C. Three European winters: 1939-42

Occupation of Norway - Return of Ice Age (3_11)

Introduction

The Second World War (WWII) was in full swing from the North Cape to North Africa shores for 16 months when a second extreme cold winter exercised an icy grip over Northern Europe. Similar winters occurred during three successive years during which an 'arctic axis' stretched from Stockholm to London. (A) The first war winter of 1939/40 and its evolution into an 'ice age event' in close conjunction with numerous relevant war activities at sea. (B), has been presented and discussed in: "Lost West Drift". (C), and "North Sea cooling". (D) This paper focuses attention on the second war winter of 1940/41 in Southern Norway, including Southwest Sweden and North Denmark, the land areas surrounding the Skagerrak.

The causation of the first arctic war winter 1939/40 as already presented in great detail in a number of other papers can also be fully applied to the second war winter 1940/41. But that would mean a lot of repetition. Therefore the Skagerrak area is focused.

Further details: (A) Cold axis, 3_22; (B) Sea and naval activities, 2_13, 2_14, 2_15; (C) Lost west wind drift, 2_12; (D) North Sea cooling (2_16.

Choosing Norway

Norway, in particular Southern Norway, is the only topic in respect of the second war winter of 1940/41. Sea areas deprived of sunshine easily provide a clue to whether weather modification had occurred. Norway's coasts saw a lot of fighting in waters off its shores during the second half of 1940 since April.


Torpedoed in Skagerrak

Two Norwegian scientists, Th. Hesselberg and B.J. Birkeland, in 1956, concluded their study of variations in the climate of Norway from 1940-50. Even though investigating climatic variation over a period of 10-years, they devoted a small section to "The Three Cold winters 1940 – 42". Evaluating this period on a mean value basis (three years), they

made only one exception in Table C, "The lowest Temperatures in January 1941", for 65 stations in Norway. Table C indicates that the minimum temperatures in January 1941 were the coldest ones ever observed at these stations. With regard to Norway this means that the cold area was actually in Southern Norway only, and the record breaking cold centre had been close to the Oslo region[1].

Hesselberg and Birkeland's paper points out that the cold temperatures in January and February had caused difficulties due to ice in February. A photo in the book with the caption 'The ice conditions in Skagerrak, 2 km south of the lighthouse Lille Torungen on 25th January 1941' shows outright polar conditions. How it looked in February is not photographed. But according to Danish ice observations, the whole Kattegat and western part of the Baltic Sea was frozen solid on 30th January 1941, but ice retreated immediately thereafter[2].

Choosing Norway to 'represent' the second arctic war winter of 1940/41 in Northern Europe aims at linking the war at sea activities with the harsh winter conditions there. While this has been done in great detail in respect of first war winter of1939/40 (2_11), the second winter must do with much less details for the following three principal reasons:

--Only during the first war months were the seawater bodies and atmospheric conditions in the same status as reflected in the climate data records;
--The first 'clash' between the natural status and war activities may more readily show a 'surprising' or unexpected deviation from the average. An attempt to explain this was made in chapter "Cyclones and shells" (2_21);
--After 15 months at war, the extent and magnitude of warfare had become more difficult to summarize or to pinpoint in specific directions, although the war was still very closely bound to Europe's realm.

But if precision work takes a long way for explaining, looking for the hammer may do, sometimes. The hammer in this case is the German invasion and occupation of Norway from April to June 1941 and the ongoing fighting in the seas along the Norwegian coast, from the Skagerrak to the North Cape. Only half a year later Norway, with a long tradition of weather observation, experienced temperatures never recorded before. After all, Norway has more than 2,000 km of coastline along

[1] Hesselberg & Birkeland [2] Det Danske

the North Atlantic, and the warm Atlantic Gulf current flows along its entire western coastline. Suddenly Norway recorded its coldest temperatures since recording had started. A natural event was not in sight. A coincidence seems impossible.

On the other hand, restricting the assessment of the war impact to the Norwegian 'ice-age' conditions to the "hammer method" does not mean that this relationship can only be proved this way. On the contrary! One day that will be due. But as explained in the 'principal reasons' (above) this requires an even more analytical precision together with computer modelling. For the purpose of the current investigation, it is enough to provide convincing facts that a link between the arctic January 1941 weather in Norway and the war activities may (or must) exist. Alternatively, this 'coincidence' cannot be just brushed aside, but requires a convincing explanation.

The War at Sea during the Year 1940 and the "Weseruebung"

Conditions in general

In summer 1940 Germany invaded a number of countries, viz. Denmark, Norway, Benelux and France thereby getting access to ports and naval bases in Norway and France, with immediate or short distance access to the Atlantic. While the Baltic Sea had not been affected during 1940 the North Sea was an aggressive battleground. Rohwer[3] recorded some 120 major activities involving several dozen naval ships and hundreds of bomber and fighter planes. While some of the events were recorded, other events such as the laying of the thousands of sea mines, the considerable number of ships which fell prey to sea mines, the thousands of depth charges that were dropped in the sea, or the hundreds of aerial bombardments, etc went unrecorded.

How tense the situation in the North Sea had been during the year can be well illustrated by a German mining operation at the Thames estuary from December 12-19, 1940. In a total of about 150 air plane missions, 300 sea mines were placed to which 12 ships, with together 20.675 tons, fell prey and sunk before years end[4].

During the year 1940, naval activities moved more and more into the Atlantic and the Mediterranean Sea. In this respect it seems remarkable that continental high air pressure could take control over the Northern Atlantic from December 21-27. At least the North Sea was quite obviously not in a position to resist the advance of the continental air. Before that happened the North Sea saw a lot of fighting which included the invasion and occupation of Norway for two months. When Hitler ordered the invasion of Denmark and Norway in early April 1940, virtually the whole German Navy was

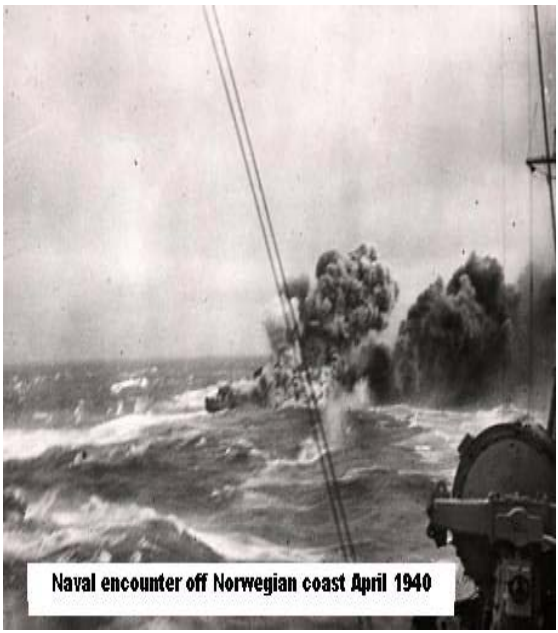
[3] Rohwer [4] Rohwer

assembled for participation in the undertaking "Weseruebung", also known as "Norwegian Campaign".

Norwegian Campaign / "Weseruebung"

Rationale behind the Invasion: Germany was dependent up on ore from North Scandinavia for its war efforts. The way through the Baltic Sea or via Narvik Port only was vital for the German ore transport. In winter when the Baltic Sea was frozen, only the way over Narvik was open, which was either a very risky or required substantial naval escort. As early as in 1938 the import of 22 million tons of ore was needed. This required ca 5-7,000 ship movements either way per year or about 600 per month. When Hitler feared that the Allies would capture Narvik and the ore mines, the invasion started on April 9th, and ended on June 10th , 1940.

Invasion plan: The invasion was to take place from Oslo to Narvik in one move. A minimum of six locations were targeted, including the two cities already named, and Kristiansand (Skagerrak), Stavanger, Bergen, Trondheim, covering a distance about 2,000 km, with numerous fjords, bights, islands and rocks.



Naval Forces: During the campaign until June 1940, presumably 80 to 120 naval vessels and ca.1,000 airplanes had been available in the service of the parties at war. Although the Norwegian Navy was small, it was able to lay sea mines with their fleet of a dozen mine layers and utilising installed coastal batteries at a number of locations. A well-known act by the Norwegian Navy is the sinking of the heavy cruiser *Blücher* with old 28cm guns and torpedoes when she attempted to enter the Oslo fjord.

First battle: In the First Battle of Narvik on April 10th, 1940, five Royal Navy destroyers entered the harbour of Narvik where five destroyers of the

Kriegsmarine were seriously damaged, thereof two sunk. Six other German ships were also sunk. And also two British destroyers sank.

Support vessels: Material and ammunition needed by the German forces were to be transported to various locations by about 50 vessels, with a total capacity of 250,000 tons. Loss of ships and tonnage amounted to about 20% of the total available ships/tonnage including two tank ships of 6,000 tons during the campaign.

Military activities: The Number of activities or events really runs into many thousands. Rohwer[5] has listed about 100 major events. The Allies, consisting of British, French and Polish personnel, were shipped in considerable numbers to Norway. Following the occupation of Narvik by German troops, 25,000 Allies soldiers were evacuated in early June. Three major encounters took place at Narvik and approaches (Vestfjorden) to the port on 10 – 13 April and on June 8 involving up to two dozen bigger naval vessels each time, with serious losses on both sides. The Campaign ended on June 10. During the struggle extending to two months a total of 34 naval vessels of about 500,000 tons including 9 submarines, 19 destroyers or bigger ships were sunk or damaged. The loss of naval vessels was equal on both sides.

Meteorological Situation – Northern Europe – 1940

General weather conditions

In Sweden the winter of 1939/40 was over by the end of March with lively cyclone activities and ample precipitation. End of April to mid June saw fine weather with no rain, followed by cyclone activities with plenty of rain in September. After some varying air pressures with the start of the next winter a mighty high pressure was established above Scandinavia which controlled the weather until the end of the year[6].

Some striking features were observed in respect of the British Isles, e.g. January 1940 was probably the coldest in 100 years, followed by a very dull February with a very cold week. After that, it was warm with a few cold spells followed by a cool and showery July. August and early September were dominated by a cool moist weather after which the conditions were not far from the average until end of November[7]. The year can be summarized even more shortly by noting that the means at Greenwich for the whole year was below the 75 years' average[8].

[5] Rohwer [6] Statens [7] Gunton
[8] Dines

In Germany the North and East showed a negative deviation of 1.4°C from the long-term annual average, the West and South only 0.9°C, due particularly to the cold January and February. Compared to months of August and September (North Germany only), October and December were 1-3°C colder than average. Only July and November showed positive anomalies.
Precipitation was high in South and West Germany; in March, July, and September and November with 200% at times and in July even 300% above average. North Germany, particularly the Eastern part, was extremely dry in some cases[9].

In summary it seems quite obvious that the war conditions 'forced' the autumn weather into a similar pattern as during the few war months in late 1939, creating continental conditions over Southern Scandinavia and Northern Germany. Due to activities in the North and Baltic Sea, during which the seas released more vapour than usual, the result was the penetration by north-easterly winds that pushed the humid air to more southern regions. As a further result, the ongoing war in southwest Europe (producing condensation nuclei) together with the southward pushing of heavier continental air forced the atmosphere to precipitate much more than normal. This situation is similar to that in autumn 1939 and therefore does not need to be repeated here.

Winter 1940/41

The conditions of the war winter of 1940/41 are easy to explain. Even though the winter was very cold it did not equal that of 1939/40 (Germany, Holland, Britain) or the third war winter of 1941/42, particularly in Sweden (A), Denmark and Holland. In Germany the winter of 1940/41 ranked 20 among about 150; in Holland it ranked 33 among about 150 'ice winters' between 1706 and 1946[10]; and in Sweden it ranked 23 among the cold winters since 1757, the while winter of 1939/40 was in place 9 or 10[11]. A reasonable explanation for the "mildness" of this winter (1940/41) is that the Baltic Sea was not used as a battle ground during 1940 and was left 'undisturbed' for some months. With the start of "Barbarossa" by invading Russia in June 1941 the Baltic Sea experienced its ultimate climatic drama, possibly the most spectacular regional weather modification experiment of all times. Concerning Northern Europe, during 1940, the North Sea had to bear main regional sea war activities, which had significant impact on the record cold temperatures in Norway.

Further details: (A) Stockholm's record, 3_23.

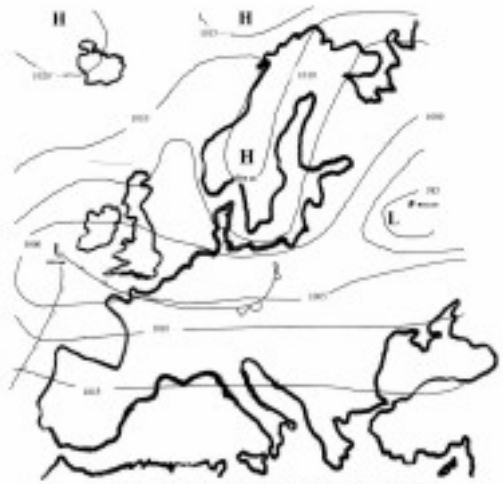
[9] Witterungsbericht [10] Labrijn [11] Österman

Sweden, Denmark and Germany - winter 1940/41 weather

December 1940

Sweden, December 1940: During the first few days of the month a number of depressions moved in an easterly direction north of Scandinavia. On 5th a strong cyclone moved to Götaland (South Sweden) and strengthened there with plenty of rain all over the country. This was followed by a mighty anti-cyclone over Scandinavia for the rest of the month. Due to cyclonic activities in the north, the high pressure area temporarily moved south followed by the formation of a secondary low pressure over middle Sweden on 29th bringing plentiful snowfall to southern Norrland[12].

Denmark, December 1940: Frost that began just before the middle of December caused icing, which started at the Northern coast of Lolland and a little bit later, among others, at some fjords in Eastern Jutland and in the Isefjord. No noticeable harm to shipping, however, was observed anywhere during this month[13]. Five light vessels in service in the Kattegat and Belts reported freezing temperatures on most days from December 12 until the end of the month[14].



Weather map of December 31, 1940

Germany, December 1940: December was too cold and, with the exception of Northwest and Central Germany, too dry. Daily mean temperatures, except for December 3 – 10, were far too low with negative anomalies of about 1.5°C at the coastal regions and 5°C in the Dresden region. Frost and ice days had been 5-10 above average. There was a declining precipitation from west to east (100 – 200mm/20-30mm)[15].

[12] Statens [13] Det Danske [14] Danish Light Vessels
[15] Witterungsbericht

German Daily Weather Charts

December 1940[16]

2 December 1940; A chain of high pressure centres (1,030mb) stretched from the Azores to Ukraine, causing serious freezing temperatures in Madrid, Marseille, France (Paris -9°) and middle Europe.

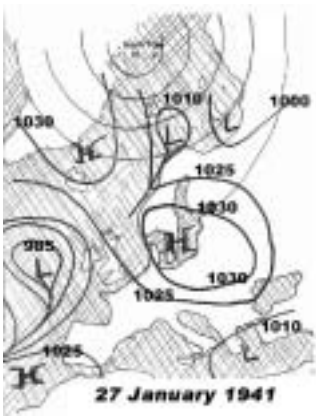
9 December; Europe under the influence of a low cyclone East of Ireland and a low-pressure area East of the Baltic countries. Anti cyclone in the West of Portugal.

15 December; High pressures (1,035mb) over Spain and Baltic countries, preventing Atlantic low pressure systems from reaching the continent.

21 December; A very mighty high pressure area (1,045mb) over South Norway (Oslo -17°, Copenhagen -11°, Hamburg -11°, Gdansk -1°, Helsinki -5°), covers the whole of Europe.

24 December; High pressure area (1,040mb) moved to the north of Scotland and stretched far north and the whole of Europe up to the Mediterranean shores.

26 December; While the high pressure area stretches from Central/SW Europe, Britain (centre with 1,035mb), Iceland to Greenland, a small cyclone (1,020mb) was active over the Skagerrak/Kattegat, another low pressure north of the North Cape (990mb) influenced the whole of Scandinavia.



--27 December; High-pressure centre (1,045mb) west of Britain (and over Rumania, 1,030); low pressure (985mb) over the White Sea (North Russia).

--28 December; The dominating high pressure area (1,035mb) moved to the Bay of Biscay, on 29 December to France, and 'disappeared' in the Mediterranean on 30th. Correspondingly Northern Scandinavia and Finland were under a low pressure influence with a low pressure centre (995mb) over Stockholm; and on 30 December a low (1,000mb) lay in the Eastern North Sea and another

[16] Seewarte

low (975mb) East of the Baltic countries. High pressure north of Iceland and in the Mediterranean.

31 December; High pressure prevails in the North (Greenland / Barents Sea) with a centre (1,010mb) north of Oslo (Oslo, -8°, Helsinki and Königsberg -15°, Berlin +2°, Frankfurt +7°, Paris +6°), while a low (995mb) SW of Ireland moved south easterly.

January 1941

Sweden, January 1941: The month started with a high over Norrland that brought cold air from the Northeast to the southern and middle parts of the country, deepening continuously while moving in the direction of Svealand and Götaland to stay there, on the 6th pushing extreme cold air to these parts of the country. At the same time a mild westerly air current crossed Norrland in association with a low pressure that moved in easterly direction in the north of Scandinavia. The air pressure was high above the west and southwesterly Scandinavia and low in the East, whereby initially warmer air from NW and N moved to the middle and southern parts of the country. The period between 11th and 21st varied by an exchange of weak low and weak high pressure. On 13th/14th a cyclone with corresponding a precipitation area crossed from NW to the middle part of the country, while a high pressure was stationary over northerly Sweden with extreme cold in company. On 21st another high formed over Norrland, moving thereafter to the southern and central parts of the country to stay there until the end of the month, generating extreme cold, especially after 26th. Together with a cyclone in the south of Sweden the anti-cyclone caused a continuous sharp E-NE wind in Götaland from 21st to 24th , temporarily with plenty of snow in the southern parts of the country[17].

In January 1941, southern and middle parts of Sweden had been colder than during January 1940, and in some locations colder than even 1860, when most of the meteorological stations in the country had been commissioned. The greatest heat deficit was observed in the inner parts of Götaland and northern Dalarna. Even in South Sweden severe night frost of -20°C and more was observed which, comparatively, is a very rare occurrence[18].

[17] Statens [18] Österman [19] Det Danske

Denmark, January 1941: Denmark recorded the coldest January since 1874. With regard to 'lower than average' water temperature or too cold water in the Skagerrak. Of particular interest is the fact that Northern Jutland recorded varying temperatures from –20 to –28°C, while Southern Jutland was about six degrees 'warmer', recording –16° to –22°C. January 1941 also served Denmark with the record temperature of –30.3C°[19], measured near Viborg station on January 29. It was the lowest temperature measured at the stations of the Danish Meteorological Institute. Until then the lowest temperature recorded was –29,6°C, measured on January 17, 1893 in Holbaek[20].

All light vessels were withdrawn from service south of Copenhagen between 4th and 16th January due to ice formation and until the end of March except the vessel *Drogden*. *Drogden* reported from 1 January to 7 February 1940 permanent freezing temperatures, the lowest being –11.5°C (26 January) and –12.7°C (5 February)[21].

Germany, January 1941: January was considerably too cold and, with the exception of large parts of Northern Germany, too wet. With the advance of a Nordic high-pressure area over Scandinavia at the start of the month, temperatures decreased 10-14°C below average, which caused lively NE winds bring considerable snow. Around 6th the high moved to Scottish waters. A depression in the Barents Sea brought a mild warming to East Prussia and Silesia from 10-13 January. Thereafter two part-depressions formed, one along the Norwegian coast and the other in the Adriatic Sea, bringing more snow again, except to the Northwest of the Reich (Helgoland Bight). Subtropical air arrived via the English Channel with an Atlantic depression on 19th, with a strong thaw for a few days, until cold air from a Greenland high pressure area advanced to middle Europe, moving the frost line from the river Elbe into France generating 14-15°C below usual means since 26th. A cyclone in the Channel region since 27th was not able to end the freezing period before month's end[22].

Comment: Both Swedish and German meteorological analysis show clearly that the Atlantic 'weather kitchen' was working. However, the West Drift directed the cyclones eastwards either via the Barents Sea or south of the British Isles towards the Mediterranean. Particularly interesting is the low-pressure area coming down from Murmansk with warmer air for eastern Germany just before the middle of the month, while another cyclone arrived from the Adriatic Sea just a few days later. It demonstrates clearly that the

[20] Det Danske [21] Danish Light Vessels [22] Witterungsbericht

Baltic Sea still had some heat in store. All these together with the move of the initial high-pressure area to Scotland on 6th January demonstrated almost perfectly that the northern North Sea was 'unusually' cold, particularly the Skagerrak and Kattegat. This attracted and sustained arctic air conditions, forming the basis for producing record low temperatures in Southern Norway, and establishing the 'glacial axis' from Stockholm to London. After all, no January since meteorological observations were first recorded in 1860, had reached such low mean temperatures in northern Dalarna and Värmland and the inner Götaland[23]. All of these regions are close to the Norwegian capital Oslo, which fact should not be ignored. Actually, average temperatures in January 1941 had been the lowest since 1914[24]. But particularly the temperature data from Denmark strongly indicate that for the winter 1940/41 Skagerrak was the 'cold bowl' which stretched actually – as already mentioned - from Stockholm to London.

Norway – The Making of Record Temperatures

Monthly mean air temperature in Norway in January 1941

The last time Norway had uniform winter conditions from the North Cape to the Skagerrak presumably ended with the Ice Age. Its long coast bordering the North Atlantic and its coastal water hosting warm Gulf currents make it virtually impossible for stable winter conditions to prevail for two or three months, as is common in inner continental regions. The winter of 1940/41 proved it again. Conditions between North and South Norway were significantly different. Generally speaking, the North was normal, while the South recorded great anomalies. While the North, north of Bergen, deviated in January 1941 from the average monthly means only by 1-3°C, the Southern region deviated toward the Atlantic coastal side by -5 to -9°C and in the Oslofjord and north of the Oslo region between –6 to -12°C from monthly means[25].

- Oslo/Blindern is recorded with –8.3°C;
- As, a few miles south of Oslo with – 9.6°C;

[23] Statens [24] Östermann [25] Jahrbuch Norweg. Met. Inst

- Ferder at the entrance to the Oslofjord with -7°C;
- Lyngor (between Ferder and Kristiansand) with –7.9°C, and
- Oksoy (near Kristansand) with –7.3°C.

At the western coast close to Stavanger, what is particularly remarkable is the temperature deviation of -10.7°C at Sauda, a station in the interior of the Boknafjord, approximately 100 km inland from the open sea, while two other stations close to the sea, viz. Klepp and Skudenes, differed from the mean monthly average by –6.5°C and –4.9°C respectively.

Lowest temperatures at a number of stations in southern Norway – January 1941

South-East region (Oslo), in: °C. Source: Hesselberg & Birkeland

Roros, -47.5°	Lillehammer -27,1°	Eidsberge -29°	Brekke Sluse -30°	Kongsberg -31°
Rena, -36.2°	Modum -30.4°	Rade -34.6°	Freder -14.5°	Horten -20.8°

South-West region (Kristiansand – Stavanger), in: °C.

Torungen, -19°	Kristiansand -21.5°	Lista -13.1°	Saudo -22.4°	Svandalsflona -23°
Tonstad, -26.6°	Skudenes -12.8°	Utsira -9.1°	Fjaerland -22.3°	Ullensvang -13.4°

As they were not very cold, the Atlantic coast stations are not included in the list of stations from Stavanger up to the North Cape covering record lows, although Narvik is listed with –18.9°C and some places in the mountains, eg. Nrodli (–36°C), Dividalen (–29.1°C), Karasjok (–46°C), and Karpbukt (–33.9°C) at the Varangafjorden (at the border to Russia).

Signals from sea water temperatures – difficulty to establish

From a climatic viewpoint it can prove disastrous to 'stir and mix' different temperate water levels, as this might have an immediate or long-term effect on the processes and the status of the atmosphere. Due to the complex sea water current system all along the Norwegian coast, it is extremely difficult to assess the available sea water data for their short-term impact.

Nevertheless, the next two sections will not refrain from attempting this in full realization that this does not meet with conventional research standards, but only aims to explain certain specific conditions in Norway's coastal waters, which could significantly have contributed to the record temperatures. The following investigation seeks only to indicate that military activities had an impact on the sea water temperature structure. The section will assess the

situation at the Skagerrak south of Oslo. Thereafter data records on deep-water temperature measurements at four Norwegian stations are briefly explained and discussed.

Water temperature in the Skagerrak – Norwegian coast

As it has been shown that the Oslo region was the cold-centre between the North Sea, North Scandinavia, and the Baltic Sea, it seems reasonable to look at the Skagerrak for some clues as to why Oslo and not another place received the 'cold hit'. For a more than 100 km wide zone along the coast from Oslo to the Lofoten (Narvik) there is no sea area as deep as the Skagerrak. Deeper water levels of the Skagerrak are possibly the most 'unmoved' of all deeper water bodies along the coast, at least on the basis of records of a few months.
Sea-surface temperatures taken by coastal stations are available in respect of the Northern Skagerrak. Seawards a very narrow coastal water strip between Ferder and Kristiansand, Skagerrak is 200 to 700 metres deep. Water is permanently cold below the level of 100-150 metres. A comparison between average water temperatures at two Skagerrak stations, viz. Ferder and Torungen Fry for the years 1935-39 and 1940 (June to December) will be made.

1937-1939 Sea surface water temperature – Ferder & Torungen Fry, in °C.

Station		May	June	July	Aug	Sept	Oct	Nov	Dec
Ferder	1939	10.7	14.7	16.9	19.4	17.5	10.3	6.5	3.0
	1938	9.2	13.2	17.2	19.4	15.5	12.3	9.4	5.5
	1937	11.2	14.7	19.0	20.2	15.8	12.1	8.4	2.6
Sum total		31.1	42.6	53.1	59.0	48.8	34.7	24.3	11.1
Mean total		10.4	14.2	17.7	19.6	16.3	11.6	8.1	3.7
Torungen	1939	9.7	12.5	15.3	17.8	16.4	9.9	7.0	4.0
Fry	1938	8.4	11.8	15.4	17.8	15.0	11.9	9.5	6.0
	1937	9.0	13.0	17.1	19.1	14.6	12.0	8.2	3.3
Sum total		27.1	37.3	47.8	54.7	46.0	33.8	24.7	13.3
Mean total		9.0	12.4	15.9	18.2	15.3	11.3	8.2	4.3

Station	May	June	July	Aug	Sept	Oct	Nov	Dec
Ferder								
Means *)	9.3	14.4	17.1	17.0	14.4	10.6	7.0	3.9
1937-39	10.4	14.2	17.7	19.6	16.3	11.6	8.1	3.7
1940	10.0	17.1	18.2	**16.9**	**13.2**	**9.9**	**6.3**	4.0
Torungen								
Means *)	8.2	12.7	15.4	15.7	13.7	10.5	7.1	4.4
1937-1939	9.0	12.4	15.9	18.2	15.3	11.3	8.2	4.3
1940	8.7	14.9	15.8	**15.5**	**12.3**	**9.7**	**6.3**	4.9
	Neutr.	warmer	neutral	colder	colder	colder	colder	Neutr.

*) Mean temperature 1871-30; Source: Frogner, Tables

The Table above indicates temperature fluctuations from August to November 1940. The water is already colder even before cold winter air covered the area. Almost two degrees of variation compared to corresponding periods of previous years is significant, indicating that military activities contributed to low temperature levels.

Since the invasion had ended in June, naval and aerial activities including the transport sector remained at high level along the coast. For more than one year the Kattegat, Skagerrak and Norway's coastal waters and fjords had been infested with thousands of mines laid by all parties to war; while mine sweepers were frequently or permanently operating to find and destroy enemy mines. In addition, presumably dozens, if not hundreds of depth charges were activated daily to hunt submarines or for protection from being targeted by enemy submarines.

Norwegian Directorate of Fisheries data series
(From 1935 –1943)

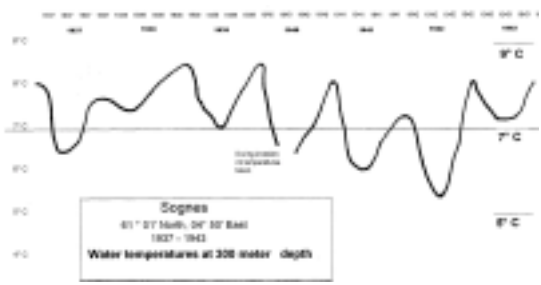
Only for a very short period the Directorate took water temperature measurements down to 300 metres at the following four stations during periods mentioned: Sognesjoen 1935-43 (near Bergen); Skrova 1937-43 and Eggum 1935-43, both at Vestfjorden, the approach to Narvik; and Ingöy, 1936-43 near the North Cape.

These short temperature series have been analysed by Frogner[26] in 1948, not only for formulating data tables for means during the observation period, but also for analysing the 'water situation' at those stations. He notes that the yearly periodic extremes are transmitted at Eggum and Ingöy fairly quickly from the surface to the bottom. At Eggum the minimum near the bottom (200 m depth) is reached in the beginning of May. At both places the bottom water seems to originate partly from the sea outside, and is influenced only partly by vertical exchange.

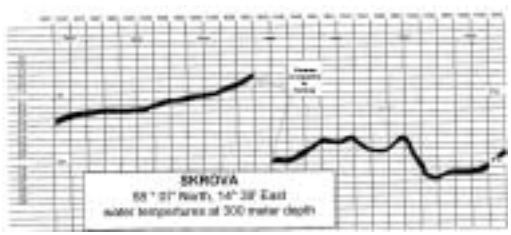
Stations at Sognesjoen (Sögnes) and Skrova have a more sheltered position than the other two and accordingly they show great difference in the vertical temperature distribution, whereby Sognesjöen seems to have a boundary level at about 100 m depth, and Skrova one at about 200 m depth. (ditto).

This investigation relied mainly on available data record of the deepest level (200/300m). Principal observations for three stations are briefly summarized as follows:

Ingöy (300m): The seasonal variation is high (~ 2°C), whereby the highest drop seemed to have occurred from about October 1939 until June 1940 by ca. 3°C, as against the usual 2°C. The deepest mark was reached in June 1941. There was a 1°C lower period, which lasted from about June 1940 to 1943. Whether the first drop in winter 1939/40 is in any way related to the Finnish-Russian war is impossible to answer here, although a number of naval activities took place in proximity of the North Cape at that time. Since December 1940 at the latest, quite a lot of activities had taken place in the very North from the North Cape to Murmansk. The second drop during winter 1940/41 could well have its origin in military activities in the Norwegian Sea or along the coast of Norway.



Records at the stations Eggum (200 m) and Sögnes (300 m), show a very small negative deviation from about June 1940 to June 1942. For Eggum this is hardly traceable. For Sögnes (temperatures had not been taken from April to July 1940) a significant low level was reached in June 1942. For three summers, i.e. 1940-42, temperatures were lower than average, while a significant positive jump (ca. 2°C, from 1942 level) occurred in 1943.



Most significant data records for the thesis of this investigation are those from Skrova (300 m) (68°07' North, 14°39'East). The importance of this observation derives from the fact that the water at the depth of 300 m is almost totally unaffected by seasonal variations, at the most, 0.2°C. From January 1937 (6.8°C) until March 1940 (7.3°C), the temperatures increased. The recording of temperatures was stopped from 30 March to 22 June 1940. When the recording resumed, the temperatures had dropped by more than one degree to 6°C, followed by temperatures within a range of 6.4 to 5.7°C until the series ended.

The same situation can be observed at Skrova at 200 metre level. As Frogner[27] already observed, the seasonal vertical distribution did not reach the 200 m level, the temperature stayed steady in a range of 1°C. Between April and June 1940 also the 200 m level temperature saw a sharp drop of one degree. Again a similar drop occurred during the time of invasion, and the decrease continued, on an even level, until the series ended in 1943.

This very significant change clearly indicates the cause, viz. numerous military activities, particularly the three major events close to Narvik (see above). On the other hand, one can assume with certainty that this temperature change at depths of 300 m and 200 m will hardly reveal a traceable impact on the arctic record temperature in Oslo just half a year later. In the case of Skrova it may take much more than half a year. But there were thousands of other places along the Norwegian coast and inside of many fjords, particularly in the south of Norway and the Skagerrak, to stir and mix warm and cold water levels that eventually invited a powerful high pressure to take control over Scandinavia and the Northern North Sea from mid December 1940 and January 1941.

At least two conclusions can reasonably be drawn from the Skrova case. If warm bottom water is replaced by colder water, the replaced warm water must emerge on a higher level and subsequently would 'warm up' the upper levels. If this happens within a short period of time, simultaneously at many places and many thousand times, the weather may alter its course or wreak 'havoc'.

Sea Ice Coverage

The Hesselberg paper[28] makes only one reference to heavy ice conditions in the Skagerrak with a photo. The photo shows ice conditions 2 kms south of Lille Torungen on 25th January 1941. That is a very significant information, but hardly enough to get a broader picture. Whether it will be possible to complete the picture one day remains to be seen. However, the appearance of so severe ice and at a fairly early time was an extraordinary event and can be

[28] Frogner [29] Hesselberg & Birkeland

proved by looking across the Skagerrak at the ice conditions in Denmark's Kattegat. The formation of solid ice as such so suddenly can only happen after the sea water has been cooled out down to deeper levels and far below the average mean temperature.

Studied on the basis of the German coast on the North and Baltic Sea[29], the winter of 1940/41 ranks fourth among the most icy winters over a period of 45 years. During the whole winter period the ice production was about 25% less in 1940/41 than in the year before, the most extreme ice winter since 1903 until then. But also the next war winter of1941/42 became a heavy ice winter, but remained, in respect of the Kattegat, less icy than the first two war winters. Therefore the discussion here will be confined to the first and second war winters.

A comparison of detailed ice charts prepared by the Danish Meteorological Institute[30] shows clearly that the extent of area covered by ice in 1939/40 was much larger and extended from the Kattegat to the Skagerrak. However, this happened only during the period from about 8th February until the end of the month. In 1940/41, however, solid ice did not extend northwards beyond Skagen and the Kattegat.

What is remarkable here is that the formation of ice started about 14 days earlier than usual in 1940/41 and covered the whole Kattegat on 30 January, and reached its peak on 6th February 1941[31]. In the winter of 1940/41, at the Swedish West coast (Kattegat) ice formed two weeks earlier than expected[32]. However, in respect of the winter of 1939/40 the ice formation had occurred two weeks later than expected. One year earlier, in 1940, only one-half of the Kattegat had been frozen over by 2nd February. It should be further noted, that the high ranking of the winter 1940/41 in the list of heavy sea ice winters derives mainly from the extensive solid icing of the Kattegat.

[30] Nusser, Eisverhaeltnisse [31] Det Danske [32] Jurva & Palosuo
[33] Östermann

Summary on Norwegian water temperatures

Norwegian coastal sea water temperatures have to be seen in the wider perspective of the whole North Sea, including the Skagerrak and Kattegat. As the extreme sea water icing process started and quickly reached a maximum in the Oslo Fjord, the Skagerrak and Kattegat region. This provides a strong indication that extraordinary low water temperature conditions must have existed between Kiel, Copenhagen and Oslo. This should not come as too big a surprise. Since Germany had occupied Denmark and Norway, the German Navy was no longer interested in minefields in the Western Baltic, the Belts, the Kattegat and Skagerrak as far as the transport connection to Oslo and Norway was

Western Baltic Sea winter 1940/41

concerned and the Germans presumably swept many mine fields. In addition transport and naval communication had to be sound between Kiel and Oslo, requiring protective measures all the way.
All these activities must have caused a constant and considerable 'stir, mix or turn-over' of sea water from the surface to lower levels. Early and immediate solid ice coverage of the Kattegat strongly supports this assumption.

Analysis of sea water temperature data also supports this thesis. Military activities at sea, subsequent sea water conditions of the region and the following winter conditions can be reasonably linked together.

Conclusion

The ‘emergence and prevalence’ of the extreme cold winter of 1940/41 enabled this thesis to allege a connection between major climatic changes and war at sea, even though the winter of 1940/41 is by far not the most significant piece of evidence to prove this but is only a very helpful and interesting one.

Viewing from different perspectives, it can be safely assumed that military contribution, excessive rain, air circulation, movement of air pressure systems etc. might have had a direct bearing on the extraordinary conditions in the first war winter of 1939/40 in Northern Europe. In respect of the winter of 1940/41, it would be prudent to concentrate on only one major outcome of the winter, i.e. the extreme conditions at the Oslo region including the Skagerrak, SW Sweden, and Northern Denmark. Here the ‘sky opened’ and extreme cold air poured down en masse. This happens if a sea area is no longer in a position to ‘play its part in climatically defined terms of mean average conditions’, or in physical terms, the sea is no longer able to transmit enough energy in the form of vapour to the atmosphere. The North Sea, Skagerrak and Kattegat, had been transformed into such a situation in late 1940, presumably due to the war at sea.

Strongest support for this argument derives from the fact that Northern Scandinavia showed, according to principal meteorological criteria, that the weather was running close to normal conditions. The cold and deep waters of the Skagerrak were the principal cause to bring record cold temperatures to South Norway, Southwest Sweden and North Denmark. A comparable signal came from the eastern Baltic Sea area, where it was very cold but not extreme cold. At least, it seemed that the Baltic Sea clearly was not a major contributor to the harsh winter. The position was different in respect of the first and third war winters. It is therefore particularly important to note, that while the Baltic Sea was in principle left ‘undisturbed’ during 1940, it prevented Sweden (except for the inner regions close to Oslo; parts of Götaland and Dalarna) from being also dragged into the record-extreme conditions. That happened the next year (A), and possibly even much worse than Southern Norway had experienced.

Further details: (A) Stockholm record winter, 3_23.

The invasion of Norway was only a small fraction of the war activities at sea during 1940. But a major portion of all sea borne activities along Norway’s coast from April to December 1940 comprise those activities conducted in the whole North Sea over the same period. These activities, fully comparable with those during the first few months in late 1939, will have again dragged Northern Europe into an ice-age winter. Presumably, without the “Norwegian

Campaign" and the occupation of Denmark and Norway, and without 'intensive' use of the Kattegat, Skagerrak and other coastal waters of Norway, the Oslo region would surely have been spared of having record arctic cold conditions in January 1941.