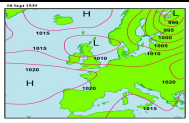	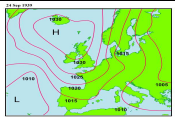	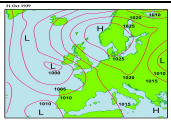	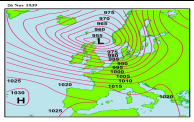	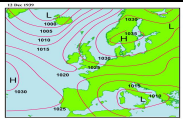	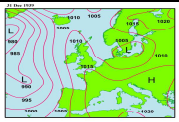
10 September	24 September	31 October	26 November	12 December	31 December

A Large-Scale Experiment with Climate
– The Extreme Winter of 1939/40 and Climate Research –

- Pages 14 -

THE ISSUE: Europe suddenly experienced its coldest winter in more than 100 years. Since the 19th century, winters had become successively milder. "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," reported the British scientist A. J. Drummond in the QJoR Met. Society as early as 1943. But neither he nor climate researchers in general went searching for the cause. This article explores the possible reasons.

By Arnd Bernaerts

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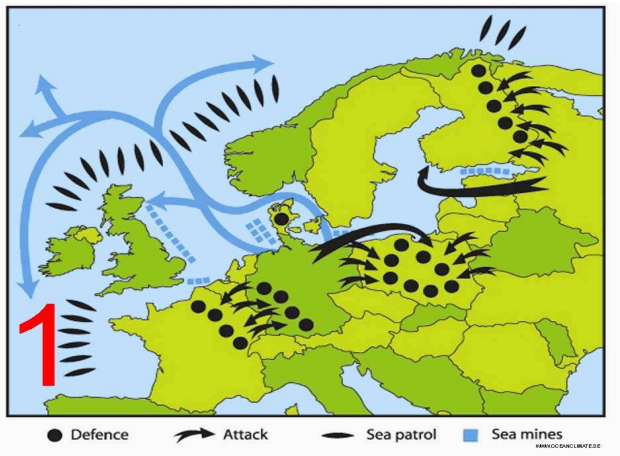
A. Why Is the War Winter 1939/40 Interesting?

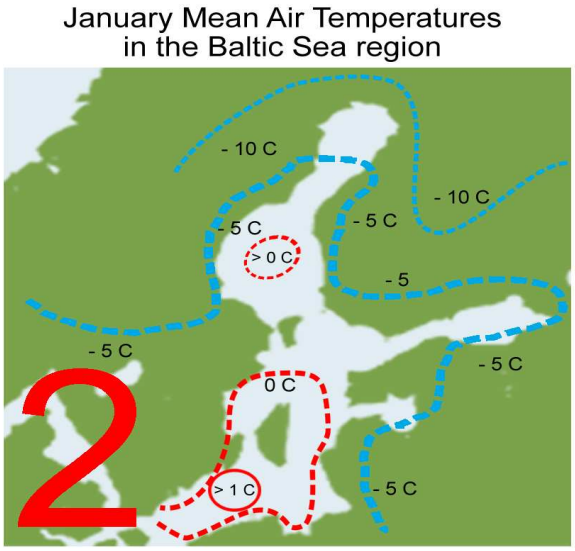


From the time the Second World War began on 1 September, the weather displayed a broad range of peculiarities on both the local and large scale. Only four months into the war, Northern Europe was back in a small ice age. A look at meteorological developments through the end of February 1940 reveals a direct or indirect relationship to the high level of naval warfare activities in the North and Baltic Seas. But the thesis of the effects of the naval war is only one side of the coin. The other side of the coin is much more decisive and, in view of the ongoing climate discussion, can be called dramatic, even irresponsible. The climate makes an abrupt about-face in the winter of 1939/40, and cli-

mate researchers show no interest – neither immediately after the war nor half a century later. The IPCC has been talking about climate change for 20 years now, yet still does not have a clue about events in the autumn and winter of 1939/40 and whether this was the start of global cooling lasting more than 30 years. This is not a question of just any historical study, but of recognising how climate functions, how it can 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 in a period of more than 100 years?
The naval war in the autumn and winter of 1939/40 was a gigantic field study with verifiable effects. Researchers should have realised this and drawn conclusions relevant for the current climate discussion long ago.

B. Why Are Six Months of a Single Winter So Important?

What had happened? In the summer of 1939, everyone was talking about war, and shortly afterwards the Second World War began indeed. Poland was razed to the ground within three weeks. Three million soldiers immediately moved into position on both sides of the Rhine, and a number of war navies "were unleashed onto the oceans." (Fig. 1) Thousands of ships criss-crossed the North Sea and Baltic day and night, ordered to fight, to monitor, to train. Huge areas of water were agitated, and consequences were quickly felt. Before the year had come to an end, the weather was beginning to display the extremes that would lead to record winter conditions in January and February 1940. Could anyone have foreseen this? Should the politicians have been warned? The possibility was certainly there, if sufficient consideration is given to the influence of the seas on weather and climate. But meteorology had not reached such an advanced stage at the time, and meteorologists did nothing to prevent cruising and fighting warships from conducting a gigantic "field study". Even today, the extreme winter of 1939/40 remains largely neglected, although this winter in particular would be an outstanding object of study to explore the effects of human activities. Simply change the condition of the oceans, and weather and climate promptly begin to undergo long-term changes.



The January temperature situation demonstrates perfectly the impact of the sea. Throughout the winter the Baltic Sea releases an enormous amount of heat in the atmosphere until it is stopped by sea ice.

The time for the start of the "field study" was well chosen for two reasons:

FIRST: The winter half of the year is especially suitable for an experiment with the climate because of the significantly reduced influence of the sun in the region from Central Europe to the North Pole. North of the 50th Parallel (English Channel, Frankfurt, Prague), the major climate factor of the sun plays a substantially weaker role for a number of months. The North Sea and the Baltic have stored a maximum quantity of heat at the end of August, beginning of September. **(Fig. 2)** They release this heat into the atmosphere during the autumn and winter. Northern Europe benefits enormously from this. In addition to the influence of the Gulf Stream off the western coasts of England and Norway, this heat released by the North Sea and the Baltic is a major reason why Northern Europe has such a mild winter climate, provided that these seas do not freeze over. Suddenly, an unusual component is introduced into this

system, one which acts like a spoon rapidly stirring hot coffee. The more the spoon stirs, the faster the coffee cools off. A calm sea releases heat slowly. The release of heat increases proportionately as the wind picks up and waves become higher. Travelling and fighting warships are even more effective because they "stir" the oceans at every moment of their deployment at sea, regardless of whether this is during the many periods of calm, when the wind is blowing gently or when it is at gale force. Battleships at that time had a draught of up to 10 metres and could plough through the water at 60 km/h. It would take a really strong wind to affect the ocean to such a depth. Any heat which these seas have lost is not replaced for many months. The less heat the seas can release into the atmosphere, the lower the temperatures of the air in the affected region. The main thrust of the following remarks will be to clarify this process during the course of the winter of 1939/40. (Section D, Cold Seas – Cold Weather)

SECOND: The claim, so frequently heard, that an increased concentration of aerosols, especially sulphate aerosols, was responsible for the cooling is fundamentally irrelevant for the winter season in the northern hemisphere when there is little sunshine, and especially for an extreme winter such as that of 1939/40. The climate is affected, according to the widely held theory, when more aerosols reflect more sunlight back into space or when more aerosols cause more clouds to form, with the consequence that less solar energy reaches the Earth's surface. This may have an effect on temperatures during the summer months, but it can have only negligible effects, if any at all, during the winter months when there is so little sunshine.[1] So the possibility that the winter of 1939/40 was caused by fluctuations in solar radiation or its reflection back into space as a consequence of an increase in industrial aerosols can be excluded.

But caution is advised! A dramatic increase in aerosols due to hostilities can also result in more rain from the formation of more clouds, drawing moisture from the atmosphere and making it drier. Dry air intensifies the effect of high pressure just as dry land areas do. The drier the air, the more easily cold polar air can spread out. The events in the autumn of 1939 presumably had a significant effect on precipitation in Central Europe, amplifying the effects of the naval war. More on this question later. (Next section: The Great Rain)
The striking significance of the climate story of the war winter 1939/40 is therefore not the sun or industrial aerosols or greenhouse gases, but rather the immediate effect which a sudden human intervention had on the oceans, which in turn affected the weather and climate. The story of the effects of naval warfare on the climate, which possibly extend over a period from 1939 to about 1970, has been told in detail elsewhere so that it is expedient to restrict the discussion here to the first war winter 1939/40. This winter is distinct from the later winters during the war in that human activities suddenly intervened in the natural course of the seasons in this year, whereas in the following years the "unnatural" intervention meant that weather statistics no longer described the "natural" course of events.
While on the subject of statistics, an important note: Evidence of the premature cooling of the North Sea and Baltic as a consequence of naval warfare cannot be provided in the form of measurements of seawater temperatures. The observation network which would be required for this did not exist at that time and, indeed, does not exist even today. Conclusions about the temperatures found in the oceans can be drawn only from measurements of the air. In addition to the air temperatures, the process and scope of the freezing over of the seas is important

[1] A more recent study explains the warming since 1980 with improved cleanliness of the air: "The cleaner air has fewer small particles known as aerosols, which tend to block sunlight from reaching the Earth's surface. A reduction in aerosols leads to an effect known as 'solar brightening,' which increases surface warming"; Ruckstuhl, C., et al. (2008), Aerosol and cloud effects on solar brightening and the recent rapid warming, *Geophys. Res. Lett.*, 35, L12708, doi:10.1029/2008GL034228.

indicator, and both of these factors reached such extreme values that the cause cries out for a convincing explanation.

REMARK: This researcher has taken note of the claim by S. Brönnimann et al. (Nature 2004), that the *"global climate anomaly in 1940 to 1942 constitutes a key period for our understanding of large-scale climate variability and global El Niño effects."* [2] As this is not the place to add further comments as done already elsewhere[3], only one question should be raised: "What effect does an extreme Northern Hemisphere climatic anomaly have in the South Pacific and elsewhere?" The situation during the Second World War period changed many "common statistical weather aspects" dramatically. As Brünnimann et al. bases their research on the assumption that the *"El Niño event started in autumn 1939, reached full strength in January 1940 and lasted, with varying intensity, until spring 1942,"* they actually paid little attention to the possibility that an El Niño culminated already in summer 1939[4], and whether it is possible and was actually the case that there was "one El Niño event from autumn 1939 to spring 1942" without proving such a claim to be correct. It seems that the matter is much more complex than Brönnimann et al. assume[5].

C. The Great Rain in Autumn 1939

C-1 It Is Raining Cats and Dogs

Adolf Hitler soon found out what "Great Rain" can mean politically. As early as the beginning of October 1939, Hitler had given orders to develop the plan "Yellow" for an invasion of France. But the masses of water which fell as rain on Western Europe were enormous. There was no doubt in November that any attack would bog down in mud. The invasion was postponed by 9 months. Had Hitler's war machinery on land, on sea and in the air caused this precipitation? The situation can be described statistically like this: The war had hardly begun when the rain started coming down in buckets in Western Europe, from Basle to Paris, Amsterdam and London, for three long months. (**Fig. 3)** To be precise: 200% more than average in September, 300% more in October and 200% more again in November. In some of the regions of Western, Central and Southern Germany, measured rainfall was twice, in some cases three and a half times as much as usual: for example, Augsburg 366%, Nördlingen 362%, Kaiserslautern 336%, Würzburg 316%. Three times the normal amount also fell in the southeast of England in October.

Autumn 1939 – Two million soldiers at the front

Since September 1939 huge military force faced each other along the river Rhine with frequent encounters, which may have contributed to a heavy rainfall up to 300% of average during the months October and November. AB2008

[2] Brönnimann, S.; Luterbacher, J.; Staehelin J., Svendby, T.M.; Hansen, H. & Svenøe, T.; , Extreme climate of the global troposphere and stratosphere in 1940–42 related to El Niño', in NATURE, Vol. 431, 21 October 2004, pp. 971-974. See also Brönnimann et al., 2006, „ENSO influence on Europe during the last centuries", Climate Dynamics, 28, 181-197; Brönnimann, 2007, Reviews of Geophysics, Vol. 45.

[3] See below References: 'War Changes Climate', 2006, Chapter B, p. 98-100.

[4] Diaz, Henry F. & Kiladis, G. N. (p. 7-28), 1992; in Diaz & Markgraf (ed), "El Niño – Historical and Paleoclimatic Aspects of Southern Oscillation", Cambridge University Press, 1992; which refers concerning the WWII period only to 1939 as a 'warm year event', and 1942 as a 'cold event year'.

[5] See for example: Cooper, Neill S., et al., 1989, "Recent Decadal Climate Variations in the Tropical Pacific", Int. Journal of Climatology, Vol. 9, p. 221-242.

Greenwich had seen this type of rainfall only in 1888 and 1840. This was also the case for Camden Square in London, where it rained 50 hours longer than the statistical average. In Freiburg im Breisgau, it rained on 30 of 31 days in October, other locations near the battle-ready Maginot/Westwall line had 24 days of rain. (Details in: Climate Change and Naval War, 2005, Chapter 2-31 & 2-32, pages 107 –122, also http://www.seaclimate.com/).

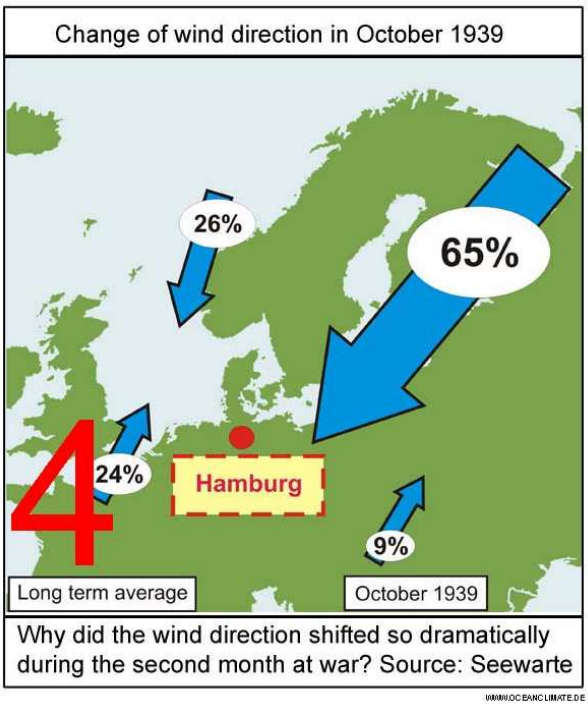
C-2 The Rain Factors

Two factors must have been involved to produce such quantities of rain and cause them to fall on Western Europe:

1. Massive fighting in Poland and along the front lines on the Rhine involving thousands of artillery pieces, aircraft, tanks and ground troops undoubtedly released enormous quantities of aerosols which could serve as condensation nuclei for a lot of rain.
2. The warships cruising and fighting on the North Sea and the Baltic would have ensured a constant supply of atmospheric moisture.

C-3 Wind Shifts

The key to the constant rainfall is found in the second factor. The rising of warm air favours the formation of low-pressure areas, and air must flow in to replace it. In 1948, M. Rodewald pointed out an extreme anomaly of the air pressure in November 1939, when a deviation of -17 mb in the sea area from the Central Norwegian coast to southwest of the Faroe Islands appeared.[6] Even more astonishing is what was happening further to the east over Scandinavia and Northern Germany, driving masses of moist air to the Rhine.[7] **(Fig. 4)** Meteorologists at the Naval Observatory (Seewarte) in Hamburg[8] determined at the end of October that the wind had suddenly "shifted" contrary to the long-term wind statistics. Where 24% of the wind, in the average of many years, had come from a south-westerly direction, it was now only 6%, and 65% instead of the usual 26% of the wind was suddenly com-

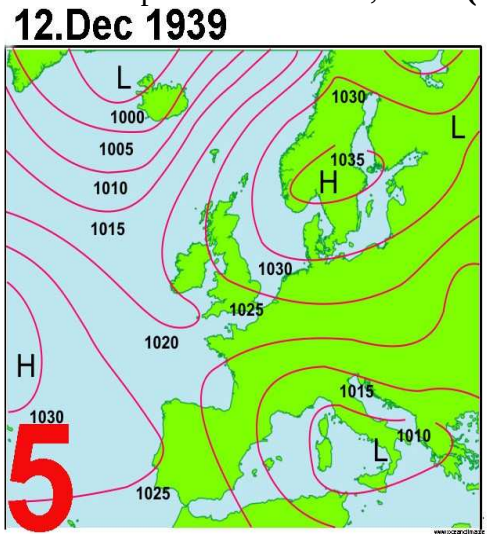


[6] M. Rodewald, 1948 "Die barische Vorbereitung strenger und milder mitteleuropäischer Winter", Annalen der Meteorologie, Vol. 4/5, p. 99 (101).

[7] The weather report of the Naval Observatory (signed Pflugbeil) of 27 October 1939 notes: "The precipitation field near Hamburg is clearly separate from this contiguous one. The former field is presumably related to the Baltic Sea air carried in by north-east winds, whereby the increased force of these winds is above all a consequence of the pressure wave crest approaching over Southern Scandinavia."

[8] Established in the second half of the 19th century, the German Naval Observatory (Deutsche Seewarte) was under the authority of the Ministry of Transport from 1919. In 1934, the weather service department was assigned to the authority of the Minister of Aviation (headed by Minister Hermann Göring), while the other services were under the high command of the war navy until the end of the war. After 1945, all of the responsibilities were transferred to the DHI (1945 – 1990) and after 1990 to the Federal Maritime and Hydrographic Agency (BSH). For more details, see: Peter Ehlers, 1999, "Die Geschichte maritimer Dienste in Deutschland – Das BSH und seine Vorgänger". http://www.bsh.de/de/Das_BSH/Organisation/Geschichte/Geschichte.pdf .

ing from the north-east quadrants.[9] A dramatic rise in the evaporation rate of the North Sea and Baltic and the enormous quantities of rain over the war-front along the Rhine could have been a major cause of these wind shifts.
High air pressure over Scandinavia prevailed in autumn, as indicated by an example, the weather map of December 12, 1939. **(Fig. 5)**



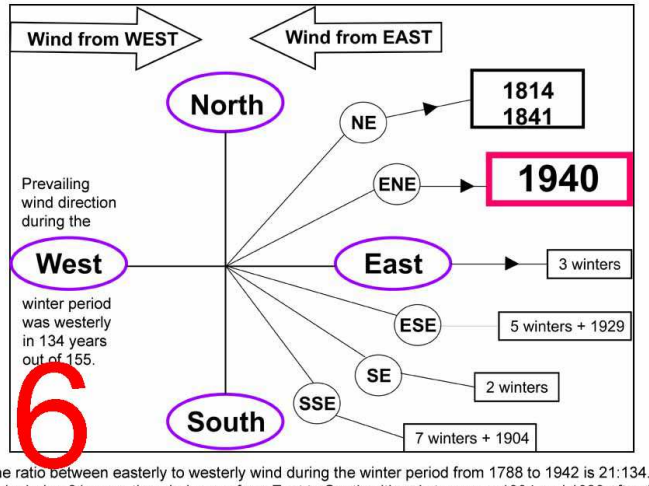
The extreme situation is also illustrated by another observation in England in 1943. Over an observation period of 155 years (1788 – 1942), the prevailing wind direction in winter in 134 years was from the west; the wind came from the east-south quadrant in only 21 years, and from the north-east quadrant only in the years 1814, 1841 and the winter of 1939/40 **(Fig. 6)**.

Note: War was being waged in China and Outer Mongolia as well in the autumn of 1939. Following heavy rainfall on the East Coast of the USA in September, large regions of the USA had almost no rain at all in October and November.
More information in: Reference books and websites

C-4 No West Wind Drift, But Circulation Disruptions

The weather report of the Naval Observatory from 2 November 1939 referred to an important weather anomaly: *"The current reports have pointed out a number of times that the west wind drift in the moderate latitudes is very slight this year and is almost completely lacking over Europe."* The first effect of the naval war on the North Sea and Baltic became apparent here: higher evaporation rates and the inflow of cold air from a north-easterly direction prevented the west wind drift. Moreover, the atmospheric moisture usual during the autumn in the northern hemisphere was reduced to such a degree by the widespread war events in Europe (and in the Far East) that the circulation was disrupted. The German meteorologist Richard Scherhag described this phenomenon in 1951: *"In complete contrast to the situation of the severe winter 1928/29 ... the remarkable winter of 1939/40 was caused by a general disruption of circulation,"*[10] with the closing remark: *"So there is still no*

Wind direction in London and district throughout the winter period from 1788 -1942



The ratio between easterly to westerly wind during the winter period from 1788 to 1942 is 21:134. Only during 21 years the wind came from East to South with only two year, 1904 and 1929 after 1900, and only for three times the wind came from Northeast to East-North-East, which includes the first war winter 1940. Why? What caused this remarkable deviation? Data source: Drummond, QJoRMS, 1943.
WWW.OCEANCLIMATE.DE

[9]The weather report of the Naval Observatory (signed Pojadi (?)) on 02 November notes: "On almost 2/3 of all of the observation dates, winds from the quadrants N-E were reported in Hamburg (65%, thereof 33% E wind), while in the average of many years the N-E wind represent only about one-fourth (26%) of all observations. The wind direction SW which is otherwise the most frequent (24%) was observed in only 9% of all cases at this time. So these observations of one station show what the weather map for a large area indicates."
[10] Richard Scherhag, 1951, "Die große Zirkulationsstörung im Jahr 1940"; Annalen der Meteorologie, Issue 7-9, pp. 321 and following

plausible theory to explain the large inflow of cold air over the Arctic"[11] Indeed, the explanation has still not been provided even today, although the primary cause will be found in the reduction of atmospheric moisture in the air circulating in the northern hemisphere caused by the war. This not only resulted in disruptions of the circulation, but also cleared the way for very cold Arctic air masses to push forward without difficulty into the middle latitudes of the USA, China and Central Europe in January 1939/40. But while there was only one cold wave in January 1940 in the USA and China (see reference books and websites), Northern Europe was battered by a second one in February, making the winter of 1939/40 the coldest one in more than 100 years. The reasons for this will be described in the following section.

D. Cold Epeiric Seas – Cold Winters

One can approach the course of the war winter 1939/40 with two questions:

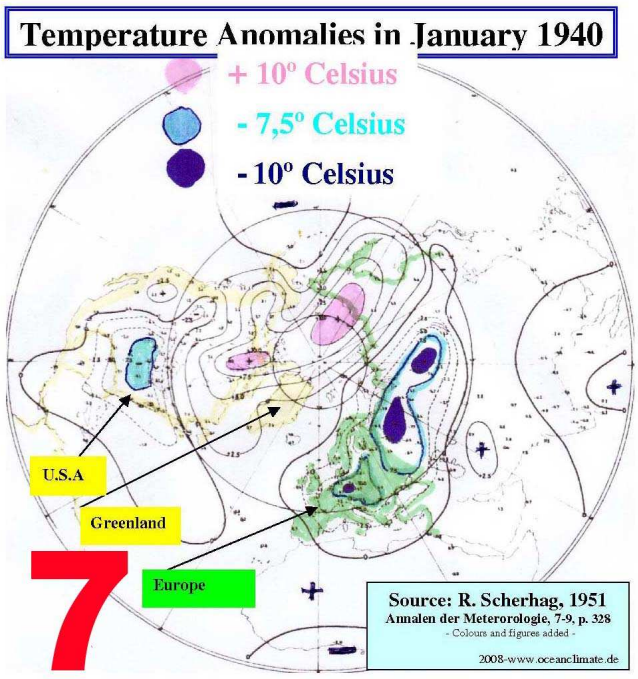
(1) When are the deviations from a statistical mean of such magnitude that the search for convincing explanations becomes mandatory?

(2) To what extent can a relationship to naval war activities be derived from the course of the winter, e.g., temperatures and freezing of the seas?

The following discussion seeks to answer these questions.

D-1 The Unusual Global Circulation Disruption in Winter 1939/40

In evaluating the deviations, it is absolutely essential to distinguish between the first cold wave in January and the second in February 1940, even though they must have had a common cause. While the January wave affected large areas in the USA, China, Russia and Northern Europe, the second wave basically affected Northern Europe only. This is emphasised in further remarks by Richard Scherhag (1951)[12]: *"The temperature anomalies which were observed in the northern hemisphere in January 1940 can easily be explained by the occurrence of the pressure deviations. A shift of the Asian cold pole to Western Russia is linked to the expansion of the Siberian high to the Arctic, whereby the greatest negative temperature deviations of -10° occurred along an axis stretching from the northern Urals to the heart of Central Europe. The additional eastern flow components over the Atlantic region simultaneously allowed the air masses, which had been warmed significantly over the ocean, to enter Canadian space where a positive temperature deviation of the same magnitude occurred in the area where the cold pole was normally located. The American cold pole had shifted to the south so that the United States also suffered from an extremely cold January. Eastern Siberia, on the other hand, was much too warm, just like*



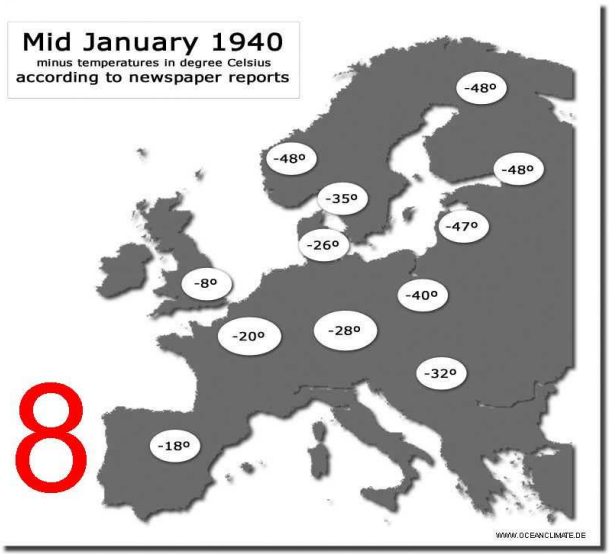
[11] Ibid, p. 328. See also p. 325: "The ultimate cause for the formation of such an extremely high atmospheric pressure over the entire polar region in January in particular still remains unknown to us today."

[12] Richard Scherhag, 1951, "Die große Zirkulationsstörung im Jahr 1940"; Annalen der Meteorologie, Issue 7-9, pp. 327-328

Canada, because this allowed the strong polar high and apparently the Pacific air masses as well to push frequently far to the west." See also the Scherhag graph: "Temperatures Anomalies in January 1940" – **Fig. 7 –** (remarks and colours added).

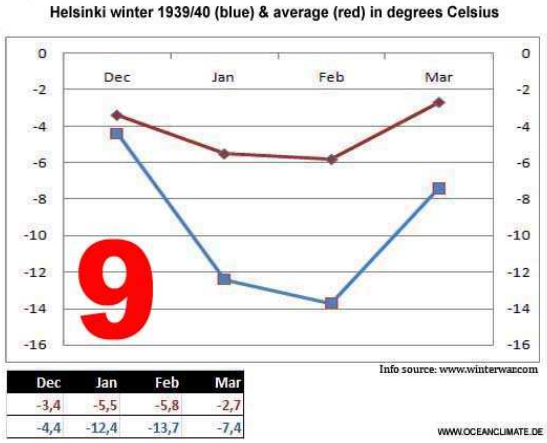
D-2 The West Wind Drift Stops

It has already been pointed out that the climate story of the war winter began in autumn 1939, illustrated by the observation by the meteorologists at the German Naval Observatory (see footnote 7) on 2 November that the west wind drift over Europe was almost completely lacking (see above). Viewed on a large scale, the first indications of the coming severe winter appeared in the early days of December. On 14 January 1940, the *Neue Zürcher Zeitung* reported among other items: *"The severe cold which has flooded all of Europe during this week is by no means a sudden phenomenon; instead, it is the high point of a development which began back in the first week of December."* (See also the weather map of 12 December 1939, Fig. 5.*)* Just how strongly it made itself felt can be illustrated by an example from Dresden where there was a massive snowfall between 6 and 8 December, depositing snow to a depth of 25 cm (corresponding to a melted water amount of 50 litres per m²) after 36 hours of uninterrupted snowfall and a temperature drop to -7° C.[13] Shortly thereafter, Dresden recorded the coldest January in 112 years,[14] but it may have been even longer; the Dresden records did not begin until 1828. **(Fig. 8)**



D-3 Cold War at the Arctic Circle

The situation was especially remarkable as early as the second half of December in Finland, which was attacked by the Soviet Union on 30 November. The *New York Times* correspondent James Aldridge reported on 25 December 1939: *"The cold numbs the brain in this Arctic hell, snow sweeps over the darkened wastes, the winds howl and the temperature is 30 degrees below zero (-34.4° C). Here the Russians and Finns are battling in blinding snowstorms for possession of ice-covered forests. … I reached the spot just after the battle ended. It was the most horrible sight I had ever seen. As if the men had been suddenly turned to wax, there were two or three thousand Russians and a few Finns, all frozen in fighting attitudes. Some were locked together, their bayonets within each other's bodies; some were frozen in half-standing positions; some were crouching with their arms crooked, holding the hand grenades they were throwing; some were lying with their rifles shouldered, their legs apart…. (T)heir fear was registered on the frozen faces. Their bodies were like statues of men throwing all their muscles and strength into some work, but their faces recorded something between bewilder-*



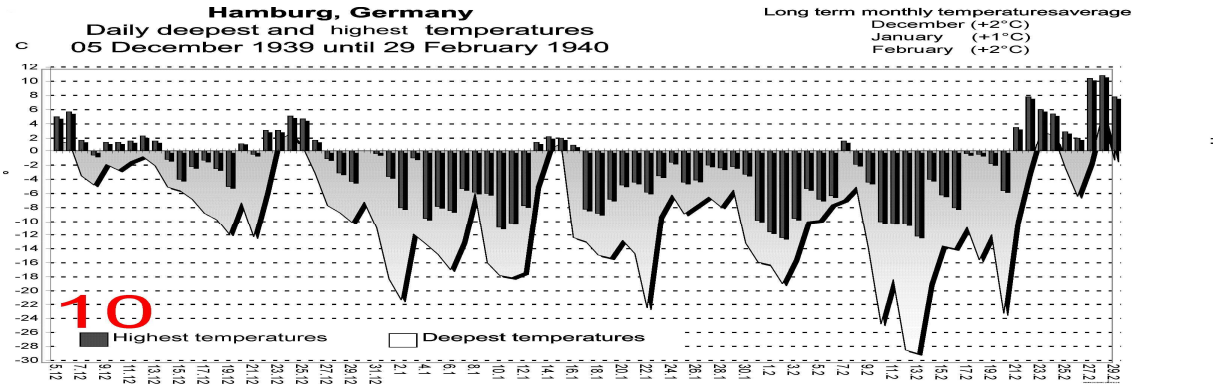
ruch im Dezember 1939", Zeitschrift für angewandte Meteorologie, pp. 91/92.

[14] W. Naegler, 1940, "Der kälteste Januar seit mindestens 112 Jahren in Dresden", Zeitschrift für angewandte Meteorologie, pp. 91/92.

ment and horror." The *Hamburger Anzeiger* reported on 22 December that the temperatures in North Finland ranged between 30° and 36° below zero. The December statistics for Helsinki **(Fig. 9)** are more moderate, but they also bear witness to the coming plunge in temperatures.

D-4 The Cold Powers In

Northern Germany also suffered early from colder temperatures. **Fig. 10** shows that the first cold phase occurred between 7 and 23 December. The *Hamburger Anzeiger* reported that the Alster had frozen over, even though the ice was very thin (20/12), called on the city's citizens to clear away snow and ice (22/12) and boasted: "The Elbe will never freeze over again; ice-breakers which keep the channel clear have been patrolling the river since 1874/75" (23-24/12), a claim which was to prove false within only a few weeks. The second cold wave started before the year came to an end and had a dramatic effect all over Europe: -48° in Northern Europe, -32° in Bulgaria and -18° in Spain (see Fig. 8).



D-5 A Real Winter for Great Britain

Even Great Britain was affected. January 1940 was the coldest month since 1895. The southern part of the country was much more severely hit, and it was possibly the coldest winter there in 100 years, wrote H. C. Gunton, chronicler of the Royal Met Society, only a few months later.[15] A report for the Kew Observatory (near London) noted that January was the coldest month since 1791 and had the most days below freezing. It was with some surprise that Drummond determined in 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. Never since the winters of 1878/79, 1879/80 and 1880/81 have there been in succession three such severe winters as those of 1939/40, 1940/41 and 1941/42."*[16] The January data document the lowest temperatures measured for the past 100 years in Greenwich as well[17]. Finally, there was the "Great Snow" of 26 – 29 January 1940 in Southern England, with cold, wind and snow drifts measuring 3 metres and more in height.[18] The *Neue Zürcher Zeitung* reported on

[15] Gunton, H. C., 1941; "Report on the Phenological Observations in British Isles from Dec. 1939, to Nov. 1940", in: Quarterly Journal of Royal Met. Soc. 1941, pp. 67-68

[16] Drummond, A. J.; 1943; "Cold winters at Kew Observatory, 1783-1942"; Quarterly Journal of Royal Met. Soc., No. 69, 1943, pp. 17-32, and ibid; Discussion of the paper: "Cold winters at Kew Observatory, 1783-1942"; Quarterly Journal of Royal Met. Soc., 1943, pp. 147 and following

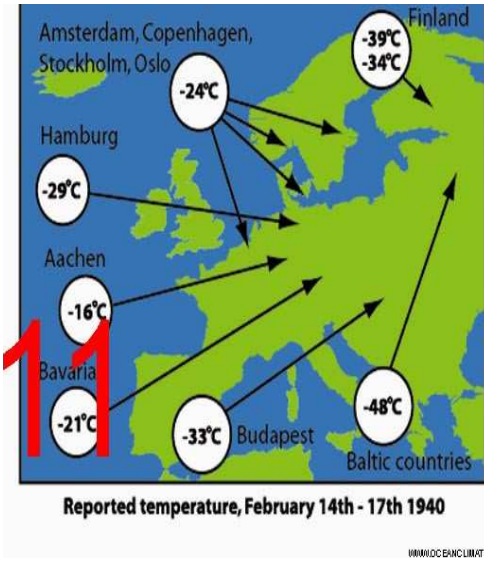
[17] According: http://www.metoffice.gov.uk/index.html, (Section: English Climate, Wales): The lowest recorded temperature in Wales has been recorded, -23.3 °C at Rhyader on 21 January 1940.

[18] See: Hawke, M.A.; 1940 "The Snowstorm and Drifts in January 26-29, 1940 in the Northern Chilterns", QJR Met. Society, Vol. 66, pp. 152 and following; and Cave, C. J. P.; 1940; "The Ice Storm of January 27-29, 1949", QJR Met. Society, Vol. 66, pp. 143 and following. See also *The New York Times* from 28th January 1940.

29 January 1940 that the Thames had frozen over near London for the first time since 1814. The fact that it was the south-east of England which was especially affected by the cold is strong evidence that the large military presence in the southern North Sea, the English Channel and the Irish Sea was a contributing factor.

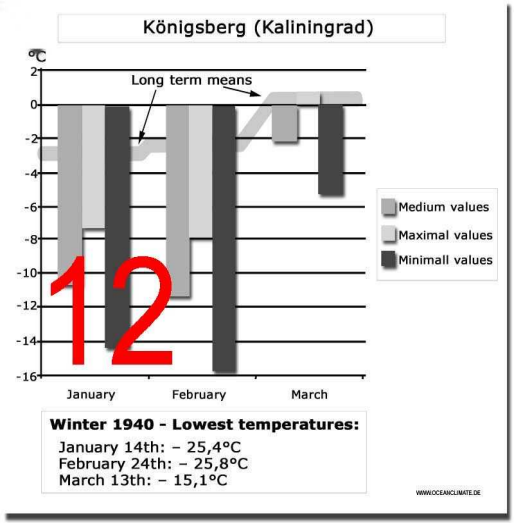
D-6 The Second Cold Wave and Not Only Denmark Was Shivering

While the far western part of Europe was spared a second extreme cold wave, Central, Northern and Eastern Europe were hard hit a second time in the middle of February **(Fig. 11)**. It was to be the coldest winter in 110 years for Berlin and Halle, for example (time from November to March). It was the most severe winter for Denmark as well since 1860, reported the *New York Times* (NYT) on 15 February 1940. Snowstorms had swept across Denmark before the end of December 1939 (*Frankfurter Zeitung*, 29 December). Jutland was also affected (*Neue Zürcher Zeitung*, 3 January 1940). 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 (NYT, 18 January 1940). In the middle of February, the temperatures fell again to -25° C (NYT, 14 February 1940), which may have been a result of Denmark's being so close to the naval war activities on the North Sea and Baltic. The significance of being located on these waters is vividly demonstrated by the graph for Königsberg. **(Fig. 12)** The low temperatures deviated from the mean values of the long-term statistics by about 11° in January, by about 15° in February and by about 5° in March 1940. (See Fig. 7.)

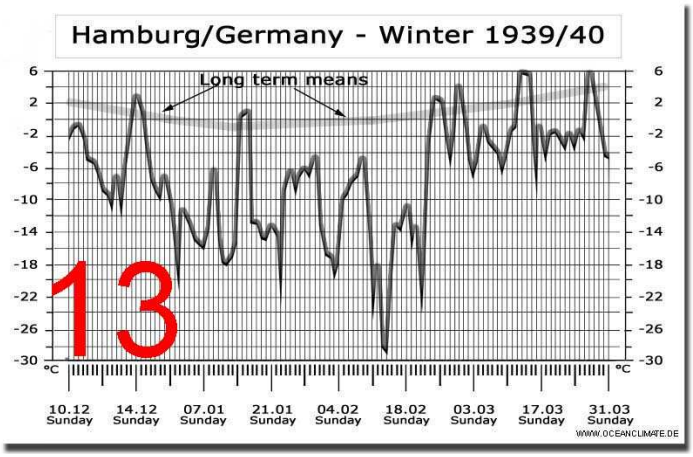


D-7 Record Cold Between the Seas

The low temperatures in Hamburg fell below -20° C four times within a two-month period, dropping below -28° C on 13 and 14 February 1940, the coldest temperatures ever recorded in Hamburg. **(Fig. 13)** The Finish expert Erkki Palusuo 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."*[19] Why did such a rare event happen in winter 1939/40, and then in Hamburg, a city close to two seas? One must only recall that the Germany Bight was travelled by an extremely large number of warships, that the English flew a number of bombing attacks, that English submarines penetrated the bay and engaged in battles and that a gigantic carpet of sea mines numbering about 60,000 to 100,000 mines, thousands of which exploded before the end of the year, was laid from Holland all the way up to Skagerrak within the first three months of the war. The same



[19] Palosuo, Erkki; 1953, "A Treatise on severe ice conditions in the central Baltic", Fennia 77, No.1, Helsinki, p. 92.

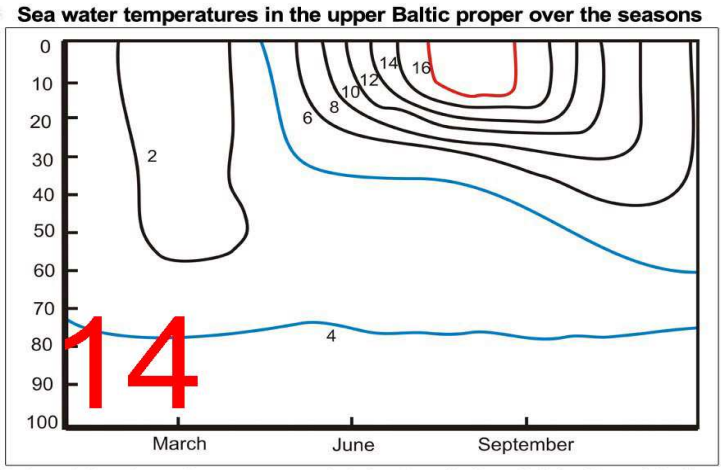


was true for the western and southern Baltic Sea which had been the scene of tremendous activity for naval warfare, training and monitoring since the invasion of Poland. It should therefore come as no surprise that the largest cold zone in February 1940 stretched from Königsberg to Amsterdam and that Hamburg was, so to speak, at the centre of this zone.

D-8 To What Extent Can A Relationship to Naval Warfare Activities Be Determined?

This question really should be superfluous, because "every child" knows that stirring a hot soup causes the steam to rise and the soup cools off more quickly. But since climate scientists have not yet learned about such obvious matters, an analysis of the "field study" carried out in the North Sea and Baltic by conducting naval warfare from September 1939 will help to make this clear. This is possible only in abbreviated form and only with regard to winter 1939/40. Anyone wishing to see a convincing answer to this question must also examine the course of the next two winters in Northern Europe 1940/41 and 1941/42 (as has been done elsewhere; see: reference books and websites), because it was a European naval war until the beginning of 1942; only after Pearl Harbor in December 1941 did it become a global war fought on all of the world's oceans, giving a completely new dimension to the effects of naval warfare activities on the climate. For more than four years, gigantic sea regions in the North Atlantic and the Pacific Ocean were "ploughed up," which must have affected long-term the natural temperature and salt content structures of several dozen metres of water below the surface, influencing global air temperature over a longer period of time. (Details: Climate Change & Naval War; p 225-247)

It is really more than surprising that no answers have yet been found to such important questions as the lack of the west wind drift over Europe, the rain along the Rhine, the shifting of the winds and the two plunges in temperature, first in January and then in February 1940. There is excellent, extensive documentation of the meteorological autumn 1939. This autumn was the starting mark of a climate change as determined by A. J. Drummond as early as 1943 (see above) and was noteworthy for a large number of unusual aspects which indicate a decisive effect of naval warfare activities in the waters of the North Sea and Baltic, still warm from the summer.



The images indicates the annual seawater temperatures in the Central part of the Eastern Baltic Sea (Western Gotland Sea, Gulf of Riga and Gulf of Gdansk), and the heat storage, culminating in August and mainly released by years end, whereby even a modest two degrees during Jan/Feb. would significantly contribute to regional winter conditions.
By approximation only.
AB2008
WWW.OCEANCLIMATE.DE

E. Concerning the Freezing of the North Sea and Baltic

(With excerpts from "War Changes Climate – The Naval War Effect", pp. 82 – 89)

Reference has already been made to the outstanding importance of these waters for the winter climate in Northern Europe. The Baltic Sea in particular, which is protected from the North

Atlantic by a high mountain range stretching from North Cape to Oslo, is a major factor for the moderate winters even into the north of Finland. The temperature difference over the winter between coastal and inland stations 100 to 200 km apart is several degrees (see Fig. 2 above). Between August and December, the Central Baltic Sea releases as much as about 10 degrees of the heat which it has stored to a depth of about 30 metres, then from January to March approximately another 4 degrees. **(Fig. 14)** If this statistical process in affected by intense naval war activities, it is possible to distinguish three phases:

- Phase 1: The cooling process is first accelerated, and more heat and moisture is transferred to the atmosphere (late autumn).
- Phase 2: Although the surface of the sea has cooled off sufficiently for the water to begin to freeze, cruising ships or battles "stir up" warmer water from greater depths, preventing early freezing (turn of the year).
- Phase 3: The upper seawater layer has cooled to a depth of more than 10 metres and to a greater extent than normal, leading to a very sudden and substantial freezing of the seas.

E-1 Northern Baltic Sea

The Baltic Sea along the coasts of Finland had not frozen over such a wide area and to such a depth since 1883. The most intense battles ever conducted in these waters had been going on in the Gulf of Finland (80 – 100 metres deep in part) since 30 November. They continued until the middle of January 1940. The naval war activities were not stopped for military reasons; naval movements came to a complete standstill for a number of weeks in the Baltic Sea because of the very sudden and deep freezing over of the sea, ultimately spreading over the entire Baltic. The chronology of the process reads as described in the following.

In the middle of October 1939, the first lakes and rivers froze over in Northern and Central Norrland (northernmost province in Sweden) and in the north-west of Svealand (Central Sweden), a phenomenon which usually did not occur until the end of the month. On 11 December 1939, ship traffic was suspended in Kalix and Oulu (Gulf of Bothnia) because of the freezing of the water. The ice began to grow near Hanko, at the western outlet of the Gulf of Finland, from 27 December, and an "ice bridge" formed between Turku and the Swedish Åland Islands, where the water is shallower, on 6/7 January 1940, about two and a half weeks earlier than usual.

Nevertheless, the Gulf of Finland was still open to about 50 km east of Helsinki on 15 January 1940. The fact that the Gulf had only moderately iced over despite the very low temperatures which had dominated since 20 December (see Fig. 9) can be seen as a consequence of the intensity of the naval warfare activities. The naval war theory is supported further by the fact that the complete icing over the Gulf which followed happened within a very short time span. *"The ice formed very rapidly on the parts of the sea still open, and on January 27, with a fairly weak 3-4 Beaufort NE wind blowing, the northern Central Baltic even, off Utö (ca. 100 km west of Hanko) froze,"*, observed the Finish expert E. Palosuo.[20]

The Swedish expert C. J. Östman[21] had the following remarks about ice conditions in Swedish waters in winter 1939/40: The ice was generally thicker than is usually the case. In the Gulf of Bothnia, it was only slightly thicker, while the ice in the southern Baltic and on the west coast of Sweden reached thicknesses of up to 60 centimetres, twice that of normal winters.

[20] op. cit., Palosuo, Erkki; 1953.

[21] Östman, C. J.; 1940; "Den svara isvintern 1939/40", Statens Met-Hydro. Anst., Meddelanden Ser. Uppsatzer, No. 33, Stockholm 1940, pp. 1-25

E-2 Southern Baltic Sea

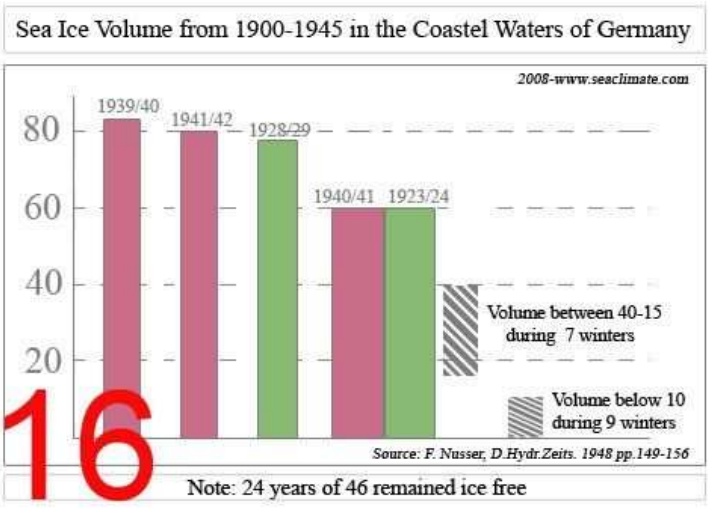
Ice had already begun to appear in the southern Baltic Sea in the middle of December. This development is not surprising when once considers the activities of the naval forces: since Germany's invasion of Poland, warships and coastal artillery had been firing at each other at many points along the Polish coast. The Germans laid a series of mine fields south of the Danish waters, but Denmark also laid sea mines. German, Danish and Swedish warships patrolled the southern Baltic heavily. The German navy was training tens of thousands of future crew members as well as developing and testing new ships and weapons in this sea region. Once the conquest of Poland was complete, heavy supply traffic from the west to the east began. The Bay of Greifswald south-east of Rügen began to freeze over on 18 December and

did not start to thaw again until 4 April 1940. It was 11 April before the ice had disappeared completely. (See Fig. 16)

E-3 Kattegat

The ice began to form in the middle of December and quickly spread into shipping lanes. As many as 115 ice days were recorded. The last ice floating in the sound was observed on 19 April 1940. **(Fig. 15,** Sea Ice – 13 Feb. 1940**)** Owing to the early formation of ice, 1940 became one of the most severe ice winters ever. Low temperatures reached -22.2° in December, -24.3° in January, -27.4° C in February and -22.0° C even in March. The monthly temperatures in Copenhagen, even in February, do not otherwise fall below zero as an average. Ships securing supply lines were able to pass through the frozen channels only by travelling in convoys accompanied by ice-breakers.

Sea ice appeared already about the middle of December 1939, which became unusually severe and the duration was extreme long, maximum 115 days., lasting in the Sound until 19 April 1940.
Data source: Det Danske Meteorologiske Institut (1940). Here: www.seaclimate.com/2008



E-4 German Bight

The first ice-breakers were deployed on the Elbe as early as 16 December 1939. Temperatures in Hamburg had remained almost constantly below zero since 8 December. The pack ice spread even further from 26 December and did not melt for more than 90 days – until the middle of March 1940. **(Fig. 16)** The first ice in the German Bight was registered in Tönning at the mouth of the Eider on 17 December. The freezing over did not begin until two weeks later only at Germany's northernmost point, the island of Sylt. This is a clear indication of deeper water – and of the

still relatively warm water masses in the northern North Sea. Moreover, the navy was more active in the shallower waters south of Tönning. Helgoland was a key naval base. In the southern region (Borkum), the ice remained 60 – 70 days – until the end of February. 102 days were counted at the mouth of the Elbe, 100 days in Tönning. North of this region, there were 60 days from the beginning of January until early March.

F – Closing Comments

Even after having existed for many decades, the science of weather and climate did not attach the importance to the oceans which they deserved. In 1939 at the latest, it should have become apparent to experts that climate is a function of water. Leonardo da Vinci (1452 – 1519) put it succinctly long ago: "Water is the driver of nature." Since the oceans exceed the total amount of atmospheric moisture by a factor of 1000, there is ample justification for defining climate as the "continuation of the seas by other means,"[22] because they feed gigantic quantities of heat and water into the atmosphere (see above). If climate had been understood in this sense at the time, it would have been possible to mitigate the rising political turbulences in 1939 at least to some degree by warning about the climate changes which would occur. But the science of meteorology did not understand much at that time and said nothing.
For more than 20 years now, scientists have believed they are called upon to predict apocalyptic scenarios of climate change and to demand costly programmes and taxes from politicians. They do so without any consideration of events which their fathers and grandfathers experienced themselves. Those generations marched off to a world war in 1939, and only four months later there was a collapse of the climate. The temperatures in Northern Europe fell to a level which was extreme even for the small ice age. Such low temperatures had not been experienced in more than 100 years. The temperatures were 5 – 10 degrees below the average of many years. Although this was not even 69 years ago, the extreme winter of 1939/40 remains un-investigated. The two following winters, 1940/41 and 1941/42, set a large number of records for cold in Northern Europe as well as marking the start of a noticeable cooling of the northern hemisphere lasting more than three decades. In 1948, the German meteorologist M. Rodewald described it in this way: *"(It is ... shown) ... – a "secular heat wave" made itself felt over most of the Earth. We noticed this especially in the increasing mildness of the winters which, while beginning in the previous century, became more and more striking between 1900 and 1939. So it is all the more surprising that there was a series of three severe winters in succession in 1939/40, 1940/41 and 1941/42, appearing to indicate a sudden reversal of the previous development rather than a slow deceleration, contrary to the sustainment tendency of circulation and temperature deviation."*[23] Anyone who claims to understand climate change must also be able to explain these events. Anyone who can explain these events will recognise that the oceans play the key role in any and all questions of the climate.

G. Reference Books and Websites (Selected)

Published by Trafford Publishing, Victoria/Canada.

- Principal work: "Climate Changes & Naval War – A Scientific Assessment -", 2005, p. 325; ISBN 1-4120-4846-X; available also at: http://www.seaclimate.com/
- Shorter version: "War Changes Climate – How Two World Wars Changed Climate – The Naval War Effect", 2006, page 177, ISBN 14129059-8; http://www.warchangesclimate.com

[22] See the author's Letter to NATURE, Volume 360, 26 November 1992, page 292
[23] M. Rodewald, 1948, "Das Zustandekommen der strengen europäischen Winter", in: Annalen der Meteorologie, Vol. 4/5, p. 97

Websites (Selection)
General and various articles since 1992: http://www.oceanclimate.de/

H. The author Dr. Arnd Bernaerts trained as seaman and served as ship master before becoming a jurist, lawyer and international consultant.