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Suspended Matter and Hydrocarbons Fluxes in the Kara and Laptev Seas

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Abstract: The distribution of suspended particulate matter (SPM) by filtration and the magnitude of its fluxes using sediment traps in the Kara and Laptev Seas (cruise 72 of the R/V Akademik Mstislav Keldysh, August–September 2018) was studied. The composition of the SPM was determined by the material composition using an electron microscope, the organic component (Corg and hydrocarbons) and the inorganic component (amorphous silica and calcium carbonate). It was found that the SPM content in surface waters varied from 0.2 to 5.9 mg/L (on average 0.90 mg/L) with a maximum in the Blagopolychia Bay and aliphatic hydrocarbons from 10 to 49 µg/L (average 22 µg/L) with a maximum in the area of the removals of the river Ob. The SPM flux decreased from the surface to the near-bottom horizon only into the Blagopolychia Bay (from 13,127 to 11,900 mg/m^2/day), but in most samples the flux increased in the near-bottom horizon with a maximum of 6920 mg/m^2/day in the Ob's discharge water area and correlated with the maximum of the C_{org} flux 695 mg/m^2/day. In the composition of SPM, as well as in organic compounds, including hydrocarbons, allochthonous basically prevailed over autochthonous.

Keywords: suspended particulate matter; fluxes; sediment traps; carbon flux aliphatic and aromatic hydrocarbons; Ob River; Kara Sea; Laptev Sea

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1. Introduction

The first studies of the sedimentary matter of the Central Arctic and the continental margin of Europe were carried out in 1988–1990. [1,2]. Some researchers have studied individual components of the current in the upper active layer of ocean water [3,4] and determined the sedimentation rates and the main composition of the settling suspension. A detailed study of the scattered forms of sedimentary matter is extremely important, since these particles are sorbents, and their composition and concentration carry information about all aspects of the sedimentary process in the region. Here, terrigenous sediments predominate, specific in terms of the methods of preparation of sedimentary matter, its transportation in the water column and deposition on the seabed. In addition, a large amount of dispersed sedimentary matter is concentrated in the atmosphere, snow and sea ice [5].

Studies have shown that the rate of sedimentation on the continental shelf in the Arctic Ocean reached 10 mm/year [6] and averaged 0.01 mm/year 0.2 mm/year in the White Sea [7]. Currently, due to the increasing importance of resources and climate change, the Arctic region is becoming the center of international attention [8]. To study the natural systems of the Arctic seas and their modern variability, a unified methodological approach is important [9,10].

The state of the shelf of the marginal Arctic seas is largely determined by the huge volume of continental runoff, which is estimated at 2300–2500 km^3/year, and its transformation in the river-sea barrier zone [9]. This fact explains why, in the study of the ecosystem of the Arctic shelf, great importance is given to the distribution and composition of suspended matter [6,11]. Suspended substances are formed from numerous sources:

under the influence of living organisms (mainly zooplankton, phytoplankton and benthos), terrigenous runoff, and at the same time they can absorb various pollutants, so their study is important for a better understanding of the processes of sedimentation and the transport of pollutants in marine ecosystems. One of these pollutants is petroleum aliphatic hydrocarbons (HCs), which have both natural and anthropogenic origin. Therefore, interest in their study is due not only to the high oil and gas potential of the Arctic shelf, but also to natural processes, of which they are a significant part.

After understanding that the sedimentary process in the ocean occurs under the influence of various factors, it became necessary to measure sediment using direct methods, one of which is the sediment trap method. With their help, it is possible to obtain samples of suspended matter (SPM), to calculate the flux of suspended matter—the main quantitative characteristic particulate of sedimentation. The flux is determined by the amount of substance passing through a unit area per unit time (mg/m^2/day), and corresponds to the absolute mass of the sediment. The input of various components, including pollutants, into the surface layer of bottom sediments can be calculated on the basis of vertical fluxes of sedimentary matter.

An analysis of the composition of the SPM flux allows one to show what physicochemical conditions prevail in a particular region. In the Arctic, marine suspension consists of two main groups of substances: the lithogenic matter of allochthonous genesis and biogenic [12] autochthonous origin containing the remains of living organisms and detritus. Biogenic matter consists of particulate organic carbon, the marker of which is Corg, amorphous silica (SiO_{2bio}), and calcium carbonate ($CaCO_3$) [13]. Environmental factors such as temperature and salinity, significant river runoff, river ice and sea icebergs, coastal abrasion and Atlantic advection shape the ratio of runoff components. Amorphous silica (SiO_2) and calcium carbonate ($CaCO_3$) are part of the phytoplankton skeleton; therefore, their concentration in the total suspended matter flux depends on the number of cells, biomass, and species composition of phytoplankton. $CaCO_3$ can also form as a result of continental weathering or coastal reworking as part of a detrital component, especially in shallow waters [14]. The main source of SiO_{2bio} in the Arctic shelf seas are diatoms (the genera *Skeletonema* and *Chaetoceros*) and, to a lesser extent, dinoflagellates (the genera *Protoperidinium*, *Ceratium*, and *Dynophysis*) [15].

The variability in the distribution of SPM, HC_s and its components was studied at the hydrological stations of the Kara Sea and the Laptev Seas (cruise 72 of the R/V Akademik Mstislav Keldysh).

2. Sampling, Materials and Methods

2.1. Sampling

Water samples were collected with Niskin bathometers using the Rosette complex at hydrological stations. The position of the sampling horizons in the water column was chosen based on the of water temperature, electrical conductivity, and fluorescence measured by Idronaut and SBE319 Plus CTD 3 samplers (Seabird Electronics, Bellevue, WA, USA) equipped with fluorescence and turbidity sensors.

To study the SPM sedimentation and distribution in water column, it is most promising to use sediment traps, which allows for studying the sedimentation processes in its dynamics and in time [16–22]. Currently, various types of sediment traps are introduced into the oceanographic research routine, and they can be used to trap suspended matter at different depths [12,21].

To study the SPM fluxes, we used small sediment traps (MSL-110) with a collection area of 0.0095 m^2 (Figure 1) [23]. The trap consists of two plastic cylinders, inside of which, in the bottom part, a cone with a thread for a sampler is mounted. The trap is attached to the loops of the nylon cord with a diameter of 12 mm, weighing 100 g per linear meter, using a halyard and plastic ties. Polyethylene bottles with a volume of 500 mL were used as samplers, a load weighing at least 120 kg was used as an anchor, and discs made of dense foam were attached for buoyancy.

Figure 1. General view of the small sediment traps.

Small sediment traps were installed at two to three horizons: surface, middle layer (under the thermocline) and near-bottom, at about 15 m above the bottom, in order to exclude the ingress of sediments stirred up during the landing of the anchor to the bottom. The exposure lasts for several days.

To study the HCs used other type of sediment trap: differential 12-glass conical sedimentation traps "Lotos-3" with a sample collector area of 0.5 m^2 make it possible to obtain a series of samples of the precipitating substance continuous in time (up to October 2018 to May 2019) with a given exposure (one month).

To exclude the biological transformation of the collected substance, the sample bottles of the trap are dissolved in $HgCl_2$ (1% of the saturated solution).

2.2. Materials

Each sample (except for the filtration SPM) was sieved through a sieve with a mesh size of 1 mm (to remove swimmers).

To determine the concentration of SPM, water samples were filtered in the onboard laboratory under a vacuum of 400 mbar. Weighted nuclear membrane filters with a pore size of 0.45 μm (manufactured by JINR, Dubna, Russia) were used. The concentration (after drying the filters) was determined under laboratory conditions gravimetrically with an accuracy of ±0.001 mg.

To determine organic compounds (C_{org}, HCs), a sample (3–5 L) was simultaneously filtered through Whatman GF/F glass fiber filters (with a pore size of 0.7 μm) calcined at 450 °C under a vacuum of 400 mbar.

2.3. Methods

The concentration of total and organic carbon (C_{total} and C_{org}) was determined by dry combustion on an AN-7560 analyzer (Russian Federation). The sensitivity of the method is 6 μg of carbon in the sample, and the accuracy is 3–6 relative percent [24]. The difference between C_{total} and C_{org} was used to determine mineral carbon (C_{inorg}); a coefficient of 8.3 was used to determine the concentration of calcium carbonates ($CaCO_3$) [23]. To calculate the total organic matter concentration, the C_{org} value was doubled [17].

The concentration of the lithogenic substance was calculated by the formula [18]:

$$Al \cdot 10 \cdot C_{CaCO3} - C_{inorg} \cdot 8.3 \quad (1)$$

where Al—aluminum content; 8.3 is the average content of Al in the earth's crust in percent [25].

Amorphous silica (SiO_{2bio}) was calculated by the terrigenous matrix method according to the difference in the concentrations of total and terrigenous silica [16].

The main chemical elements—Si, Al—were determined by the photometric method with an accuracy of 2–5%. The determination of amorphous silica was carried out by photocolorimetry using the reduced form of silicomolybdenum heteropolyacid after a double soda extraction [16].

The composition of the trap material was studied using a VEGA-3 TESCAN scanning electronic microscope (Czech Republic) with an Oxford INCA Energy 350 X-ray spectral microanalysis system (Great Britain).

The concentration of HCs was determined by the IR method on an IRAffinity-1 spectrophotometer, Shimadzu (Japan) using the 2930 cm^{-1} band. A mixture of 37.5% isooctane, 37.5% hexadecane and 25% benzene was used as a standard. The sensitivity of this method is 3 µg/mL of the extract [26].

The composition of alkanes was determined by gas chromatography on a Crystal-Lux 4000-M (RF), with a flame ionization detector, a capillary column 30 m × 0.22 mm (Supelco), with a phase of 5% phenyl and 95% methylpolyxylan, at temperature from 60 to 300 °C, at a rate of 8/min, the carrier gas is helium, and the gas flux rate is 1.5 mL/min.

3. Results

3.1. Distribution of Suspended Particulate Matter

The sediment traps were set in the Kara Sea; in the Blagopoluchiya Bay of Novaya Zemlya, the Novaya Zemlya Depression and the Ob estuarine zone, as well as on the shelf of the Laptev Sea and in the Vilkitsky Strait (Figure 2). At the transarctic section, the concentration of suspended matter in surface water in the river mouth areas were three to four times higher than at the marine stations seaward. In the Vilkitsky Strait, the concentration of suspended matter at the surface horizon varied from 0.22 to 0.25 mg/L during the whole study period. The highest concentrations (0.4–5.9 mg/L) were found in Blagopoluchiya Bay.

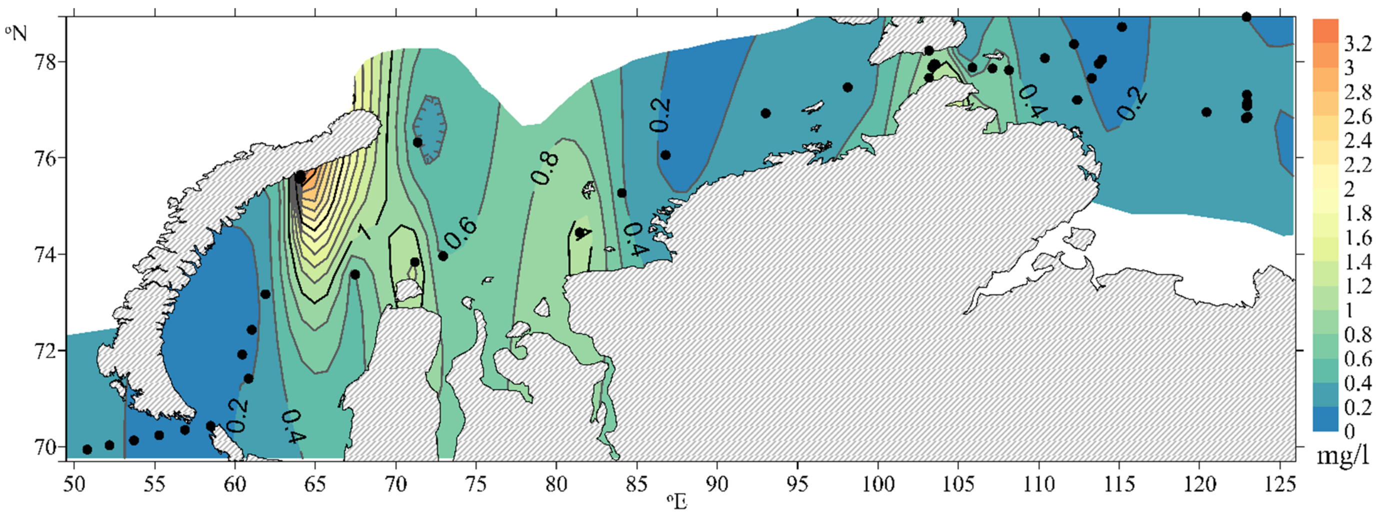


Figure 2. Distribution of suspended particulate matter (mg/L) in surface waters. The data were taken from the surface horizon using a Niskin bathometer, and the suspended matter concentration was measured by filtration.

It is noteworthy that the distribution of SPM did not change eight days after the trap had been installed at station 5946 (shelf slope of the Laptev Sea) (Figure 3b), while at station 5942 in the deep part of the Kara Sea, the difference in concentrations was revealed in the intermediate water layer: the minimal concentration of 0.3 mg/L was observed in the beginning of the trap setting and the maximum of about 0.5 mg/L was observed in the end (Figure 3a). This happened due to a change in hydrological conditions.

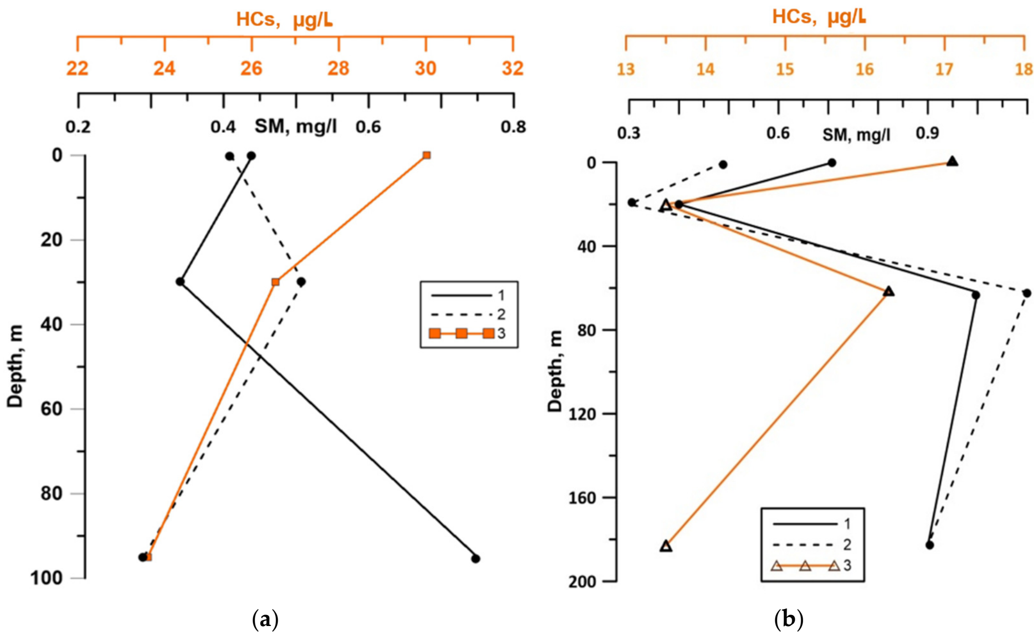


Figure 3. Variability of suspended matter concentrations with depth before (1) and after (2) removal of the trap, as well as HC (3) at station 5942 (**a**) (Kara Sea) and 5946 (**b**) (shelf slope of the Laptev Sea).

The SPM concentration increased from the surface to the near-bottom horizon at most stations, with a maximum of 36 times at station 5943 (Figure 4) (from 0.6 to 21.8 mg/L), which is affected by the influx of the Ob River. In the Vilkitsky Strait, the concentration of suspended matter rose up to 32 times (from 0.1 to 3.2 mg/L).

The distribution of HCs concentrations in surface waters was similar to that of suspended matter, their concentrations correlated with the coefficient r (SM.-HC) = 0.74 (n = 28, $p < 0.05$). However, the increase in HCs concentrations in barrier estuarine zones was less pronounced than in the particle concentration. The higher average HCs concentration in the Kara Sea (22.5 µg/L compared to that in the Laptev Sea (15.3 µg/L) is most likely due to the lower biological productivity of the latter. In the Blagopoluchiya Bay, hydrocarbons amounted to only 9–10 µg/L despite the high concentration of suspended matter, while its concentration reached up to 352 µg/mg in the western part of the Kara Sea.

3.2. Fluxes of SPM

The value of SPM fluxes varied from 79 to 13,127 mg/m^2/day (Figure 4), with a maximum in the surface water in Blagopoluchiya Bay of the Kara Sea (station 5981, Figure 3). This is the only station where the surface flux exceeded the flux in the near-bottom layer (Table 1). Finely dispersed terrigenous material is deposited in the bay; it comes with eolian transport from Novaya Zemlya [27], and also contributes to the entry of suspended matter into the bay by a small runoff from the melted Nally glacier. Thanks to these sources and the presence of a stable pycnocline in the bay [28], a maximum of suspended matter is formed in surface waters (up to 20 m).

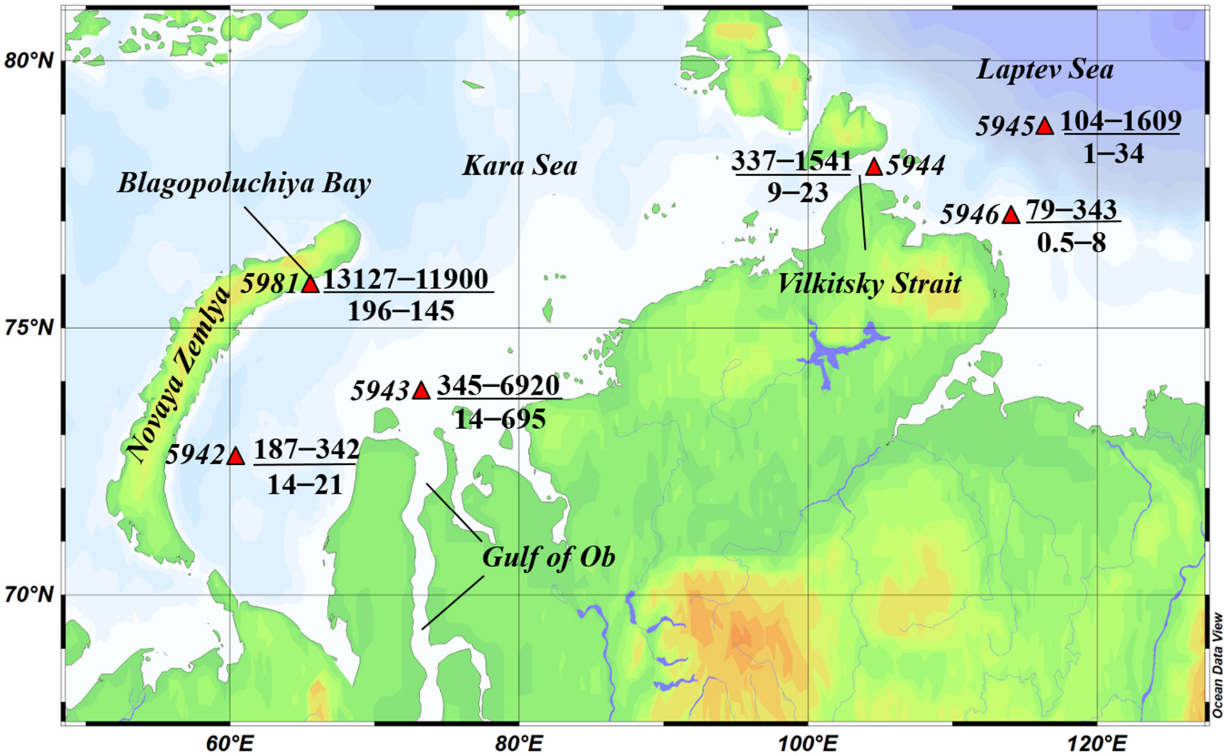


Figure 4. Flux variability "surface layer-depth layer" of particulate matter (mg/m^2/day) (numerator) and organic carbon (mgC/m^2/day) (denominator) obtained using sediment traps in the Kara and Laptev seas (triangles indicate location, italics indicate station numbers).

Table 1. Results of studying the flux of suspended matter and C_{org} in sediment traps.

Station	Date of Trap Setting	Date of Trap Removal	Exposure, Days	Depth, m	Layer, m	Flux, mg/m^2/day	
						SPM	C_{org}
5942	20.08.18	12.09.18	23	90	55	241	14
5942					65	342	21
5942					75	187	14
5943	21.08.18	7.09.18	17	30	10	345	14
5943					20	6920	695
5944	23.08.18	4.09.18	12	214	50	337	9
5944					100	567	10
5944					160	1541	23
5945	24.08.18	31.08.18	8	190	50	104	1
5945					100	1609	34
5945					160	1534	18
5946	25.08.18	31.08.18	7	65	20	79	0,5
5946					45	117	1
5946					55	343	8
5981	9.09.18	11.09.18	2	113	20	13,127	196
5981					60	12,135	171
5981					90	11,900	145

In the Novaya Zemlya Trench at station 5942, the maximum flux of SPM was observed in the intermediate water layer at the depth of the pycnocline (50–60 m), and amounted to 342 $mg/m^2/day$.

In the Vilkitsky Strait (station 5944), the SPM flux reached 1541 $mg/m^2/day$ near the bottom and, taking into account the composition of the SPM, was mainly resulted from coastal abrasion. On the shelf of the Laptev Sea (station 5946), the value of the suspended matter flux was minimal: —79 $mg/m^2/day$ at the depth of 20 m, and near the bottom (55 m) it reached 343 $mg/m^2/day$. At the same time, on the continental slope (station 5945), the suspended matter flux at a depth of 50 m was 104 $mg/m^2/day$, that is significantly lower than in the bottom layer, where it reached 1534 $mg/m^2/day$.

At the mouth of the Ob River, a significant increase in the SPM flux with depth was also observed, and it increased by almost 20 times in the near-bottom horizon compared to the surface one (6920 $mg/m^2/day$).

3.3. C_{org} Fluxes

The highest values of the C_{org} flux were observed in the zone where river waters flux into the Kara Sea (Figure 4). The C_{org} flux varied within 14–21 $mgC/m^2/day$ on the slope of the Novaya Zemlya Trench, where the mineralization of organic matter in the water column slows down under the influence of colder Atlantic waters. According to hydrological data, water fluxs are directed from the Kara Sea to the Laptev Sea through the Vilkitsky Strait [29]. In the upper 20-m layer, the water mass is fresher and rich in biogenic elements, as it has a continental genesis. The C_{org} flux is 10 $mgC/m^2/day$ there, while the flux of C_{org} and the total flux of SPM reach their maximum (23 $mgC/m^2/day$ and 1541 $mg/m^2/day$, respectively) in the near-bottom water layer, where sediment is stirred up due to along-slope currents.

In the Laptev Sea, the increased flux of C_{org} reaches 34 $mgC/m^2/day$ (station 5945) and connects to the deep layer on the shelf slope, which may be caused by the advection of warm and fresh water from the Vilkitsky Strait along the continental slope spreading up to 150 m [29].

3.4. The Composition of SPM

The samples of the upper water horizons are dominated by destroyed diatom cells and rare intact dinoflagellate cells, which is confirmed by electron microscopy data (Figure 5a,b).

An increased proportion of amorphous silica in the total flux (more than 20%) was recorded at stations in the middle shelf and continental slope of the Laptev Sea (Figure 6).

The markers of the lithogenic substance are aluminum and silicon, which dominate in most of the samples. In Blagopoluchiya Bay, the proportion of lithogenic matter in the suspended matter flux was the highest, at 90% (Figure 5b). Nutrients and organic matter are found in small concentrations in the Bay waters, as they drain the stony soils of the Novaya Zemlya. Plankton was present in insignificant amounts only in the upper homogeneous layer, which was no more than 10 m deep here according to hydrophysical data. At greater depths, the amount of plankton was minimal and destroyed diatom cells were observed in negligible amounts (Figure 5c). In comparison with the other samples, where the C_{org} concentration reached 30%, the C_{org} concentration was 10% in Blagopoluchiya Bay, which was caused by the presence of carbonate minerals dolomite and calcite. An increased iron concentration was also revealed, mainly due to the presence of pyrite in the aluminosilicates.

In the apex part of the Blagopoluchiya Bay, a high proportion of Si concentration (up to 27%) was observed in SPM, despite the fact that the proportion of amorphous silica in them was no more than 1%. In this station, amorphous silica is negligible and all silicon is part of the clayey shales, therefore, Si has a terrigenous origin.

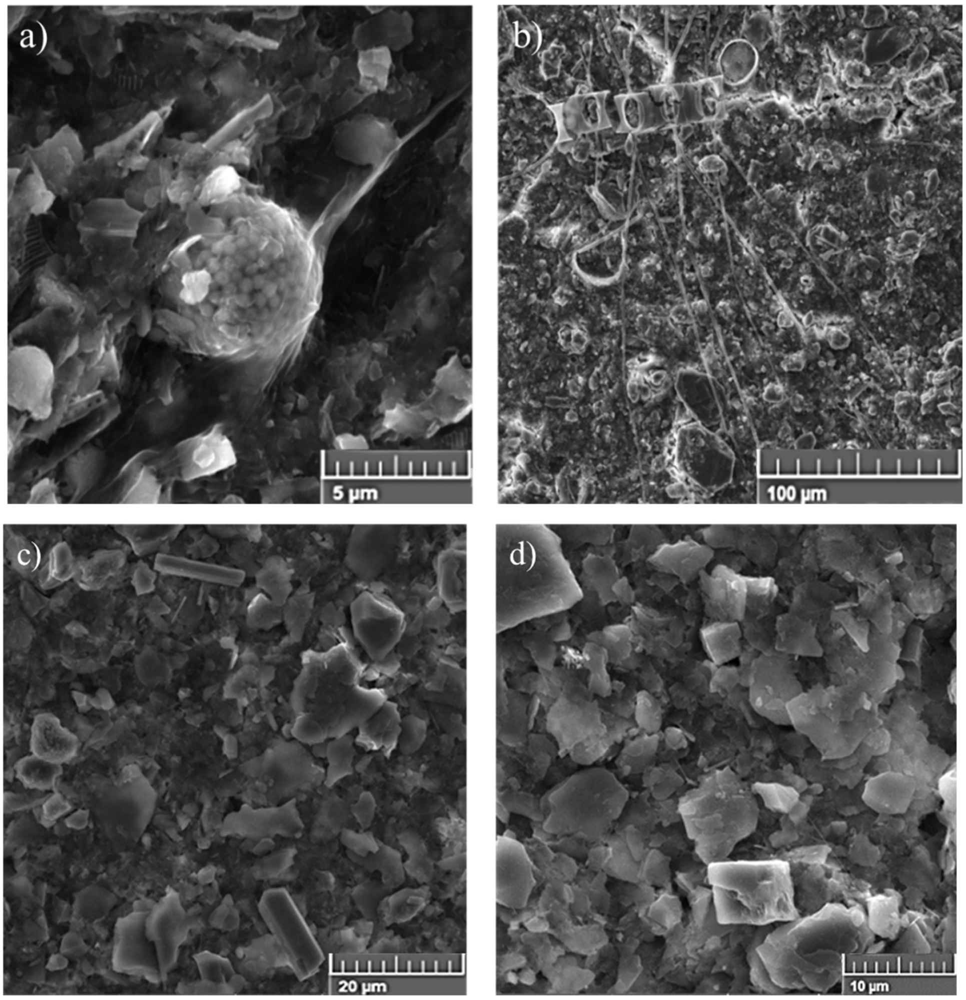


Figure 5. The composition of suspended particulate matter at station 5945: (**a**)—layer 50 m, (**b**)—layer 160 m; station 5981 (**c**)—20 m, (**d**)—90 m.

In a trap on the continental slope (station 5945), at a depth below 100 m, the amount of lithogenic material increased to 70% of the total SPM flux (Figure 6b).

In addition, there were unrounded particles of feldspar, plagioclase, and apatite coagulating on organic remains. Titanium was found in aluminosilicate minerals and in rutile as well as iron oxides. An insignificant amount of ash particles was noted in the samples.

3.5. Hydrocarbon Flux

"Hydrocarbons" Flux composition of hydrocarbons changed during the precipitation of particles through the water column. On the coast of the Ob River (station 5943), the CPI (Carbon Preference Index—odd to even homologues ratio) was only 0.92 at a depth of 10 m, which is typical for filtered suspension [30,31]. However, at a depth of 20 m, odd terrigenous alkanes dominated in the high molecular weight spectrum, coming with nepheloid suspension from bottom sediments, and the CPI value increased to 1.75. A similar distribution of homologues was also observed in the particulate matter from a sediment trap set in the Vilkitsky Strait (station 5944), where a smooth distribution of homologues was observed at a depth of 50 m, and a series of odd C_{27}–C_{35} alkanes dominated in the high-molecular spectrum at a depth of 160 m.

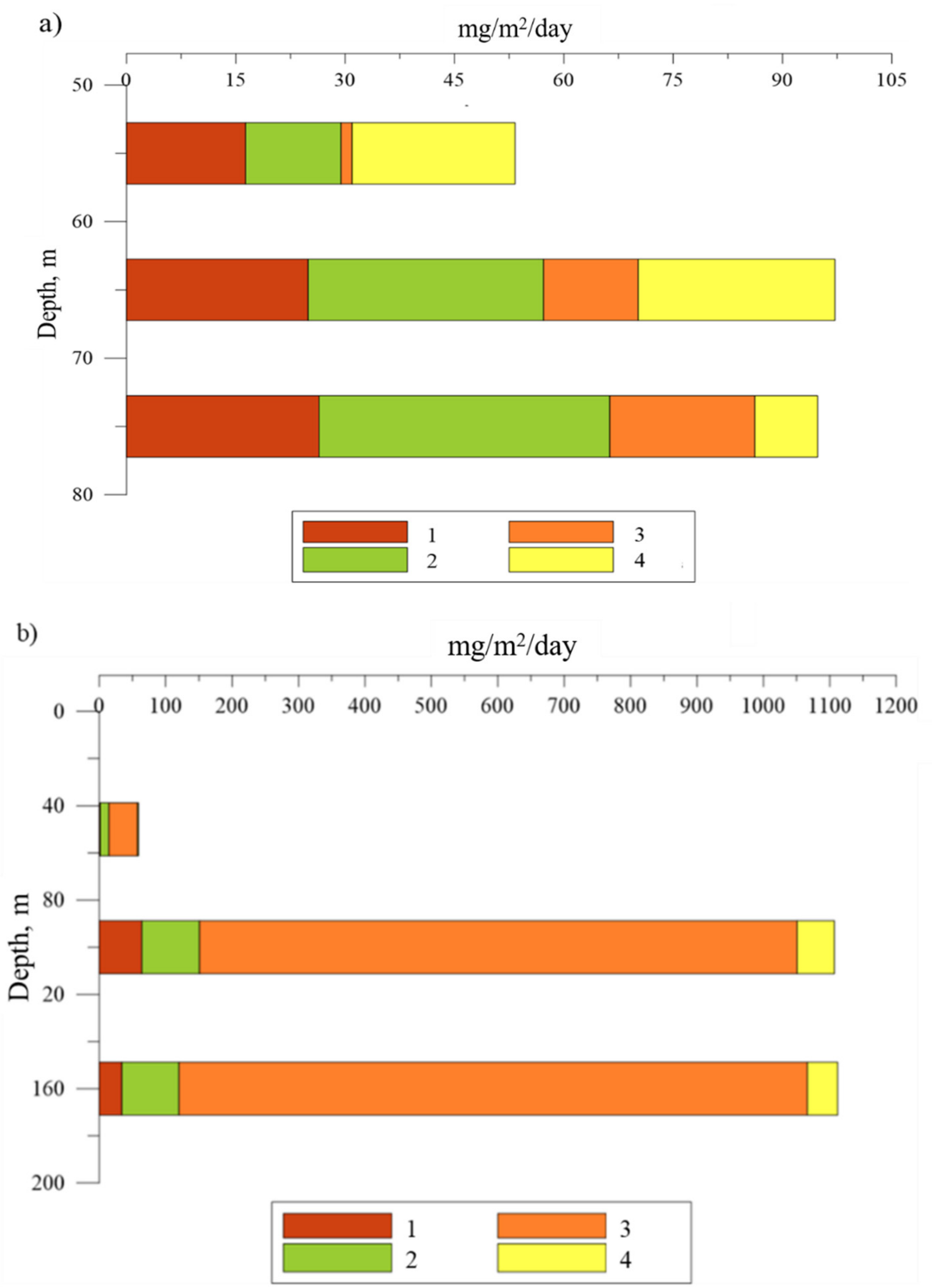


Figure 6. *Cont*.

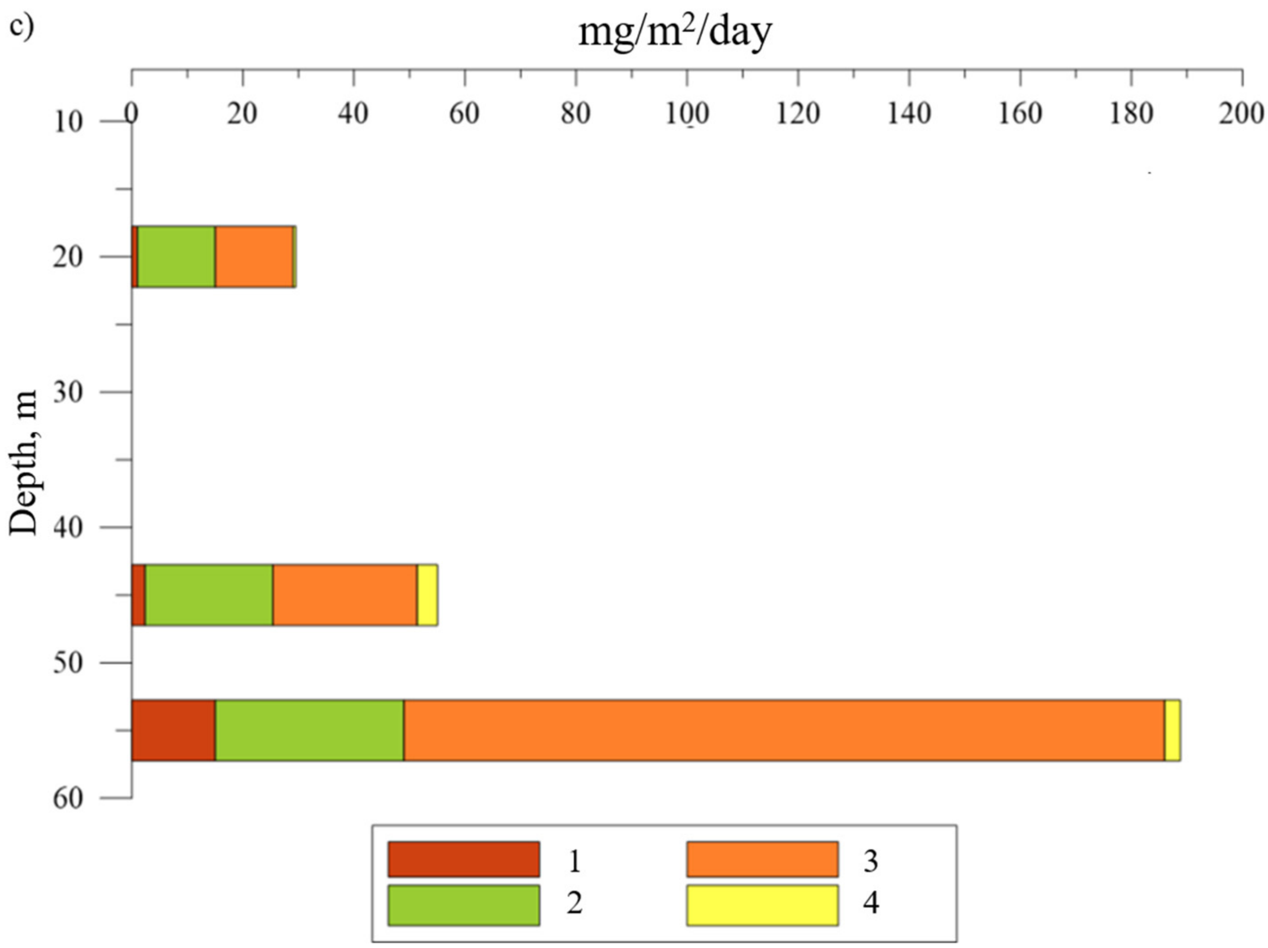
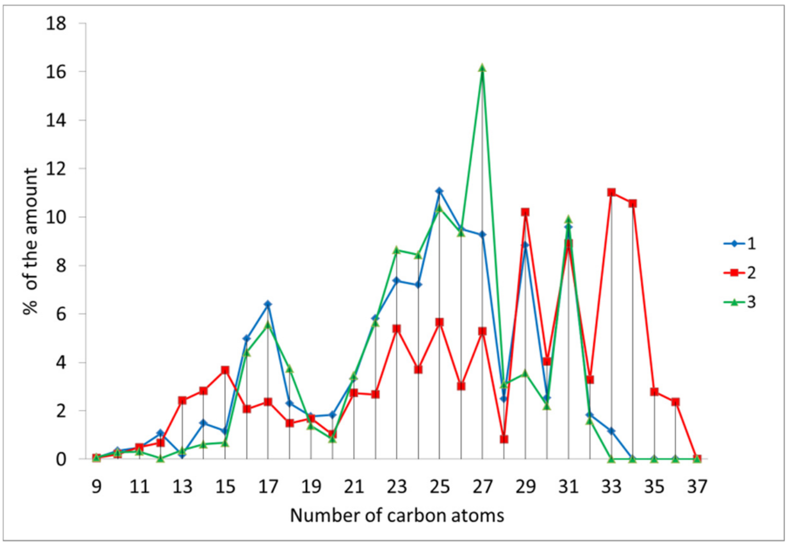


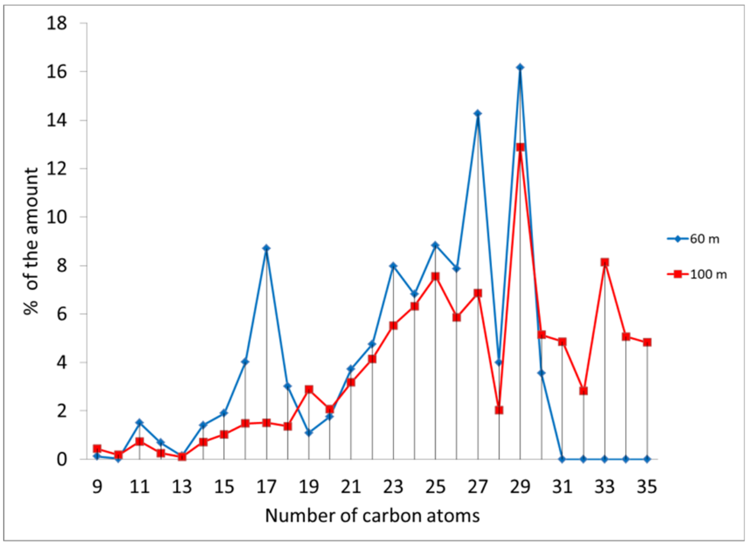
Figure 6. The material composition of suspended matter in sediment traps at stations 5942 (**a**), 5945 (**b**) и 5946 (**c**). *1*—organic matter; *2*—amorphous particulate silica; *3*—lithogenic matter; *4*—calcium carbonate.

In the St. Anna Trough, where a trap was settled from September 2018 to June 2019, the composition of HCs was also dominated by high-molecular homologues, and the ratio of light to high-molecular alkanes varied from 0.45 to 0.87. The phytoplankton originated alkane n-C_{17} dominated in the low-molecular spectrum (Figure 7) from October to May (Figure 7a), and at different depths (Figure 7b). At the same time, the amount of low molecular weight alkanes has been decreased along the exposure time, and their proportion was greater in October 2018 (45%) compared to May 2019 (34%). The proportion of high molecular weight homologues and CPI rose up toward deeper layers: from 55% and 1.4 (70 m) to 70% and 1.7 (110 m), accordingly.

In the upper photic layer, the biogenic type of suspended matter dominates during the period of its generation by living organisms, then the inputs of autochthonous biogenic markers (n-C_{15}, -C_{17}) increases. Terrigenous components in this layer are less than 5%.



(**a**)



(**b**)

Figure 7. Chromatograms of alkanes in the St. Anna Trough according to the one-year sediment trap (**a**) for different months: 1—October 2018, 2—March 2019, 3—May 2019 and (**b**) for different layers.

4. Discussion

The distribution of suspended matter in the waters of the Kara Sea and the Laptev Sea is largely affected by rivers, SPM rafting, coastal abrasion, and aeolian transport. During our studies, the most intensive flux of sedimentary material was observed in the coastal zone. This is due to the fact that the coastal abrasion and glacier discharge affect the concentration and composition of SPM [7]. While glaciers melt they release sedimentary materials which came from land and the atmosphere. The longest daylight hours increase the bioproduction in water, which raises the proportion of biogenic SPM in the total flux in summer [15]. Yet a high concentration of terrigenous SPM is observed throughout the entire study period [32]. A similar pattern was observed in the White, Barents, and East Siberian Seas [33–35], who applied sediment traps during similar research time in the Central Arctic and also recorded total flux of 150–200 mg/m^2/day throughout the entire water column, while the value of C_{org} flux varied from 10 to 20 mgC/m^2/day, which is consistent with our results.

It is also worth noting that the typical circumcontinental zonal distribution of suspended matter is regularly observed, such as increased concentrations of dispersed material in the shelf zone and the estuarine areas of rivers. We found that the fluxes in the Ob River mouth (6920 mg/m^2/day) were 20 times higher than the fluxes in seaward areas (station 5943 and station 5946, Table 1), which is typical for the marginal filter zone. Our data confirm the conclusions described in articles [19,20], where it was shown for the late summer period that the SPM fluxes varied within 100–500 mg/m^2/day in the central deep-water part of the White Sea, while their values significantly exceeded 2000 mg/m^2/day near the coastal and estuarine areas.

We have found that the most intense sedimentation process is observed in the iceberg discharge zone in the Blagopoluchiya Bay and amounts to more than 13,000 mg/m^2/day. According to [36], the suspended matter fluxes reached 7760 mg/m^2/day in the near-bottom layer in the north arch, Novaya Zemlya. Our data shows that the particulate matter composition was dominated by mineral components due to the introduction of clastic material from the shore. The average value of SPM fluxes was higher in the Kara Sea than in the Laptev Sea. This is explained by the higher bioproductivity in the Kara Sea and the large input of suspended matter brought by the Ob and Yenisei Rivers [37], as compared to the Laptev Sea.

In the Vilkitsky Strait, the increase in the concentration of suspended matter in the surface water layer is most likely caused by coastal abrasion. The near-bottom maximum (up to 1541 mg/m^2/day) can be associated with a near-bottom countercurrent, which raises up the flux of suspended matter near the bottom [29].

The highest concentration of particulate matter was found in the Blagopoluchiya Bay, which is probably associated with the influx of mineral particles with aerosols from Novaya Zemlya that enter the water from the melting ice of the archipelago.

According to the composition of matter, destroyed cells of diatoms and rare whole cells of dinoflagellates dominated in the samples taken from the upper water layers. Rarely occurring ash particles indicate an insignificant contribution from anthropogenic sources. The waters of the Kara and Laptev Seas are classified as ultraoligotrophic with a primary bioproduction of <50 mgC/m^2/day [9,10]. The study period falls on the stage of the seasonal succession of phytoplankton, and the shortening daylight causes an increase in the density of plankton cells in the upper 20-m layer.

In Blagopoluchiya Bay, the continental layer of the Laptev Sea, the lithogenic component prevails in suspension throughout the whole water column.

The distribution of fluxes in depth was of two types: with a maximum in the pycnocline layer, above the pycnocline [12], and with a maximum near the bottom, in the nepheloid layer. The first type of distribution was noted in the Novaya Zemlya Trench, where the maximum flux of matter was located at a depth of 65 m (Table 1) and near the continental slope in the Laptev Sea at a depth of 100 m. The particle concentration rises in the bottom layer under the influence of bottom currents (Station 5944), and is also determined by the dispersion of sediments. In the pycnocline layer an increase in suspended matter concentrations can also occur.

In the Blagopoluchiya Bay, the fluxes decreased with depth, and the maximum flux of SPM reached 13,127 mg/m^2/day in the euphotic layer, which was located here at a depth of more than 10 m. In this case, the stable stratification of the water column and the sandy sediments [38] lead to decreasing flux in the near-bottom layer compared to the euphotic layer.

The specific thermohaline characteristics of the intermediate water layer (higher temperature compared to the surface water) indicate [29] that there is a consolidated water transport by slope currents from other areas in this area. These currents stir up the sedimentary masses on the continental slope, which causes an increase in suspended matter fluxes [6].

In addition, there were unrounded particles of feldspar, plagioclase, and apatite coagulating on organic remains. Titanium was found in aluminosilicate minerals and in rutile as well as iron oxides.

The higher average HCs concentration in the Kara Sea compared to the Laptev Sea may be due to decreasing bioproductivity from the western to the eastern Arctic seas [39]. Significant seasonal differences in the composition of alkanes are associated with the production of phyto- and zooplankton [40]. In deep water layers, the amount of high-molecular odd alkanes, which are the most resistant to decomposition [41,42], increases due to the intensive decomposition of pellets and the influx of particles from nepheloid layers (Figure 7).

5. Conclusions

In surface waters, the distribution of suspended matter is largely determined by the influence of rivers and coastal abrasion, as well as eolian fluxes from Novaya Zemlya, where its content reached 5.92 mg/L.

The content of hydrocarbons in the revealed swellings of water depends on the infection, since there are countless correlations between them (r = 0.74). In most of the studied areas, the HCs content corresponds to the background values and does not exceed 20 µg/L. The lower productivity of the Laptev Sea compared to the Kara Sea causes a lower HC content. Due to the heavy nature of suspended matter, the minimum HCs content (8–10 µg/L) is established in the Blagopoluchiya Bay of Novaya Zemlya.

The study of fluxes (using sediment traps) established two types of their distribution with depth: an increase in the concentration of suspended phenomena from the surface to the bottom layer due to the formation of a nepheloid layer (in most observations), and an increase from the surface to the lower horizon (in the Blagopoluchiya Bay)

The most intensive process of sedimentation occurs in the Blagopoluchiya Bay in the surface layer and in the Ob River mouth area (6920 and 13 127 mg/m^2/day, respectively).

The fluxes are dominated by the mineral particles of aluminosilicate composition. The biogenic component of the flux is present in the surface layers and is mainly represented by diatom cells. With depth, the proportion of the biogenic component decreases due to the destruction of phytoplankton cells and the reducing biological production below the pycnocline layer, which also affects the HCs composition.

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