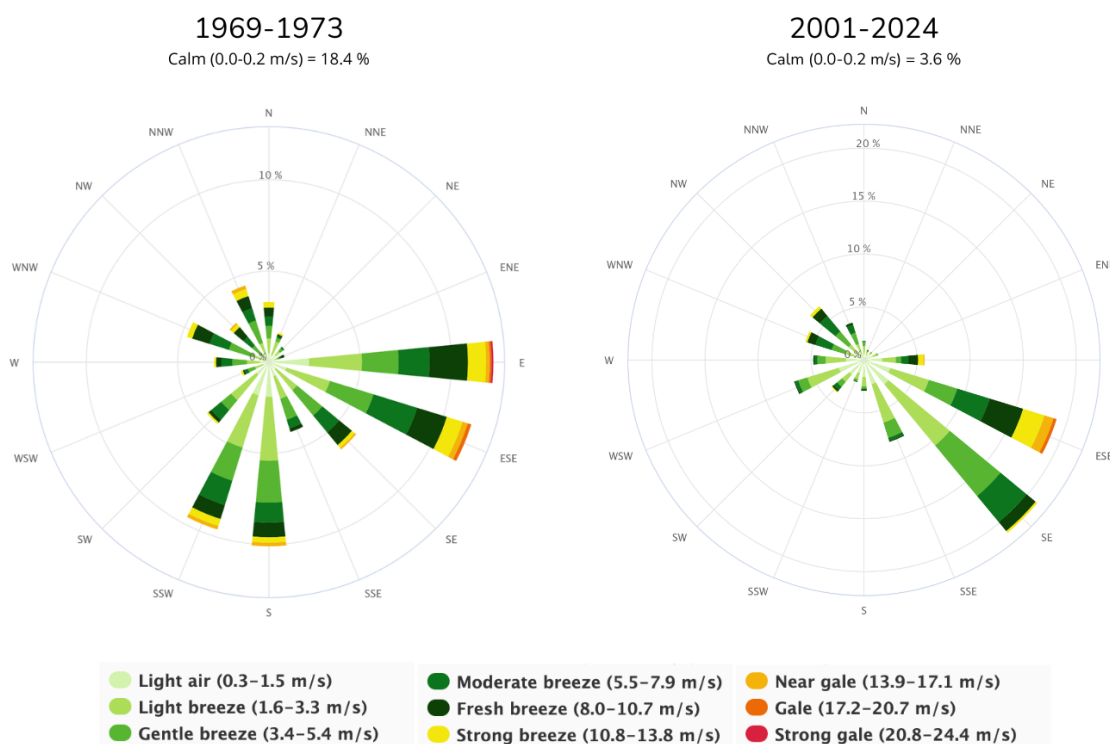


FIGURE 21 | Wind roses. Left: Data from the location at Hamnerabben (1969–1973). Right: Data from the current location in Measurement field II (2001–2024).

5.6 Air pressure

The air pressure measurements from Ny-Ålesund in Fig. 22 show relatively small variation in the median value throughout the year. When it comes to variability, there is a much larger variability in air pressure during winter than during summer, due to more cyclonic activity in winter with larger pressure gradients.

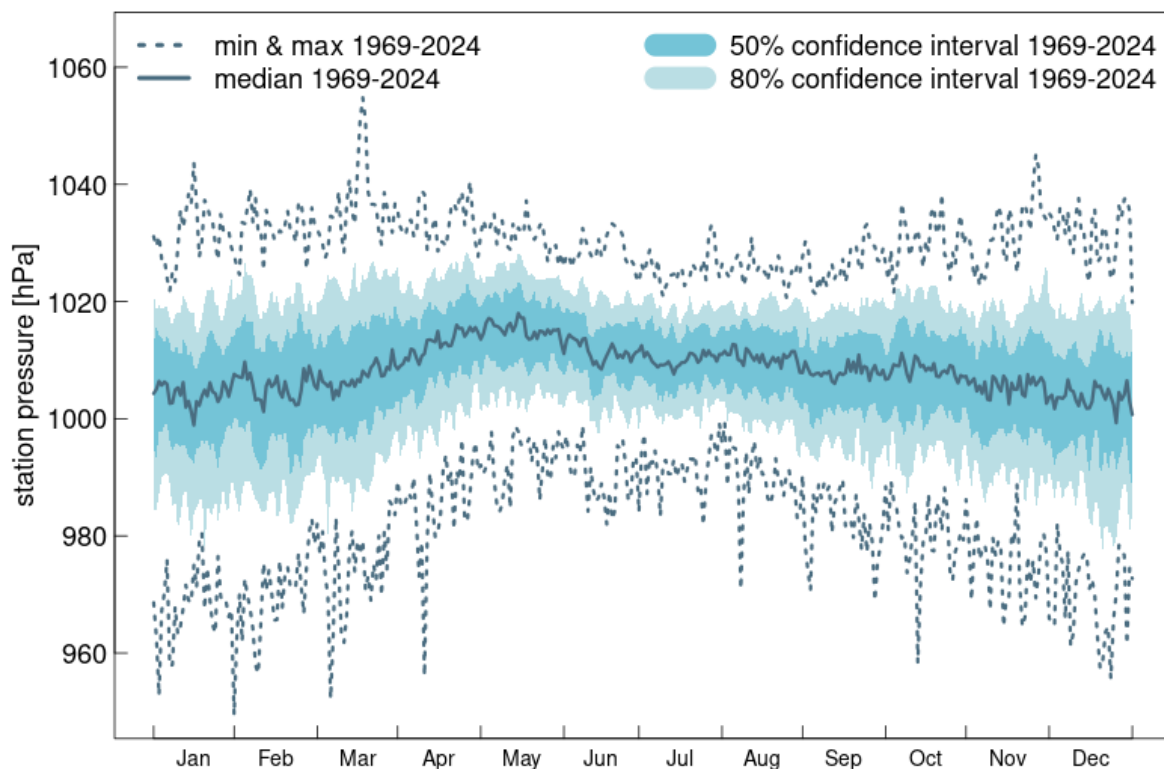


FIGURE 22 | Air pressure from Ny-Ålesund in the period 1969-2024. The figure shows the median for the entire period (dark blue line) and the 50 % and 80 % confidence interval (medium and light blue shaded area, respectively). In addition, the recorded minimum and maximum values for the entire observational period of the station are shown (dotted lines).

5.7 Relative humidity

The relative humidity in Ny-Ålesund is highest between June and September, with a median value of around 80 % in June, July and August, see Fig. 23. Winters in Ny-Ålesund are on average drier with lower relative humidity than during summer but are characterized by a larger variability.

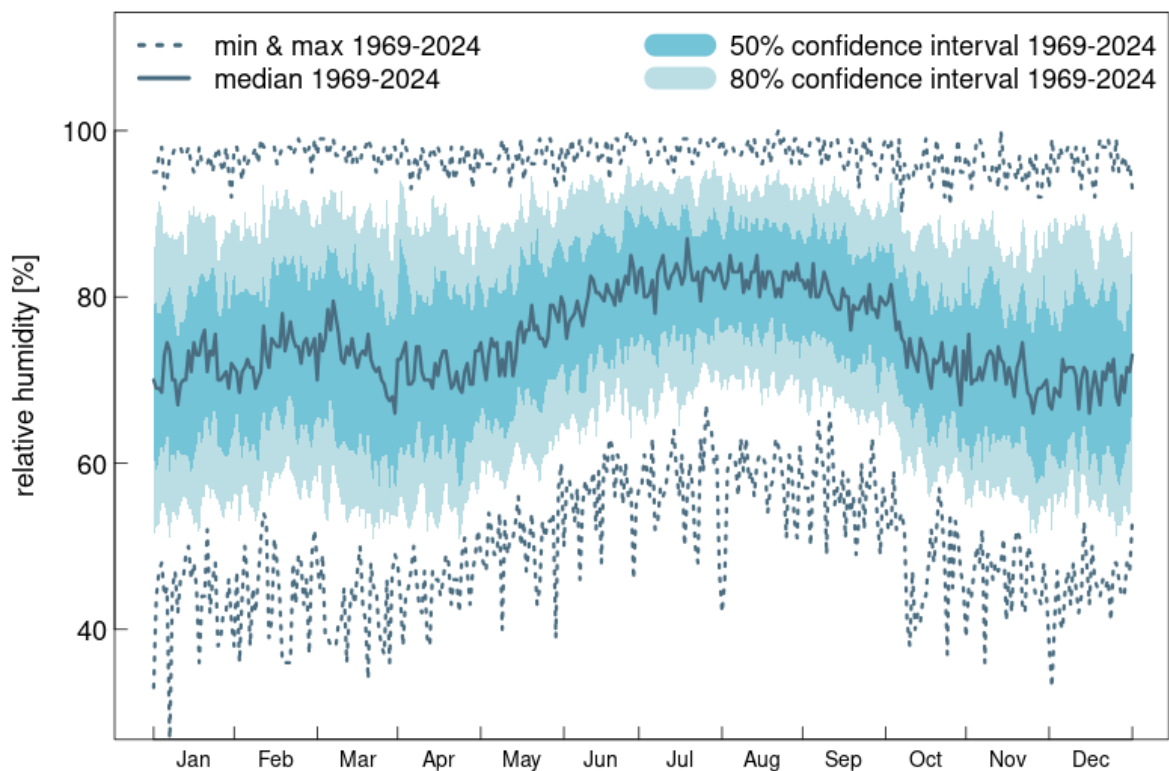


FIGURE 23 | Relative humidity from Ny-Ålesund in the period 1969-2024. The figure shows the median for the entire period (dark blue line) and the 50 % and 80 % confidence interval (medium and light blue shaded area, respectively). In addition, the recorded minimum and maximum values for the entire observational period of the station are shown (dotted lines).

5.8 Cloud cover

The number of days per month with cloudy weather in Ny-Ålesund is largest in the summer half year, with more than 50 % of the days being overcast between May and October, see Fig. 24. The largest number of days with fair weather occur in December and January, with 8-10 days of fair weather per month.

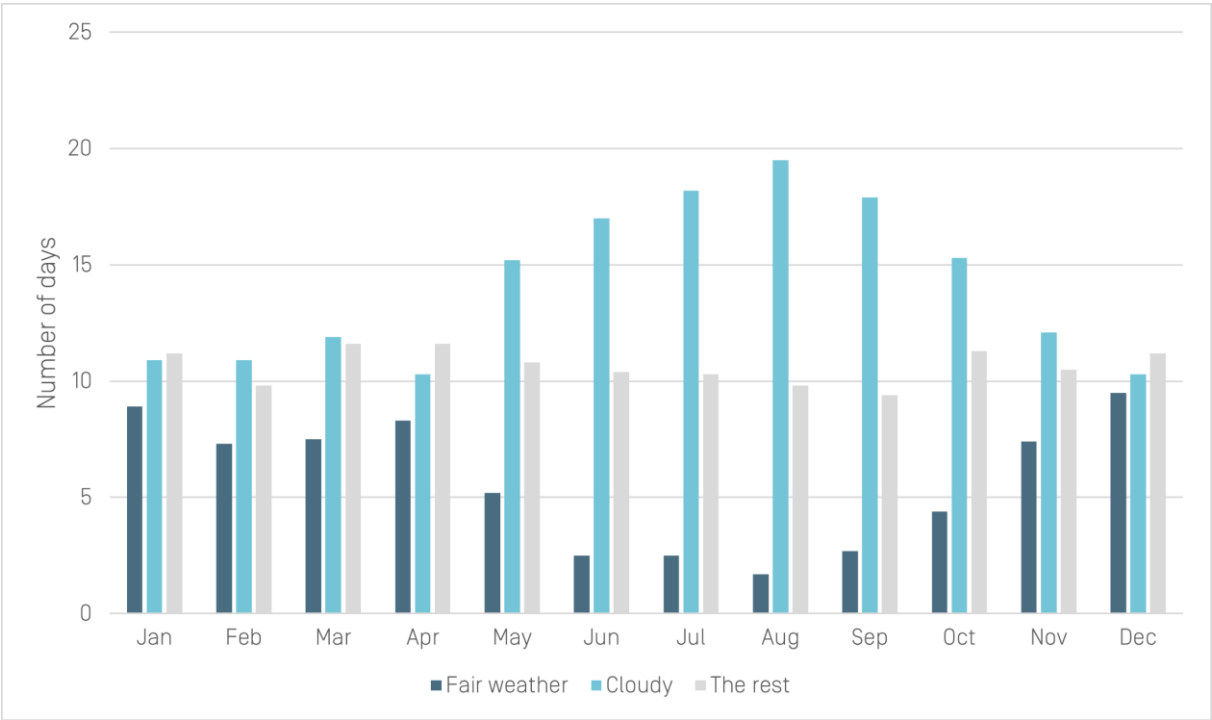


FIGURE 24 | Average number of days per month for the period 1969-2024 with fair weather, cloudy weather and the remaining days. Fair weather is defined as days where the sum of the cloud cover for the three observation hours 6,12,18 UTC are below 10. Cloudy weather is defined as days where the sum is 20 or more.

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Lastly, we want to thank Ragnar Brækkan, Svein Olav Sundal and other colleagues for maintaining, repairing, and updating the Ny-Ålesund weather station through the years - not a small achievement in such challenging environments. Without this effort we would not have this valuable climate data record from the Norwegian Arctic.

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Appendix A – Parameter names

The tables below list parameter names for the main parameters at Ny-Ålesund. A full list of all parameter names with all available time resolutions and aggregated values can be found here: <https://frost.met.no/elementtable>

TABLE A1 | Parameter names and description for all **air temperature** parameters available from Ny-Ålesund surface synoptic network station. More aggregated values (12-hourly, daily, monthly and seasonal mean, maximum and minimum values) may also be available but are not listed in the table.

Parameter name	Description	Unit	Time resolution
air_temperature	Air temperature (default 2 m above ground), present value	°C	Manual: 3-4 times daily Automatic: 1 minute mean value
mean(air_temperature PT1H)	Hourly mean temperature.	°C	hourly
mean(air_temperature P1D)	Daily mean temperature. The mean is an arithmetic mean of 24 hourly values (00-00 UTC), or a formula based mean value when only a limited number of observations is available (e.g. 06, 12, 18 UTC).	°C	daily
max(air_temperature PT10M) max(air_temperature PT1H) max(air_temperature P1D)	Highest recorded air temperature per ten minutes, per hour, per day	°C	
min(air_temperature PT10M) min(air_temperature PT1H) min(air_temperature P1D)	Lowest recorded air temperature per ten minutes, per hour, per day.	°C	
best_estimate_mean(air_temperature P1M)	Homogenised monthly mean temperature.	°C	monthly

TABLE A2 | Parameter names and description for all **precipitation** parameters available from Ny-Ålesund surface synoptic network station. Aggregated values (daily, monthly and seasonal mean, maximum and minimum values) may also be available but are not listed in the table.

Parameter name	Description	Unit	Time resolution
accumulated (precipitation_amount)	Automatic gauge: Total precipitation amount in gauge (accumulated since last emptying)	mm	hourly
sum(precipitation_amount PT12H)	Manual gauge: amount of precipitation per 12 hours. Values of -1 means 0 mm*	mm	12 hourly, measured at 06 and 18 UTC
sum(duration_of_precipitation PT1H)	Net precipitation time: Number of minutes where precipitation has been detected during the last hour	minutes	hourly
sum(precipitation_amount P1D)	Daily precipitation sum (between 06-06 UTC)	mm	daily
best_estimate_sum(precipitation_amount P1M)	Homogenised monthly precipitation sum	mm	monthly

* This stems from the old database where a blank cell means that the observation was not performed, a value of -1 means that the observation was performed but there was no precipitation in the past 12/24 hours, and a value of 0 means that the observation was performed and there had been precipitation in the past 12/24 hours, but there was no precipitation amount in the gauge at the observation time. This form of encoding is no longer in use in Seklima, but there might be some remnants of this when using Frost.

TABLE A3 | Parameter names and description for **snow cover**, **state of ground** and **snow depth** parameters available from Ny-Ålesund surface synoptic network station. Aggregated values (daily, monthly and seasonal mean, maximum and minimum values) may also be available but are not listed in the table.

Parameter name	Description	Unit	Time resolution
snow_coverage_type	Snow cover observed using a code 0-4. 1=mostly snow free ground. 2=equal parts of snow covered and snow free ground. 3=mostly snow-covered ground. 4=Completely snow-covered ground. Code=0 or -1 means «no snow» (-1 is presented as «.»).	code	1974-1979: daily 2009 →: 6-hourly
state_of_ground	State of ground, describing whether the ground is dry, wet, or covered by snow or ice. BUFR code table 020026. State of ground data from before 2013 was originally from an older code table, but these data has been translated to the current code table.	code	6-hourly and daily
state_of_ground_legacy	State of ground, describing whether the ground is covered by snow or ice. WMO code table 0975 in use from 1982 to 2017. These codes have been translated into the current code table and these data can be found in the element-ID state_of_ground.	code	daily
surface_snow_thickness	The depth of the snow is measured in cm from the ground to the top of the snow cover. (Code=-1 means «no snow» and can be presented as «.»)	cm	Manual: daily Automatic: hourly

TABLE A4 | Parameter names and description for all **air pressure** parameters available from Ny-Ålesund surface synoptic network station. Aggregated values (12-hourly, daily, monthly and seasonal mean, maximum and minimum values) may also be available but are not listed in the table.

Parameter name	Description	Unit	Time resolution
air_pressure_at_sea_level	Air pressure reduced to mean sea level. The parameter is usually called QFF in aviation and shows the measured air pressure reduced to mean sea level by applying actual atmospheric conditions.	hPa	Manual: 3-4 times daily Automatic: hourly
air_pressure_at_sea_level_qnh	Air pressure reduced to sea level by applying the ICAO Standard Atmosphere. Used in aviation and the parameter is then usually called QNH. Rounded down to the nearest hPa.	hPa	Manual: 3-4 times daily Automatic: hourly
surface_air_pressure	Air pressure at station level. The parameter is usually called QFE in aviation and shows the measured air pressure reduced to the reference height of the station.	hPa	Manual: 3-4 times daily Automatic: hourly

TABLE A5 | Parameter name and description for **wind direction** parameters available from Ny-Ålesund surface synoptic network station. More aggregated values (12-hourly, daily, monthly and seasonal mean, maximum and minimum values) may also be available but are not listed in the table.

Parameter name	Description	Unit	Time resolution
wind_from_direction	Mean wind direction over the last ten minutes before the observation time. Wind direction is defined as the direction from which the wind blows and is registered in degrees, where 360 degrees is north and 90 degrees is east.	degrees	Manual: 3-4 times daily Automatic: hourly

TABLE A6 | Parameter names and description for all **wind speed** parameters available from Ny-Ålesund surface synoptic network station. Aggregated values (12-hourly, daily, monthly and seasonal mean), maximum and minimum values may also be available, but are not listed in the table.

Parameter name	Description	Unit	Time resolution
beaufort_wind_force	Wind force in Beaufort. The Beaufort wind force scale ranges from 0 to 12 and is an empirical measure for describing wind intensity based on observed conditions of the sea, trees, smoke etc.		3-4 times daily
wind_speed	Mean wind speed is registered as a mean value of the wind speed over the last ten minutes before the observation time. (default: 10 meters above ground, some stations have measurements at 2 meters)	m/s	Manual: 3-4 times daily (converted from Beaufort) Automatic: hourly
wind_speed_of_gust	Highest wind gust since last observation. A wind gust is registered as a three second mean of the wind speed.	m/s	Manual: 3-4 times daily Automatic: hourly

TABLE A7 | Parameter names and description for all **humidity** parameters available from Ny-Ålesund surface synoptic network station. Aggregated values (12-hourly, daily, monthly and seasonal mean, maximum and minimum values) may also be available but are not listed in the table.

Parameter name	Description	Unit
relative_humidity	Relative air humidity	1/100
specific_humidity	Specific humidity	g/kg
dew_point_temperature	Dew point temperature	°C

TABLE A8 | Parameter names and description for all **visual observations** available from Ny-Ålesund surface synoptic network station. Aggregated values (daily, monthly and seasonal mean, maximum and minimum values) may also be available but are not listed in this table. WMO code tables used can be found in WMO (2019).

Parameter name	Description	Unit	Data from
weather_type	Weather at observation time, given as synoptic code 00-99, WMO code table 4677	code	1969.01→
over_time(weather_type_additional1 PT6H)	Additional information about the weather since the last main observation. National code table (see Table B3 in Appendix B)	code	2005.04→
over_time(weather_type_additional2 PT6H)			2005.04→
over_time(weather_type_additional3 PT6H)			2005.04→
over_time(weather_type_primary_significance PT6H)	Highest (primary) and second highest (secondary) code for weather since last main observation time, WMO code table 4561	code	1969.01→
over_time(weather_type_secondary_significance PT6H)			1974.08→
cloud_area_fraction	Total cloud cover is registered using a code 0 - 8 describing how many eights of the sky are covered by clouds (0 = no clouds, 8 = completely overcast, WMO code table 2700)	octas	1969.01→
low_type_cloud_area_fraction	Amount of all low clouds, or amount of middle clouds, if there are no low clouds (same code as for cloud_area_fraction)	octas	1974.08→
low_type_cloud	Cloud type, low clouds (base 0 - approx 2500 meter), by code 0 - 9 (Cu, Cb, St, Sc, ref. cloud atlas, WMO code table 0513)	code	1969.01→
medium_type_cloud	Cloud type, medium clouds (base approx 2500-6000 meter), by code 0 - 9 (As, Ac, Ns, ref. cloud atlas, WMO code table 0515)	code	1969.01→
high_type_cloud	Cloud type, high clouds (base above approx 6000 meter), by code 0 - 9 (Ci, Cs, Cc, ref. cloud atlas, WMO code table 0509)	code	1969.01→
cloud_base_height	Height of lowest cloud base, reported with code (WMO code table 1600), converted to meters	m	1969.01→
visibility_in_air_poorest_direction	Horizontal Visibility at the Surface in the direction of the poorest visibility. reported in code following WMO code table 4377, converted to metres. maximum value 75 000 m	m	1969.01→

Appendix B – Code tables

TABLE B1 | Code tables for **state of the ground** used in Ny-Ålesund. The code is an adapted version of WMO code tables 0901 and 0975. The parameter name for these two in Frost is *state_of ground* (2013→) and *state_of_ground_legacy* (2009-2013).

Description	State of ground 2013 →	State of ground legacy 2009 - 2012*
Surface of ground dry (no cracks or appreciable amounts of dust/loose sand)	0	-
Surface of ground moist	1	-
Surface of ground wet (standing water in small or large pools on surface)	2	-
Flooded	3	-
Surface of ground frozen	4	-
Glaze on ground	5	0
Ground predominantly covered by ice	10	0
Compact or wet snow (with or without ice) covering less than one-half of the ground	11	1
Compact or wet snow (with or without ice) covering at least one-half of the ground, but ground not completely covered	12	2
Even layer of compact or wet snow covering ground completely	13	3
Uneven layer of compact or wet snow covering ground completely	14	4
Loose dry snow covering less than one-half of the ground	15	5
Loose dry snow covering at least one-half of the ground, but ground not completely covered	16	6
Even layer of loose dry snow covering ground completely	17	7
Uneven layer of loose dry snow covering ground completely	18	8
Snow covering ground completely; deep drifts	19	9

*The data from the period 2009-2012 (*state_of_ground_legacy*) has later been converted to the new codes (*state_of_ground*), so there is data under the parameter name «*state_of_ground*» in Frost from 2009 onwards.

TABLE B2 | **Snow cover** code table used in Ny-Ålesund in the period 1974-1979.

Description	Code
No snow on ground	0
Ground mostly without snow but some snow patches left	1
About half of the ground snow covered	2
Mostly snow-covered ground, but some patches without snow	3
Completely snow-covered ground	4

TABLE B3 | National code table used at MET Norway for **additional information about the weather** since the last observation.

Description	Code
Dew	0
Frost	1
Blowing snow	2
Fog	3
Freezing rain/drizzle (<i>which freezes upon contact with surfaces</i>)	4
Rain, rain showers or drizzle	5
Sleet, sleet showers	6
Snow, snow showers, snow grains or diamond dust	7
Hail, ice pellets or graupel	8
Thunderstorm	9
Not observed	x

Appendix C – Data coverage information

TABLE C1 | Data coverage for **automatic snow depth** measurements from 1997.

Year	
1997	Data available from October, outliers and data gaps in the time series, especially during first month
1998	Data available from January to August and from mid-December
1999	Data available throughout the year
2000	Data available from January to mid-September
2001	No data available
2002	No data available
2003	Data available from October to December
2004	Data available from January to June
2005	Data available from end of April to May
2006	No data available
2007	Some doubtful data in September
2008	Data available from mid-September to December with minor data gaps
2009	Data available from January to mid-December, with larger data gaps
2010 - 2016	No data available
2017	Data available from mid-September to December
2018	Data available throughout the year
2019	Data available from January to June and from November to December
2020 →	Data available in the snow season. In summer, when there is no snow, the data from the sensor is excluded to avoid having small changes in the ground height and ground cover register as snow.
2024	No data in the winter season 2024/2025.

TABLE C2 | Periods where daily precipitation sums were calculated as a combination of manually measured and automatic data. The table gives the percentage of **missing data per month in the manual precipitation data set** for each year. Non-listed months have a complete manual data set. To provide a precipitation time series as consistent as possible, the daily precipitation sums were recalculated in May 2018 where the daily precipitation sums are generally based on the manual data set for the entire period. Only when manual data were unavailable, the automatic data were used to replace the missing data in the manual series

Year	Percentage of missing data in the manual precipitation data set	Year	Percentage of missing data in the manual precipitation data set
2005	April: < 5 % May: < 5 % July: < 25 % October: < 5 % December: < 5 %	2006	January: < 5 % February: < 5 % March: < 5 % April: < 5 % May: 76 % July: < 5 % October: < 5 % November: < 5 % December: < 5 %
2007	January: < 5% February: < 5% March: < 5% April: < 5% May: < 5% June: < 5% July: < 5% August: 80 % September: < 50 % October: < 50 % November: < 50 % December: < 50 %	2008	January: < 25 % February: < 50 % March: < 50 % April: < 25 % May: < 25 % June: < 50 % July: < 25 % August: < 25 % September: < 25 % October: < 50 % November: < 25 % December: < 25 %
2009	January: < 25 % February: < 25 % March: < 25 % April: < 5 % May: < 5 % July: < 5 % August: < 5 % October: < 5 % December: < 25 %	2010	January: < 50 % February: < 50 % October: < 5 % November: < 5 % December: < 5 %
2011	January: < 5 % April: < 5 % May: < 5 % August: < 25 % September: < 5 %	2012	January: < 5 % April: < 5 % August: < 5 % November: < 5 %
2013	January: < 5 %		

Appendix D – Wind roses

Wind roses for all six measurement periods at the different locations in Ny-Ålesund are shown in Fig. D1. At all six places, the dominant wind direction is from east to southeast.

At Hamnerabben (1969-1974, site 3 in Fig. 1), a second main wind direction from south and south-southwest can be seen.

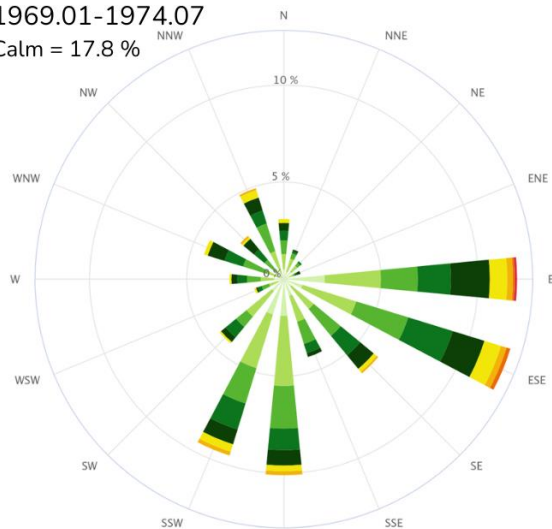
Between 1974 and 1984, the dominant wind direction was slightly more east than in the following years 1984-2024 where the dominant wind was blowing from east-southeast to southeast directions.

After the major move from the airport to the village centre, the wind measurements were performed in relative closeness to buildings until 1994, thus an impact of the structures on the measurements is likely.

In 1994, with the move to Measurement field I, a distance of 100 m to the nearest building was established. The distance was further increased by 50 m when Measurement field II was established in 2000.

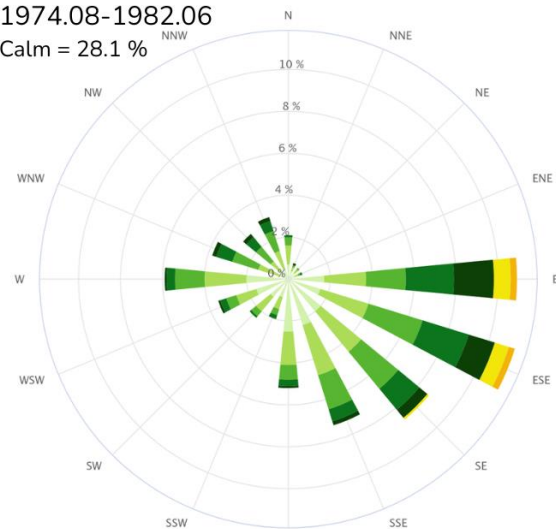
1969.01-1974.07

Calm = 17.8 %



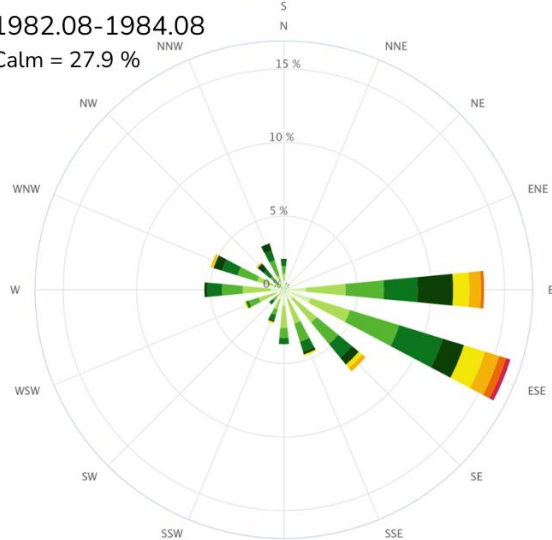
1974.08-1982.06

Calm = 28.1 %



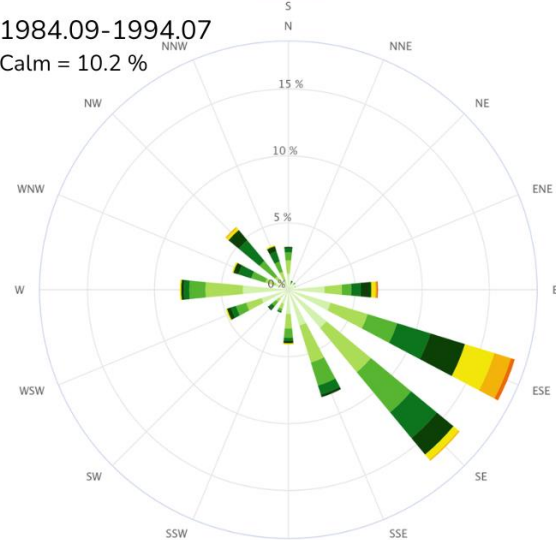
1982.08-1984.08

Calm = 27.9 %



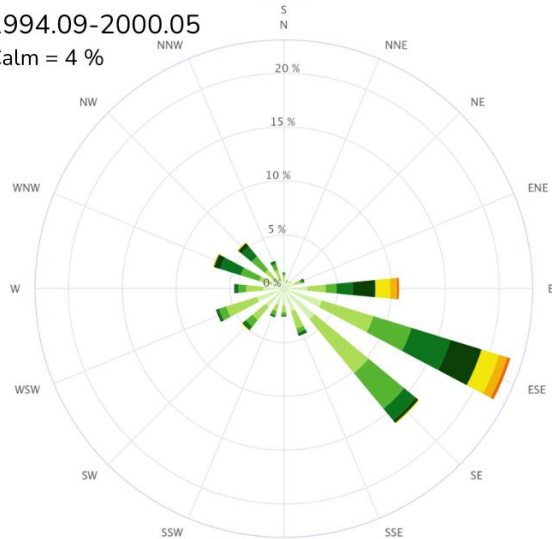
1984.09-1994.07

Calm = 10.2 %



1994.09-2000.05

Calm = 4 %



2000.08-2024.12

Calm = 3.5 %

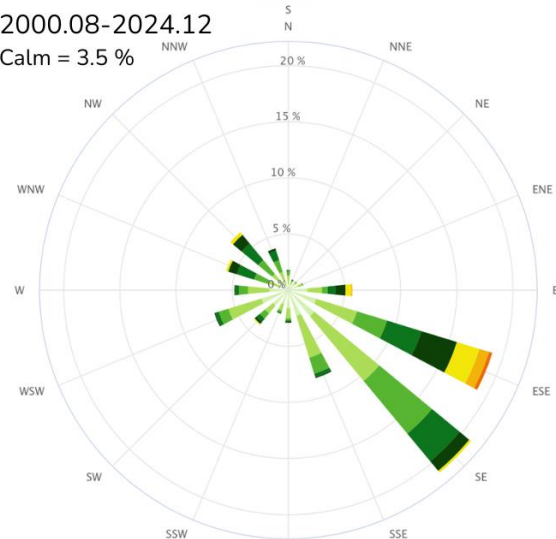


FIGURE D1 | Wind roses for the different placements of the wind sensors.

Appendix E – Station history 1950-1967

1950-1953 and 1961-1967

Ny-Ålesund was originally established as a mining settlement, and the first meteorological measurements were taken in the village centre by employees at the Kings Bay A/S in the periods 1950-1953 and 1961-1967.

The first meteorological station in Ny-Ålesund was established 1 November 1950. The instruments were placed in and outside of the hospital building, see Fig. E1.

The station was moved on 1 November 1951. The thermometer was then moved 260 m northeast to the new observer's private house while the barometer was moved to the office building of Kings Bay A/S across the street from the hospital building. The precipitation gauge was not moved.

The station was relocated again on 4 September 1952. It was moved 440 m north to the power station down by the seashore. The station was closed down 5 August 1953.

The meteorological station was re-established 14 June 1961 in Ny-Ålesund. The indoor instruments were placed in the old telegraph station, see Fig. E1. This building lies about 100 m east of the hospital. The new precipitation gauge was placed about 30 m south-southeast of the old placement (1950.11-1952.09) and a free-standing temperature screen was placed close by. Kings Bay was still the station holder. The station was closed down in April 1967.

Air temperature

1950-1953

Observations made before 1969 are not stored in the MET database due to poor quality. Instruments, locations and routines before 1969 are still briefly described below.

Two thermometers (one main thermometer and one minimum thermometer) were placed in a white painted screen of the type MI-30. The screen had four walls with a louvered front door. This kind of screen had no floor and so radiation exchange between the ground and the thermometer took place. The screen was placed on a north-facing wall of the hospital building from 1 November 1950, see Fig. E2. The screen was moved 260 m northeast on 1 November 1951 and set up on a north-facing wall of the observer's private house. The thermometer was moved 440 m north on 4 September 1952 to the power station. The screen was mounted on posts by the north-facing wall of the power station. This was done to avoid the heat from the power station.

1961-1967

The thermometers (a mercury thermometer for measuring air temperature, a maximum thermometer and a minimum thermometer) were placed in a free-standing screen (MI-33) when the station was re-established in 1961. The screen was located close to the precipitation gauge and about 20 m from the old telegraph station, see Fig. E1 and E3. The door of the screen faced northeast. The ground below and around the screen were mostly moss covered in summertime. Observations were taken three times a day at 06, 12 and 18 UTC.

Precipitation

1950-1953

The first meteorological station in Ny-Ålesund was established 1 November 1950. The precipitation gauge was placed outside of the hospital building, Fig. E1, and the gauge was equipped with a windshield. The gauge was relocated 4 September 1952 when it was moved 440 m north to the power station down by the seashore. The station was closed down 5 August 1953.

1961-1967

When the meteorological station was re-established 14 June 1961, the new precipitation gauge was placed about 30 m south-southeast of the old placement (1950.11-1952.09). The station was closed down in April 1967.

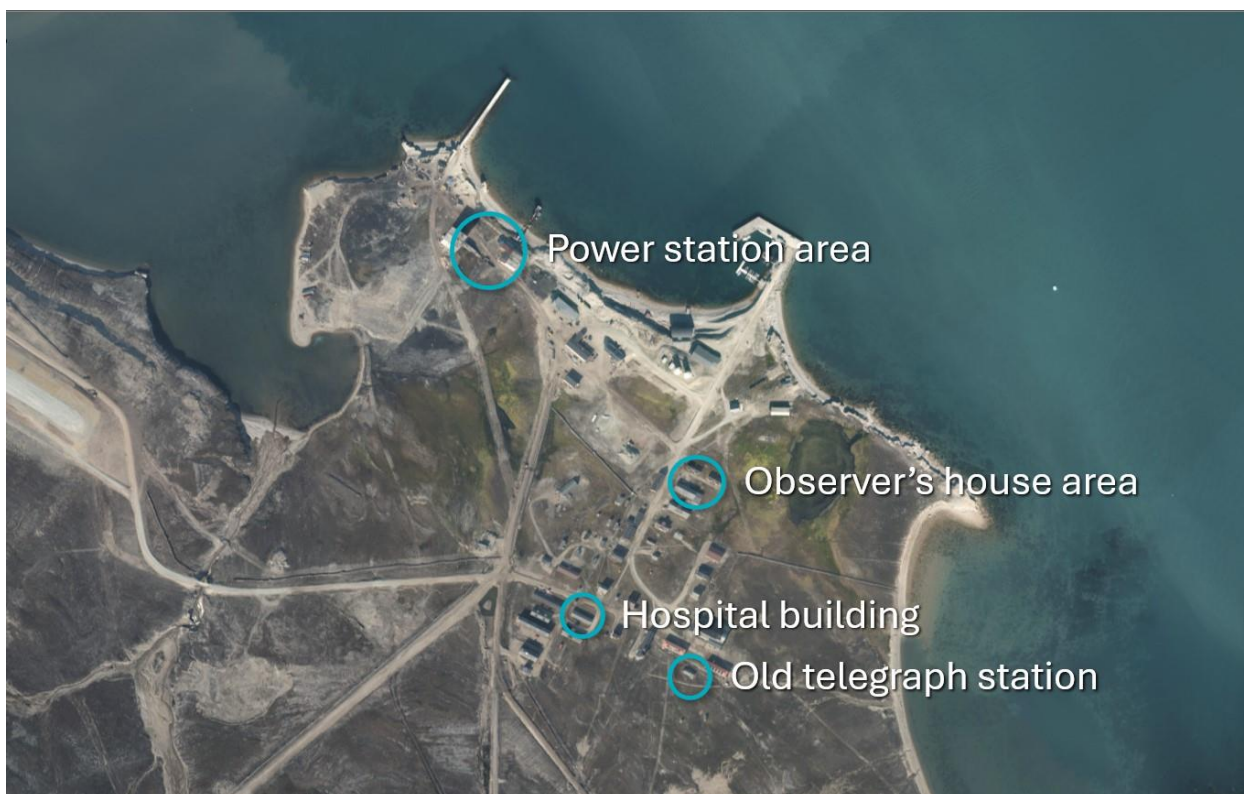


FIGURE E1 | The locations in the periods 1951-1953 and 1961-1967. Aerial photo from TopoSvalbard © Norwegian Polar Institute.



FIGURE E2 | The wall mounted screen on the hospital building in 1951. Photo: MET Norway.



FIGURE E3 | The weather station in 1961. Photo: MET Norway.