Polarforschung, 92, 33–45, 2024
https://doi.org/10.5194/polf-92-33-2024


Polarforschung
DEUTSCHE GESELLSCHAFT FÜR POLARFORSCHUNG e.V.
Open Access
Scientific article

# Meteorological observations from German military weather stations on Svalbard, 1941–1945

**Björn-Martin Sinnhuber**

Institute of Meteorology and Climate Research IMK-ASF, Karlsruhe Institute of Technology,
76344 Eggenstein-Leopoldshafen, Germany

**Correspondence:** Björn-Martin Sinnhuber (bjoern-martin.sinnhuber@kit.edu)

Received: 10 June 2024 – Revised: 2 September 2024 – Accepted: 7 October 2024 – Published: 6 December 2024

**Abstract.** During World War II, the German Kriegsmarine and Luftwaffe operated a series of weather stations on Svalbard between 1941 and 1945 to obtain information on synoptic weather situations in the Arctic. These activities also included some of the first automatic weather stations. With a few exceptions, the meteorological observations from these military stations are regarded as lost. Most of these observations could now be retrieved from weather maps of the German Zentrale Wetterdienstgruppe (ZWG) that are preserved in the archives of the Deutscher Wetterdienst (DWD). Reports of surface pressure and temperature have been digitized for the military weather stations Bansö in 1941/42, Knospe in 1941/42, Nussbaum in 1942/43, Kreuzritter in 1943/44, and Svartisen in 1943/44 and for automatic weather stations operated on Svalbard. These data can help to close the existing gap in the Svalbard climate record for 1941–1945 and to provide additional observational constraints for future climate reanalysis. These data also provide a new perspective on the history of the German meteorological activities in the Arctic during World War II by showing the impact these observations had on the meteorological analyses. In this sense, this paper also tries to bridge the gap between climate research and history.

## 1 Introduction

The Arctic climate is changing rapidly, with the largest changes in the Svalbard and Barents Sea area (Isaksen et al., 2022). Knowledge of past climate change is essential to test our understanding of forced changes and internal variability. Long-term meteorological reference data for the Arctic are sparse, in particular for the early 20th century. One of the longest quasi-continuous temperature time series in the High Arctic is the homogenized extended Svalbard Airport series (Nordli et al., 2014, 2020), going back to 1898. Unfortunately, there is a gap in the Svalbard climate time series during World War II between July 1941 and September 1945. After the evacuation of Svalbard by the Allied forces in early September 1941, regular weather reports were no longer available from Svalbard. Also, for other parts of the Arctic, regular observations had ceased, and the German navy (Kriegsmarine) tried to replace these with weather ships in the North Atlantic, together with the weather reconnaissance flights of the Luftwaffe (e.g. Lüdecke, 2020). However, soon, both the Kriegsmarine and the Luftwaffe, operating largely independently of each other, decided to also install land-based weather stations on Svalbard to fill the gap. Accounts of these military weather stations on Svalbard during 1941–1945 are given, inter alia, by Blyth (1951), Holzapfel (1951), Macht (1951), Nusser (1979), Selinger and Glen (1983), Selinger (1991), and, most importantly, in the comprehensive work of Selinger (2001). Particular attention has been paid to the last weather station on Svalbard during 1944/45, Operation Haudegen (Dege, 1960, 2006). With a few exceptions, the original meteorological observations from these stations are considered to be lost. Most of these observations can now be retrieved from weather maps of the German Zentrale Wetterdienstgruppe (ZWG) that are preserved in the book stacks of the library of the Deutscher Wetterdienst (DWD) in Offenbach. Reports of surface pressure and temperature have been digitized for the military weather stations Bansö in 1941/42, Knospe in 1941/42, Nussbaum in 1942/43, Kreuzritter in 1943/44, and Svartisen in 1943/44, along with some data from automatic weather stations operated on Svalbard (Fig. 1).


**Figure 1.** Weather stations on Svalbard during 1941–1945. Map data © by the Norwegian Polar Institute under Creative Commons Licence 4.0.

While much has already been written about the German military Arctic weather stations during World War II, a presentation and discussion of the meteorological observations is still missing. In this paper, the historical overview should be repeated only as far as it is necessary to understand the meteorological observations and to provide a metadata context. For example, names of weather station members, vessels, or places are included here, as they may provide a starting point or hint at further searches in archives (e.g. part of archived personal legacy or ship logbooks) to retrieve missing data or metadata.

The purpose of the present paper is to describe the available meteorological data and to provide some historical and geographical context. A further analysis of the data, including comparison with the ECMWF's ERA5 reanalysis (Hersbach et al., 2020; Bell et al., 2021; Hersbach, 2023), is currently under way and may be described in a forthcoming publication elsewhere.

## 2 Weather maps of the German Zentrale Wetterdienstgruppe 1941–1944

The National Meteorological Library of the Deutscher Wetterdienst (German Weather Service, DWD) in Offenbach holds a near-complete set of weather maps from the German Zentrale Wetterdienstgruppe (Central Weather Service Group, ZWG) during World War II (Rapp, 2015). The Zentrale Wetterdienstgruppe (denoted as "Zentraler Wetterdienst Berlin" on maps until 5 December 1941) was part of the German Luftwaffe and reported to the central command of the Wehrmacht. An account of the ZWG, in particular during its last years, is given by Schwerdtfeger (1985), who was appointed as chief of the ZWG in August 1943. Maps of different scales and purposes exist at the DWD library. Of particular relevance here are the synoptic surface maps for Europe in 1 : 1 000 000 scale that contain the stations for the North Atlantic and European sector of the Arctic, including Svalbard. The maps were hand-drawn five times per day at 02:00, 05:00, 08:00, 14:00, and 19:00 LT. An example for 24 June 1942 is shown in Fig. 2. Available maps at the DWD are near-complete for the period of 1939 until the end of May 1944. Thereafter, only a few maps for October 1944 are available, with no maps preserved for the first half of 1945.

The maps contain the station reports in a station model (Fig. 3) including total cloud cover and wind speed and direction in the centre and clockwise from top right. The measured criteria are sea level pressure in 10ths of hPa without the leading hundreds, pressure tendency, low cloud cover and cloud base height, relative humidity, visibility, and temperature in °C. While sea level pressure is given in 10ths of hPa, temperature is given only in full degree steps. Rounding to full degrees introduces a maximum error of $\pm 0.5$ °C and, assuming that the 10ths are statistically equally distributed, a mean error of 0.3 °C (theoretically $1\,°\mathrm{C}/\sqrt{12}$). Already, when computing daily mean temperatures, this error source becomes negligible compared to other error sources. Much more serious, however, are the frequent gaps in the reported observations. Fortunately, the mean diurnal temperature variation in the Arctic is small and totally absent during polar night in winter, so the calculation of daily and monthly mean temperatures from unevenly distributed temperature data introduces only a small bias (e.g. Sinnhuber, 2021).

All times are given as Central European Time (Mitteleuropäische Zeit, MEZ, UTC+1) or German Summer Time (Deutsche Sommerzeit, DSZ, UTC+2), with DSZ between 1 April 1940, 02:00, and 3 November 1942, 03:00 (no change back to MEZ during winters 1940/41 and 1941/42); between 29 March 1943, 02:00, and 4 October 1943, 03:00; between 3 April 1944, 02:00, and 2 October 1944, 03:00; and after 2 April 1945, 02:00.

More than 4800 ZWG maps have been scanned at DWD, and the observations for Svalbard between 1941 and 1944 have been digitized by the author for pressure (only partly so far) and temperature. Digitization has been done solely "by hand", which is still practically feasible for individual stations, but it will have its limits when digitizing larger amounts of data. As no metadata are contained in the weather maps, it is important to relate the data from the ZWG maps with historical information on the individual stations, as discussed in the following sections.

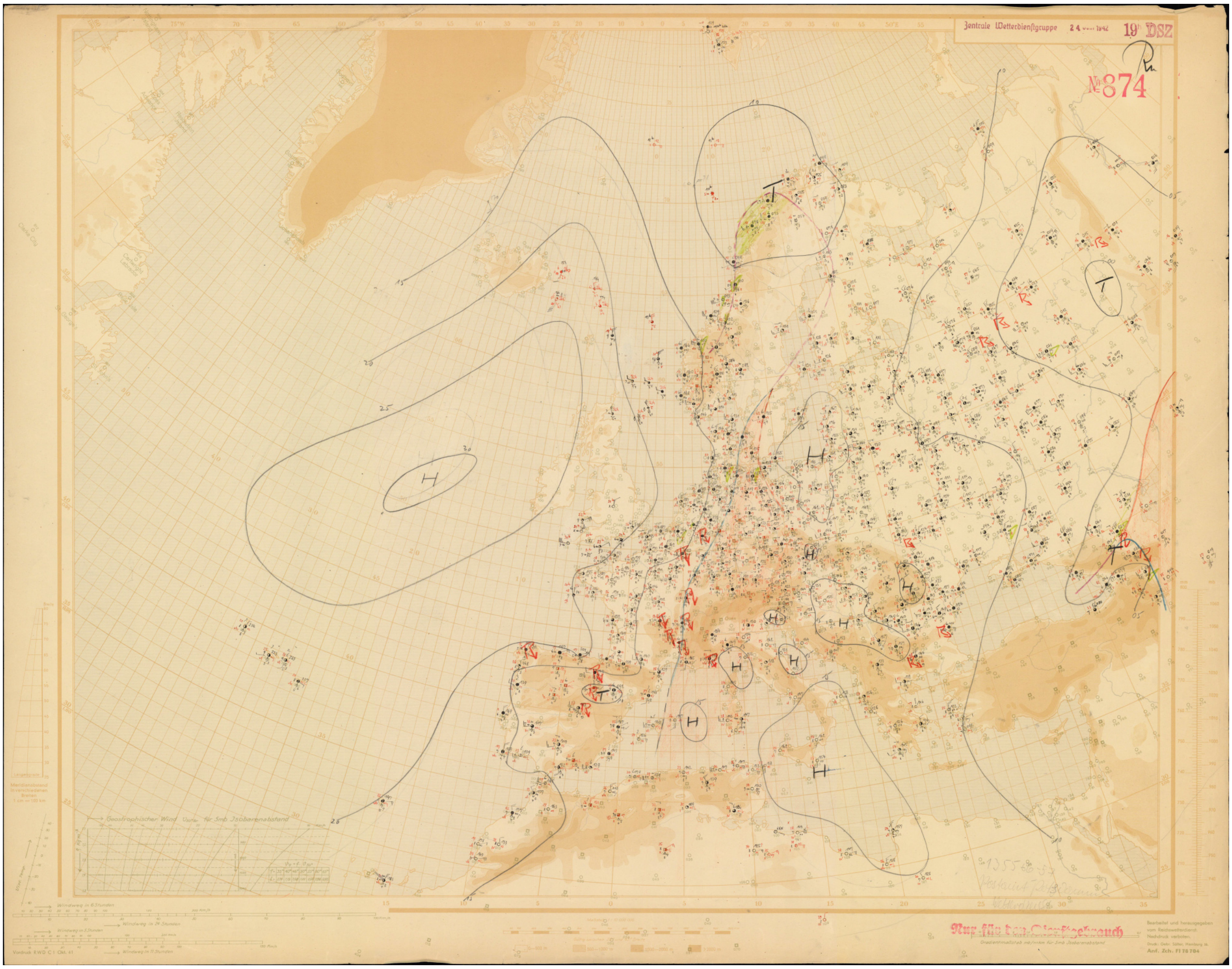


**Figure 2.** Example of a synoptic surface weather map from the German Zentrale Wetterdienstgruppe (ZWG) for Europe, 24 June 1942, 19:00 DSZ (Deutsche Sommerzeit, German Summer Time, UTC+2). The original maps are 63 by 81 cm in size. © Deutscher Wetterdienst.

## 3 Isfjord Radio 1941

Isfjord Radio at Kapp Linné (78°04′ N, 13°38′ E; station elevation 6 m a.s.l.; Steffensen et al., 1996) provides one of the primary long-term meteorological data sets for Svalbard. Observations started on 3 September 1934 and continued until the destruction of the station during the evacuation of Svalbard by Allied forces on 3 September 1941. After the war, Isfjord Radio was rebuilt, and operations started again on 29 August 1946 (Lyngaas, 1947, p. 6). Currently, the Norwegian Met Office (http://seklima.met.no, last access: 27 November 2024) holds records for Isfjord Radio from September 1934 until the end of June 1941 and then from September 1946 onwards. The ZWG maps contain the data to extend the Isfjord Radio time series beyond June until 3 September 1941.

After the German occupation of Norway in 1940, meteorological operations in Svalbard continued as before. There were no German forces on Svalbard. Only in April 1941 did a German military plane land in Longyearbyen on request by the Norwegian authorities to transport urgently needed firefighting equipment to assist at an accident in one of the coal mines (Elbo, 1952, p. 485; Schwerdtfeger and Selinger, 1982, p. 66; Amundsen, 2001, p. 161). The plane was piloted by Rudolf Schütze, who played an important role in German Arctic operations during World War II, conceiving and carrying out most of the airlifts associated with the forthcoming German Arctic meteorological stations (Schwerdtfeger and Selinger, 1982; Selinger, 2001). On the afternoon of 31 July 1941, an Allied naval command landed at Isfjord Radio and in Longyearbyen. A Norwegian military observer was installed, and the weather station was instructed to continue with the normal weather reports to conceal the presence of Allied forces. Already on the evening of 31 July, the naval command left Svalbard again. On its way back, the weather station at Bjørnøya was evacuated


**Figure 3.** Details of the map for 24 June 1942, 19:00, showing the station model for Bansö (sea level pressure 1013.3 hPa, surface temperature +2 °C) and Knospe (1012.9 hPa, 0 °C) and two reports of the automatic weather station Kröte at 17:30 (1012.5 hPa, +3 °C) and at 20:30 (1013.8 hPa, +3 °C). The station model includes total cloud cover and wind speed and direction in the centre and clockwise from the top right. The measured criteria are sea level pressure in 10ths of hPa without the leading hundreds, pressure tendency in 10ths of hPa over the past 3 h, low cloud cover in eighths and cloud base height (e.g. 4 = 300–600 m), relative humidity (e.g. IX = 90 %–94 %), visibility (e.g. 7 = 10–20 km, 8 = 20–50 km), and temperature in °C. Kröte provided only temperature and pressure. Temperature, pressure tendency, and humidity are generally (but not always) given in red – unfortunately, it is not known if the different colours have a particular meaning. Note that the geographic positions of the stations are only approximate or sometimes even arbitrary. © Deutscher Wetterdienst.

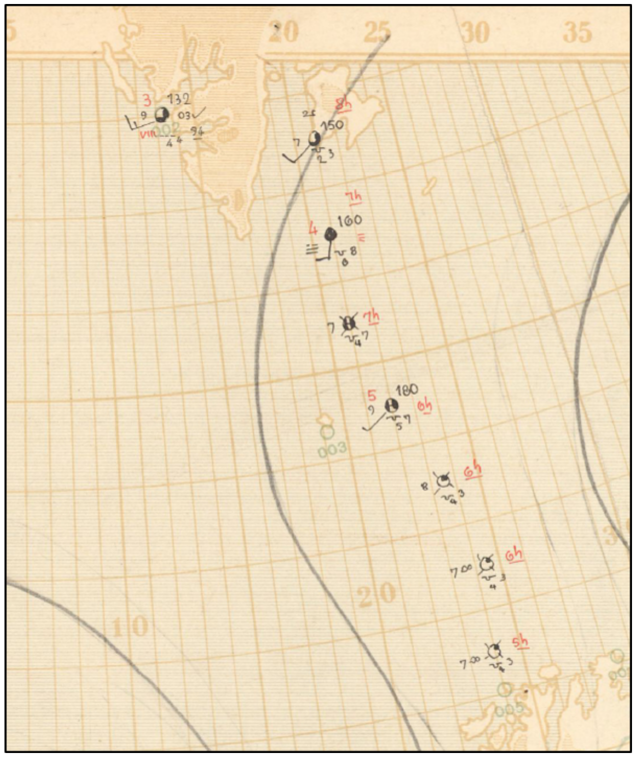


**Figure 4.** Details of the weather map for 3 September 1941, 08:00, the last day of weather reports from Isfjord Radio before the *Empress of Canada* and its escort group leaving Svalbard as part of the Allied Operation Gauntlet. Note the general consistency of the Isfjord Radio report with the observations of the German weather reconnaissance flight from Banak, northern Norway, towards Svalbard between 05:00 and 08:00. Visibility for Isfjord Radio is reported as 9, i.e. > 50 km and cloud cover of 6/8. © Deutscher Wetterdienst.

and destroyed on 2 August (Selinger, 2001, p. 52/53). The last report from Bjørnøya on the ZWG weather maps is on 1 August 1941, 19:00. It was then decided to evacuate the Norwegian and Russian inhabitants of Svalbard in a joint operation of British, Canadian, and Norwegian forces, called Operation Gauntlet. The naval command encompassed the Canadian ocean liner *Empress of Canada* together with the escorting cruisers *HMS Nigeria* and *Aurora* and the destroyers *HMS Anthony*, *Antelope*, and *Icarus*. The naval command reached Svalbard on 25 August. A Canadian detachment was installed at Isfjord Radio. The Russian inhabitants were evacuated by the *Empress of Canada* that left Svalbard on the evening of 26 August to Arkhangelsk, accompanied by *Nigeria* and the three destroyers, leaving only *Aurora* in Svalbard (Stacey, 1955, p. 306). The *Empress of Canada* returned to Svalbard on 1 September and left again on the evening of 3 September 1941, evacuating the Norwegian population, leaving Svalbard abandoned and Isfjord Radio destroyed (Selinger, 2001, p. 55; Stacey, 1948, 1955, p. 306). Part of the British force of Operation Gauntlet was Lt. Cdr. Alexander R. "Sandy" Glen, who had led the overwintering of the Oxford University Expedition on Nordaustlandet, northeastern Svalbard, during 1935/36 (Selinger and Glen, 1983; see also Sinnhuber, 2021). As a somewhat bizarre side note, through Glen's service in naval intelligence operations during the war, he was known to Ian Fleming and is often cited, correctly or not, as one inspiration for Fleming's fictional character James Bond (e.g. Cathcart, 1996).

It has repeatedly been reported that the weather reports from Isfjord Radio during the time of Operation Gauntlet have been faked to conceal the operation. According to Blyth (1951, p. 189), "At the end of July Longyearbyen in Spitsbergen was occupied. Every precaution was taken to conceal this move from the Germans and bogus weather reports were transmitted from Spitsbergen to Norway by stations under Allied control. However, on 3 September, after destroying the wireless stations at Barentsburg, Longyearbyen, Kapp Linné and Grønfjorden, and setting fire to coal and fuel dumps in the area, the Allies evacuated the inhabitants and Spitsbergen was abandoned." Glen himself (Selinger and Glen, 1983, p. 564) states "That this force was able to stay several days unmolested in Svalbard waters was a result of the bogus reports of consistently bad weather transmitted to Norway during this period, and – let us be frank – there was good luck involved too." Stacey (1955, p. 306) specifically mentions the falsified reports of fog: "The Signals detachment, with the help of the Norwegian staffs of the Spitsbergen wireless stations, had done especially valuable work. Normal transmissions of meteorological information were kept up to conceal from the Germans the fact that anything unusual was going on. The information sent out, however, was not wholly accurate. Fog was reported throughout the period when the *Empress* was present at Spitsbergen, the object being to discourage enemy air reconnaissance. The last signal was sent on the evening of 3 September, and the wireless stations were then put out of action." While the ZWG maps do show fog for the whole day of 27 August 1941 (a day after the *Empress of Canada* had left Svalbard for Arkhangelsk with the Russian population of Barentsburg on board), for the days when the *Empress of Canada* was in Spitsbergen, good visibility was reported. As an example, Fig. 4 shows the report of Isfjord Radio on 3 September 1941, 08:00, the day when the Norwegian population of Svalbard embarked on the *Empress of Canada*, before she left Svalbard on the late evening of 3 September. Good visibility is reported, and the reported weather is generally consistent with observations from a German weather reconnaissance flight from Banak, northern Norway, during this time. So, while it cannot be ruled out that individual reports from Isfjord Radio have been falsified, based on the reports included in the ZWG weather maps, this seems rather unlikely.

From the ZWG maps, temperature and pressure data have been digitized for Isfjord Radio between 1 July 1941, 02:00, and 3 September 1941, 19:00. In total, 291 reports are available on all of the 65 d, corresponding to 90 % of the data in this period.

## 4 Bansö 1941/42

After the loss of the weather reports from Isfjord Radio, the German Luftwaffe decided to install a new station on Svalbard under the code name Bansö. As the base, an existing hut further up in Adventdalen was chosen (Hans Lund's hut, in some maps also indicated as "Svalbardhytta", which finally accidentally burned down on Christmas Day of 1968; Amundsen, 2001, p. 182), about 6 km southeast of Longyearbyen at 78°11′ N, 15°52′ E (∼ 25 m a.s.l.). Setup of the station started on 8 October 1941 through airlifts and was completed with the last supply flight on 9 November 1941 (Selinger, 2001, p. 80). Members of the station were (Selinger, 2001; Blyth, 1951)

- Dr Albrecht Moll, physician, station leader;
- Heinz Niewert, meteorologist;
- Adolf Pfohl, wireless operator;
- Max Bensegger, wireless operator.

Meteorological observations started on 16 November 1941. The first reports in the ZWG weather maps are on 17 November 1941, 14:00. Operations continued successfully throughout the winter without any larger problems. In early May 1942, Allied forces started the re-occupation of Svalbard under Operation Fritham (Elbo, 1952; Selinger, 2001). The Norwegian-led operation consisted of 83 men, including many former employees of Store Norske Spitsbergen Kulkompani A/S and three British liaison officers, Lieutenant-Colonel Arthur Stuart Talbot "Daniel" Godfrey, Lieutenant-Colonel Amherst Barrow "Brownie" Whatman, and Lieutenant-Commander Alexander Richard "Sandy" Glen, with Godfrey and Whatman, also being former members of Glen's 1935/36 Oxford University expedition to Nordaustlandet (Elbo, 1952). The Bansö crew was finally evacuated by airlifts on 9 July 1942. Already in May 1942, resupply flights were performed, and with one of these flights an automatic weather station of type Kröte was installed close to Bansö (see section on automatic weather stations below). The last entry from Bansö in the ZWG maps is on 4 July 1942, 05:00. In total, 849 reports on 209 d are contained in the ZWG maps, corresponding to 74 % of the total observations during this period. The original meteorological logbooks were taken over after the war by the Norwegian Meteorological Institute but have meanwhile unfortunately been lost (Steffensen et al., 1996, p. 39). Only monthly means of the Bansö observations are available to date at http://seklima.met.no. ECMWF's ERA5 reanalysis contains observations of surface pressure between November 1941 and April 1942 at the location of Isfjord Radio (Hans Hersbach, personal communication, January 2024). These are almost certainly the Bansö observations (i.e. more than 50 km inland east of Isfjord Radio). It is likely that Bansö reported under Isfjord Radio's station identifier, as the Bansö reports are also always included at the location of Isfjord Radio in the ZWG maps (Fig. 3).

## 5 Knospe 1941/42

At the same time that the Luftwaffe operated the station Bansö, the German Kriegsmarine set up its own station, Knospe, further north at the Lillihöökfjorden on the Mitra peninsula (79°15.7′ N, 11°30.4′ E; 33 m a.s.l.). The name is derived from its leader, Hans-Robert Knoespel. After his return from service with the weather ship *Sachsen* in the North Atlantic, Knoespel had suggested to Admiral Conrad, then director of the German naval meteorological service, that "semi-permanent shore weather stations should be established at suitable points in the Arctic regions as the naval superiority of the Allies forbade the continued employment of ship-borne meteorological units" (Blyth, 1951, p. 191). The location for Knospe was only about 11 km north of the former German observatory of 1912–1914 at Ebeltofthamna (Wegener and Robitzsch, 1916; Dege, 1962). According to Nusser (1979, p. 21), this was one consideration for the choice of the location, as it would suggest interesting climatological comparisons. For the transport, two weather ships, the *Sachsen* and the *Fritz Homann*, were employed, reaching Signehamna, a small bay on the western side of the Lilliehöökfjorden, on 15 October 1941 (Nusser, 1979, p. 8). After construction of the station, the ships left Lilliehöökfjorden on 15 November 1941 (Nusser, 1979, p. 12). The wintering team of the station encompassed (Blyth, 1951; Nusser, 1979; Selinger, 2001)

- Hans Robert Knoespel, station leader;
- Walter Drees, meteorologist;
- Gustav Moninghoff, radiosonde technician;
- Anton Pohoschaly, stores officer;
- Johann Zima, wireless operator;
- Heinz Ackermann, wireless operator.

The first report in the ZWG weather maps is on 19 November 1941. Wireless operations proved difficult at times, and there are larger periods when no contact with the German station in Tromsø could be established; in particular, between 22 February and 24 March, no reports could be transmitted (Selinger, 2001, p. 72). On 16 March 1942, the team moved to the so-called summer station about 2 km southwest on a ridge at 159 m a.s.l., which provided a better outlook both towards the open sea and over Lilliehöökfjorden and provided better wireless transmission (Nusser, 1979, p. 13). As a result of the Allied presence on Svalbard (operations Fritham and Gearbox), radio silence was imposed for Knospe (Blyth, 1951), with the last observation report sent on 22 July 1942 (Selinger, 2001, p. 110). The team was finally evacuated by the U-boat *U-435* on 22 August 1942 (Selinger, 2001, p. 110), leaving most of the station equipment behind, with the view to continue operations during the next winter. To bridge the gap until the next winter, an automatic weather station was installed close to Knospe on 9 September 1942; see section on automatic weather stations below.

The ZWG weather maps contain 432 reports from Knospe on 195 d between 19 November 1941 and 22 July 1942, corresponding to only 35 % of the observations on 79 % of the days. To the author's knowledge, the original meteorological logbooks of Knospe are not preserved. These would add considerably to the data that have been retrieved through the ZWG maps.

## 6 Nussbaum 1942/43

In continuation of the station Knospe, the Kriegsmarine established the station Nussbaum for winter 1942/43. The code name was again derived from the name of the foreseen station leader, Dr Franz Nusser. As Nussbaum could use much of the equipment left behind from Knospe and, on the other hand, the Allied presence at Svalbard forbade the use of surface vessels, the transport was performed by U-boat *U-377*, reaching Signehamna on 13 October 1942 (Selinger, 2001, p. 116; Nusser, 1979, p. 33). The overwintering team encompassed (Blyth, 1951; Selinger, 2001)

- Dr Franz Nusser, leader;
- Heinz Köhler, second-in-command;
- Rudolf Garbaty, radiosonde technician;
- Heinz Ehrich, senior wireless operator;
- Eduard Müller, wireless operator;
- Friedrich-Wilhelm Krüger, general assistant.

Routine meteorological observations started on 23 October 1942. The first observations report was sent on 29 November 1942 (Nusser, 1979, p. 40), in agreement with the first entry in the ZWG maps on 29 November 1942, 19:00. Between 6 and 14 April 1943, observations took place in parallel between the winter and the summer station, and the final move into the summer station occurred on 14 April (Blyth, 1951). On 20 June 1943, Nussbaum was discovered and attacked by a Norwegian command, during which Köhler was killed (Selinger, 2001, p. 155; see also Ullring, 1949). The rest of the team retreated and was finally evacuated on 22 June by the U-boat *U-302* (Blyth, 1951; Nusser, 1979, p. 49; Selinger, 2001, p. 158).

The original meteorological logbooks of the station Nussbaum between October 1942 and May 1943 are preserved at the German Bundesarchiv in Freiburg and were digitized by the author of this paper. These provide important metadata (Fig. 5) and much more detailed observations than contained in the ZWG weather maps. This is especially fortunate as, for the first half of 1943, the ZWG weather maps are available only once daily for 5 h. A comparison for December 1942 between the data from the meteorological logbook and those retrieved from the ZWG maps enables a validation of the data from the ZWG maps (Fig. 6). In this comparison for December 1942, sea level pressure and temperature from the ZWG maps are in agreement with the original logbooks, except for two or three outliers in pressure and one clear outlier in temperature: the ZWG map for 27 December, 18:00, clearly states a temperature of −8 °C, whereas, according to the original logbooks, it should be −18 °C.

## 7 Kreuzritter 1943/44

After the detection of Nussbaum in June 1943, the weather station for the season 1943/44 under code name

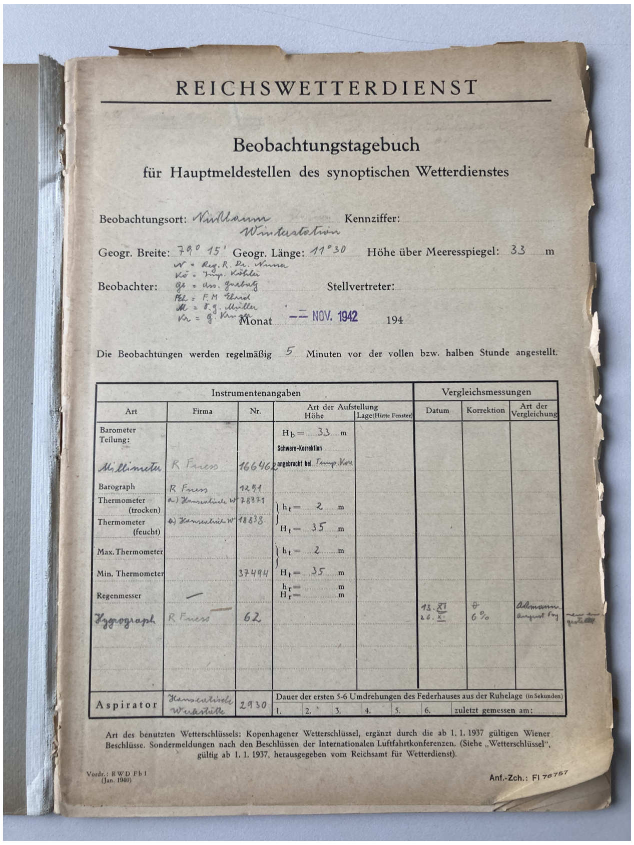


**Figure 5.** Title page of the meteorological logbook for Nussbaum, November 1942, providing important metadata for the station. The original is at the German Bundesarchiv in Freiburg (BArch RM 7/3126).

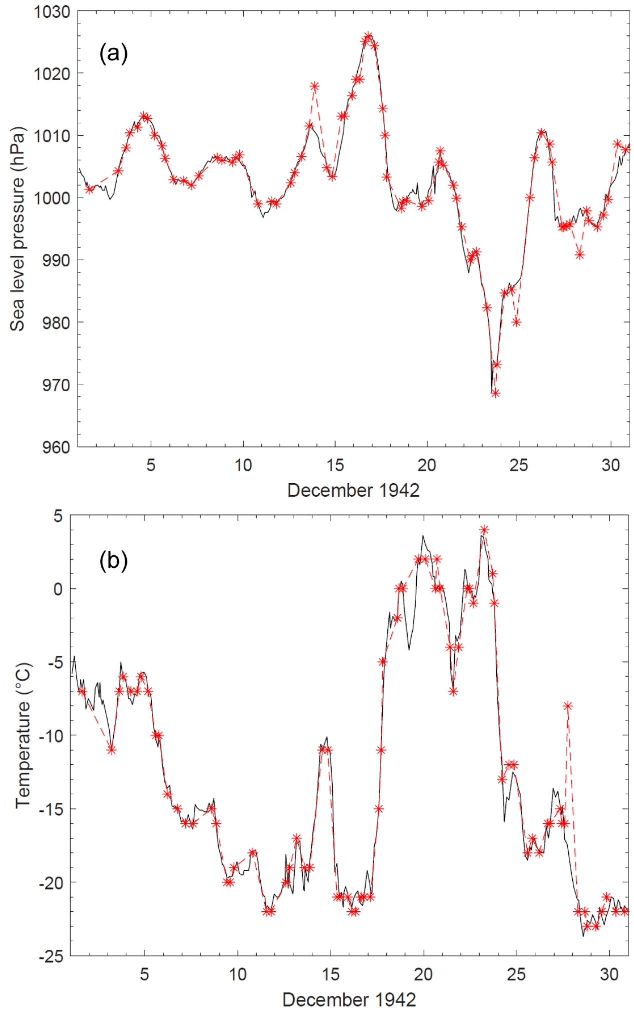


**Figure 6.** Comparison of the original Nussbaum observations (solid black line) with retrieved data from ZWG maps (red stars and dashed line) for **(a)** sea level pressure and **(b)** temperature during December 1942.

Kreuzritter was located further north at the Sørdalsodden in Liefdefjorden (79°42′ N, 13°08′ E). The station was under the leadership of Hans-Robert Knoespel again. The size of the team was increased to provide additional military defence if attacked. It encompassed (Blyth, 1951; Nusser, 1979; Selinger, 2001, p. 191)

- Hans-Robert Knoespel, scientific leader;
- Ltn. Heinz Scharlipp, military leader;
- Gustav Moninghoff, radiosonde technician and photographer, former member of Knospe;
- Anton Pohoschaly, stores officer, former member of Knospe;
- Emil Laurenz, cook;
- Fritz Graumann, radiosonde technician;
- Heinz Ackermann, wireless operator, former member of Knospe;
- Franz Kraus, hunter;
- Helmuth Köhler, paramedic;
- Walter Keim, wireless operator;
- Friedrich Wilhelm Krüger, general assistant, former member of Nussbaum;
- Ernst Müller, general assistant;
- Hein Müller, hunter.

The station was transported by the weather ship *Carl J. Busch* (WBS 3) with the U-boat *U-355* as an escort, reaching Liefdefjorden on 6 October 1943 (Nusser, 1979, p. 68). Regular weather observations started on 1 November 1943 (Knoespel, 1944). The first entry in the ZWG maps is on 1 December 1943, 05:00. The team was picked up by the U-boat *U-737* on 30 June 1944. Just before the arrival of the U-boat, Knoespel was killed in an accident when he tried to defuse a land mine near the camp. Before leaving on 1 July 1944, the U-boat crew installed the automatic weather station WFL 33 Edwin III near the Kreuzritter station (see section on automatic weather stations below).

Between 1 December 1943 and 31 May 1944, there are 431 reports in the ZWG maps on 168 d, corresponding to 47 % of the data and 92 % of the days. Unfortunately, there are no ZWG maps preserved after May 1944, with the exception of a few days in October 1944. To the author's knowledge, the original meteorological logbooks of Kreuzritter are not preserved.

## 8 Svartisen 1943/44

After some experiments with automatic weather stations in the previous years, the Luftwaffe decided to set up another staffed weather station for 1943/44, and ultimately the island of Hopen was chosen (Blyth, 1951; Selinger, 2001, p. 215). Hopen is an island about 220 km east of the southern tip of Spitsbergen, 34 km long, and only between 1 and 2 km wide. The weather station was installed in an existing hut built in 1934 (Rossnes, 1993, p. 159) on the eastern side of Hopen at 76°30.5′ N, 25°01′ E, at 6 m a.s.l. (the location for measurements at Hopen prior to October 1945 of 76°24′ N, 25° E, as given by Steffensen et al., 1996, p. 12, is implausible and not credible). Transport of crew and material was performed by the U-boat *U-354*, with disembarkment completed by 30 October 1943. The overwintering crew consisted of (Selinger, 2001, p. 215)

- Dr Franz Ertl, physician, station leader;
- Dr Albert Schwarz, meteorologist;
- Werner Tulatz, wireless operator;
- Hans-Dieter Görwitz, wireless operator.

Regular weather observations and reports started on 19 November 1943 (Selinger, 2001, p. 219). The first entry in the ZWG maps is on 25 November 1943, 08:00. Until 31 May 1944, in total, 600 reports on 167 d are included in the ZWG maps, corresponding to 63 % of the data on 88 % of the days. Unfortunately, no ZWG maps are preserved after 31 May 1944, with the exception of a few days in October 1944. The Svartisen crew was evacuated again by the U-boat *U-354* on 22 July 1944 (Selinger, 2001, p. 263). To the author's knowledge, original meteorological logbooks of Svartisen are not preserved.

## 9 Helhus 1944/45

After the very successful completion of Svartisen, the Luftwaffe operated the same station on Hopen again in the season 1944/45 under the code name Helhus. Transport of crew and material was performed by the U-boat *U-636*, with disembarkment completed by 13 October 1944. Members of the overwintering crew were (Selinger, 2001, p. 292)

- Dr Josef Neunteufl, meteorologist and station leader;
- Josef Plank, radiosonde technician;
- Fritz Schäfer, wireless operator;
- Herbert Bigalke, wireless operator.

Regular meteorological observations started on 8 November 1944, but the radio transmission of reports started only on 3 January 1945 after the sea ice around Hopen was strong enough to provide safety against possible attacks (Selinger, 2001, p. 294). Helhus continued observations throughout the winter and even after the German surrender on 9 May 1945 until the team was finally evacuated on 5 August 1945. Unfortunately, there are no reports from Helhus in the available ZWG maps, as no maps for 1945 are preserved. As with the data for Bansö, the original meteorological logbooks were taken over after the war by the Norwegian Meteorological Institute but have meanwhile unfortunately been lost (Steffensen et al., 1996, p .12). This is particularly regrettable, as the Norwegian Meteorological Institute continued the weather station at Hopen from October 1945 until today, without any interruptions. It is thus the longest uninterrupted time series of weather and climate observations in Svalbard. Data for Hopen from 1 November 1945 onwards are available at http://seklima.met.no.

## 10 Haudegen 1944/45

The weather station for 1944/45 was installed at the suggestion of its leader, Wilhelm Dege, in an even more remote place than any of the previous stations, at Rijpfjorden on the northern coast of Svalbard's Nordaustlandet. The code name Haudegen was again derived from the name of the leader, Dege. Haudegen was transported by the weather ship *Carl J. Busch* (WBS 3) and the U-boat *U-307*, reaching Rijpfjorden on 14 September 1944. The Haudegen overwintering crew consisted of (Selinger, 2001; Dege, 2006)

- Dr Wilhelm Dege, station leader;
- Arthur Baumann, meteorologist;
- Wilfried Maaß, radiosonde technician;
- Heinrich Ehrich, wireless operator;
- Hannes Semkat, wireless operator and weather technician;
- Heinz Schneider, wireless operator and weather technician;

- Werner Schlösser, wireless operator and weather technician;
- Sigfried Czapka, wireless operator and weather technician;
- Heinz Grams, wireless operator and weather technician;
- Gustav Scheidweiler, weather technician;
- Josef Reyer, general assistant.

Routine meteorological observations started on 16 September 1944 and continued until 5 September 1945, when Haudegen was finally evacuated. It was thus the last German military unit to surrender (on 4 September; Selinger, 2001, p. 331). Synoptic observations and radiosonde data from Haudegen were published by Dege (1960). As Nordaustlandet in northeastern Svalbard has a much colder High Arctic climate compared to western Spitsbergen and only few long-term observations on Nordaustlandet exist, it is challenging to connect the Haudegen data with the long-term Svalbard data sets (Sinnhuber, 2021). Dege (1960) refers to the observations by Glen's Oxford University Expedition in 1935/36 (Glen and Croft, 1937) as the only other available year-round measurements at that time. Sinnhuber (2021) presented weather observations by the hunters and trappers Gunnar Knoph and Henry Rudi who overwintered 1934/35 very close to the later Haudegen station at Rijpfjorden. While these meteorological data are of questionable quality, they correlate well with data from other places on Svalbard. Further nearby year-round data are available from a Swedish–Finnish–Swiss expedition that overwintered at Kinnvika at Murchison Bay on the western side of Nordaustlandet for 2 years during 1957–1959. Meanwhile, it was possible to retrieve the original meteorological logbooks of the Murchison Bay 1957–1959 expedition from the archives of the Royal Swedish Academy of Science. Temperature and sea level pressure observations have been digitized and submitted to the Copernicus Climate Data Store. Through these additional observations, adjustments have been derived to link the Haudegen temperature observations to the extended Svalbard Airport series (Sinnhuber, 2021). Following the publication by Sinnhuber (2021), the Haudegen data are now available at http://seklima.met.no.

## 11 Automatic weather stations

The German Luftwaffe and the Kriegsmarine developed automatic weather stations during the war, primarily for operations in the Arctic. An overview is given by Selinger (1985), and further details are given by Selinger (2001).

### 11.1 Kröte Bansö 1942

To continue weather reports after the evacuation of the station Bansö, the Luftwaffe installed an automatic weather station of type Kröte near the station. The exact location is unclear; Selinger (1985) states a location near the shore of the Adventfjorden, which, if true, would be about 5 km away from Bansö, closer to Longyearbyen. Installation started on 15 May 1942 as part of supply flights to Bansö, and first reports from the Kröte are included in ZWG maps on 23, 24, and 25 May. Continuous reports started on 21 June 1942, 05:30, and continued until 16 July 1942, 19:00. It thus extends the reports from Bansö by 12 d. Most likely, the Kröte was found and destroyed by Allied forces on 16 July (Selinger, 2001, p. 102). In total, there are 103 entries in the ZWG maps between 21 June and 16 July, with both temperature and pressure data generally agreeing well with the Bansö reports during the overlap period (Figs. 3 and 8).

### 11.2 WFL 21 Gustav 1942

In order to bridge the gap between the evacuation of the station Knospe in August 1942 and the reoccupation of the station by operation Nussbaum in October 1942, the Kriegsmarine also installed an automatic weather station of type WFL under the code name WFL 21 Gustav close to the station Knospe. Transport towards Signehamna was by the U-boat *U-377*, with installation completed on 9 September 1942, 22:00 (Selinger, 2001, p. 113). The first report from WFL 21 Gustav is included in the ZWG maps on 11 September 1942, 17:15. In total, 75 reports are included in the ZWG maps more or less continuously until 16 November 1942, 17:15, with another final report on 27 November 1942, 17:15. There is thus overlap between WFL 21 and the observations of Nussbaum, which started on 23 October, providing us with an assessment of the data quality of the automatic weather station after about 2 months of operation. A comparison of pressure and temperature between WFL 21 and Nussbaum is shown in Fig. 7. While the pressure data seem plausible and generally agree well after 2 months of operation of the automatic weather station, temperature data of WFL 21 are questionable and appear to be erroneous.

### 11.3 Kröte Sørkapp 1943

On 24 July 1943, the Luftwaffe again installed an automatic weather station of type Kröte on Svalbard close to Sørkapp, the southernmost point on Spitsbergen, at 76°37′ N, 16°19′ E, directly next to the coast (Selinger, 2001, p. 185). The automatic weather station was delivered by an aeroplane piloted by Rudolf Schütze. The first entry in the ZWG maps is on 28 July 1943, 08:00. In total, there are (only) 23 reports from the Kröte Sørkapp between 28 July and 3 September 1943 on 14 out of the 43 d.

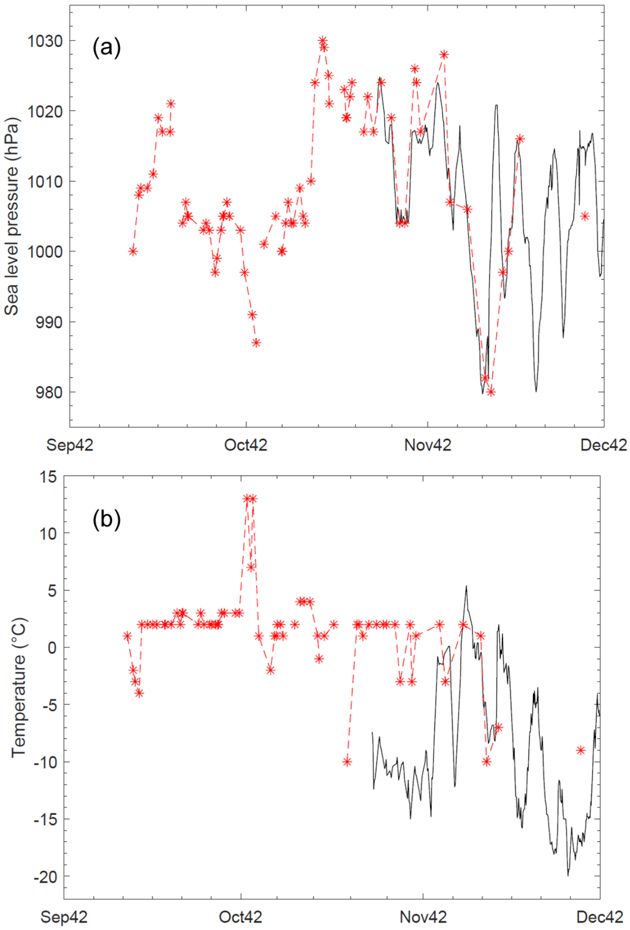


**Figure 7.** Comparison of automatic weather station WFL 21 Gustav (red stars and dashed line) with Nussbaum (solid black line) for **(a)** pressure and **(b)** temperature between 1 September and 1 December 1942.

### 11.4 Kröte Edgeøya 1943

On 4 August 1943, 11 d after the installation of the Kröte at Sørkapp, another automatic weather station of type Kröte was installed in Dianadalen on the southern coast of Edgeøya, again through an aeroplane piloted by Rudolf Schütze (Selinger, 2001, p. 184). There are no entries of weather reports from Kröte at Edgeøya in the ZWG maps. This could either mean that this Kröte failed or that the reports of the Kröte at Edgeøya are erroneously included in the ZWG maps at the position of the Kröte Sørkapp.

### 11.5 WFL 33 Edwin III 1944

During evacuation of the station Kreuzritter by the U-boat *U-737* on 1 July 1944, an automatic weather station of type WFL was installed near the station, with code name WFL 33 Edwin III. The place was visited again on 27/28 September 1944 by weather ship *Carl J. Busch* and *U-307* after their delivery of Haudegen in order to clear the former Kreuzritter station and to take back equipment left behind in July (Selinger, 2001, p. 288). Selinger (1985) states that WFL 33 Edwin III sent reports throughout the winter of 1944/45 until the end of the war. Can this be true, a continuous operation for more than 10 months? Unfortunately, after May 1944, there are only a few ZWG maps preserved for some days in October 1944, so it cannot be verified for how long reports from WFL 33 were received. In total, we have only 15 reports from WFL 33 Edwin III in the ZWG maps on 8 d between 11 and 20 October 1944. A comparison of these WFL 33 reports with the Haudegen observations on Nordaustlandet, about 190 km further east, shows a similar development for the pressure but no correlation for temperature.

## 12 Summary and conclusions

More than 4800 ZWG weather maps have been scanned at DWD from which almost 3000 individual reports for stations on Svalbard between 1941 and 1944 have been digitized. Retrieving the original records of the Nussbaum observations provided an opportunity to independently validate the time series derived from the ZWG maps. Together with the digitized logbooks for Nussbaum (another 2000 individual observations digitized) and Haudegen, the existing gap in the Svalbard climate time series between 1941 and 1945 can be filled considerably (Table 1). Figure 8 shows a composite of the temperature observations between 1941 and 1945. Notable gaps remain only in the summer months. It would be very helpful in this regard if meteorological observations from Norwegian or Allied operations in Svalbard could also be retrieved. Weather charts from 1940–1945 preserved at the UK Met Office (https://digital.nmla.metoffice.gov.uk/SO_b0e547f1-03fe-4212-b166-f5f3d91a13a0/, last access: 28 May 2024) unfortunately do not contain observations from Svalbard after 1940.

A remaining challenge will be the adjustment and homogenization of the different data sets. The Svartisen data can be linked in a straightforward way to the Hopen time series after 1945, as observations have been continued at essentially the same location. There is also a good chance that the Bansö data can be linked to other observations at Longyearbyen. Both data sets may then serve as anchor points for the other time series. The overlap between Bansö and Knospe in 1941/42 and between Svartisen and Kreuzritter in 1943/44 may be of advantage in this respect. For example, the monthly temperature biases between Bansö and Knospe are largely in line with spatial temperature variations across Svalbard from present-day data (Przybylak et al., 2014). However, connecting climate time series from different places in Svalbard remains a challenge as the bias may change from year to year, depending on sea ice conditions, and the magnitude of temperature trends is different for different places on Svalbard (Isaksen et al.,

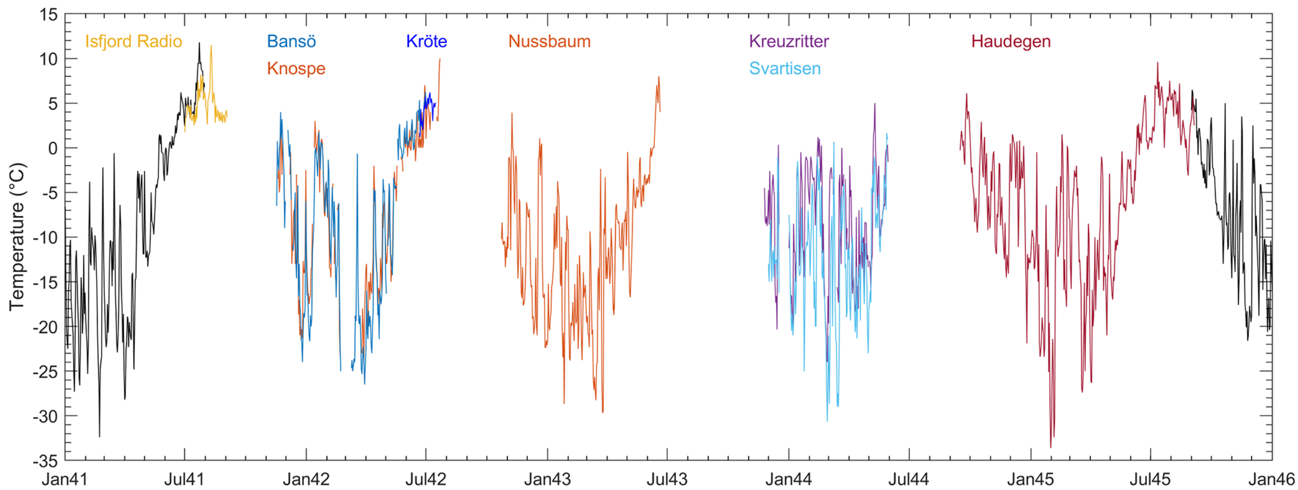


**Figure 8.** Composite of daily mean temperature observations on Svalbard 1941–1945. Time series are included without any adjustments. In black is the homogenized Svalbard Airport time series (Nordli et al., 2020), which is based on Barentsburg observations until 31 July 1941 and on Longyearbyen observations from 1 September 1945 onwards.

**Table 1.** Summary of observations digitized from ZWG maps and the Nussbaum journals as included in the data set of Sinnhuber (2024).

| Station | Location | Period | Number of days included | Number of individual reports |
|---|---|---|---|---|
| Isfjord Radio | 78.062° N, 13.616° E; 6 m a.s.l. | 1 Jul 1941–3 Sep 1941 | 65 (100 %) | 291 (90 %) |
| Bansö | 78.183° N, 15.867° E; 25 m a.s.l. | 17 Nov 1941–4 Jul 1942 | 209 (91 %) | 849 (74 %) |
| Knospe | 79.262° N, 11.507° E; 33 m a.s.l. | 19 Nov 1941–22 Jul 1942 | 195 (79 %) | 432 (35 %) |
| Kröte | 78.218° N, 15.700° E; 4 m a.s.l.[a] | 21 Jun 1942–16 Jul 1942 | 26 (100 %) | 103 (79 %) |
| WFL 21 | 79.262° N, 11.507° E; 33 m a.s.l. | 11 Sep 1942–27 Nov 1942 | 49 (63 %) | 75 (19 %) |
| Nussbaum | 79.262° N, 11.507° E; 33 m a.s.l. | 23 Oct 1942–20 Jun 1943 | 234 (100 %)[b] | 2025 (100 %)[b] |
| Kreuzritter | 79.698° N, 13.133° E; 4 m a.s.l. | 1 Dec 1943–31 May 1944 | 168 (92 %) | 431 (47 %) |
| Svartisen | 76.509° N, 25.016° E; 6 m a.s.l. | 25 Nov 1943–30 May 1944 | 167 (88 %) | 600 (63 %) |

[a] Exact location of Kröte unclear. [b] From the original logbooks 23 October 1942–31 May 1943

2022). Data assimilation, such as in the upcoming ERA6 reanalysis (Hans Hersbach, personal communication) may ultimately make optimal use of the data at different places to provide a consistent climate reanalysis. To this end, the newly digitized data are made publicly available (Sinnhuber, 2024).

From the ZWG maps, pressure and temperature observations for the automatic weather stations on Svalbard were retrieved, and, for a few cases, they could be validated against other nearby independent data. Though these early automatic weather stations were technological pioneers at their times and, in particular, the pressure measurements provided important information for the weather maps in the absence of other measurements, their contribution to the Svalbard temperature record is very limited. Records are either too short or the temperature data are questionable (Fig. 7b). Additional and longer records exist for Bjørnøya, where the Luftwaffe and Kriegsmarine installed eight automatic weather stations in total between October 1942 and June 1944 (Selinger, 2001). Reports from these automatic weather stations are included in the ZWG maps in some cases for up to 3 months, but this was not systematically investigated here.

The focus of this study is on Svalbard. The present work can be extended in a straightforward way to also retrieve data from the German military weather stations in Greenland and Franz Josef Land (Blyth, 1951; Nusser, 1979; Selinger, 2001) and maybe also observations from weather ships or weather reconnaissance flights (Fig. 4). More generally, the ZWG maps contain a huge amount of data for many other areas of climate or historical research. While digitalization "by hand" has proved possible for individual stations, leveraging all data included in the ZWG maps, e.g. for assimilation in climate reanalyses, will require some degree of automation. This may be an interesting application of machine learning techniques for analyses of big data.

The data from the ZWG weather maps also provide a new perspective on the history of the German meteorological activities in the Arctic during World War II by showing the impact these observations had on the meteorological analyses. In this sense, this paper also tries to bridge the gap between climate research and history.

**Data availability.** The digitized time series of sea level pressure (partly) and temperature are available at https://doi.org/10.35097/oTPlaeEogFkmbiTd (Sinnhuber, 2024). The Haudegen data (at sub-daily resolution) and the homogenized Svalbard Airport time series (at daily resolution) are available at http://seklima.met.no (Norsk Klimaservicesenter, 2024).

The ZWG weather maps are available upon request from the DWD National Meteorological Library (bibliothek@dwd.de).

**Competing interests.** The author has declared that there are no competing interests.

**Disclaimer.** Publisher's note: Copernicus Publications remains neutral with regard to jurisdictional claims made in the text, published maps, institutional affiliations, or any other geographical representation in this paper. While Copernicus Publications makes every effort to include appropriate place names, the final responsibility lies with the authors.

**Acknowledgements.** The author expresses his sincere thanks to the DWD for supporting this work by providing the ZWG maps and in particular to Peter Keitz from the DWD library for the herculean task of scanning more than 4800 individual ZWG weather maps. The Nussbaum logbooks were retrieved from the German Bundesarchiv in Freiburg, and the author thanks the Bundesarchiv for the support.

**Review statement.** This paper was edited by Bernhard Diekmann and Anja Wendt and reviewed by Cornelia Lüdecke and one anonymous referee.

## References

Amundsen, B.: Svarthvitt, Mitra Forlag, ISBN 82-990807-6-2, 2001.

Bell, B., Hersbach, H., Simmons, A., Berrisford, P., Dahlgren, P., Horányi, A., Muñoz-Sabater, J., Nicolas, J., Radu, R., Schepers, D., Soci, C., Villaume, S., Bidlot, J.-R., Haimberger, L., Woollen, J., Buontempo, C., and Thépaut, J.-N.: The ERA5 global reanalysis: Preliminary extension to 1950, Q. J. Roy. Meteor. Soc., 147, 4186–4227, https://doi.org/10.1002/qj.4174, 2021.

Blyth, J. D. M.: German meteorological activities in the Arctic, 1940–1945, Polar Rec., 6, 185–226, https://doi.org/10.1017/S0032247400040596, 1951.

Cathcart, B.: The name's Dunderdale, Biffy Dunderdale, The Independent, London, https://www.independent.co.uk/news/the-name-s-dunderdale-biffy-dunderdale-1338360.html, (last access: 7 June 2024), 23 June 1996.

Dege, W.: Wissenschaftliche Beobachtungen auf dem Nordostland von Spitzbergen 1944–1945, Berichte des Deutschen Wetterdienstes, 72, Offenbach, Germany, 1960.

Dege, W.: Deutsches Observatorium Ebeltofthafen – Spitzbergen. Zur 50. Wiederkehr der 1. Überwinterung 1912/13, Polarforschung, 32, 136–140, https://doi.org/10.2312/polarforschung.32.1-2.136, 1962.

Dege, W.: Gefangen im arktischen Eis. Wettertrupp "Haudegen" – die letzte deutsche Arktisstation im Zweiten Weltkrieg, Convent Verlag, Hamburg, ISBN-13 978-3-934613-94-2, 2006.

Elbo, J. G.: The war in Svalbard, 1935–1945, Polar Rec., 6, 484–495, https://doi.org/10.1017/S0032247400047276, 1952.

Glen, A. R. and Croft, N. A. C.: Under the Pole Star – the Oxford University Arctic Expedition, 1935–6, Methuen, London, 1937.

Hersbach, H.: ERA5 reanalysis now available from 1940, ECMWF Newsletter, 175, 10, 2023.

Hersbach, H., Bell, B., Berrisford, P., Hirahara, S., Horányi, A., Muñoz-Sabater, J., Nicolas, J., Peubey, C., Radu, R., Schepers, D., Simmons, A., Soci, C., Abdalla, S., Abellan, X., Balsamo, G.,Bechtold, P., Biavati, G., Bidlot, J., Bonavita, M., De Chiara, G., Dahlgren, P., Dee, D., Diamantakis, M., Dragani, R., Flemming, J., Forbes, R., Fuentes, M., Geer, A., Haimberger, L., Healy, S., Hogan, R.J., Hólm, E., Janisková, M., Keeley, S., Laloyaux, P., Lopez, P., Lupu, C., Radnoti, G., de Rosnay, P., Rozum, I., Vamborg, F., Villaume, S., and Thépaut, J.-N.: The ERA5 global reanalysis, Q. J. Roy. Meteor. Soc., 146, 1999–2049, https://doi.org/10.1002/qj.3803, 2020.

Holzapfel, R.: Deutsche Polarforschung 1940/45, Polarforschung, 21, 85–97, 1951.

Isaksen, K., Nordli, Ø., Ivanov, B., Køltzow, M. A. Ø, Aaboe, S., Gjelten, H. M., Mezghani, A., Eastwood, S., Førland, E., Benestad, R. E., Hanssen-Bauer, I., Brækkan, R., Sviashchennikov, P., Demin, V., Revina, A., and Karandasheva, T.: Exceptional warming over the Barents Area, Sci. Rep., 12, 9371, https://doi.org/10.1038/s41598-022-13568-5, 2022.

Knoespel, H.-R.: Tagebuch der Unternehmung "Kreuzritter" 1943/44, in: Erkundung in der Arktis im Dienste der Wettervorhersage, Buchreihe Stella Polaris, Norderstedt, 2020, edited by: Lüdecke, C., ISBN 978-3-7519-9794-2, 1944.

Lüdecke, C.: Erkundung in der Arktis im Dienste der Wettervorhersage, Buchreihe Stella Polaris, Norderstedt, ISBN 978-3-7519-9794-2, 2020.

Lyngaas, R.: Oppføringen av Isfjord Radio, automatiske radio fyr og fyrbelysning på Svalbard 1946, Norges Svalbard- og Ishavsundersøkelser, Meddelelse 67, Oslo, 1947.

Macht, H. G.: Meteorologische und fliegerische Erfahrungen von deutschen Wettererkundungsflügen in der Arktis, 1941–1944, Polarforschung, 21, 2–9, 1951.

Nordli, Ø., Przybylak, R., Ogilvie, A. E. J., and Isaksen, K.: Long-term temperature trends and variability on Spitsbergen: the extended Svalbard Airport temperature series, 1898–2012, Polar Res., 33, 21349, https://doi.org/10.3402/polar.v33.21349, 2014.

Nordli, Ø., Wyszynski, P., Gjelten, H. M., Isaksen, K., Łupikasza, E., Niedźwiedź, T., and Przybylak, R.: Revisiting the extended Svalbard Airport monthly temperature series, and the compiled corresponding daily series 1898–2018, Polar Res., 39, 3614, https://doi.org/10.33265/polar.v39.3614, 2020.

Norsk Klimaservicesenter: Seklima Observations and weather statistics, Norwegian Meteorological Institue [data set], https://seklima.met.no, last access: 27 November 2024.

Nusser, F.: Die Arktisunternehmungen des deutschen Marine-Wetterdienstes in den Jahren 1940–1945, Deutscher Wetterdienst, Seewetteramt Hamburg, 1979.

Przybylak, R., Arazny, A., Nordli, Ø., Finkelnburg, R., Kejna, M., Budzik, T., Migała, K., Sikora, S., Puczko, D., Rymer, K., and Rachlewicz, G.: Spatial distribution of air temperature on Svalbard during 1 year with campaign measurements, Int. J. Climatol., 34, 3702–3719, https://doi.org/10.1002/joc.3937, 2014.

Rapp, J.: Die geheimen Wetterkarten der Zentralen Wetterdienstgruppe 1939–1945 – eine historisch einmalige Sammlung aus dem Zweiten Weltkrieg, Beiträge des Deutschen Wetterdienstes in Offenbach/M zur Berliner Wetterkarte, SO 02/15, 2015.

Rossnes, G.: Norsk overvintringsfangst på Svalbard 1895–1940, Meddelelser 127, Norwegian Polar Institute, Oslo, 1993.

Schwerdtfeger, W.: Die letzten zwei Jahre der ZWG (1943–1945), Promet, 15, 55–61, 1985.

Schwerdtfeger, W. and Selinger, F.: Wetterflieger in der Arktis 1940–1944. Aus dem Tagebuch von Flugkapitän Olt. Rudolf Schütze, Motorbuch Verlag Stuttgart, Germany, ISBN 3-87943-854-4, 1982.

Selinger, F.: Deutsche automatische Wetterstationen in der Arktis 1942–1945, Polarforschung, 55, 55–67, 1985.

Selinger, F.: Abriß der Unternehmungen des Marinewetterdienstes in der Arktis 1940–1945 nach dem Erkenntnisstand von 1990, Einzelveröffentlichung Nr. 96a, Deutscher Wetterdienst Seewetteramt, Hamburg, 1991.

Selinger, F.: Von "Nanok" bis "Eismitte", Meteorologische Unternehmungen in der Arktis 1940–1945 , Convent, Hamburg, ISBN 3-934613-12-8, 2001.

Selinger, F. and Glen, A.: Arctic meteorological operations and counter-operations during World War II, Polar Rec., 21, 559–567, https://doi.org/10.1017/S0032247400021963, 1983.

Sinnhuber, B.-M.: Historic temperature observations on Nordaustlandet, north-east Svalbard, Polar Res., 40, 7564, https://doi.org/10.33265/polar.v40.7564, 2021.

Sinnhuber, B.-M.: Historical meteorological observations from military weather stations on Svalbard, 1941–1944, Karlsruhe Institute of Technology [data set], https://doi.org/10.35097/oTPlaeEogFkmbiTd, 2024.

Stacey, C. P.: The Canadian army 1939–1945, An official historical summary, Minster of National Defence, Ottawa, https://www.canada.ca/content/dam/themes/defence/caf/militaryhistory/dhh/official/book-1948-army-1939-1945-en.pdf (last access: 27 November 2024), 1948.

Stacey, C. P.: Official History of the Canadian Army in the Second World War, Volume I, Minster of National Defence, Ottawa, https://www.canada.ca/en/department-national-defence/services/military-history/history-heritage/official-military-history-lineages/official-histories/book-1955-army-ww2-1.html (last access: 27 November 2024), 1955.

Steffensen, E., Nordli, P. Ø., and Hanssen-Bauer, I.: Stasjonshistorie for Norske Meteorologiske Målinger i Arktisk, Rapport Nr. 17/96 KLIMA, Det Norske Meteorologiske Institutt, 1996.

Ullring, E.: På langtur på Svalbard under krigen, Polarboken, 7–26, 1949.

Wegener, K. and Robitzsch, M.: Klimatologische Terminbeobachtungen während der Überwinterung 1912/13, Veröffentlichungen des Deutschen Observatoriums Ebeltofthafen-Spitzbergen, 5, 1–44, 1916.