Did the Extreme Winter of 1939/40 in Europe Initiate a Global Cooling?

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(2011, Fig.1 replaced)

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The winter 1939/40 marked one of the most decisive climatic shifts from a warming period since about the mid 19th Century to a ‚global cooling' (1940 to 1970). Although the winters in Europe had been getting milder since the Little Ice Age a number of locations in the realm of the North and Baltic Sea suddenly and unexpectedly experienced the coldest winter for more than 100 years. It concurred in time and location with the commencement of World War II when thousand of naval vessels were sent out to sea for war operations. It was as if a field experiment had been launched to test whether human activities in the marine environment can influence the weather and change the climate. Historical circumstances indicate that the experiment worked. They will be analyzed together with available temperature data series with the aim to identify the center and magnitude of changes as basis for a discussion of convincing links and evidential circumstances. The temperature profile for Europe in winter 1939/40 confirm that the structure of the freezing conditions point strongly to a noticeable contribution by human activities in the form of naval warfare.

Introduction

"Water is the driver of Nature"

Leonardo da Vinci regarded "water as the driver of nature". Was water the driver of a global cooling period during the last century? Actually, the thematic of the paper has its origin in the statement that "Climate is the continuation of the oceans" (Bernaerts, 1992:292, 1994:159) and whether human activities at sea in autumn and winter of 1939/40 could be called a large-scale field experiment in the marine environment which contributed to a period of global cooling. Although this will be explained in detail it might be helpful if the following notion would be met with sympathy: "Until one has experienced the sea around one, one has no idea of world and its relation to the world". (Goethe, 1787:3rd April)

The Surprising Arrival of an Extreme Winter

If one is aware what the word extreme with regard to the winter of 1939/40 means, the title of the paper is not too ambitious. After a long period of cooling from 1450 AD to about 1880, called the Little Ice Age, the world had been getting warmer, which suddenly stopped in winter of 1939/40. The British scientist at the Kew-Observatory, A. J. Drummond expressed his astonishment as early as 1943:

"The present century has been marked by such a widespread tendency towards mild winters that the 'old-fashioned winters', of which one had heard so much, seemed to have gone for ever. The sudden arrival at the end of 1939 of what was to be the beginning of a series of cold winters was therefore all the more surprising". (Drummond, 1943:17).

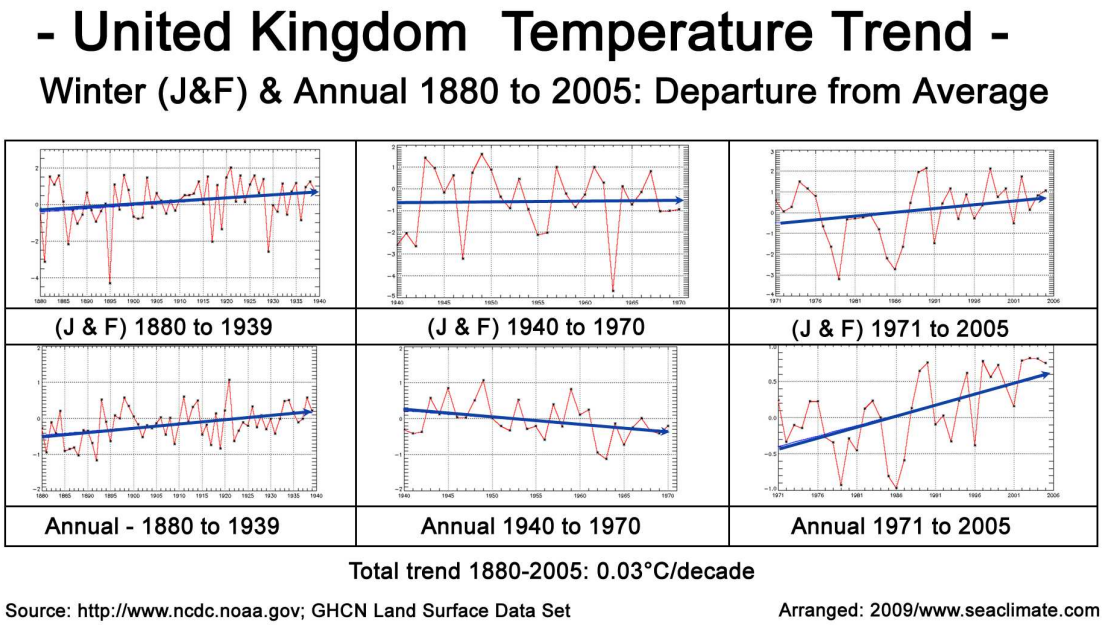

Figure 1: United Kingdom Jan/Feb-Trend, and Annual-Trend according global trends. 1880-1939 = warming; 1940-1970 = cooling; 1971-2005 = warming; (Data source: Nasa/Giss, 2009)

While it is necessary to highlight the unusualness of the first winter of World War II (WWII), it should be very clear that not the winter, but only a physic-dynamical force could have been a contributing factor. The word "winter" is used to describe general or statistical conditions, but it does not tell anything about the forces that changed the short or long term weather conditions. Speaking in so far about the winter of 1939/40, it actually means looking for the reasons that made this winter so exceptional, namely, whether the naval war which started on September 1, 1939 contributed to that.

Table 1: The Ranking of the War Winter of 1939/40 - Over a period of 300 years at Berlin-Tempelhof/Germany 1701- 1940; (Data source: Wetterzentrale, 2009)

Year	Coldest January	January + February	+ previous December	Coldest Dec/Jan/Feb
1709	-13.2°C	-13.2 (+) -6.9 = - 20,1°C	(Dec.1708) -4.6°C	- 24.7°C
1740		-8.5 (+) -7.3 = -15,8°C	(Dec.1739) +1.5°C	
1823	-11.6°C	-11.6 (+) -0.4 = -12,0°C	(Dec.1822) -2.2°C	
1830		-7.4 (+) -3.4 = -10.8°C	(Dec.1929) -8.5°C	-19.3°C
1838	-10.0°C	-10.0 (+) -4.6 = -14,6°C	(Dec. 1837) +0.7°C	
1929		-4.4 (+) -10.4 = -14,4°C	(Dec. 1928) -0.3°C	
1940	-9.6°C	-9.6 (+) -7.1 = -16.8°C	(Dec. 1939) -1.3°C	- 18.1°C
1940	Rank IV	Rank II	Rank app. (37th)	Rank III

Actually it was a winter on the level of the most severe European winters since systematic recording started around the year 1700.

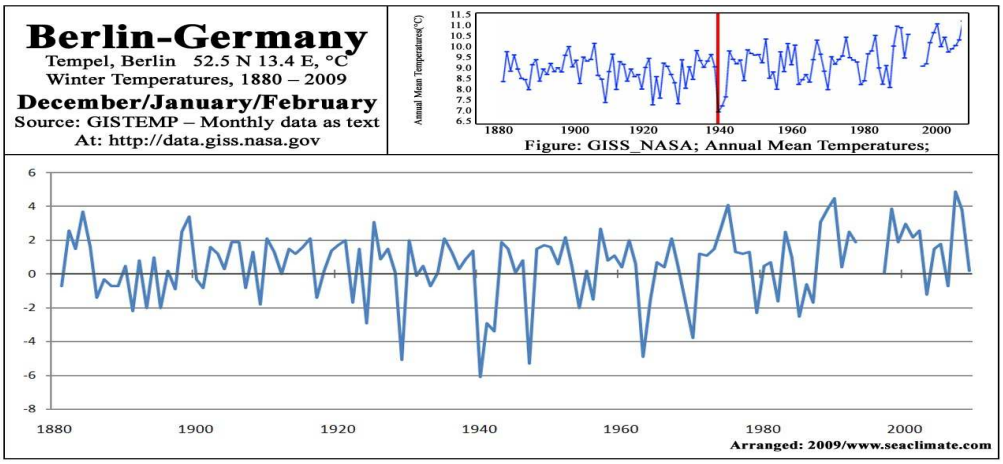

Figure 2: Winter temperatures (D/J/F) at Berlin-Tempelhof, from 1880 to 2006 (Data source: Nasa/Giss, 2009)

A station from Berlin-Tempelhof/Germany already recorded the famous winter 1708/09, see: (Table 1). It "must have been the coldest winter hitherto known in Central Europe" concluded a research paper of the German Weather Service some years ago (Lenke, 1964:3). The lowest temperatures recorded for January and February was just –10°C in 1709, following immediately the means of January and February 1940 with –8.4°C, see: (Table 1). However, the 18th century was part of the Little Ice Age and about two degrees colder as the 20th century. The years before the extreme winter 1708/09 had been almost three degrees colder than the winters prior the winter 1939/40, which resulted practically in a higher temperature difference of one degree colder towards the winter 1708/09, see: (Table 2).

Table 2: The actual temperature difference between the record winters 1709 and 1940 as observed at Berlin-Tempelhof (Data source: Wetterzentrale, 2009)

Year	JAN	FEB	Year	JAN	FEB		Year	JAN	FEB	Year	JAN	FEB
1701	-4.2	-1.5°C	1706	-3.4	-2.8°C		1932	1.7	-1.1°C	1937	-3.0	2.2°C
1702	2.0	-0.5°C	1707	-2.3	1.0°C		1933	-3.0	0.1°C	1938	1.8	1.9°C
1703	-2.8	-0.9°C	1708	1.4	-0.7°C		1934	1.2	2.7°C	1939	3.0	3.0°C
1704	-4.9	-0.5°C	Total mean 1701/08:				1935	-.5	2.6°C	Total mean 1932/39		
1705	-7.1	NN (-1)	**-1.75°C**				1936	3.3	0°C	**+1°C**		
1709 Jan: -13.2, Feb: -6.9 mean: -10.05°							1940 Jan: -9.6, Feb: -7.1 mean –8.35°					
Difference 1701/08 to 1709 = - 8.3°C							**Difference 1932/39 to 1940 = -9.35°C**					

Even though the extraordinary severity and suddenness of the 1939/40 winter deserves the highest attention, the primary goal of the paper is to seek an answer on, whether this winter, respectively those physic-dynamical forces that may have caused the conditions had any thing to do with the phase of the global cooling from 1940 to about the 1970s.

The Start of the Cooling Period

There had been a warming from around 1920-1940 (Houghton, 1990:214, 228). The winter 1939/40 marked a trend change from a warming period during the early 1900s to three decades of cooling. Usually the years from 1940 to the mid 1970s are indicated as phase of global cooling. The first IPCC report confirms that: "A cooling of the Northern Hemisphere occurred between the 1940s and the early 1970s" (Houghton, 1990:199), with the decrease of tempera-

tures from the late 1930s to the mid-1960s of about 0.2°C (Houghton 1990:207). But the strong correlation between the commencement of WWII and the climatic trend toward cooling does not necessarily say anything about the causation.

The Search for a Link

Concerning the question to what extent can a connection be established between the winter of 1939/40 and the longer lasting cooling, the key word is "initiated"? The word "initiate" may mean: to cause, to facilitate the beginning of, or originate. Having this objective in mind, the role of the winter of 1939/40 should be analyzed. This investigation requires outlining the main parameters concerning the rational of this research, the means of investigation, and the intended results. While the paper will restrict the investigation to the air temperatures during the winter of 1939/40, a brief introduction of the wider context shall first be given.

The wider context:

The global cooling and World War II started together. The war lasted six years, the cooling thirty years. From September 1939 until the early 1942, the major area for naval activities lay in Northern Europe. From thereon the naval war went global until the surrender of Japan in August of 1945. A possible source for the cooling was a change of the oceans and seas' state, to which the naval war might have contributed significantly.

Within this 6 year period of interaction between human activities at sea on one hand and the oceans and seas on the other hand, the period of about six months (from September 1st to March 1, 1940) is only a small fraction of the whole, but could have been crucial due to its suddenness, timing (winter season), magnitude, and confinement to the North Sea and Baltic. Moreover, if it is possible to establish that the harshness of the first war winter was not mere natural variability, but partly it had been caused by naval war activities, it would be easier to assess the wider implication of the other war years on the global cooling from 1940 to 1970.

The rational part of the investigation:

From an analytical point of view the winter of 1939/40 offers a unique situation. Since the 1st of September the belligerents sent thousand of naval ships into action, resulting in many thousands of other activities, e.g. daily shelling, sea mining, and bombing. Looking backward, one could call it a Grande Field Experiment at a narrow location (North Sea and Baltic) and time period (the autumn and winter season), which aimed to test the impact of the effected sea areas (weather and climate). As the influence of the sun above the latitude of 50°North (English Channel, Frankfurt a/M, Prague) is very much reduced during the winter months, the air temperatures all over Northern Europe are significantly influenced by the heat released from the North Sea and Baltic, which had been stored during the summer season. An earlier heat release than usually may show up in the air temperature data.

The aim and limits of the investigation:

The investigation is restricted to the winter conditions in Northern Europe as observed by air temperature. The need to review air instead of water temperatures stem from the fact that the latter, as far as available, are totally insufficient in number and quality for such an investigation. The investigation will fully concentrate on establishing a causal link between the prevailing winter air temperatures in Northern Europe and the naval war activities.

The paper will not raise other observations with a possible impact on the winter condition. There was, for example, a severe dryness in the USA during October and November and a heavy rainfall in an area stretching from Bavaria/Germany to Wales/England, from September

to November, with up to 300% above the average. This and other contributing aspects have been discussed elsewhere (Bernaerts, 2005:1f & 2008:1f).

The intended results:
Providing evidential circumstances that the severity of the winter 1939/40 has partly been caused by sea areas that saw most of the naval activities. A well established explanation for the sudden arrival of the winter 1939/40 is not only required to understand the reasons for the global cooling, but could be also a significant contribution to the climatic change issue.

The "Field Experiment" Conditions During the Winter of 1939/40

What is to be Said About the Cooling?
This so called "Field Experiment" could presumably be better highlighted as a clash between human activities and the common marine environment. The physics dynamics of large sea areas are suddenly and severely churned and turned by a huge array of anthropogenic activities. A decade later the winter of 1939/40 was viewed with some astonishment due to the "sudden reversal of the previous development, rather than a slow deceleration, contrary to the sustainment tendency of circulation and temperature deviation."(M. Rodewald, 1948:97). Another time witness had this to say:

- "the remarkable winter of 1939/40 was caused by a general disruption of circulation;
- The ultimate cause for the formation of such an extremely high atmospheric pressure over the entire polar region in January, in particular, still remains unknown to us today.
- So, there is still no plausible theory to explain the large inflow of cold air over the Arctic" (Scherhag, 1951:321).

Little has changed ever since. More recently NASA expert James Hansen explained that the cooling (1940 –1970) was due in part to natural variability, and also to the aerosols factor, which could even be the dominant cause (Herring, 2007:4). This explanation neglects one of the main aspects, at least in regard to the first war winter. Due to common understanding aerosols may have a cooling effect on the climate because they scatter and reflect sun rays back out into space. During the winter season, at higher latitudes, the incoming sunlight is too low to be significantly effected by the aerosol.

As far as it could be observed, there is only one attempt to provide an explanation directly connected to the three cold war winters by saying (excerpt): "the global climate anomaly in 1940 to 1942 - previously poorly documented - constitutes a key period for our understanding of large-scale climate variability and global El Nino effects."(Brönnimann, 2004:974). As this investigation scrutinizes the impact of human activities in Europe, the Brönnimann et al. thesis is a very different issue with little if any correlation to the matters here discussed. We refer to comments made elsewhere (Bernaerts, 2005:23,26).

A plausible theory is still missing. Not even the mentioned explanation pay any attention to the extraordinary situation which prevailed during the first war winter of 1939/40. This is not a question of any historical study, but of recognizing how climate functions, how it could suddenly change and what the underlying causes of such changes can be. In particular, did human activity play a small or even a major role in the occurrence of the most severe winter ever recorded in Central Europe, see: (Table 2)? The naval war in the autumn and winter of 1939/40 was an immense field activity which could have had a verifiable effect.

As we lack any direct results from the Field Experiment, e.g. the size and depths of the water areas effected by war, and which difference in water temperatures to the statistical mean emerged, we will describe the two general situations, which are on one hand the naval war fare and on the other hand the prevailing winter condition. We will draw a brief overview of the main area and intensity of naval activities during the first few war months and thereon about the general weather conditions in Europe during the winter of 1939/40. Underlining these two scenarios shall serve as basis to demonstrate the close or even evident contribution of the Field Experiment by a subsequent analysis of the observed data and information and its interconnection in the realm of the North Sea and Baltic.

An Unusual Physical Force for Early Release of the Summer Heat

Although naval war activities could be observed almost every where around the globe, and a loss by the Allies of about 50 cargo ships in the North Atlantic during the first four war months in 1939, the centre stretched from the Eastern part of the Baltic Sea to the Eastern Coast of Great Britain, from Dover to the Shetland Islands. It started with the German ambush on Poland at Gdansk with more than a dozen bigger war ships, three dozen smaller ships, and about 10 submarines on September 1st , 1939. The Polish fleet was small, but many coastal batteries were active until they were destroyed or when Poland surrendered in late September. It was an endless number and variance of naval activities that rocked the Baltic and the North Sea from the first day of war until the beginning of the first war winter.

Insofar as the sinking of about 170 sizable ships of the Allies cargo fleet around Great Britain and Northern Europe, respectively more than one ship per day until the end of the year can be regarded as 'peanuts' to what else happened. The German navy plastered the Bight of Helgoland (German Bight) with sea mines. In September the Kriegsmarine had employed several dozen ships to lay a huge mine filed from The Netherlands up to the Danish waters, and thereon even further north. The number is difficult to verify but the figure is presumably not less than 20,000, but could be as high as 100,000 during the first four months. The Kriegsmarine furthermore laid many thousand of sea mines in British waters and in the Baltic Sea. The Royal Navy was not less active during the first four war months. "British naval vessels are sowing some of the last mines needed to complete Great Britain's 30,000,000-pounds protective shield for east-coast shipping. The minefield extending from Kinnairds Head, Scotland, almost to the mouth of the Thames, is the most extensive field ever laid." (New York Times – NYT-, 11. Jan.1940). This could have meant another 20,000 to 100,000 sea mines in the North Sea. Such war with sea mines required the employment of many hundreds of mine sweepers. Even the neutral countries such as Denmark, Sweden, and Norway laid sea mine barrages and increased naval activities considerably.

Other threats came from the bombing of ships and the use of depth charges against submarines. It could have been causing many hundred if not thousand of explosions on a single day. Submarines were destroyed, and bombers and fighter planes were shot down. Since the end of November even the Gulf of Finland was fully included in the sea war area, after the Soviet Union attacked Finland by land, air, and sea operations.

Although the use of a huge diversity of weapons that churned and turned the sea surface layer manifold, the presumably most substantial alteration came from the cheer number of naval ships and boats operating at sea regardless of the type of mission. Particularly, the Baltic Sea, from Germany to the Baltic Countries, had suddenly seen activities which could have been easily twenty to fifty times higher than during pre-war times due to surveillance, fighting, training, transport etc.

All these activities during the first few war months took place when the relative shallow North Sea and Baltic loose more heat than they receive from the sun. The heat had been stored during the summer season until about the end of August, which is from thereon released into the atmosphere during the winter months. The process is usually slow, but may be considerably increased by wind. The higher the wind speed is, the quicker the release occurs. The more the sea surface layer is churned and turned about, the more quickly the stored heat is released into the atmosphere. The result is reflected in temperature statistics. However, in autumn of 1939 this common relation between the sea surface, atmosphere, and wind forces was severely effected by naval war operations. Even when the weather was calm, or there was only a modest wind, and the release of heat from the sea was low, the array of naval activities added a component to the marine environment that worked like the effects of the wind. If this was the case, it had to be proven with historical facts about weather condition and, subsequently, along with some temperature series.

Is the Plunge of Temperature Due to the Field Experiment?

After having explained where the main naval war activities took place during the initial war months, it shall now be shown that the geographical area corresponds with the deviation of temperatures from the mean. For this purpose it shall be proven that there is a central area, which is very close to the bulk of naval activities, while the wider area should show a less significant temperature deviation from the average. Correspondingly, we present the situation in two parts and thereon discuss the facts.

Record Cold Temperatures Between the Seas

Particularly the countries Denmark and Germany can be regarded as being placed in the middle between Great Britain and the Baltic Countries, respectively having a coastline at the North Sea as well as at the Baltic.

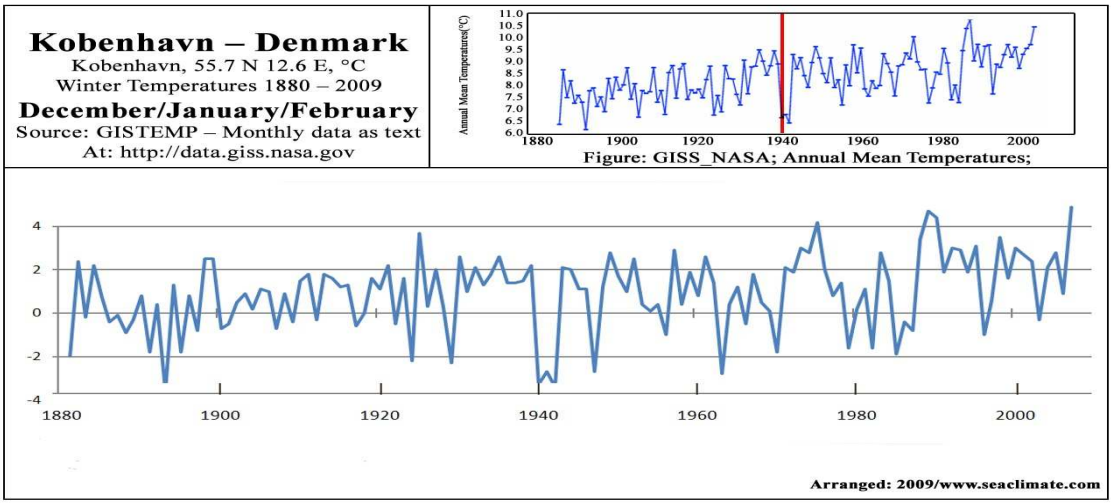

Figure 3: Winter temperatures (D/J/F) at Kopenhavn (Copenhagen), from 1880 to 2006 (Data source: Nasa/Giss)

Denmark:
The winter must have arrived very suddenly. Although the mean temperatures for December with +0.8°C had been quite usual, snowstorms had swept across Denmark before the end of December, 1939 (Frankfurter Zeitung, December 29). In the middle of January, the temperature fell to -26° C. In combination with heavy snowfall, this brought transport to a standstill in

many parts of the country. In the middle of February, the temperatures again fell to -25°C (NYT, January 18, 1940; NYT, 14 February 1940). It became quickly clear that is would become the most severe winter for Denmark since 1860, reported New York Times on February 15, 1940. Based on the three months J/F/M it was actually the third coldest since 1768, the year the recording commenced, and only surpassed by the years 1814 and 1838. The Danish Meteorology Service noted the following:

> "Indeed it must be stated that the winter of 1939/40 was unusually severe. Some frost occurred about the middle of December, interrupted, however, by a few mild days; the last week of the month was again cold and so was the first third of January. After a few mild days, especially the 13th –15th, a sudden fall of temperature set in and the thermometer remained upon low degrees until about the 22nd of February, when a decided change of weather came about. After the mentioned date, the weather was unsettled, but still often rather cold. The lowest temperatures noted were: December –22.2°C, in January –24.3°C, in February –27.4°C, and in March –22.4°C." (Det Danske, 1940:16)

From the nine Danish Light ships on station in the Sound and Belts in December 1939, the first to report freezing temperatures was the most northern station "Skagens Rev" (06-15 Dec.), followed by the about 250 km more southern stationed ship "Halsskov Rev" (15-20 Dec), while all light ships reported permanent freezing temperatures since December 26th. The lowest temperature was reported to be –6.3°C from "Lappegrund", about 50 km north of Copenhagen (Danish Light Vessels; 1940:65f).

Germany:

According to the report from the German Weather Service, which was published after the war had ended, a reshuffle of the general weather situation in Europe took place on the 5th of December. A high pressure bridge established itself stretching from Spain, via France, Germany to Scandinavia. While the overall December temperatures for Germany were 1-2 °C too cold, a negative deviation of 3°C to 2°C was observed along a stretch in North Germany from about Hannover to Dresden (Witterungsbericht, 1948). It remained a core freezing cell throughout the winter that culminated in February 1940, when the region had the highest deviation within a month in Central Europe, see Figure 18. What was special to this winter was that it started early and lasted longer, than other harsh winters, e.g. the famous winter of 1928/29, which was intense for a shorter time period. (Geiger, 1948:1) The preceding colder winter in North Germany had been 1828/29 as shown in Table 1. But even if the ranking is placed on the "cold-sum" of five winter months (November to March), the war winter of 1939/40 was second after the winter 1829/30, while 1928/29 with a late and extreme cold February (-10.4°C) in Berlin only came on third position (Lenke, 1964:4). The "cold-sum" for Berlin had been: for 1829/30 (-791°C); 1939/40 (-636°C); and 1928/29 (-503°C). The corresponding ranking at the city of Leipzig put the winter 1928/29 only on the fifth place as follows: for 1829/30 (-746°C); 1939/40 (-603°C); 1837/38 (-564°C), 1870/71 (-529°C) and 1928/29 (-502°C, (Geiger, 1947:4). The mean deviation in Central Europe for December to February 1939/40 is

shown in Figure 4, and the lowest temperatures recorded in Figure 6. The record plot – Figure 5 – from Eberswalde, a small city app. 50 km north-east of Berlin indicated the temperature profile from December 1939 to February 1940 (blue) from the long-term mean (red).

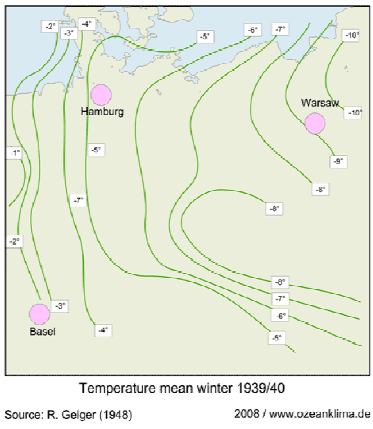

Figure 4 : Mean temperature (D-J-F) in central Europe 39/40, (Data: Geiger 1948:Abb.5)

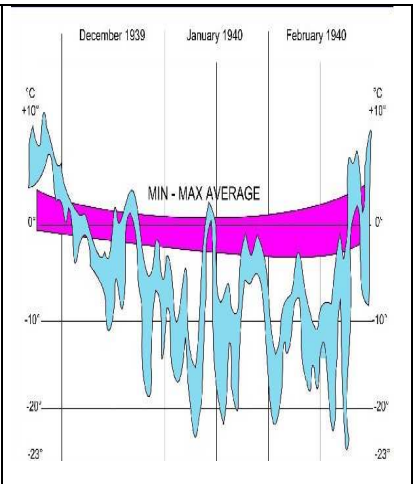

Figure 5: Mean temperature at Eberswalde, app. 50km NE of Berlin; (Data: Geiger 1948:Abb.1)

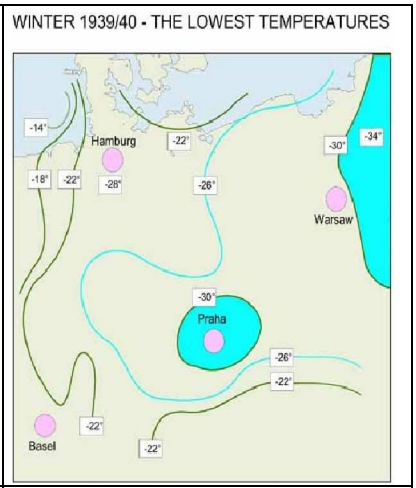

Figure 6: Lowest temperatures in winter 1939/40, (Data: Geiger 1948:Abb.3)

According to Geiger, the winter started in early December, whereby temperatures fell below the average daily mean first at North Sea stations on the 7th of December, and only a few days later in Silesia (12th December) which marked the arrival of winter, and the first cold phase (Geiger, 1948:5). The first sea ice in the German Bight, north of the river Elbe, was registered on the 15th of December staying until March 25th (Tönningen). From the Elbe to the Dutch boarder sea ice appeared on December 18th (Borkum island) lasting until mid March. Also in Hamburg the ice came early on December16th, and after about 90 ice-days the last ice disappeared between 16th and 18th of March. (Deutsches Hydrographisches Institut, 1961).

The last of the five cold phases that lasted from about the 9th to 22nd of February was particularly significant in The Netherlands and from there along all the northern parts of Germany up to the Baltic Countries (Geiger, 1947:4). In this respect it might be worth mentioning, that in Hamburg, the nearest mega city to the two seas, low temperatures fell below -20° C four times within a two-month period, dropping below -28°C on the 13th and on the 14th of February 1940, the coldest temperatures ever recorded in Hamburg. On the other hand, Karlsruhe, a city about 600 km south of Hamburg, recorded the absolute minimum with –25.4°C one month earlier, on January 18th, 1940 (Wetterzentrale, 2009). The meteorological reason for the difference between the two locations, respectively for Hamburg in the final phase of the winter is illustrated by the Finish expert Erkki Palusuo who noted: “A cold air pool in the German area in mid January and lasting for about a week began to move on January 24, towards the Baltic region from where, reinforced, it pushed back to German territory on February 7. February 12 its centre was in the region of Hamburg, from where, moving slowly, it arrived in East Germany about February 20.” (Palusuo, 1953:93).

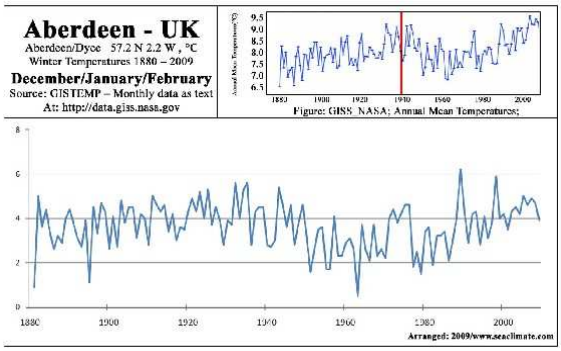

Figure 7: Winter temperatures (D/J/F) at Aberdeen/UK, from 1880 to 2006 (Data source: Nasa/Giss)

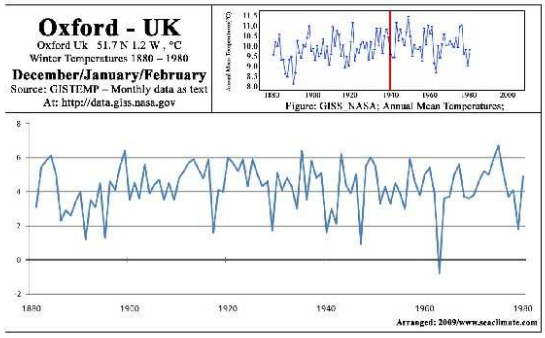

Figure 8: Winter temperatures (D/J/F) at Oxford/UK, from 1880 to 2006 (Data source: Nasa/Giss)

Great Britain

Great Britain saw the first signs of winter in the latter half of December. Most marked in the southern half of the country, with –13°C at three locations on 29/30th December (Lewis, 1940:9). January 1940 was the coldest month since 1895, and the fifth lowest since the beginning of recording in central England in the year 1659 (Hadobs, 2009). The southern part of the country was, in particular, severely hit, and it was possibly the coldest winter there in 100 years (Gunton, 1940:67). A report for the Kew Observatory (near London) noted that January was the coldest month since 1838 (Drummond, 1942: Table 1), and in Greenwich "during the whole hundred years", (Dines, 1942:180). The lowest recorded temperature in Wales had been recorded to be -23.3°C at Rhyader on the 21st of January 1940 (Metoffice, 2009). Finally, there was the "Great Snow" between 26 – 29 January 1940 in Southern England, with cold, wind, and snow drifts measuring 3 metres and higher (Cave, 1940:145). February had below normal temperatures as well but not very extreme.

The Netherlands

The winter of 1939/40 ranks as No.8 in the list of the coldest winter since 1706, (Labrijn, 1946:Table 4), and during the same time period only two months of January at the station De Bilt had been colder than the one from 1940 (-5.1°C), namely 1838 (-6.6°C) and 1823 (-7.0°C), (Wetterzentrale, 2009). February was still cold with an average below zero degrees (-0.9°C), which had occurred about twelve times since 1823.

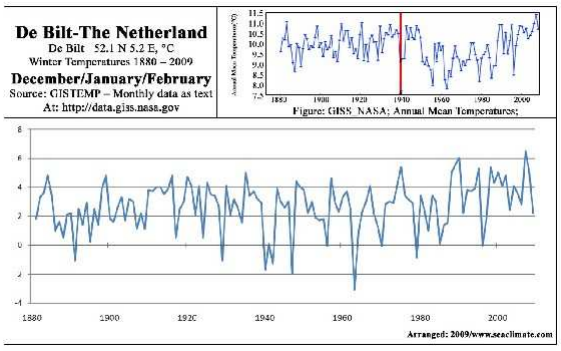

Figure 9: Winter temperatures (D/J/F) at De Bilt/The Netherlands, from 1880 to 2006 (Data source: Nasa/Giss)

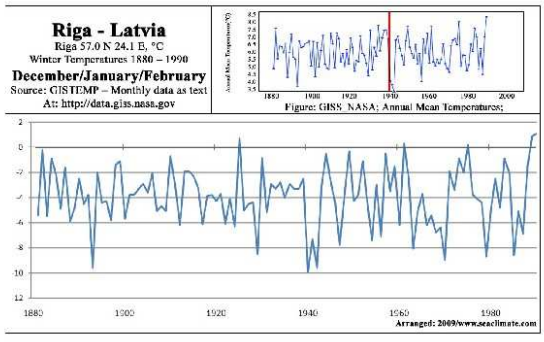

Figure 10: Winter temperatures (D/J/F) at, Riga/Latvia from 1880 to 2006 (Data source: Nasa/Giss)

Poland & Baltic Countries

Information is scarce, particularly with regard to Poland. Concerning the Baltic Countries, the New York Times reported the lowest recorded temperature for seventy years at Riga/Latvia with 47.2°C below zero (-44°C) (NYT, 18 January 1940). But in the region records were taken, of which one is presented here.

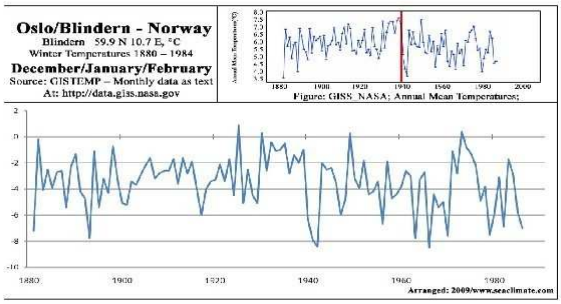

Figure 11: Winter temperatures (D/J/F) at Oslo-Bildern/Norway, from 1880 to 2006 (Data source: Nasa/Giss)

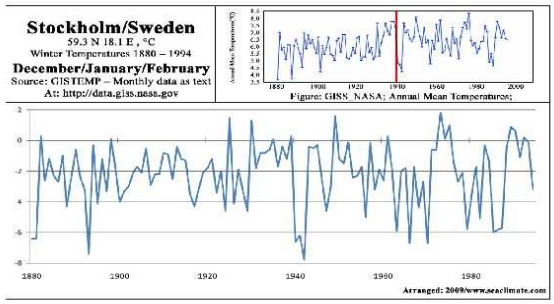

Figure 12: Winter temperatures (D/J/F) at, Stockholm from 1880 to 2006 (Data source: Nasa/Giss)

Norway and Sweden

There was a clear difference between the conditions from the southern and northern part of the country. In Oslo, it was the coldest winter (D/J/F) since 1893, while in Tromsø (app. 1200 km north of Oslo) the winter temperatures (D/J/F) had been four times –4°C or lower since 1921, namely in 1926 (-4°C), 1927 (-4.1°C), 1936 (-4.3°C), and 1940 (-4.2°C). There was a similar situation in Sweden, with the southern part being colder than the northern region, whereby Stockholm felt the cold. It was the coldest period since 1880/81 and ranks on the ninth position of severe winters since 1757. This was already commented by Gösta Liljequist in 1943 by saying: "The remarkable change in the winter climate came to an abrupt end in 1940 with the severe winters 1940, 1941, and 1942." (Liljequist, 1943:17)

Finland

The weather conditions during the so called "Winter War" which started on the 30th of November when the Soviet Union ambushed Finland are highly interesting and complex as well. During December 1939 there were two cold spells before the whole county experienced temperatures between –20 and –30°C during the last week of the year. The winter remained extreme. The days 15-19 January 1940 became the coldest during the winter when temperatures reached from –30°C to under –45°C. The winter remained exceptionally cold until March. For details see: (Korhonen, 2009).

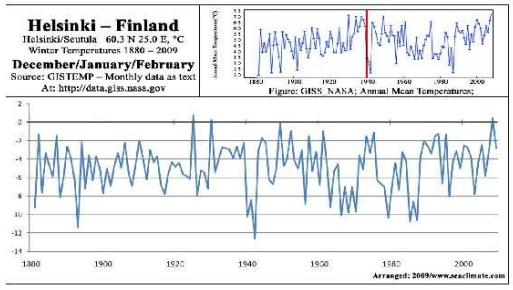

Figure 13: Winter temperatures (D/J/F) at Helsinki/Finland, from 1880 to 2006 (Data source: Nasa/Giss)

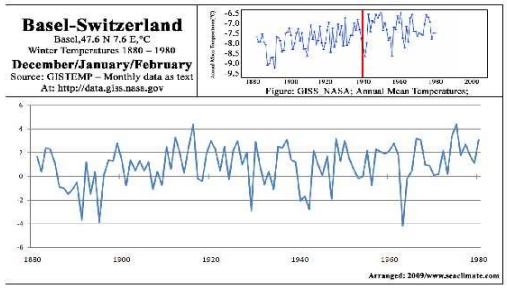

Figure 14: Winter temperatures (D/J/F) at, Basel/Switzerland from 1880 to 2006 (Data source: Nasa/Giss)

Southern Europe

The situation in Southern Europe was not extraordinary exceptional. All regions from the Atlantic to the Black Sea experienced some extreme weather events and very cold periods. Generally speaking the border was marked by the Alps, whereby the areas in the west (e.g. France) and the east (e.g. Romania and Bulgaria) some extreme low temperatures were observed but with less consistency as observed further north. The Alps seemed to have quite a smoothing effect. While the city of Basel was severely effected; the impact was already less severe in Zurich and significantly reduced in Geneva.

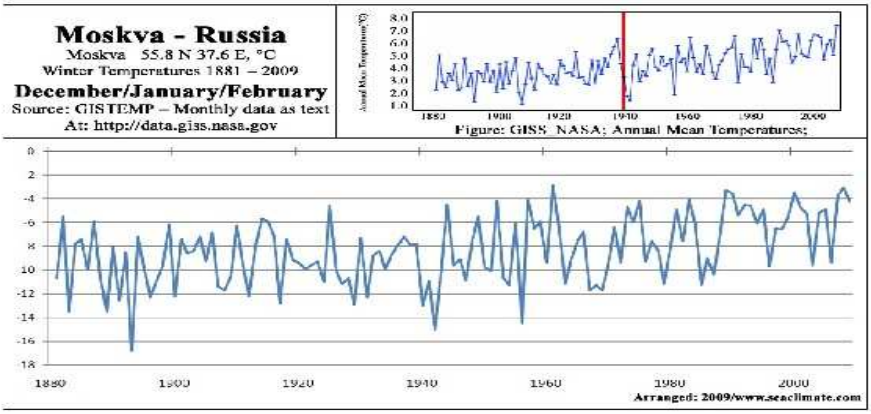

Figure 15: Winter temperatures (D/J/F) at Moscow/Moskva – Russia , from 1880 to 2006, (Data source: Nasa/Giss)

East Europe (former Soviet Union)

The eastern region of the Baltic Sea experienced the entire force of the winter well beyond the Ural (app. 60°E). This was partially significant in January, eastwards between the latitudes of 50 to 60° North. If the winter is calculated on a longer period of time, the exceptionality of the winter diminished the further the location was in the East. For example, for Moscow and the eastern region, toward the Ural Mountains, it was the coldest January since 1893 or longer, but calculating the winter on two or three months there had not been comparable winters eastwards of the Ural since the late 19th century.

This was quite different in the Northern and Southern regions of the former Soviet Union. Although the winter appears noticeable with the temperature records from Murmansk (Barents Sea), and Odessa (Black Sea), they are not exceptional.

Summary of the country overview

The core region for the exceptional winter temperatures stretches from about Rotterdam and Copenhagen to Moscow, due to the length of the winter and while the February contributed significantly to record temperatures. The wider core region can be drawn starting from the north, running from London via Oslo, Stockholm, St. Petersburg to Kirov (respectively the Ural Mountains), and south from London, via Basel, Kiev to Kirov. This region also saw an extreme January rarely experienced since records have been taken, but with a less harsh February, so that the overall winter condition were not as severe as in the core region. This is more significant in the West (England), and less in the East of the Ural Mountains.

The temperature profiles for January and February across Europe

The Concept of Presentation

The previous section draws a general picture of the winter of 1939/40 severity together with some indices in what countries or regions the winter was more exceptional than in others. Nevertheless the picture might be still somewhat too unspecific to see details concerning the question whether the naval war had an impact on the temperatures. This shall be achieved by drawing a profile of temperature differences in the war winter of 1939/40 in comparison to the previous years (from 1935 to 1939). For this purpose temperature profiles along a geographical corridor will be presented. Two of them along a corridor of latitude, and two along a corridor of longitude. The difference will show which location or regions' temperatures had been effected most, and that it correlates with the areas where naval activities were particularly high. All this could indicate an evident causal connection.

Two West to East Profiles (January & February)

Table No. 3: Difference between 1940 (J/F) towards the previous years (1935 to 1939) along the latitude 57°N to 60°N, (Nasa/Giss, 2009)

Aberdeen			**Torungen**			**Stockholm**			**St. Petersburg**			**Kirov**		
57.2°N 2.2°W			**58.4°N 8.8°E**			**59.3N 18.1°E**			**60°N 30.3°E**			**58.5 49.3°E**		
1935	5.0	4.6	1935	0.4	1.4	1935	-2.0	-0.6	1935	-8.3	-4.5	1935	-13.1	-7.4
1936	2.8	2.7	1936	0.1	-1.1	1936	-1.0	-4.6	1936	-4.5	-10.9	1936	-9.5	-14.2
1937	4.8	3.4	1937	0.8	-2.2	1937	-1.2	-3.0	1937	-7.6	-6.8	1937	-12.4	-10.9
1938	5.2	5.0	1938	1.3	1.9	1938	-1.0	0.9	1938	-6.9	-3.8	1938	-12.4	-12.4
1939	3.3	5.9	1939	-1.0	3.1	1939	-0.9	2.1	1939	-7.6	-1.9	1939	-14.5	-11.7
1940	**1.2**	**2.9**	**1940**	**-2.7**	**-5.9**	**1940**	**-6.9**	**-10.3**	**1940**	**-14.8**	**-14.7**	**1940**	**-22.9**	**-14.6**
Total 42,7 = +4,3°C			Total = 4.7 = +0.5°C			Total = 11.3 = -1°C			Total 62.8 = -6.3°C			Total: 118.5 =-12°C		
1940: +2°C			1940 = -4.3°C			1940 = -8.6°C			1940 = - 14.75°C			1940: -18.75°C		
Diff : -2,3°C			Diff = -5°C			Diff = - 7.6°C			Diff = -8.5°C°			Diff = -6.75°C		

Table No. 4: Difference between 1940 (J/F) towards the previous years (1935 to 1939) along the latitude 52°N to 56°N, (Nasa/Giss, 2009)

Oxford			**De Bilt**			**Berlin/Tempelhof**			**Minsk**			**Moscow**		
51.7°N, 1.2°W			**52.1°N, 5.2°E**			**52.5°N, 13.4°E**			**53.9°N, 27.6°E**			**55.8° N, 37.6°E**		
1935	4.9	6.1	1935	3.0	4.6	1935	-0.6	2.5	1935	-9.9	-4.2	1935	-11.2	-4.9
1936	4.4	3.0	1936	4.9	2.5	1936	3.2	-0.1	1936	-2.0	-9.1	1936	-5.0	-13.0
1937	5.4	6.5	1937	2.8	4.9	1937	-3.1	2.1	1937	-10.4	-5.2	1937	-11.7	-7.2
1938	6.1	5.1	1938	4.2	3.7	1938	1.7	1.8	1938	-6.2	-4.4	1938	-9.0	-6.2
1939	4.8	6.1	1939	4.4	3.9	1939	2.9	2.9	1939	-4.4	-1.2	1939	-8.7	-4.2
1940	**-1.3**	**2.9**	**1940**	**-5.2**	**-1.0**	**1940**	**-9.7**	**-7.2**	**1940**	**-15.2**	**-13.6**	**1940**	**-19.5**	**-11.9**
Total 52.4 = +5.2°C			Total 38.9 = +4°C			Total 13.3 =+1.3°C			Total 57,2 = -5.7°C			Total -81.1 = -8°C		
1940 = + 1.3°C			1940 = -3.1°C			1940 = -8.5°C			1940 = -14.4°C			1940= -15.7°C		
Diff= -3.9°C			Diff –7.1°C			Diff = -9.8°C			Diff: = -8.7°C			Diff = -7.7°C		

The profiles indicate that the biggest diversion occurred from the eastern part of the North Sea (Torungen/ De Bilt) to the most eastern location of the Baltic Sea (St. Petersburg) and beyond to Minsk (app. 500km east of Kaliningrad). Stations either further in the west, or in the east indicate a less significant deviation, which is particularly due to February recordings.

Two North to South Profiles **(January & February)**

Table No. 5: Difference between 1940 (J/F) towards the previous years (1935 to 1939) along the longitude 5°E to 12°E, (Nasa/Giss, 2009)

Bergen			**Haugastol**			**Copenhagen 55.7°N**			**Frankfurt**			**Lyon**		
60.4°N 5.3°E			**60.3°N 7.5°E**			**12.6°E**			**50.1°N 8.5°E**			**45.7°N 4.7°E**		
1935	2.3	1.8	1935	-6.9	-7.3	1935	0.3	2.0	1935	1.2	3.8	1935	0.4	4.7
1936	2.1	1.5	1936	-8.8	-10.9	1936	2.8	-0.9	1936	5.0	2.4	1936	7.5	5.5
1937	3.2	1.1	1937	-9.7	-12.8	1937	-0.3	0.8	1937	1.7	4.5	1937	6.1	6.9
1938	2.9	3.0	1938	-6.3	-5.4	1938	2.1	2.0	1938	3.3	2.7	1938	3.2	2.9
1939	1.7	4.0	1939	-10.0	-3.4	1939	1.9	3.3	1939	4.8	2.6	1939	5.1	3.1
1940	**-0.9**	**-1.5**	**1940**	**-11.8**	**-13.8**	**1940**	**-4.1**	**-6.7**	**1940**	**-8.0**	**-1.4**	**1940**	**-3.5**	**5.1**
Total 23.6 = +2.4°C			Total: 81.5 = -8.2°C			Total: 14 = +1.4°C			Total 32 = +3°C°			Total 45.4= + 4.5°C°		
1940 = -1.2°C			1940 = -12.8°C			1940 = - 5.4C			1940 = -4.7°C			1940 = + 0.8°C		
Diff -3.5°C			Diff -4.6°C			Diff -6.8°C			Diff -7.7°C			Diff : -3.7°C		

Table No. 6: Difference between 1940 (J/F) towards the previous years (1935 to 1939) along the longitude 26°E to 31°E, (Nasa/Giss, 2009)

Vardø			**Helsinki**			**Kaliningrad**			**Bucharest**			**Edirne**		
70.4°N 31.1°E			**60.3°N 25°E**			**54.7°N**			**44.4°N 26.1E**			**41.7°N 26.6°E**		
1935	-4.2	-4.4	1935	-4.1	-3.7	1935	-4.7	-0.2	1935	-4.4	-1.0	1935	1.8	3.4
1936	-5.4	-7.5	1936	-2.7	-9.3	1936	1.0	-3.9	1936	4.2	1.0	1936	7.4	4.7
1937	-2.4	-5.2	1937	-4.5	-5.7	1937	-6.0	-1.1	1937	-4.3	-0.4	1937	-0.2	5.8
1938	-3.7	-1.5	1938	-3.4	-1.1	1938	-1.6	0.3	1938	-4.0	1.7	1938	2.2	4.0
1939	-4.1	-4.6	1939	-5.5	0.4	1939	0.7	2.2	1939	0.4	3.0	1939	6.2	4.5
1940	**-5.9**	**-7.1**	**1940**	**-12.4**	**-13.7**	**1940**	**-10.8**	**-11.5**	**1940**	**-6.9**	**-3.2**	**1940**	**-1.2**	**3.7**
Total = 43 = -4.3°C			Total= 39.5 = -4°C			Total - 13.3 = -1.4°C			Total= - 3.8 = - 4°C			Total 39.8= +4°C		
1940 = -6.5°C			1940 = -13°C			1940 = -11°C			1940 = -5 °C			1940 = +2.5°C		
Diff -2°C			Diff –9°C			Diff = - 9.5°C			Diff - 4.5°C			Diff: -1.5°C		

Also the two north-south profiles with it's core centre in the triangle of Helsinki, Copenhagen, and Kaliningrad, and considerable less significant deviation at the most northern or southern locations.

Analysis of the Winter Temperatures

January and February 1940

The core centre for the most extreme temperature deviation, with more than app. –7°C to –10°C during the two months of January and February, can be clearly identified within the co-ordinates De Bilt, Kopenhavn, St. Petersburg, Kaliningrad, Berlin, Frankfurt a/M, and De Bilt, while the wider area includes the region from South England (Oxford), via the northern part of Switzerland, Romania (Bucharest), the western part of Russia (Moscow), Finland (Helsinki), and the southern region of Norway (Haugastol). Note that the significance of the weather during winter of 1939/40 was felt and registered throughout Europe like in Aberdeen/Scotland, Lyon/France, Edirne/Turkey, and Vardo/Norway, with a distinct lower deviation from temperature, namely between –1.5° (Edirne) to 3.7°C (Lyon), while some stations in Central Europe were lower than –9°C. Even in the East, at stations in Moscow and Kirov, the temperatures deviated by about 2°C slightly less than in the Baltic region.

January 1940

For the whole continent conditions in January 1940 had been as severe as during bad years during the Little Ice Age. A general overview: Figure 16 & 17, which is based on a graphic published by R. Scherhag in 1951, indicates there had been three cold spots with less than –10°C, one of them in Central Europe close to Berlin. Also data for January 1940 in previous

years (see the Tables 3-6) proves that the deep freezing covered an area from Great Britain to the Ural Mountains. For example, at Oxford the temperature deviated by -6.4°C and at Moscow by –10.4°C from the January means of the previous five years. Also in more southern regions of the continent the month had been much colder, at Lyon -7.7°C, and at Edirne -4.7°. Only in the farthest north the deviation from previous years was noticeable but comparably modest. In Vardø the difference was –1.9°C.

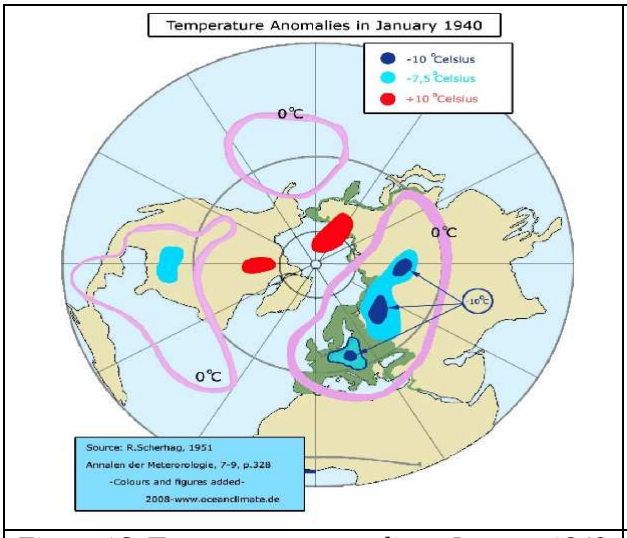

Figure 16: Temperature anomalies - January 1940 (Data source. Scherhag, 1951:Abb.7)

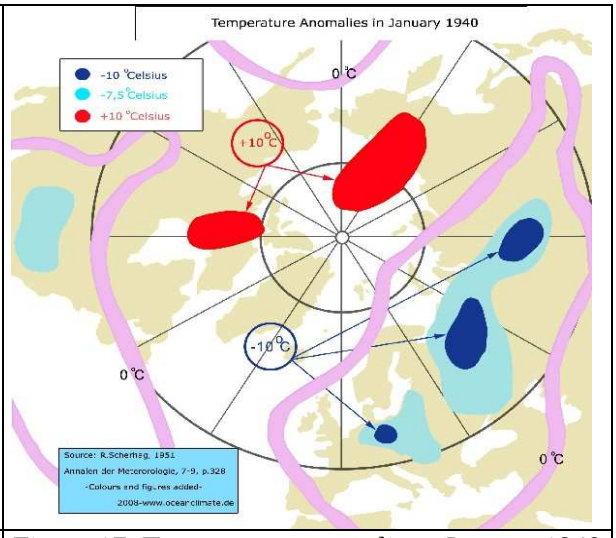

Figure 17: Temperature anomalies - January 1940 (Data source. Scherhag, 1951:Abb.7)

With regard to the North Sea and Baltic Sea region the January data for De Bilt and Berlin-Tempelhof reached a top level (-9,1°/-10.3°), while stations directly located at the Baltic Sea show a slightly more moderate figure (Copenhagen, -5.1°; Stockholm, -5.7°; St Petersburg, -8.0°C; Kaliningrad, -8.8°C). Thus it is possible to establish that the record freezing zone runs along the corridor from Oxford, via De Bilt, Berlin and to Moscow. Although the distance between the corridor and the Baltic Sea is only about 150 km, the slightly less severe temperatures drop at sea side locations during January 1940 is noticable.

February 1940

Within the extremes of the whole winter as outlined in the previous chapter, February of 1940 has a number of special aspects. The most remarkable fact on one hand is that the further a location is afar from the Baltic Sea the less distinct February of 1940 differed from the years 1935-39. It is not necessarily a very pronounced figure but noticeable. For Aberdeen and Oxford January/February figure is –2°C/-3.9°C, see: (Table 3-4), while the February difference is -1.4°/-2.4°C. The corresponding figures for Moscow and Kirov are for J/F –7.7°/-6.75° and for the February 1940 –4.8/-5°C. The north-south axis shows even a smaller difference. Actually, at Vardø February is slightly negative versus the J/F figure, and in Bucharest slightly positive, in each case by approximately 0.5°C.

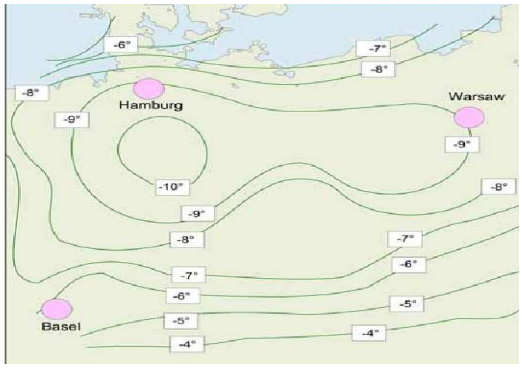

Figure 18: February 1940, deviation from mean; Data source: Geiger 1948:Abb.4

The situation is different in the region from the Skagerrak to the Baltic Countries. All stations produce negative February figures as compared to those calculated for January and February together. While the figure is modest with –0.5° at Haugastol/Skagerrak, it is higher at Copenhagen (-1.2°); Stockholm (-1.7°C), St. Petersburg (-0.6°C), and in Kaliningrad (-1.5°C). The figures indicate convincingly that the share of freezing between the two months January and February was of more weight in February only across the sea area from the easterly part of the North Sea (German Bight and Skagerrak) and the Baltic Sea.

The contrast to the previously mentioned corridor De Bilt – Berlin/Tempelhof, as explained in section "January 1940", is remarkable. The corresponding figures for February are positive; De Bilt (J/F = -7.1°; Feb= -5°; Diff +2°); Berlin/T (J/F = -9.8°; Feb= -9°; Diff +0.8°).

Discussion

The investigation could establish that the highest and lasting decrease of the temperatures during January and February of 1940 occurred in the sea areas that were most involved in naval activities. Nevertheless there is a remarkable difference between North Sea and Baltic Sea observations. According to temperature profiles the temperature difference of the pre-war winter months to the corresponding January and February 1940 was significantly higher in the Baltic Sea than in the North Sea. In Oxford the figures are about –4°C, in Kaliningrad –9,5°C. Such a difference is inevitable regardless of in which sea area more naval activities took place, due to the huge difference in the structure and location between the two seas. While the Baltic Sea is totally confined by land and the water salinity is low and negligible tidal motion, any loss of heat due to naval war has a much more lasting impact than in the North Sea, which is not only close to the warm Atlantic Gulf current, but is even better supplied with warm air flowing in from the Atlantic Ocean.

While the main influence on the downturn of temperatures came from the Baltic Sea, the North Sea may hold some interesting indices concerning the reason. As the southern part of the North Sea up to middle England (app. 55°N), including the German Bight, has only a depth of less than 40 metres, the summer heat could have been lost quickly. In the mouth of the river Elbe and other coastal stations at the German Bight the winter came very early on the 7th of December and only few days later sea ice appeared as well (see: above) which reflects the huge naval activities throughout the eastern part of the North Sea. A similar conclusion can be drawn for South East England with an outstanding cold and snowy January.

It is more difficult, if not impossible to explain why the situation was quite different concerning the region from the German Bight eastwards on a corridor well beyond Moscow, due to the continuation of polar conditions throughout most of February. Since the sea ice came early, became very heavy, and stayed throughout the winter, it is easy to come to the conclusion that the sea ice was the main reason for the very cold February throughout the Baltic Sea region, but leaves little chance to assess which other forces or circumstances may have contributed. Any assessment has to review primarily the timing and conditions prior to the ice building process, while the finally established sea ice conditions, the timing, and duration could enhance the reliability of findings, that have been published elsewhere (Bernaerts, 2008:11f).

There might be many further aspects worth being analyzed, each one may require considerable efforts to identify a relevance for this war winter. For example the earlier mentioned fact

that the city of Hamburg had its absolute freezing record in mid February 1940, although it is well established that for Germany the year with a record cold February was in 1929 (Geiger, 1947:1). Which circumstances supported the arrival of the cold air pole over Hamburg around the 12th February 1940 (Palusuo, 1953:93), and subsequently the record freeze at –28°C few days later?

As the paper was to focus on the temperature issue concerning the reasons for the winter of 1939/40, which is implicitly the starting point for the global cooling since 1940 for three decades, it is time to ask whether this could be achieved. In a wider sense it seems rectified to regard the naval war during the first few war months as a force that contributed to more severe winter conditions. In a narrow sense the answer may depend on how someone understands and weights the influence of the North Sea and Baltic on the winter weather.

Viewing the initiation of the global cooling caused by the winter of 1939/40 in a wider sense means taking into account the whole time period for which records are available, in some few cases longer than 200 years, respectively in a number of cases since 1880 due to the available Nasa/Giss data as they are presented in tables and figures. On this background of a wealth of data and the fairly consistency of their values with gradual changes over long periods of times, a winter of such exceptional magnitude as 1939/40 requires an explanation, by a force in form of sun ray, volcanism, tsunami, El Nino. Since the world had been getting steadily warmer after the Little Ice Age had ended, the dramatics of the winter can not be explained only be 'natural forces'. During the recorded time period since 1700, there had been a number of huge volcanic eruptions, and presumably a dozen or more tsunami, El Nino, and other events relevant to the climate system. During all the years none matched the winter of 1708/9 in Central Europe. The winter 1939/40 could, and came even along more severe as the decrease of temperatures towards the previous years and was one degree higher, see: (Table 2), at least at the station Berlin-Tempelhof. The temperature profiles across Europe pinpoint to the North Sea and Baltic as a contributing source for the record freeze. Inevitably this will occur if either a natural force (e.g. wind), or an un-natural force (e.g. human activities) has caused the release of stored heat too early or too sufficient in autumn or the early winter season. The latter was a dominant factor in North Europe since September 1st, 1939. The naval war thesis is fully able to provide the answer convincingly.

In a narrow sense the naval war thesis has limits to prove a link by reference to the winter air temperatures in time and location alone if merely viewed as a statistical matter over a time period of a few months. The necessity to rely overwhelmingly on air temperatures does not make it easier if it is too much regarded as an atmospheric issue, for example assuming, as Scherhag did, that it was a matter of air circulation. (Scherhag, 1951:321) This may quickly change if the information and temperature profiles provided are analysed on the awareness of the importance of the seas on weather in general, of regional seas in North Europe on the winter weather Northern Europe in particular, and of the impact a naval war has on the marine environment.

Conclusion

The winter 1939/40 in Europe deserves highest attention. It is not only a unique winter with regard to its record coldness, but also to its closeness in time and location of human war activities since September 1st, 1939. From one day to the other huge armadas sailed the seas and fought battles below and above the sea surface at day and at night. Few months later the North Sea and Baltic region experienced the coldest winter since the Little Ice Age, if not the coldest since taking of records in 1701 (Berlin-Tempelhof). If one regards the seas in North Europe as an important heat supplier during the winter season, then naval war activities at a

large scale will inevitably have a substantial impact on the lasting availability of the summer heat stored, until it is renewed during the next summer season. As soon as the heat is lost the way is free for the reign of cold continental air across Western Europe up the shores bordering the North Atlantic. Numerous historical information and a temperature profiles for Europe convincingly confirm that the structure of the freezing conditions strongly indicate a noticeable contribution by human activities in the form of naval warfare, which may have any rate from as small as 1%, or higher, or very much higher.

However this statement should rather be regarded as an invitation for more research than as a claim of conclusive and final evidence. That is not a matter of doubt but acknowledgment that the winter 1939/40 is only a primary and very short part of naval warfare during WWII. The eventually required evidence of the impact of naval war on the weather and climate needs not necessarily to be conclusively established with the 1st war winter, if other observations during the remaining 55 months of naval war would contribute to prove it, for example the 2nd and 3rd war winter in Europe.

After all, a comprehensive explanation concerning the initiation of the global cooling during the last century, as well as the naval war thesis needs further research. The paper hopefully could raise the awareness that a thorough explanation for the extraordinary war winter 1939/40 is required.

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