The ice winter of 2017/18 on the German North and Baltic Sea coasts with a brief description of ice conditions in the entire Baltic Sea region

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Ice coverage in the Bay of Greifswald on March, 6th 2018 Courtesy of Frank Sakuth

Progression of the ice winter at the German North Sea and Baltic Sea coasts

Weather conditions at the German coastal areas

Temperatures in the months November to January were on average 1-2°C higher in the winter of 2017/2018 compared to the long-term average (Tab. 1). In contrast, the months February and March were about 2-3°C colder compared to the 1981-2010 reference period. In November and December, air temperature where mostly above the freezing point (see Fig. 1). In January, daily averaged temperatures dropped below zero degrees Celsius for three periods, but still it was about 2°C warmer than normal. At the end of January, measurements reached values of 4° to 10°C. In the beginning of February, the weather conditions changed. Easterly and northerly winds transported cool continental air to the German coasts and as a result, air temperatures dropped below the freezing point for most days in February and March. End of March, winter seemed to come to its end when westerly winds established more frequently. However, at the 1st of April, the Baltic Sea region had become a further cold day with temperatures around the freezing point and with masses of snow fall before westerly and southerly winds quickly brought warm air to the German coasts. Only one week later, on the 8th of April, daily averaged temperatures reached already 15°C with maximum temperatures of over 20°C in the afternoon, in some regions.

Table 1: Monthly mean air temperatures (°C) and their deviations from the reference period (1981 – 2010) in °C for the winter 2017/2018 (Data source: Deutscher Wetterdienst, www.dwd.de).

Station	November		December		January		February		March	
	T_{air}	ΔT_{air}	T_{air}	ΔT_{air}	T_{air}	ΔT_{air}	T_{air}	ΔT_{air}	T_{air}	ΔT_{air}
Greifswald	5,9	1,2	3,5	2,0	2,9	2,2	-1,3	-2,4	0,4	-3,3
Rostock-Warnemünde	7,0	1,5	4,2	1,9	3,4	2,0	-0,2	-1,9	1,2	-2,9
Schleswig	5,8	0,8	3,7	1,7	2,9	1,6	-0,5	-1,9	1,5	-2,2
Norderney	8,1	1,5	5,0	1,5	4,3	1,7	0,7	-1,9	2,5	-2,4

In summary, two weak cold periods occurred in the winter of 2017/2018, the first one in January, and the second one from February to mid-March. Both periods were occasionally interrupted by warmer phases. On most stations along the German coast, daily averaged temperatures reached their minima on the 28th of February, except for the eastern parts of the German Baltic Sea. There, minimum values were measured two days later on the 2nd of March. On these days, temperatures varied between -5.4°C in Arkona and up to -10.1°C in Hamburg and Greifswald (Fig. 2). At the North Sea the winter 2017/2018 was colder than the two former winters. At the Baltic Sea coast, winter temperatures in 2017/2018 are comparable to those in 2015/2016. The only difference is that in 2015/2016 the lowest temperatures where measured in January while in this year's winter, the coldest days occurred between end of February and the first days of March.

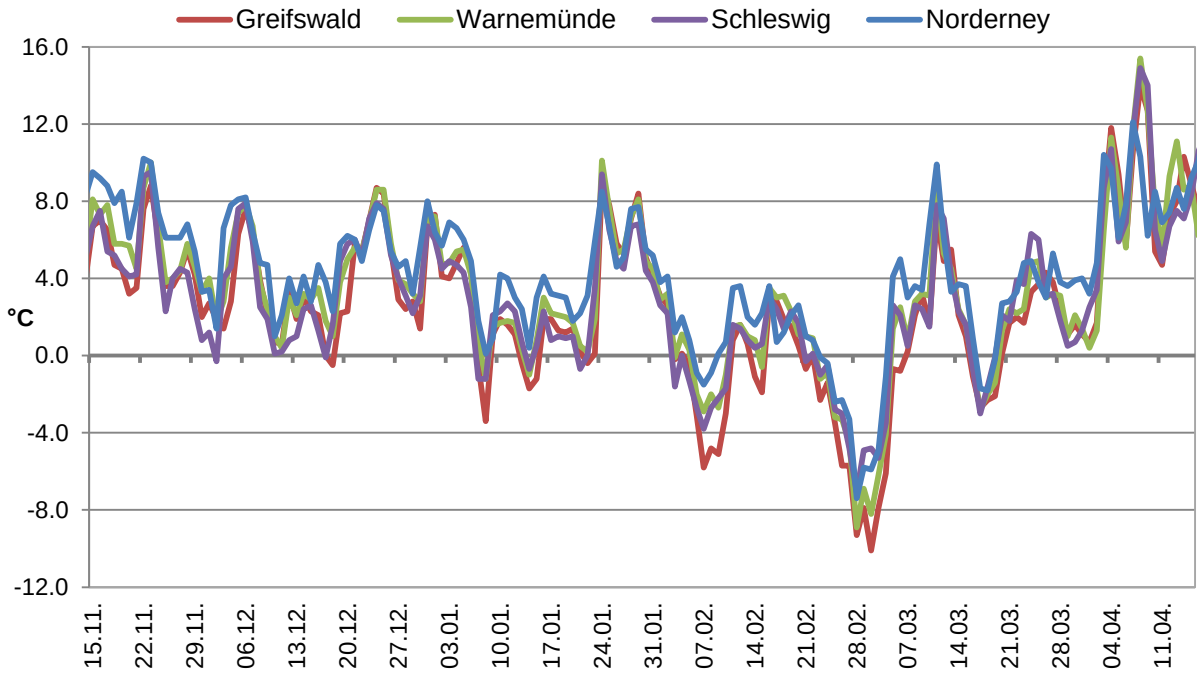

Figure 1: Daily averaged air temperatures in the winter 2017/18 (Data source: Deutscher Wetterdienst, www.dwd.de/) exemplarily for Greifswald, Rostock-Warnemünde, Schleswig und Norderney.

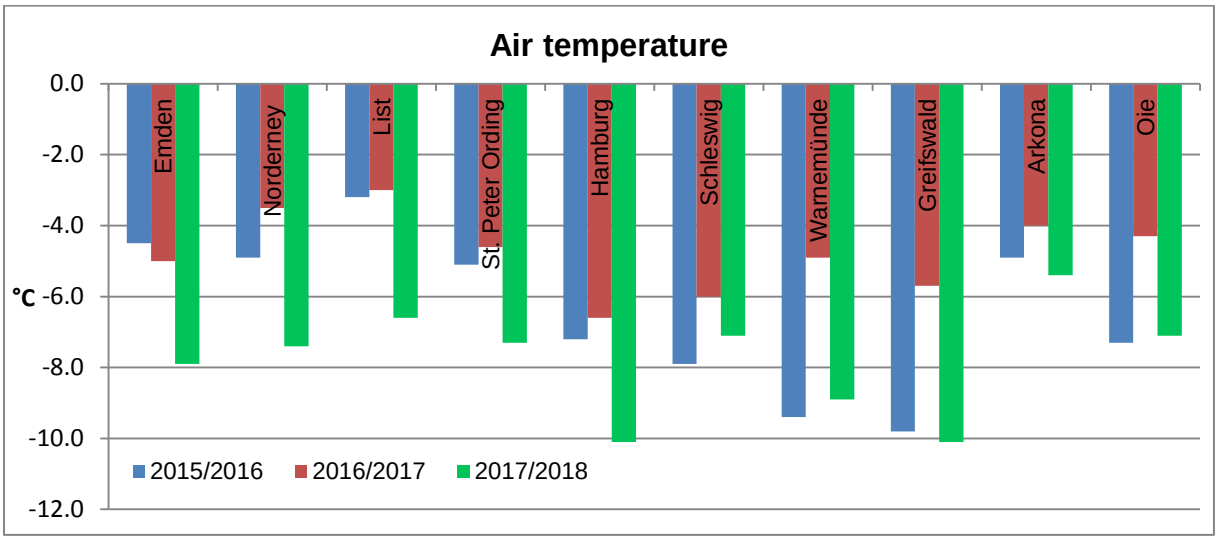

Figure 2: Minimum air temperatures for chosen stations from the west to the east along the German coasts.

In the inner waters of the eastern German Baltic Sea coast, water temperatures dropped below the freezing point in mid-January. However, since air temperatures increased again also water temperatures raised above 0°C only few days later. In the beginning of February there was another short-term drop and finally water temperatures stayed below the freezing point from end of February until end of March in some places. Further west, and in the outer coastal waters, there were only two short periods, end of February and mid-March, when water temperatures were below the freezing point. In the inner North Sea waters, water temperatures dropped also below the freezing point for some days in the beginning of March (see Fig. 3), in contrast to the last recent years.

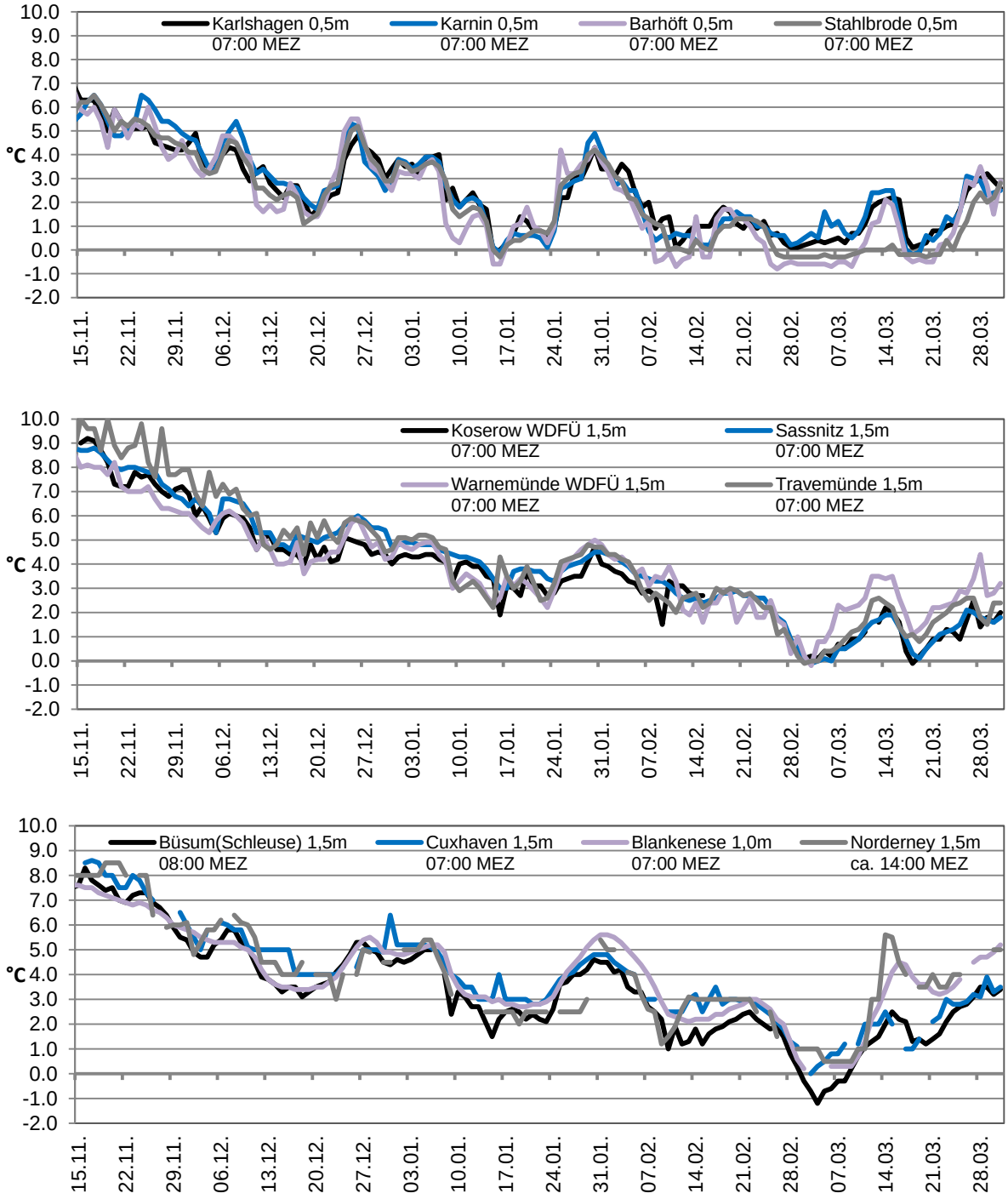

Figure 3: Water temperatures of the German coastal waters. Data sources: Karlshagen, Karnin, Barhöft, Stahlbrode, Koserow, Sassnitz and Warnemünde – WSA Stralsund; Travemünde – WSA Lübeck; Büsum – Schleuse Büsum; Blankenese - Institut für Hygiene und Umwelt; Norderney – Deutscher Wetterdienst; Brunsbüttel – WSA Brunsbüttel.

Ice conditions at the German North and Baltic Sea coasts

Although there have been few days of ice growth every now and then at some stations over the ice season 2017/18, the winter consisted more or less of one significant ice period at the German North Sea and Baltic Sea coasts. At the North Sea coast, it happened from 26th February to 10th of March and at the Baltic Sea from 6th February to 22nd March. At both coasts, the coldest days with the highest ice productions rates occurred between 2nd and 7th March.

Figure 4: Ice conditions around Rügen at the time of maximum ice extent on the German Baltic Sea coast. Courtesy of Frank Sakuth.

The first ice of the winter 2017/2018 formed in the beginning of December on the Schlei, but over day it melted again. Between the 8th and the 11th January and on few days mid-January, there was little ice formation at some stations along the Baltic Sea coast. Significant ice formation started on the 6th of February on the Schlei and in Neustadt, and went on along the Baltic Sea coast over the following days. At the same time, little ice formation was also noticed in the North Sea, along the North Frisian coast, but it stopped after few days for a while. On 26th of February ice formation went on in the North Sea and in both seas ice production rates increased rapidly. The maximum ice extent was reached on the 4th of March 2018 (Fig. 5). The ice coverage varied mostly between very open to open ice and open water along the entire German North Sea coast. In sheltered areas of the western and in most parts of the eastern German Baltic Sea coast, close to very close ice occurred, with some very open ice and open water at the ice edge towards the open ocean. Maximum ice thicknesses of 15-30 cm were measured around Rügen and at the northernmost parts of the North Frisian coast by that time. However, new ice and ice with thicknesses from 5-15 cm dominated the ice thickness distribution.

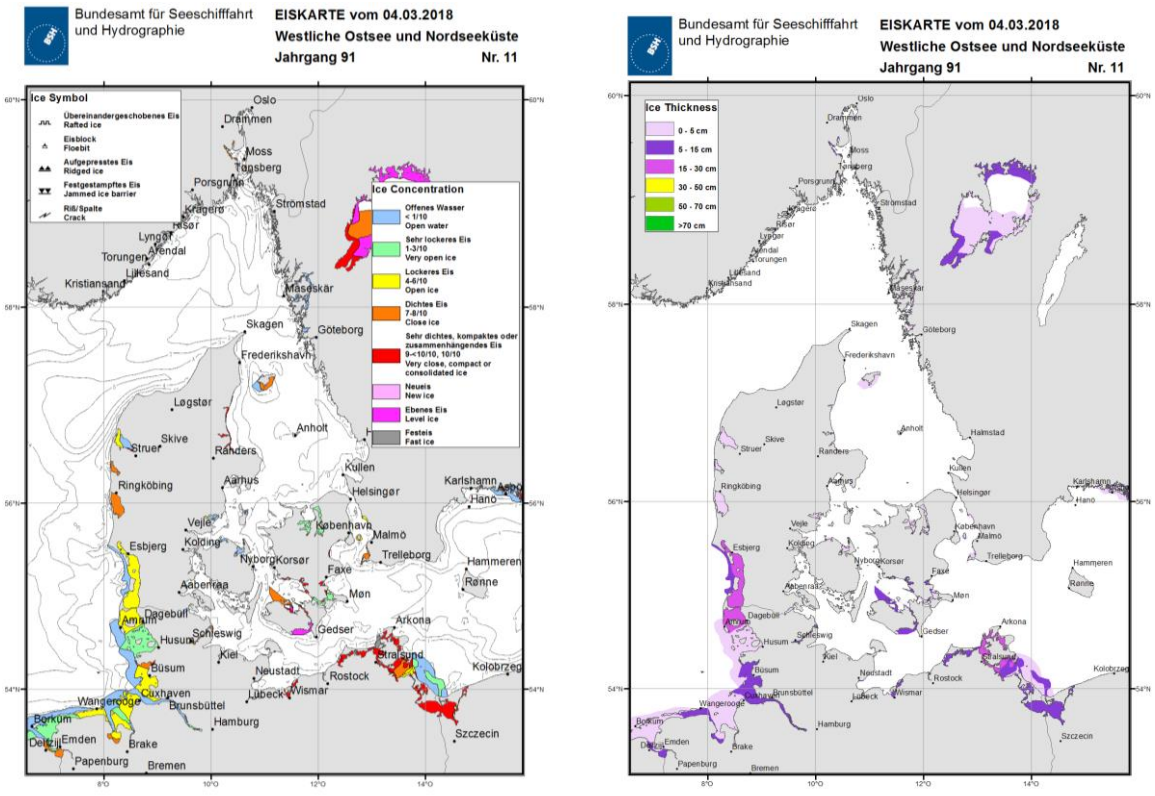

Figure 5: Sea ice extent and sea ice thickness in the German waters off the North and Baltic Sea coasts at the time of maximum ice development (4th March) in the ice winter 2017/18.

End of March, westerly winds established more frequently, transporting mild air masses to the coastal regions and initiating the ice retreat for that winter. Again, the longest ice coverage was noticed for the Baltic Sea: In the Dänische Wiek ice occurred on 57 days and on the Schlei, on 53 days. In the sheltered waters between Rügen and Hiddensee, ice persisted for 36-42 days and in the Darß-Zingster Bodden Chain on 39-47 days. Even in Rostock ice could be found for up to 30 days. In the Mecklenburger Bay, ice was observed on up to 20 days. At the North Sea coast, the longest ice occurrence was observed in Emden (new inner Harbour) with 19 days. The Bay of Jade was covered by ice for 5-9 days. On the Weser, ice was found on 3-9 days and on the river Elbe for up to 12 days in sheltered areas. Along the north Frisian Coast, ice occurred for up to 15 days (see Tab. A1 and A2).
The evolution of the ice winter 2017/2018 is shown in Figure A1 in the appendix. Table A1 and A2 of the appendix summarize the most important ice parameters for this season.

Navigational conditions at the German Baltic Sea coast

Navigation was hampered by ice conditions mainly in the eastern part of the German Baltic coast. From 1st to 16th March 2018, navigation was prohibited during night for the northern ship route to Stralsund (including the Bodden waters west), for the eastern ship route to Stralsund from the buoy „Landtief B“ up to the ports of the Greifswalder Bodden and Stralsund as well as for the northern Peenestrom (WSA Stralsund BfS, 2018). One day later, at 2nd March, ship navigation to the northern and eastern approach to Stralsund, the ports in the Greifswalder Bodden, the fairway “Osttief”, the Peenestrom and the Kleines Haff was only allowed for ships with ice class E1 (IC) and a power of 1000 dwt (WSA Stralsund BfS, 2018). This restriction also lasted until the 16th of March.

Figure 6: Ice coverage at Landtiefrinne on 2nd March. *Courtesy of Frank Sakuth*

Ice winter intensity

The ice winter 2017/18 counts to the weak winters for both the North Sea and the Baltic Sea region although it was stronger than the winter 2016/2017 and is close to being a moderate winter. It is the 6th weak winter in succession. The indices for the ice winter strength are calculated out of observational data from the 13 climatological stations at the Baltic Sea coast and the 13 climatological stations at the North Sea coast. They are expressed in terms of the

reduced ice sum and as the accumulated areal ice volume ($V_{A\Sigma}$), respectively, shown in Table 2. For the Baltic Sea, the ice winter strength was also calculated for the coasts of Mecklenburg-West Pomerania and Schleswig-Holstein separately. This year's winter, ice occurred not only very late in the season, the ice production at the coast of Mecklenburg-West Pomerania was also lower than the production at the coast of Schleswig-Holstein, which is usually the other way round. In fact, if we look at the coast of Schleswig-Holstein by its own, the ice situation reflects a moderate strong winter.

Table 2: Reduced ice sum and accumulated areal ice volume at the German coasts in the winter of 2017/18.

Area	Reduced ice sum	Accumulated areal ice volume
North Sea coast	6.4	**0.30**
Baltic Sea Coast	11.8	**0.49**
Coast of Mecklenburg- West Pomerania	7.3	0.45
Coast of Schleswig-Holstein	17	0.54

Figure 7 shows the evolution of the ice formation by means of the daily areal sea ice volume for both German coastal areas and Figure 8 illustrates the respective daily accumulated areal ice volume over the climate stations. At the Baltic Sea coast, there were some few short-lasting ice production phases, but significant ice growth began only in the beginning of February, with the major ice production rates in the beginning of March.

At the North Sea coast, ice formation occurred during one period starting end of February. For few days in the beginning of March ice production rates even exceeded those in the Baltic Sea. However, afterwards ice had melted quickly, so that the German North Sea coast became ice free by the 13th March, about two weeks before the Baltic Sea became completely ice free.

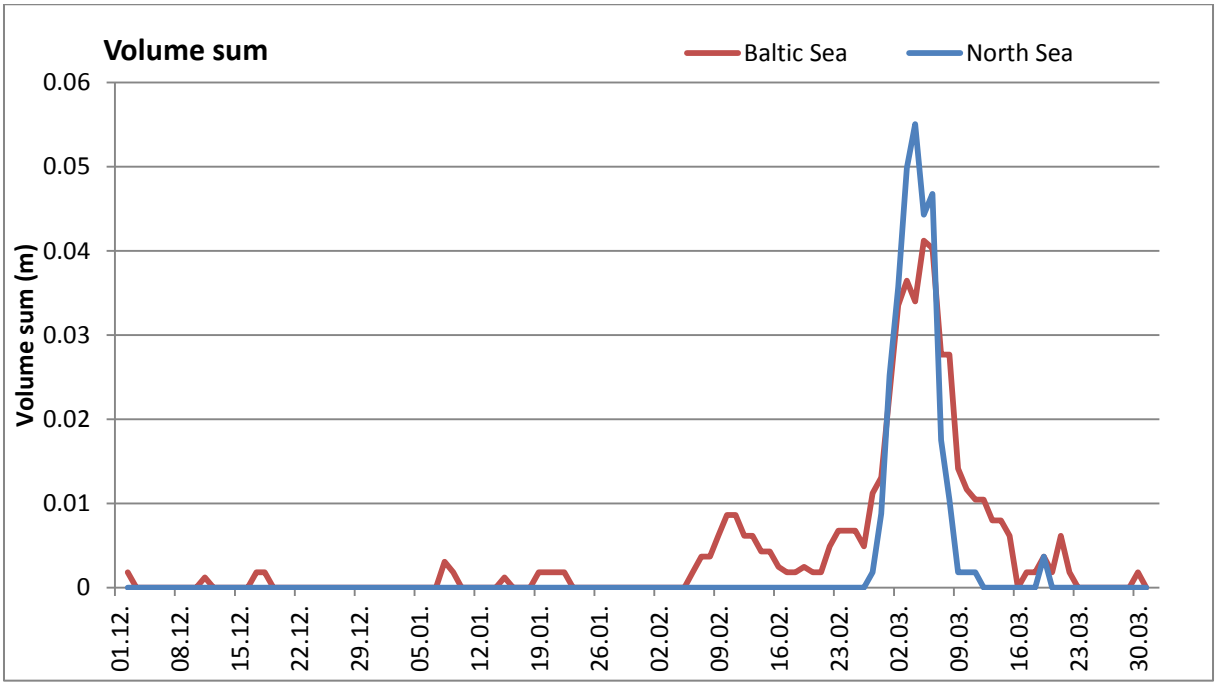

Figure 7: Areal ice volume at the German coasts in the winter of 2017/18.

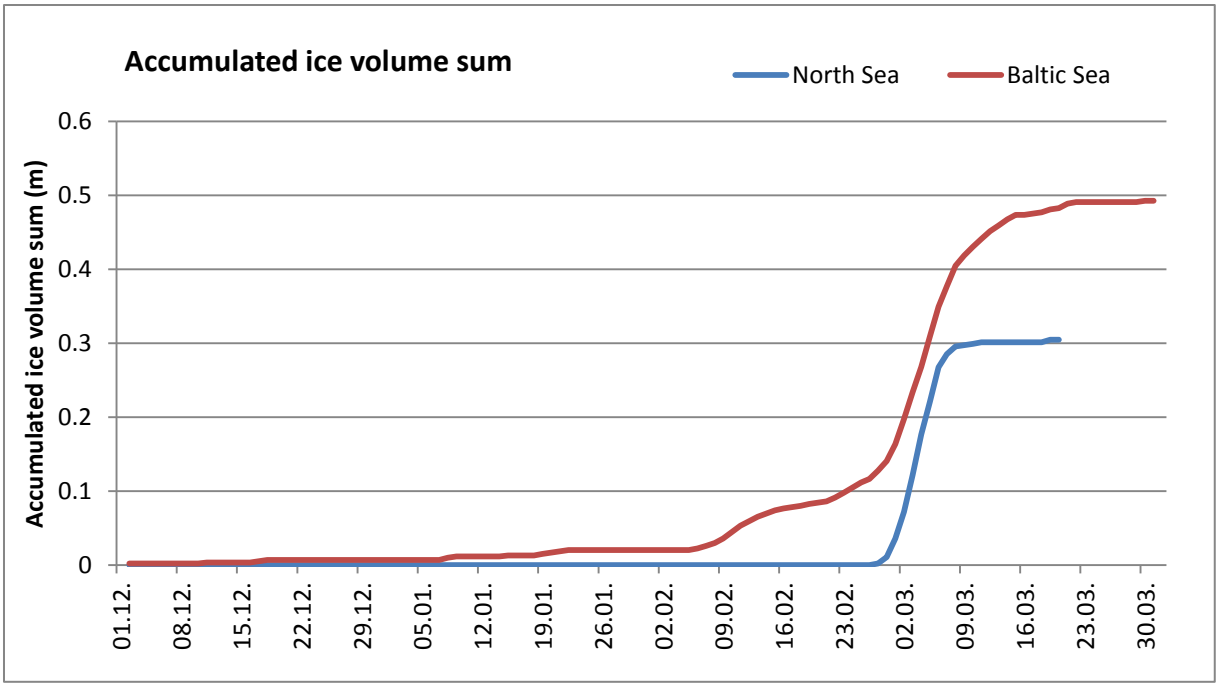

Figure 8: Accumulated areal ice volume at the German coasts in the winter of 2017/18.

The BSH reported on ice conditions and expected ice development in the entire Baltic Sea region and German coastal waters in the ice winter **2017/18** by the following reports and ice charts:

109 ice reports (official reports issued Mondays to Fridays),
30 German Ice Reports (international exchange, issued when ice forms in German fairways),
about 30 NAVTEX - reports (in German and English for the German North and Baltic Sea coasts),
35 ice reports “German Baltic Sea coast” (detailed description of ice situation for German users),
10 ice reports “German North Sea coast” (detailed description of ice situation for German users),
23 weekly reports (information for the BMVBW and the public),
23 general ice charts (once per week as reference for the entire Baltic Sea),
26 special ice charts (German Baltic Sea coast).

The current ice reports and charts of the BSH are available online and free of charge under https://www.bsh.de/DE/DATEN/Eisberichte-und-Eiskarten/Eisberichte-und-Eiskarten_node.html. The archive with all ice charts issued so far is available at ftp://ftp.bsh.de/outgoing/Eisbericht/.

The strength of the ice winter 2017/2018 is shown in Figure 9 and Figure 10, compared to former years. Since 1896/97 (122 Years) 51 winters have been weaker than the winter 2017/2018 at the German North Sea coast and 52 at the German Baltic Sea. In total, the ice winter 2017/2018 was the 6th weak winter in a row.

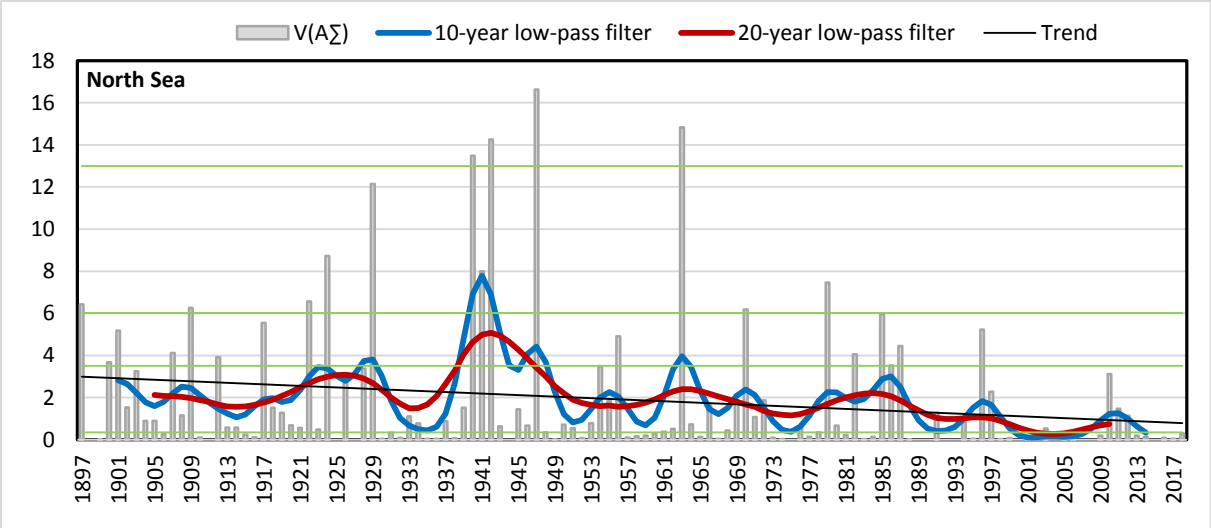

Figure 9: Distribution of the areal ice volume sum for the German North Sea coast with 10-year (blue) and 20-year (red) low-pass filter as well as the long-term trend (black).

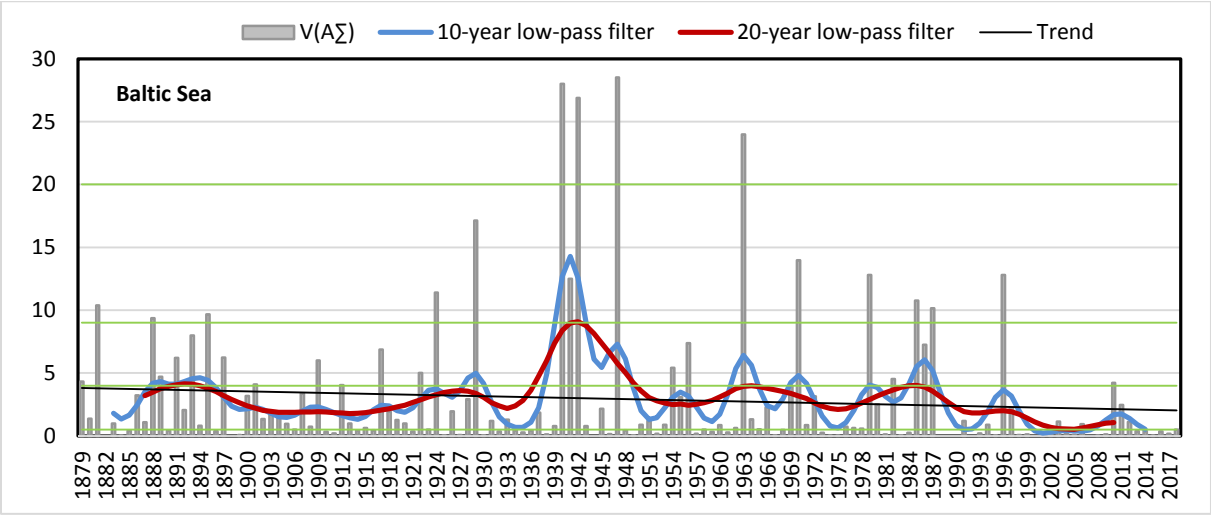

Figure 10: Distribution of the areal ice volume sum for the German Baltic Sea coast with 10-year (blue) and 20-year (red) low-pass filter as well as the long-term trend (black).

Ice conditions in the western and southern Baltic Sea

In sheltered areas of the coast of the Netherlands, some ice formed between the 2nd and the 15th of March. Ice thicknesses were mostly up to 8 cm in the Ijsselmeer, but could also reach up to 40 cm in sheltered areas. In the Danish waters, new ice formed end of February. Ice concentrations varied from open water and very open ice to open and close ice in sheltered bays. Ice thicknesses went up to 10-15 cm, along the North Sea coast ice grew also thicker due to ice drift. Ship traffic was not significantly affected by the ice situation.

In the Skagerrak, Kattegat, Belts and Sound area, some ice formed in sheltered areas. However, the major shipping was not affected.

In the southern Baltic Sea, the first pack ice occurred in the Curonian and Vistula Lagoons mid-January. A month later, mid-February, ice growths started also in the Szczecin Lagoon and on few locations along the Polish coast. In the Bay of Puck, ice formation started in the beginning of March. The ice thicknesses reached 5-15 cm in the Szczecin Lagoon by mid-March and up to 10-20 cm in the Vistula Lagoon. By the end of March, the Szczecin Lagoon and the Bay of Puck were virtually ice free, in the Curonian and the Vistula Lagoons, there was regionally some ice up to the 7th of April.

Ice conditions in the northern Baltic Sea (north of 56°N)

In the Bay of Bothnia, ice formation started at the beginning of December in the winter 2017/2018. However, until end of December, the ice coverage barely changed and until end of January ice formation proceeded very slowly and was mostly restricted to shallow waters. From the beginning of February, there was suddenly a quick increase in ice coverage up to the beginning of March, when the maximum ice extent was reached for that winter. By then, the Gulf of Bothnia was nearly completely covered by ice, except for the center part of the Sea of Bothnia. Also the Gulfs of Finland and Riga were completely covered by sea ice. Further south, ice occurred in most places along the coast up to the south-western Baltic Sea. By the beginning of April, ice retreated quickly south of the Bay of Bothnia. In the Bay of Bothnia, ice remained until the 24th of May.

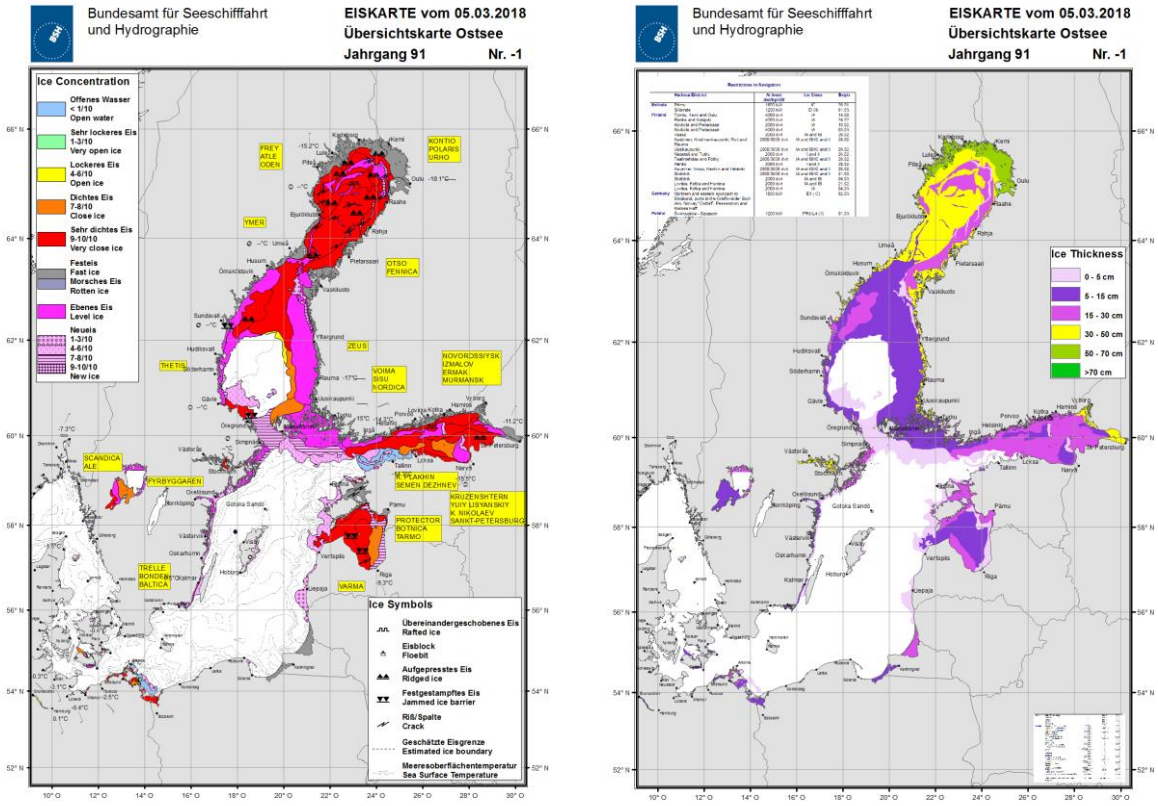

Figure 11: Ice chart for the entire Baltic Sea at the day of maximum sea ice extent in this winter (05. March 2018). Left: Ice coverage (coloured), form of the ice (symbol), temperature and wind at individual stations, water temperature and icebreaker operation for shipping assistance. Right: Ice thickness distribution and shipping restrictions.

The maximum ice thicknesses varied between 30-75 cm for the northern fast ice and 20-50 cm for the pack ice in the Bay of Bothnia. In the Gulf of Finland, the fast ice grew up to 15-45 cm and the pack ice to 15-30 cm. Ice in the Gulf of Riga reached 10-30 cm of thickness.

The maximum ice extent was reached on the 5th of March and amounts to 175000 km^2 according to the Finnish or 182005 km^2 according to the German ice service. Hence, the ice winter 2017/2018 was a moderate winter following the Finnish ice winter strength classification (Seinä und Palosuo, 1996).

The ice volume was at its maximum around the 23rd of March with 24.5 km^3. According to the ice volume, the winter is classified as weak.

Nevertheless, in the Gulfs of Bothnia, Finland and Riga restrictions regarding ice class, ship size and deadweight were announced and several icebreakers were deployed for shipping assistance. The Lake Saimaa and Saimaa Canal were closed for ship traffic from the 1st of January up to the 18th May 2018. The traffic separation scheme in the Quark was out of use between the 27th February and the 4st May.

Maximum sea ice extent and maximum sea ice volume in the Baltic Sea

Figure 12 shows the maximum sea ice extent of each winter calculated from the Finnish and German ice service, respectively, compared to each other, as well as the class boundaries for the ice winter strength according to Nusser (1948) listed in Table 3.

Table 3: Class boundaries for different ice winter types.

Max. Area	Min. Area		Max. Volume	Min. Volume
1000*km^2	1000*km^2		km^3	km^3
405 (1987)	> 380	Extreme strong ice winter	**99.4** (1987)	> 89
380	295	Strong ice winter	89	65
294	171	Moderate ice winter	64	30
170	85	Weak ice winter	29	17
< 85	**49** (2008)	Extreme weak ice winter	< 17	**7.6** (1992)

As in every year, there is a slight difference between the Finnish and the German maximum ice extent, since the interpretation of satellite data may slightly differ and different land masks are used in both services. However, the difference does generally not influence the classification of the ice winter strength. As mentioned before, the winter 2017/2018 is classified as a moderate winter with respect to the ice extent. It is the 25th moderate winter since 1961. Over the recent 57 years, this ice winter class is the most frequent one.

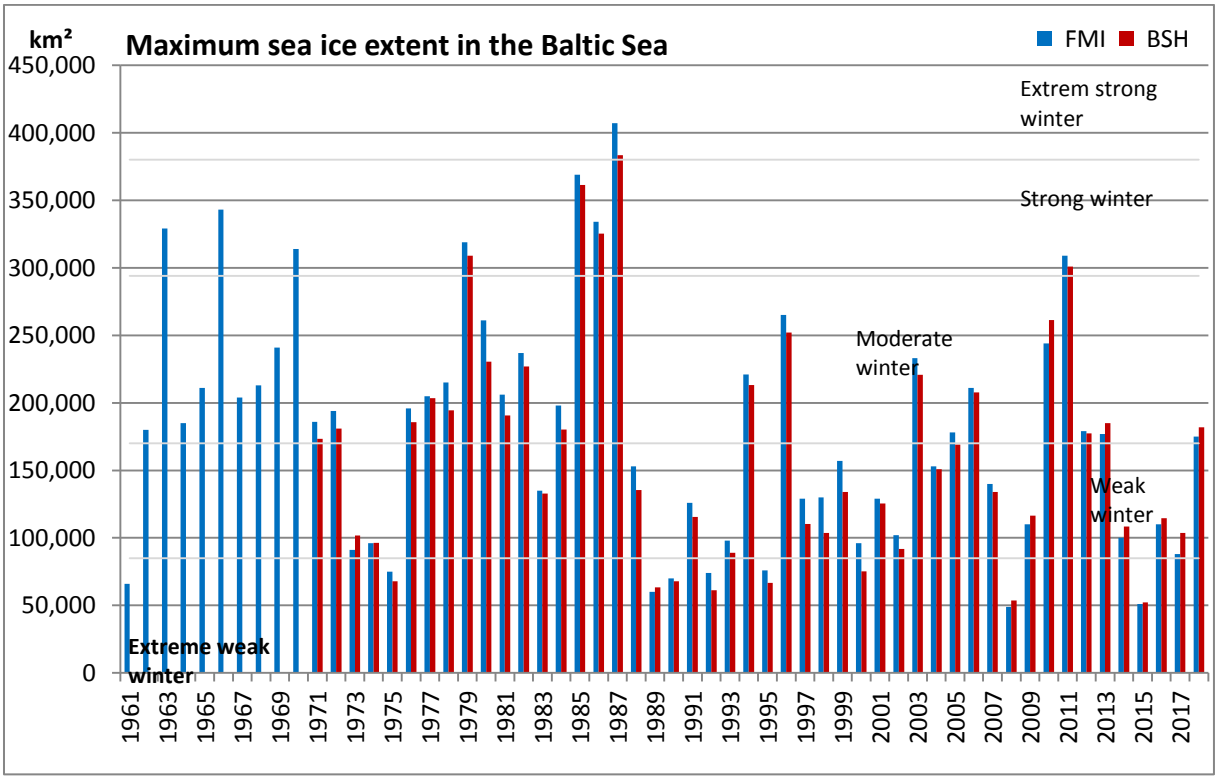

Figure 12: Yearly maximum sea ice extent in the Baltic Sea for the period 1961 – 2018 (Data source: FMI and BSH).

Figure 13 shows the maximum sea ice volume from the BSH data set since 1971. As the maximum yearly sea ice volume comprises the ice extent as well as the sea ice thickness, it is a much better measure for the description of the ice winter strength. Although the ice volume of the winter 2017/2018 is a little bit higher than it was in the former four years, it still leads to a weak winter classification.

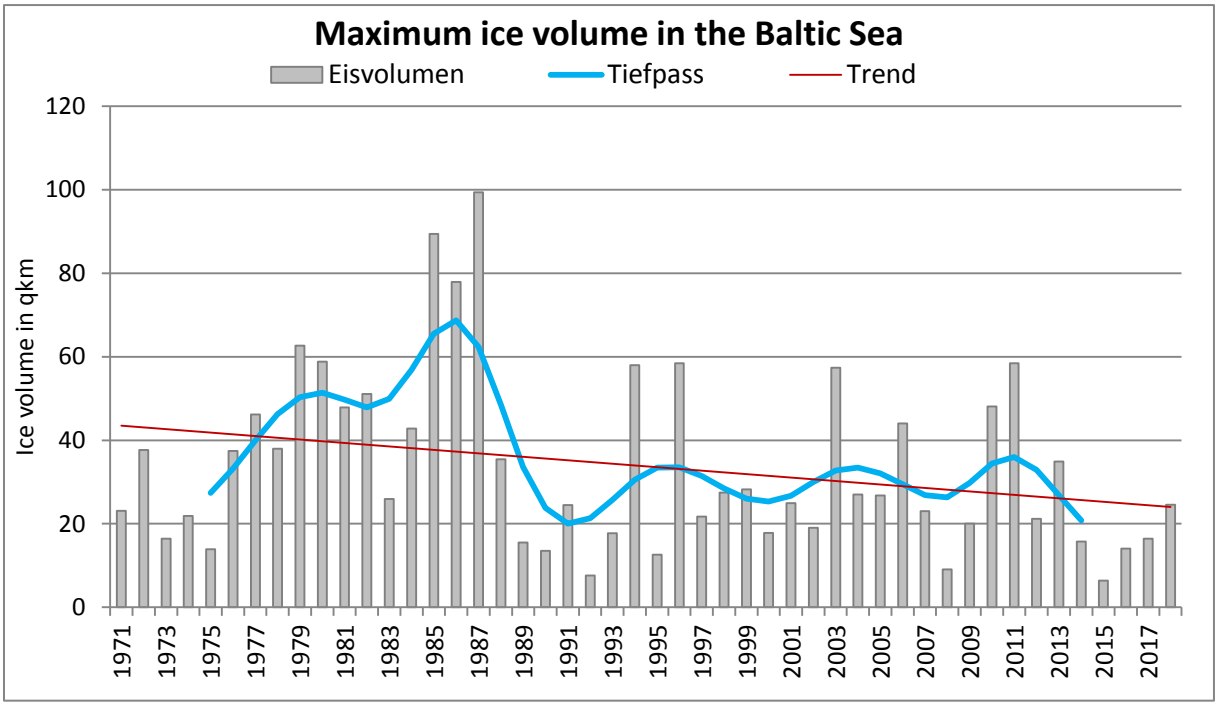

Figure 13: Yearly maximum sea ice volume of the Baltic Sea for the period 1971 – 2018.

Literature

Nusser, F., 1948: Die Eisverhältnisse des Winters 1947/48 an den deutschen Küsten. Dt. hydrogr. Z. 1, 149–156

Seinä, A., E. Palosuo, 1996: The classification of the maximum annual extent of ice cover in the Baltic Sea 1720-1995, Meri – Report Series of the Finnish Institute of Marine Research, No. 27, 79–91

WSA Stralsund, 2018: Bekanntmachung für Seefahrer, (T) 014/18-018/18, (T) 020/18-022/18, (T) 28/18-29/18

Appendix

Table A 1: Ice conditions at the German North Sea coast in the winter of 2017/18.

Observation station	Begin of ice occurrence	End of ice occurrence	Days with sea ice	Sea ice thickness
Brunsbüttel, Channel entry	04.03.	06.03.	3	5 cm
Ellenbogen, Listertief	27.02.	19.03.	14	10 cm
Sylt, Harbour List	27.02.	20.03.	15	30 cm
Dagebüll, Harbour	26.02.	01.03.	4	5 cm
Dagebüller Fairway	27.02.	27.02.	1	5 cm
Wyk on Föhr, Harbour	28.02.	08.03.	9	30 cm
Wyk on Föhr, Norderaue	28.02.	08.03.	9	22 cm
Amrum, Harbour Wittdün	28.02.	09.03.	10	30 cm
Husum, Harbour	28.02.	19.03.	8	10 cm
Husum, Au	01.03.	19.03.	6	5 cm
Nordstrand, Hever	02.03.	07.03.	6	22 cm
Tönning, Harbour	28.02.	19.03.	15	15 cm
Eiderdamm, Sea area	07.02.	19.03.	15	15 cm
Büsum, Harbour	07.02.	08.03.	15	15 cm
Büsum, Norderpiep	10.02.	08.03.	11	10 cm
Büsum, Süderpiep	10.02.	08.03.	11	10 cm
Harburg, Elbe	28.02.	08.03.	9	10 cm
Hamburg, Elbbrücken-Kehrwieder	28.02.	11.03.	12	10 cm
Hamburg-Landungsbrücken, Elbe	28.02.	11.03.	12	10 cm
Altona, Elbe	28.02.	11.03.	12	10 cm
Stadersand, Elbe	01.03.	08.03.	8	10 cm
Brunsbüttel, Elbe	04.03.	06.03.	3	5 cm
Cuxhaven, Harbour and entrance	28.02.	05.03.	6	10 cm
Cuxhaven, Elbe	01.03.	04.03.	3	10 cm
Cuxhaven- Neuwerk	01.03.	01.03.	1	5 cm
Neuwerk, Elbe	01.03.	02.03.	2	5 cm
Großer Vogelsand	01.03.	01.03.	1	5 cm
Bremen, Weser	07.02.	05.03.	9	5 cm
Brake, Weser	01.03.	06.03.	6	5 cm
Bremerhaven, Weser	04.03.	06.03.	3	10 cm
Hohe-Weg-Leuchtturm, Fairway	04.03.	04.03.	1	5 cm
Alte Weser, Fairway	04.03.	05.03.	2	5 cm
Neue Weser, Fairway	04.03.	06.03.	3	5 cm
Wilhelmshaven, Harbour entries	02.03.	07.03.	6	10 cm
Wilhelmshaven, Tankerlöschbrücke	01.03.	09.03.	9	30 cm
Schilling, Jade area	01.03.	05.03.	5	10 cm
Wangerooger Fairway	01.03.	05.03.	5	10 cm
Wangerooge, Watten	01.03.	07.03.	7	15 cm
Wangerooge, Harle	01.03.	06.03.	6	15 cm
Norderney, Watten	01.03.	06.03.	6	30 cm
Norderney, Seegat	01.03.	06.03.	6	30 cm

Papenburg-Emden	01.03.	06.03.	6	30 cm
Emden, New inner harbour	05.02.	08.03.	19	22 cm
Emden, Ems and outer harbour	27.02.	08.03.	10	22 cm
Ems, Emden-Randzelgat	02.03.	07.03.	6	15 cm
Borkum, Randzelgat	02.03.	07.03.	6	10 cm
Borkum, Westerems	02.03.	07.03.	6	10 cm

Table A 2: Ice conditions at the German Baltic Sea coast in the winter of 2017/18.

Observation area	Begin of ice occurrence	End of ice occurrence	Days with sea ice	Max. ice thickness
Kamminke, Harbour and vicinity	09.02.	13.03.	17	10 cm
Ueckermünde, Harbour	27.02.	10.03.	12	15 cm
Ueckermünde, Harbour to Uecker	27.02.	11.03.	13	15 cm
Ueckermünde, Szczecin Lagoon	26.02.	26.03.	29	15 cm
Karnin, Szczecin Lagoon	09.02.	21.03.	20	15 cm
Karnin, Peenestrom	09.02.	21.03.	20	15 cm
Brücke Zecherin, Peenestrom	01.03.	09.03.	9	15 cm
Rankwitz, Peenestrom	09.02.	24.03.	32	10 cm
Warthe, Peenestrom	08.01.	21.03.	36	15 cm
Wolgast – Peenemünde	10.02.	09.03.	14	15 cm
Peenemünde – Ruden	27.02.	21.03.	14	10 cm
Koserow, Sea area	02.03.	04.03.	3	10 cm
Stralsund, Harbour	27.02.	25.03.	19	10 cm
Stralsund – Palmer Ort	01.03.	21.03.	20	15 cm
Palmer Ort – Freesendorfer Haken	01.03.	15.03.	15	10 cm
Greifswald-Wieck, Harbour	07.02.	21.03.	31	10 cm
Dänische Wiek	08.01.	27.03.	57	22 cm
Greifswald-Ladebow, Harbour	07.02.	27.03.	34	15 cm
Osttief	27.02.	10.03.	12	10 cm
Landtiefrinne	02.03.	09.03.	8	30 cm
Thiessow, Bodden area	28.02.	21.03.	19	22 cm
Thiessow, Sea area	28.02.	21.03.	19	22 cm
Lauterbach, Harbour and vicinity	01.03.	21.03.	17	15 cm
Sassnitz, Harbour and vicinity	03.03.	22.03.	7	5 cm
Stralsund – Bessiner Haken	01.03.	15.03.	15	10 cm
Vierendehlrinne	01.03.	21.03.	16	10 cm
Barhöft – Gellenfahrwasser	01.03.	20.03.	17	10 cm
Neuendorf, Harbour and vicinity	08.01.	26.03.	46	30 cm
Kloster, Bodden area	15.01.	26.03.	42	15 cm
Dranske, Bodden area	09.01.	25.03.	36	15 cm
Althagen, Harbour and vicinity	08.01.	30.03.	47	15 cm
Zingst, Zingster Strom	27.02.	19.03.	11	15 cm
Barth, Harbour and vicinity	07.02.	21.03.	39	22 cm
Rostock, City harbour	09.02.	21.03.	30	10 cm
Rostock, Warnemünde	09.02.	12.03.	24	10 cm
Rostock, Sea harbour	09.02.	08.03.	12	10 cm
Warnemünde, Seekanal	09.02.	08.03.	9	5 cm
Wismar, Harbour	12.02.	10.03.	19	10 cm
Wismar, Walfisch	28.02.	10.03.	11	10 cm
Walfisch-Timmendorf	28.02.	06.03.	7	5 cm
Lübeck-Travemünde	10.02.	08.03.	20	10 cm
Travemünde, Harbour	07.02.	06.03.	4	5 cm
Neustadt, Harbour	06.02.	09.03.	15	10 cm
Neustadt, Sea area	08.02.	09.03.	9	10 cm
Kiel, Harbour	08.01.	04.03.	9	5 cm
Holtenau-Laboe	04.03.	04.03.	1	5 cm
Heiligenhafen, Harbour	07.02.	21.03.	19	10 cm
Fehmarnsund, West entrance	05.03.	09.03.	5	10 cm
Fehmarnbelt, East entrance	01.03.	06.03.	6	5 cm
Eckernförde, Harbour	08.02.	06.03.	9	5 cm
Eckernförde, Bay	04.03.	05.03.	2	5 cm
Schlei, Schleswig – Kappeln	02.12.	21.03.	53	15 cm
Schlei, Kappeln – Schleimünde	09.02.	11.03.	13	10 cm
Flensburg-Holnis	08.01.	30.03.	20	5 cm
Falshöft, Sea area	05.03.	06.03.	2	5 cm

Figure A 1: Daily ice occurrence at the German North and Baltic Sea coast in the winter of 2017/18.

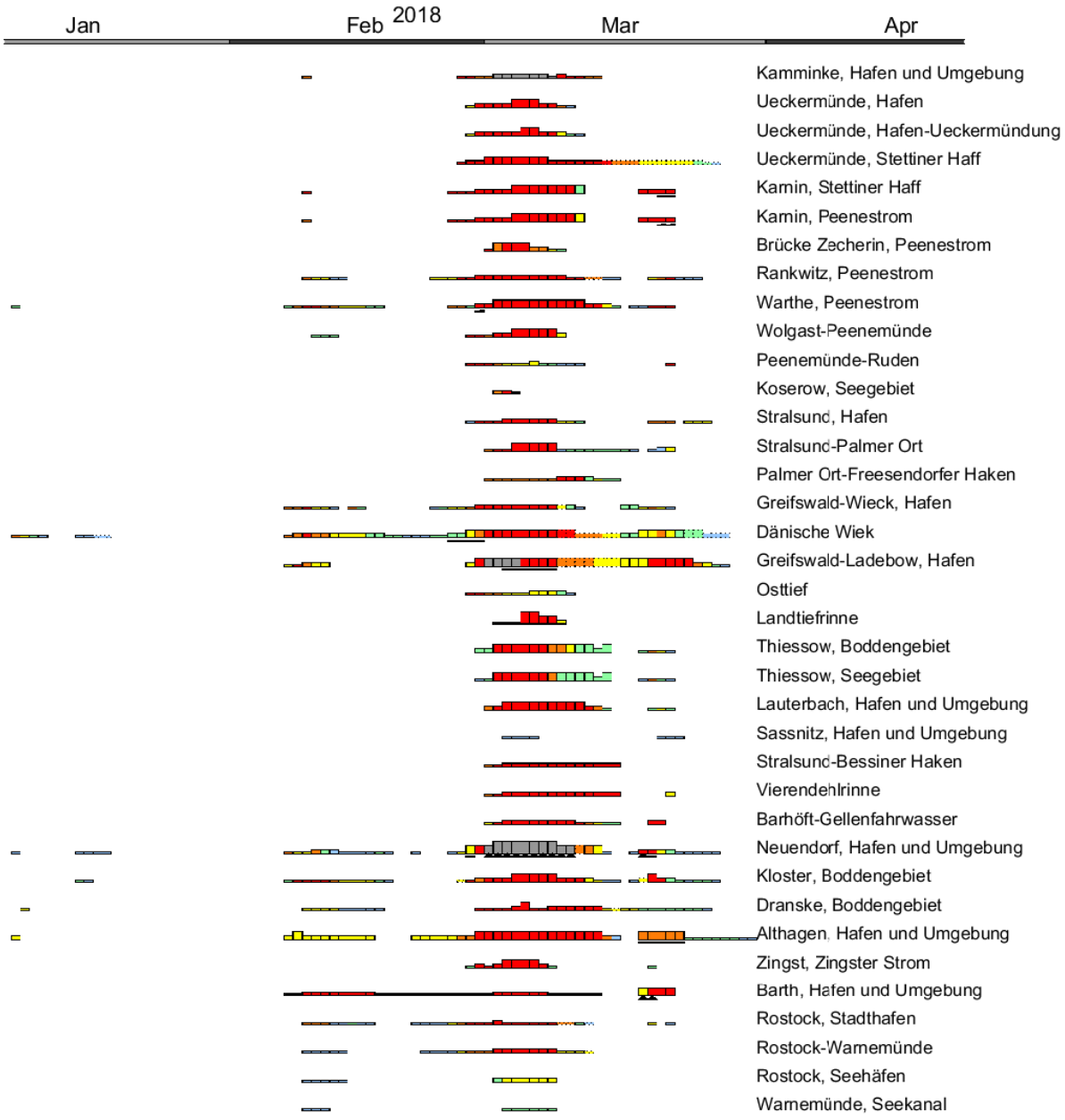

Figure A1: Continuation

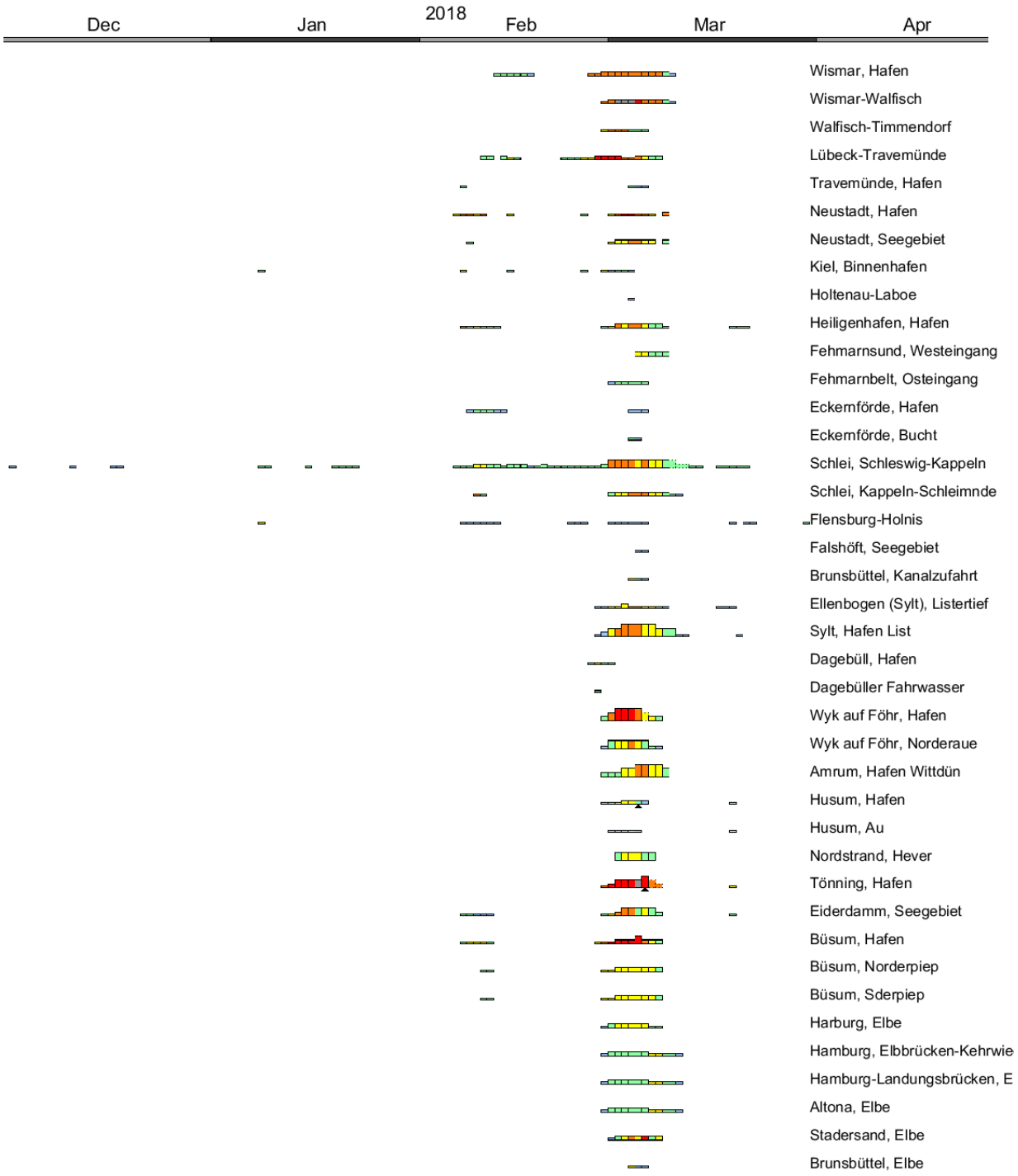

Figure A1: Continuation