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Temporal and spatial variability of the suspended particulate matter in the Gdansk Deep and Eastern Gotland Basin

Vadim Sivkov, Ekaterina Bubnova

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Abstract. The work was carried out in the south-eastern part of the Baltic Sea on the meridional section along the Russian–Polish border during 2015–2018 using the CTD-sounding. The suspended particulate matter samples were taken with the use of ultrafiltration of sea water (0.4 micron filters). The research was focused on identifying the temporal and spatial variability of suspended particulate matter distribution after a series of inflows of the North Sea waters in 2014–2016. The vertical structure of the suspended particulate matter distribution in the south-eastern Baltic, both on a seasonal and interannual scale, contains the main features common for all marine basins, namely increased concentrations of SPM at the sea surface and bottom and an intermediate layer of minimum concentrations located at a depth of 50–70 m. Seasonal fluctuations in the SPM concentration are very significant and are mainly due to the seasonal variation of bioproduction in the surface layer of the sea and the flow of rivers. The confirmation of the barrier role of density boundaries (thermocline and halocline) in sedimentation and geochemical processes has not been obtained.

Keywords: *major Baltic inflows; Gdansk Deep; Gotland Deep; hydrological structure; suspended matter*

✉ *Vadim Sivkov (vadim.sivkov@atlantic.ocean.ru), Immanuel Kant Baltic Federal University, Nevskogo Str. 14, Kaliningrad, Russia, 236014; Ekaterina Bubnova (Bubnova.kat@gmail.ru), Shirshov Institute of Oceanology, Russian Academy of Sciences, Nahimovskiy prospekt 36, Moscow, Russia, 117997*

INTRODUCTION

The suspended particulate matter (SPM) plays an important role in the ecosystem functionality: not only does it indicate phytoplankton productivity, but it also supports the sedimentation of the excessive organic matter. This has a high importance for the Baltic Sea, since one of its well-known large-scale problems is eutrophication (EEA 2019). Even though the integrated status of eutrophication in the Gdansk Basin improved (HELCOM 2018) in comparison to previous assessment results (2007–2011; HELCOM 2014, 2015) this status is still about 1.5, which is far from being good. The SPM concentration within the Gdansk Basin is significantly higher than in the Baltic Proper due to several reasons, including underwater slope erosion and shore abrasion, solid flow of the Vistula River and, undoubtedly, plankton bioproductivity (Blazhchishin 1984; Cyberska, Krzyminski 1988; Kudryavtseva 2017). The starting point of SPM research via filtration method in this area was the 1960s (Emelyanov 1968; Emelyanov, Pustelnikov 1976; Emelyanov *et al*. 1986; Emelyanov *et al*. 1987; Prandke *et al*. 1987). Conductometric data was later obtained using a Coulter counter (Jonasz, Zalewski 1978; Jonasz 1982). Nephelometric studies were fragmentary (Prandke *et al*. 1987; Sivkov, Zhurov 1991). Satellite methods of SPM research gained visibility in the recent times, providing data regarding relative SPM concentrations in the sea surface layer within wide areas (Bukanova *et al*. 2011; Vaiciute *et al*. 2012; Kopelevich *et al*. 2016; Bukanova *et al*. 2018). The generalization of the data obtained by different methods made it possible to characterize the spatial structure, seasonal and interannual variability of SPM distribution within the research area in general terms (Sivkov 2012; Sivkov *et al*. 2017; Lukashin *et al*. 2018).

At the same time, the relationship between the SPM distribution and the sea hydrological structure remains understudied. There are two main layers in the Baltic Sea: upper (desalinated) and lower, which is relatively salty. There is a gradient zone between these layers – the halocline, which causes the existence of a permanent pycnocline, also called the "density jump". Another pycnocline occurs during the warm season in the upper layer of the sea due to the seasonal heating of surface waters and thermocline formation. According to Liblik and Lips (2019) the Baltic Sea has become more stratified during the recent 35 years. The pycnocline, defined by the strongest vertical gradient, is weak during the existence of the summer thermocline (May–September) and strong in winter (January–February) (Reissmann *et al*. 2009). Both pycnoclines slow down the vertical water mixing and interfere with the transfer of heat, salt and oxygen. They are also believed to reduce the sedimentation rate of particulate matter and play the role of sedimentation and geochemical barriers (Emelyanov 1986; 2005).

Significant interannual fluctuations of temperature (Bradtke *et al*. 2010; Laakso *et al*. 2018) and salinity (Liblik, Lips 2019) occur in the upper sea layer due to the variability of heat exchange processes between the sea and the atmosphere and the processes that form the freshwater balance of the sea, respectively. The same variability in the deep sea areas occurs mainly owing to the advection of saline waters from the North Sea; the leading role in this is played by the irregular so-called "major Baltic inflows" (Matthäus, Franck 1992; Nehring *et al*. 1995; Fischer, Matthäus 1996; Mohrholz 2018). The dense waters of the "major inflows" consistently displace the bottom water from the Baltic Sea deeps, which are separated by sills. Mixed inflow water reaches the south-eastern Baltic in 2–4 months after passing the Danish straits (Piechura, Beszczynska-Möller 2003; Rak 2016; Krechik *et al*. 2017). The inflow route furcates after the Slupsk Furrow; the major part of it goes north to the Gotland Deep (Meier 2007).

The purpose of this work is to identify the relationship of SPM distribution with the hydrological conditions of the south-eastern Baltic after the "Christmas" major Baltic inflow (2014) and smaller following inflows (2014–2016) during the period 2015–2018.

MATERIALS AND METHODS

Seven surveys were carried out on a 122 km long submeridional section (Fig. 1, Table 1) for the period 2015–2018. Studies were conducted at five reference stations. The first two of them were located in the Gdansk Deep (104 and 97 m deep), the third and fourth over the Gdansk-Gotland Sill (78 and 84 m deep), and the fifth over the south-eastern slope of the Gotland Deep (104 m deep). Four additional stations between the main ones were introduced in 2016 and later.

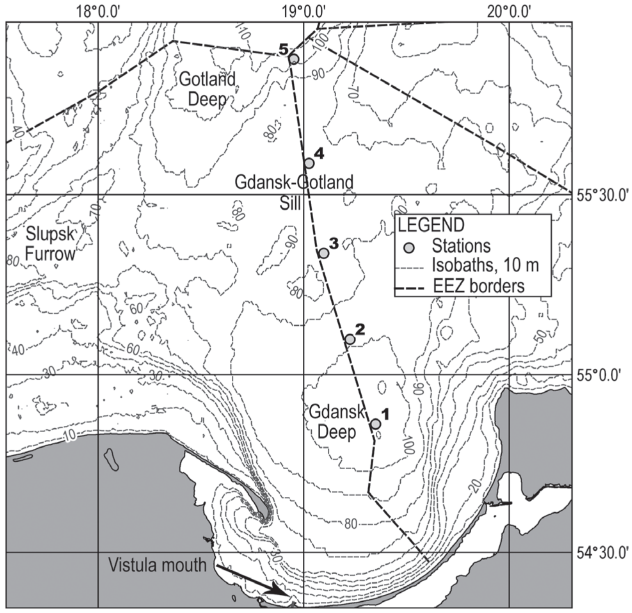

Fig. 1 Study area within the south-eastern Baltic and sampling points location at the section (shown by dots with numbers). The dotted line shows the boundaries of the EEZ

Table 1 Data on surveys at the reference section in the south-eastern part of the Baltic Sea

Date	Vessel, cruise number	SPM samples	Survey duration, hours
24–25.04.2015	Nord-3, nn	25	21
07.08.2015	Nord-3, nn	23	16
29–30.10.2015	R/V «Akademik Mstislav Keldysh», 64	25	21
31.03–01.04.2016	R/V «Professor Shtokman», 131	29	48
27–28.07.2017	R/V «Akademik Nikolaj Strakhov», 35	21	11
25.10.2017	R/V «Akademik Nikolaj Strakhov», 37	22	10
09.08–10.08.2018	R/V «Akademik Boris Petrov», 43	34	14

Particulate matter samples were collected via ultrafiltration of sea water (volume of 1–3 litres) under the 0.4 mbar pressure. We used membrane filters of a diameter of 47 mm and a pore diameter of 0.4 microns. Each sample was filtered on three filters with the subsequent calculation of the average value. Water for filtration was gathered by Niskin bottles on special horizons (surface layer, thermocline, cold intermediate layer, halocline, bottom layer), which were selected according to the hydrophysical sounding data. There was an uneven number of SPM samplings every cruise due to various hydrological situations (e.g. one pycnocline instead of two).

Measurements of temperature and salinity at the stations were carried out by hydrophysical probes: first, Idronaut Ocean Seven 316 Plus (the first two surveys and the survey of July 2018; Table 1) and then CTD90M (Sea & Sun Technology). Sounding was performed from the surface to the bottom in the free-fall mode of the probe at a speed of about 1 m/s. The temperature measurement accuracy for CTD 90M is ± 0.005 °C and conductivity is 20 μS/cm. For the Idronaut 316 probe, the temperature measurement accuracy is ± 0.003° C and electrical conductivity is 3 μS/cm. The hydrological data of the first four surveys were partly published in Russian (Krechik *et al*. 2017), but for a more vivid representation of SPM distribution we show this data in this paper with a reference as well.

The dissolved oxygen (DO) concentration in water samples was determined by the Winkler method (VNIRO Technique 1991). To characterize the conditions of the first survey, oxygen concentration data were obtained on 11 April 2015.

RESULTS

Several oceanographic surveys which were carried out along the section made it possible to trace seasonal and interannual variations of the SPM concentration in the south-eastern Baltic, including under the influence of the major Baltic inflows (MBIs). The gradual depletion of dissolved oxygen content in the bottom layer of the section is shown in Table 2.

The survey conducted in April 2015 corresponds to the time of occurrence of an MBI which took place at the end of 2014 ("Christmas inflow") in the south-eastern Baltic (Mohrholz *et al*. 2015). The Gdansk Deep's high salinity (> 13 psu) and temperature (> 7 °C) appeared to be due to this inflow influence at the depths greater than 80 m (Fig. 2). The maximum values of the bottom salinity (14.2 psu) were significantly higher than the long-term averages (11.43 psu according to Feistel *et al*. (2008)) and the maximum average annual values for the period 1947–2005 (13.8 psu according to Drozdov, Smirnov 2008). The bottom salinity and temperature were even lower above the slope of the Gotland Deep (depth 80–110 m). The DO concentration was 1.7–2.1 ml/l in the bottom layer of the Gdansk Deep and about 2.0 ml/l above the slope of the Gotland Deep. The seasonal thermocline had not yet been formed, and the halocline lied at depths between 60–75 m and 90–95 m. Halocline values were within 8–13 psu in the Gdansk Deep and within 8–11 psu over the slope of the Gotland Deep. A high concentration of SPM was observed in the upper part of the mixed layer (30–40 m deep), especially over the Gdansk Deep – more than 1.6 mg/l. SMP accumulation in the halocline and above it was not noticed. A significant increase in SPM concentration occurred under the halocline (more than 1.0 mg/l) in the Gdansk Deep. There was an intermediate layer of minimum SPM concentration values at a depth of 50–70 m.

The bottom layer of the Gdansk Deep during the August 2015 survey experienced signs of transformation of the North Sea waters which had arrived four months before as a result of the "Christmas inflow". Salinity and, to a less extent, temperature (Fig. 3) and oxygen concentration (0.8–2.0 ml/l) decreased. At the same time, the DO concentration slightly rose (to 3.0 ml/l) over the slope of the Gotland Deep. The seasonal thermocline was well pronounced (15.0–5.5 °C) and located at depths from 20–35 m to 50–65 m. The depth and thickness of the halocline remained stable for almost four months. As in the previous survey (April 2015), high concentrations of SPM were

Table 2 Dissolved oxygen content in the bottom layer on the transect from the Gotland Deep to the Gdansk Deep

Date	Station	5		4		3		2		1	
Apr. 2015	Depth, m	*75*	*100*	*62*	*83*	*50*	*76*	no data			
	Dissolved oxygen, ml/l	1.35	2.03	6.46	2.72	5.94	1.55				
Aug. 2015	Depth, m	*70*	*100*	*65*	*81*	*65*	*77*	*70*	*96*	*70*	*103*
	Dissolved oxygen, ml/l	4.54	3.02	5.64	3.32	5.50	2.00	6.48	1.97	6.55	0.76
Oct. 2015	Depth, m	*84*	*103*	*75*	*84.5*	*70*	*75*	*70*	*96*	*65*	*103*
	Dissolved oxygen, ml/l	1.97	1.94	3.13	2.39	3.69	3.15	4.11	1.68	3.98	0.92
Mar. 2016	Depth, m	*67*	*103*	*62*	*80.5*	*77*	*82*	*64*	*95*	*70*	*100.5*
	Dissolved oxygen, ml/l	7.31	3.45	7.20	4.46	8.19	2.78	4.29	2.87	5.19	3.67
July 2017	Depth, m	*58*	*101.5*	*49*	*76*	*57*	*77*	*56*	*94*	*55*	*103*
	Dissolved oxygen, ml/l	5.16	1.75	6.25	1.97	5.76	0.77	5.60	1.10	6.58	0.95
Oct. 2017	Depth, m	*43*	*103*	*62*	*81*	*56*	*74*	*64*	*96*	*64*	*102*
	Dissolved oxygen, ml/l	6.08	1.70	3.72	1.90	6.08	1.74	6.43	0.27	6.03	0.83
Aug. 2018	Depth, m	*74*	*103*	*89*	*103*	*75*	*82*	*63*	*74*	*83*	*103*
	Dissolved oxygen, ml/l	0.44	0.00	0.34	0.00	3.14	0.00	12.23	0.45	0.17	0.00

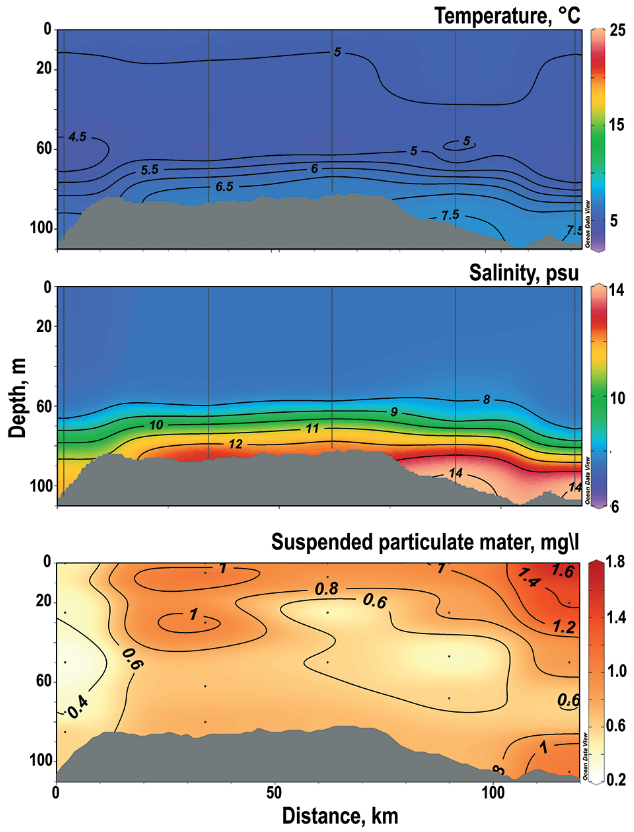

Fig. 2 Hydrological conditions (temperature, salinity) and concentration of SPM in April 2015. Temperature and salinity are shown according to Krechik *et al*. (2017). The section is shown from its north-western part to the south-eastern one (station 5 to 1)

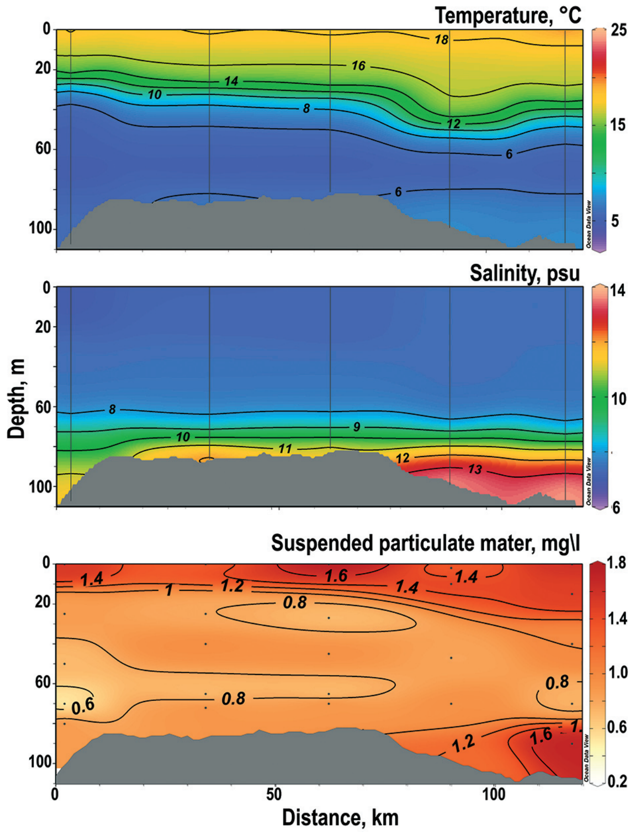

Fig. 3 Hydrological conditions (temperature, salinity) and concentration of SPM in August 2015. Temperature and salinity are shown according to Krechik *et al*. (2017). The section is shown from its north-western part to the south-eastern one (station 5 to 1)

observed at the sea surface up to depths of 15–40 m (1.0–1.6 mg/l) and under the halocline in the Gdansk Deep (up to 1.6 mg/l). The minimum level of SMP was recorded above the halocline upper boundary, especially in the northern part of the section. SPM accumulations on the thermocline or halocline were not identified.

In October 2015, the transformation of the "Christmas inflow" water in the Gdansk Deep continued: the bottom salinity, temperature and DO concentration (0.9–1.7 ml/l) reduced (Fig. 4). The DO concentration also decreased (to 1.9 ml/l) during the two months (from August 2015) over the Gotland Deep slope. Compared to the previous survey, the upper extent of the halocline in the Gdansk Deep moved up to the 50 m horizon and the gradient became less pronounced. As a result of the beginning of autumnal convection, the upper boundary of the seasonal thermocline deepened to 35–40 m. The eroded thermocline (11.0–6.0 °C) became thinner. SPM concentrations were low throughout the section, and their minimum values, as usual, were in the intermediate layer (depth 50–70 m). SPM accumulations in the partially eroded seasonal thermocline and in the halocline were not detected.

In March 2016, water of more than 14 psu salinity appeared in the Gdansk Deep bottom layer again. The volume of water of > 13 psu salinity and > 7 °C temperature increased (Fig. 5). The bottom salinity on the Gotland Deep slope also increased but only up to 12.4 psu. The bottom DO content increased: up to 3.8–4.3 ml/l in the Gdansk Deep and up to 3.5 ml/l on the slope of the Gotland Deep. All these facts justify another big inflow of the North Sea waters into the Baltic, which occurred in November 2015. During this survey, the thermocline had not yet begun to form. The upper boundary of the halocline dropped to 60–65 m and the gradient of the halocline itself became stronger. There was no accumulation of SPM inside the halocline or above it. The SPM level increased in the surface and in the bottom layer of the Gdansk Deep (up to 0.6 mg/l).

The survey of July 2017 was carried out almost a year after the September 2016 inflow of the North Sea waters to the Baltic. Even though the inflow had taken place a considerably long time before, the salinity of the Gdansk Deep bottom layer remained relatively high (13.6 psu). At the same time, the southern slope of the Gotland Deep occurred to have salinity level

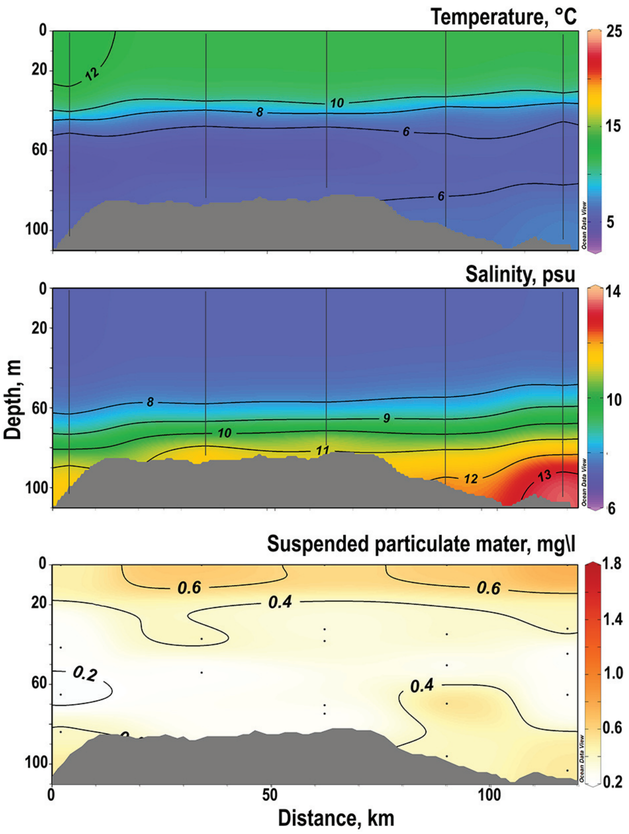

Fig. 4 Hydrological conditions (temperature, salinity) and concentration of SPM in October 2015. Temperature and salinity are shown according to Krechik *et al*. (2017). The section is shown from its north-western part to the south-eastern one (station 5 to 1)

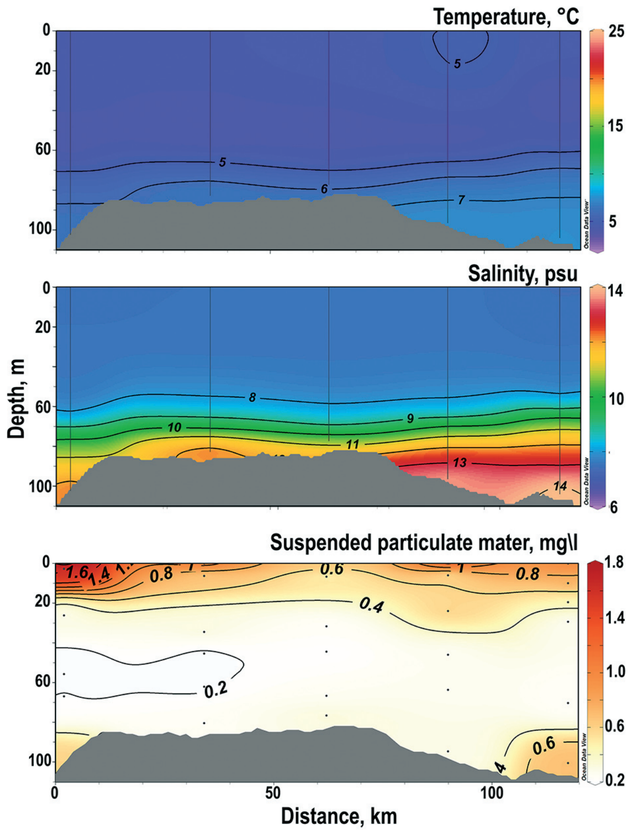

Fig. 5 Hydrological conditions (temperature, salinity) and concentration of SPM in March 2016. Temperature and salinity are shown according to Krechik *et al*. (2017). The section is shown from its north-western part to the south-eastern one (station 5 to 1)

that barely exceeded 12.0 psu (Fig. 6). The water temperature of the Gdansk Deep bottom layer did not reach 7 °C, and the DO concentration also decreased to 1.0–1.1 ml/l. The DO content at the Gotland Deep slope was higher – up to 1.8 ml/l. The thermocline upper boundary (from 16.0 to 6.0 ºC) was located at a depth of 14–16 m, and the lower one was located at about 35 m. The only exception was the southern part of the Gdansk–Gotland Sill area, where the thermocline lower boundary "sank" to a depth of 50 m, possibly as a result of the presence of an intrathermoclinic vortex. Halocline was located at a depth from 50–60 m to 85–90 m. SPM concentrations both in the surface and bottom layers (0.6 mg/l and 0.4 mg/l, respectively) decreased in comparison to the previous year. SPM maximum (up to 1.2 mg/l) were noted in the upper mixed layer in the Gdansk Deep. The thermocline and halocline did not show increase in SPM concentration again, and the minimum SPM concentration was observed in the intermediate layer (0.2–0.4 mg/l).

During the survey in October 2017, the further transformation of the 2016-year North Sea water was observed. The bottom layer of the Gdansk Deep showed the salinity level not higher than 13.2 psu, temperature 6.6 ºC (Fig. 7), while the DO concentration dropped to 0.3–0.8 ml/l. The temperature, salinity, and oxygen concentration (1.7 ml/l) over the slope of the Gotland Deep remained stable. The seasonal, partially eroded thermocline (12–6.5 ºC) and halocline were tilted from north to south. The upper thermocline extent deepened from 40 to 65 m, and the lower from 45 to 75. The halocline upper boundary deepened from 50 to 85 m, and the lower from 70 to 90 m. Due to the fact that the seasonal thermocline extremely deepened, it coincided with the halocline, causing the rise of a density gradient. However, owing to extremely low autumn SPM concentrations, the barrier effect of such a sharp pycnocline did not play any role in the vertical SPM distribution. The subsurface and bottom SPM maximums were also weakly expressed.

In August 2018, the salinity of the bottom layer significantly decreased: not higher than 11.86 psu for the Gdansk Deep and 11.66 psu for the Gotland Deep (Fig. 8). The temperature of the bottom layer never reached 7 ºC. All this affirms the absence of a new inflow water and further assimilation of the old one.

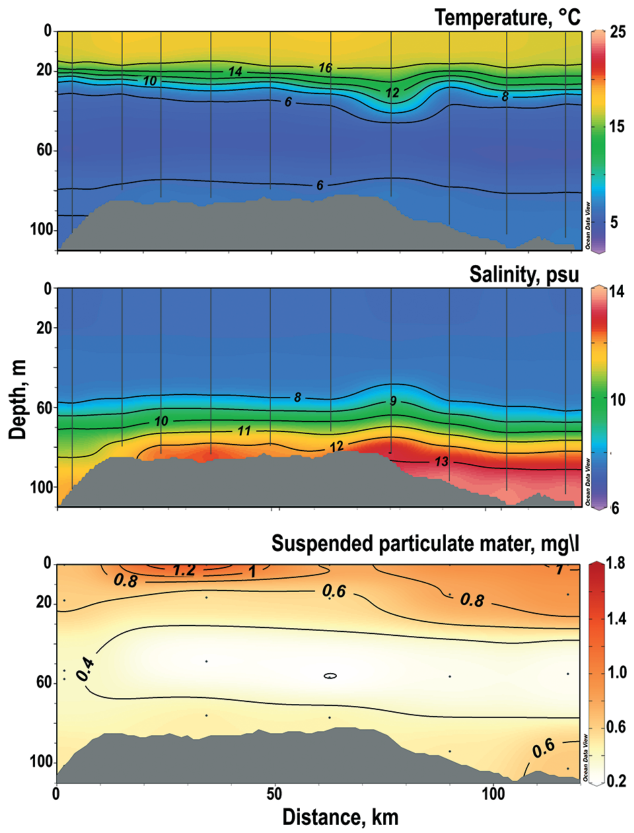

Fig. 6 Hydrological conditions (temperature, salinity) and concentration of SPM in July 2017. The section is shown from its north-western part to the south-eastern one (station 5 to 1)

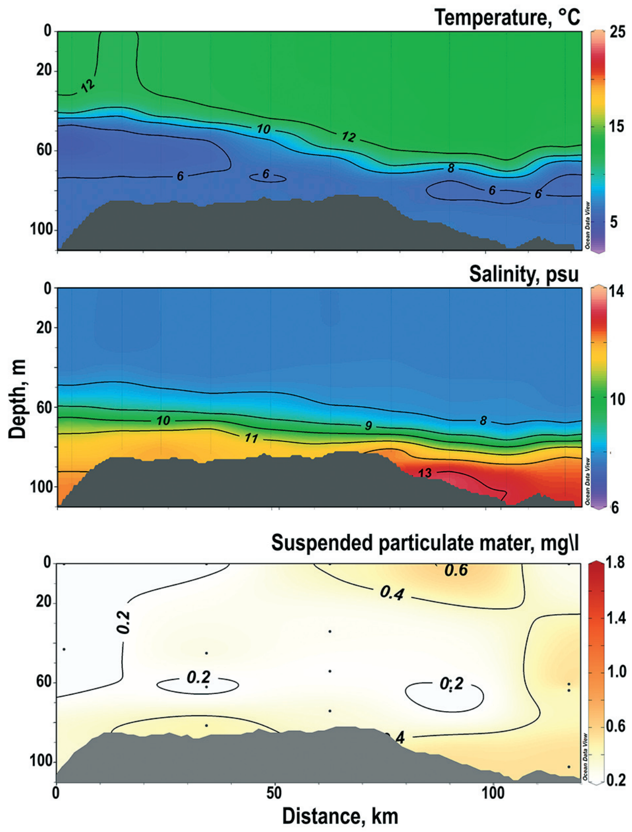

Fig. 7 Hydrological conditions (temperature, salinity) and concentration of SPM in October 2017. The section is shown from its north-western part to the south-eastern one (station 5 to 1)

DO in the bottom layers of both deeps was absent up to the 85 m depth, i.e. it was completely consumed for the oxidation of organic matter. Anoxic conditions appeared. The seasonal thermocline (5–21 ºC) was located at depths of 10–30 m, except the southern part of the section, where its lower boundary fell deeper than 50 m due to a vortex of about 20 km in diameter, which is common for upwelling formation zones (Kostyanoy, Rodionov 1986). Due to the salinity decrease in the deep-water layers, the halocline became less pronounced. The near-surface maximum of SPM (1.1 mg/l) was noticed in the northern part of the section and did not appear in its southern part. The SPM concentration was minimal (less than 0.2 mg/l) between the thermocline and halocline. The SPM concentration in the bottom layer over the Gdansk–Gotland Sill (up to 0.6 mg/l) was clearly higher than in both Gdansk and Gotland deeps starting from October 2017.

The overall seasonal variability of suspended particulate matter concentration follows the pattern of high spring-summer values with low October values (Fig. 9). The difference average (mean) between spring and summer concentrations is negligible, while the decrease in October is strongly noticeable.

DISCUSSION

The obtained data mainly correspond to the existing ideas about the hydrology of the south- eastern Baltic (Dubravin *et al.* 2012). The annual surface salinity variations depend on precipitation and river flow but are poorly expressed. The annual temperature pattern, on the contrary, is well pronounced with a maximum in August and a minimum in March. The beginning of spring warming (April) in combination with the wind-wave mixing cause the formation of the summer hydrological structure, including a warm upper mixed layer, seasonal thermocline, and cold intermediate layer. The further thermocline deepening and the erosion of the cold intermediate layer go through the summer warming till the sea surface temperature maximum in August. After this time point, the thermocline depth increase and intermediate cold layer erosion are caused by increased convective mixing and the thickening of the upper mixed layer. Convection reaches its maximum in January–February and continues until the minimum sea surface temperature establishes (March). As a result, the cold intermediate layer almost disappears and the seasonal thermocline, which was

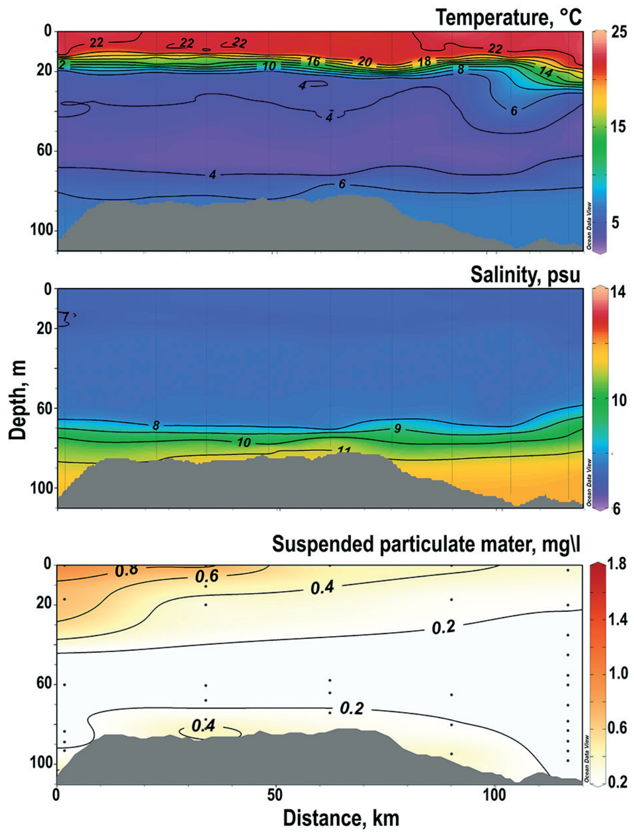

Fig. 8 Hydrological conditions (temperature, salinity) and concentration of SPM in August 2018. The section is shown from its north-western part to the south-eastern one (station 5 to 1)

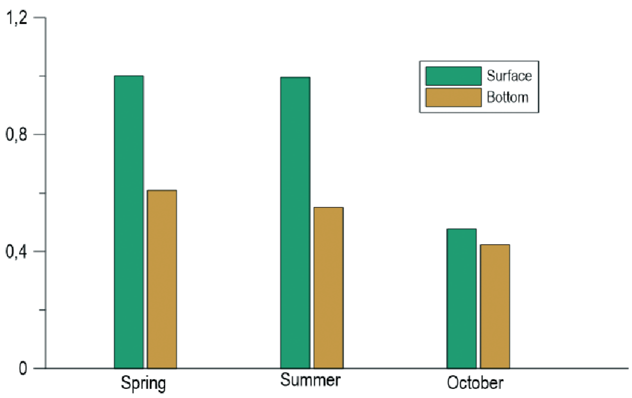

Fig. 9 Mean seasonal SPM concentrations (mg/l) for surface and bottom layers (2015–2018)

eroded, practically completely drops in depth to the halocline. The highest density of surface water at a 6–7 psu salinity is reached at a temperature of about 2.50 °C. The surface temperature becomes higher than the temperature of the greatest density in April, so the vertical convection weakens and then stops. Regarding all the aforementioned changes, the hydrological situation of October 2017 stood out, when a partial coinciding of the seasonal thermocline with halocline was observed. The abnormal deepening of the thermocline occurred apparently due to a series of strong storms.

According to Mohrholz (2018), there exists a decadal variability of MBIs with the main period of 25–30 years. One of the biggest inflows over the entire observation period since 1880 occurred in December 2014 ("Christmas inflow") after a break of 11 years (Mohrholz *et al.* 2015). The volume of this inflow is estimated at 198 km^3 (Mohrholz *et al.* 2015). In the winter period 2015–2016, two more inflows of moderate intensity were recorded: in November 2015 and at the end of January – beginning of February 2016; another inflow occurred in September 2016. There were no significant inflows in the winter of 2016–2017 (Naumann *et al.* 2018).

Both the model and measurements indicate that the Gdańsk Deep does not take active part in the inflow process to the deep areas of the Baltic Sea, but acts as a buffer (Piechura, Beszczynska-Möller 2003; Elken 1996; Jankowski 2003). According to Mohrholz (2018), the general tendency for the Baltic Sea was a rapid assimilation of DO in the Baltic Proper Deeps due to eutrophication. The oxygen that arrived in the Gdansk Deep was also relatively quickly spent for the oxidation of organic matter and biota respiration; therefore, hypoxic conditions developed. The lower values of temperature and salinity and increased DO concentrations above the slope of the Gotland Deep in comparison to the Gdansk Deep are explained by a greater overall depth of the Gotland Deep and, hence, by a deeper trajectory of MBIs.

The obtained surface and bottom SPM maximums were always expressed (up to a various degree depending on season). According to Pohl et al. (2004), the near-bottom suspended matter was specified by lithogenic components like Al and Fe during winter and by the biogenic matrix of organic carbon in spring, summer and autumn. The permanent layer of minimum SPM content coincided with the cold intermediate layer, which was also mentioned in Christiansen *et al.* (2002). The cold season in the south-eastern part of the Baltic Sea experiences minimal SPM concentrations over the entire water column depth owing to a seasonal decrease in biological activity and solid rivers runoff. The existence of a spring subsurface SPM maximum is usually associated with the seasonal phytoplankton peak caused mainly by diatoms and dinoflagellates development (Thamm *et al.* 2004; Kahru, Elmgren 2014) and the influence of the Vistula River flood (Kowalczuk 1999). The summer increase in SPM concentration is caused by the development of heat-loving blue-green algae (Mazur-Marzec *et al.* 2006; Kahru *et al.* 2007; Evtushenko and Sheberstov 2016).

The vertical SPM distribution within the south-eastern Baltic with increased concentrations at the sea surface and bottom is also correct for the averaged in-

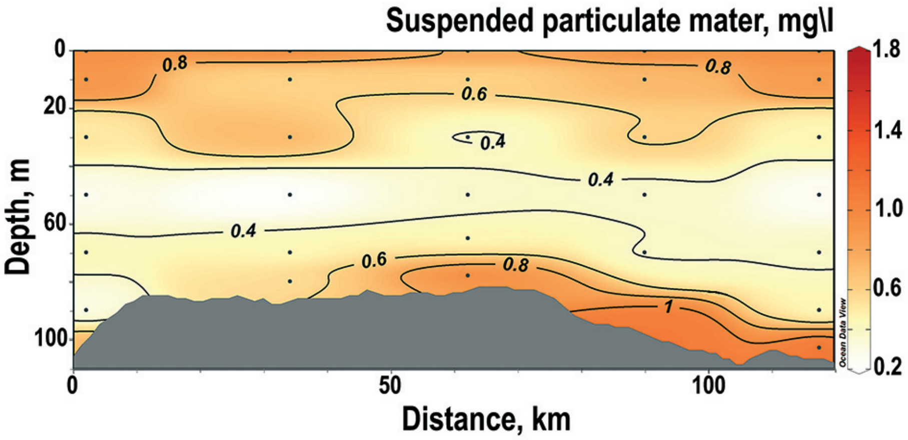

Fig. 10 The averaged interannual SPM concentration (mg/l) distribution at the section in the south-eastern Baltic between 2015–2018

terannual section (Fig. 10). The average level of SPM concentration (about 0.8 mg/l) coincides with the satellite data obtained for the Gdansk basin (Kyryliuk and Kratzer 2019). This pattern is more pronounced over both deeps than over the Gdansk–Gotland Sill. The vertical distribution of the SPM that we obtained relates mainly to the conditions of the presence of inflow water. The potential cause of high SPM concentrations over the Sill is the anoxic conditions at the bottom resulting in the occurrence of the redox barrier as the transition zone from oxidizing to reducing conditions. This zone is known for the metal (mainly Fe and Mn) migration type change, as well as for the biochemical SPM formation (Emelyanov 2005). In this case, the redox barrier was of bottom localization just above the Gdansk–Gotland Sill, causing an uncommon rise in SPM concentration within this area.

We did not observe an increase in the SPM concentration from the sea surface to the thermocline or the formation of a SPM maximum above it, which contradicts the data of Emelyanov (2005), who described the accumulation of SPM above the pycnoclines in the Gotland Deep. Nor did we observe increase in SPM concentration in the halocline or above it. Its multiple increase was found under the halocline in the Gdansk Deep, but only in April and August 2015 (nepheloid layer). This is not corresponding with the data of Jonasz (1982), who based on winter Coulter counter surveys indicated the existence of a stable bottom maximum of SPM concentration regardless of the season. The bottom SPM concentration level mainly depends on the activity of bioproduction in the surface layer of the sea due to the existence of the mechanism of accelerated sedimentation, the so-called SPM "pellet transport" (Bishop, Edmond 1976; Honjo, Roman 1978). However, one cannot completely exclude the effects of bottom currents initiated by a large inflow when vertical turbulent diffusion interferes with the sedimentation (Murray 1970).

CONCLUSIONS

Studies have led to the following conclusions:

1. The vertical structure of the dispersed system of the south-eastern Baltic, both on a seasonal and interannual scale, contains the main features common for all marine basins, namely increased concentrations of SPM at the sea surface (> 0.8 mg/l) and bottom (> 1.0 mg/l) and an intermediate layer of minimum concentrations (< 0.4 mg/l) located at a depth of 50–70 m.

2. Seasonal fluctuations in the SPM concentration are very significant and are mainly due to the seasonal variation of bioproduction in the surface layer of the sea and the flow of rivers. The SPM concentration in the bottom layer of the sea did not show any noticeable anomalies associated with the influence of the MBI and the movements of "old" (with low DO concentration) bottom waters from the western Baltic basins. The picture of the vertical SPM distribution relates mainly to the conditions of the inflow water presence, which provides ventilation of the bottom waters in the south-eastern Baltic despite its weakness. There will be a bottom nepheloid layer caused by particulation of dissolved iron and manganese compounds in a redox barrier during a long absence of inflows over the Gdansk–Gotland Sill.

3. The confirmation of the barrier role of density boundaries (thermocline and halocline) in sedimentation and geochemical processes has not been obtained. There was no slowdown in sedimentation and the occurrence of SPM accumulations at these potential geochemical barriers, which means there is no reason to talk about the intensification of biogeochemical processes associated with the activity of phyto-, bacterio- and zooplankton and decomposition of organic particles. It is possible that in order to identify the barrier effect of "density jumps" in the water column, a more detailed testing is required.

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