

Supplementary information:

Table S1. The ratio of the two mobile phases varies with time in the Ultra Performance Liquid Chromatography (UPLC) binary gradient elution program, according to the method of [Zapata et al. \(2000\)](#).

Table S2. The abbreviation and retention time of the pigment measured by UPLC.

Table S3. The percentage of different phytoplankton taxonomic groups in the water column.

Table S4. Correlations of the mean value of studying parameters at all study sites. Only data with significant correlations at the 0.05 level are shown, the underlined number is significant at the 0.01 level.

Table S5. Phytoplankton taxonomic composition (relative abundance) in the surface layer of the study area based on CHEMTAX calculation.

Fig. S1. Detailed retention time and chromatogram of pigments (used pigments in red font) measured by UPLC. a. mixed standards-a; b. mixed standards-b.

Fig. S2. Distribution of temperature (a) and salinity (b) across the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m).

Fig. S3. Distribution of nitrate concentration (a), phosphate concentration (b) and silicate concentration (c) across the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m).

Fig. S4. Distribution of N/P ratios (a), Si/P ratios (b) and N/Si ratios (c) across the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m, respectively).

Fig. S5. Distribution of chlorophyll *a* (a), Pheophorbide *a* (b), Pheophytin *a* (c), fucoxanthin (d), Chlorophyll *c*2 (e), Chlorophyll *c*3 (f), and Chlorophyll *b* (g) concentrations in the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m, respectively).

Fig. S6. The distributions of temperature (a), salinity (b), the percentage of diatoms (c) and *P. antarctica* (d) in Section L1. The location of Section L1 is shown in Plot b.

Fig. S7. The distributions of temperature (a), salinity (b), the percentage of diatoms (c) and *P. antarctica* (d) in Section L2. The location of Section L2 is shown in Plot b.

The supplementary information is available online at <https://doi.org/10.1007/s13131-021-1865-4>. The supplementary information is published as submitted, without typesetting or editing. The responsibility for scientific accuracy and content remains entirely with the authors.

Table S1. The ratio of the two mobile phases varies with time in the Ultra Performance Liquid Chromatography (UPLC) binary gradient elution program, according to the method of [Zapata *et al.* \(2000\)](#).

Time/minute	Mobile phase A/%	Mobile phase B/%
0	100	0
14	60	40
18	5	95
24	5	95
26	100	0

Table S2. The abbreviation and retention time of the pigment measured by UPLC.

Pigment	Abbreviation	Retention time / minute
Chlorophyll <i>c</i> ₃	Chl <i>c</i> ₃	4.566
Peridinin	Peri	6.252
Chlorophyll <i>c</i> ₂	Chl <i>c</i> ₂	7.296
19'-butanoyloxyfucoxanthin	But-fuco	8.762
Fucoxanthin	Fuco	9.017
Pheophobide <i>a</i>	Phide- <i>a</i>	10.549
19'-hexanoyloxyfucoxanthin	Hex-fuco	11.418
Alloxanthin	allo	13.844
Zeaxanthin	Zea	15.269
Chlorophyll <i>b</i>	Chl <i>b</i>	19.215
Chlorophyll- <i>a</i>	Chl <i>a</i>	19.774
Pheophytin <i>a</i>	Phytin- <i>a</i>	22.087

Table S3. The percentage of different phytoplankton taxonomic groups in the water column.

	Diatoms	<i>Phaeocystis antarctica</i> (<i>P. antarctica</i>)	Green flagellates	Dinoflagellates	Cryptophytes	Cyanobacteria
0 m	72% ± 17%	22% ± 12%	5% ± 7%	0% ± 1%	0% ± 1%	0% ± 0%
25 m	75% ± 15%	20% ± 12%	4% ± 5%	0% ± 1%	1% ± 3%	0% ± 0%
50 m	74% ± 11%	22% ± 9%	4% ± 5%	1% ± 2%	0% ± 2%	0% ± 0%
100 m	55% ± 10%	40% ± 10%	2% ± 2%	0% ± 2%	1% ± 2%	1% ± 3%
200 m	38% ± 22%	52% ± 19%	3% ± 2%	3% ± 8%	2% ± 6%	3% ± 11%

Table S4. Correlations of the mean value of studying parameters at all study sites. Only data with significant correlations at the 0.05 level are shown. The underlined number are significant at the 0.01 level.

	Depth	MLD	MW%	E _{stability}	PAR	Temperature	Salinity	Phosphate concentration	Silicate concentration	Nitrate concentration	N/P Ratio	Si/P Ratio	N/Si Ratio	Diatoms%	<i>P. antarctica</i> %	Green Flagellate%	Phytin- <i>a</i> concentration	Phide- <i>a</i> concentration	Chl <i>a</i> concentration
Depth						<u>-0.29</u>	<u>0.58</u>	<u>0.60</u>	<u>0.60</u>	<u>0.51</u>		<u>-0.21</u>	<u>0.20</u>	<u>-0.65</u>	<u>0.67</u>	<u>-0.19</u>	<u>-0.42</u>	<u>-0.29</u>	<u>-0.45</u>
MLD			<u>-0.64</u>	<u>0.67</u>			<u>0.34</u>	<u>0.18</u>		<u>0.26</u>	<u>0.19</u>	<u>-0.19</u>	<u>0.30</u>	<u>-0.17</u>	<u>0.17</u>	<u>0.30</u>	<u>-0.25</u>	<u>-0.22</u>	
MW%		<u>-0.64</u>		<u>0.94</u>		<u>-0.20</u>	<u>-0.57</u>	<u>-0.28</u>		<u>-0.29</u>		<u>0.27</u>	<u>-0.27</u>	<u>0.20</u>	<u>-0.20</u>	<u>-0.38</u>	<u>0.16</u>	<u>0.25</u>	
E _{stability}		<u>0.67</u>	<u>0.94</u>			<u>-0.16</u>	<u>-0.55</u>	<u>-0.29</u>		<u>-0.33</u>	<u>-0.15</u>	<u>0.28</u>	<u>-0.34</u>	<u>0.20</u>	<u>-0.20</u>	<u>-0.44</u>	<u>0.22</u>	<u>0.29</u>	
PAR						<u>-0.18</u>				<u>-0.17</u>				<u>0.64</u>	<u>-0.58</u>	<u>-0.39</u>	<u>0.43</u>		
Temperature	<u>-0.29</u>		<u>-0.20</u>	<u>-0.16</u>	<u>-0.18</u>			<u>-0.24</u>		<u>-0.23</u>		<u>0.17</u>	<u>-0.21</u>		<u>-0.18</u>	<u>0.17</u>	<u>0.27</u>		<u>0.23</u>
Salinity	<u>0.58</u>	<u>0.34</u>	<u>-0.57</u>	<u>-0.55</u>				<u>0.81</u>	<u>0.71</u>	<u>0.78</u>	<u>0.25</u>	<u>-0.45</u>	<u>0.47</u>	<u>-0.57</u>	<u>0.52</u>	<u>0.23</u>	<u>-0.48</u>	<u>-0.47</u>	<u>-0.20</u>
Phosphate concentration	<u>0.60</u>	<u>0.18</u>	<u>-0.28</u>	<u>-0.29</u>		<u>-0.24</u>	<u>0.81</u>		<u>0.65</u>	<u>0.85</u>		<u>-0.73</u>	<u>0.60</u>	<u>-0.56</u>	<u>0.53</u>		<u>-0.62</u>	<u>-0.56</u>	<u>-0.30</u>
Silicate concentration	<u>0.60</u>						<u>0.71</u>	<u>0.65</u>		<u>0.64</u>	<u>0.20</u>			<u>-0.39</u>	<u>0.35</u>		<u>-0.31</u>	<u>-0.27</u>	<u>-0.24</u>
Nitrate concentration	<u>0.51</u>	<u>0.26</u>	<u>-0.29</u>	<u>-0.33</u>	<u>-0.17</u>	<u>-0.23</u>	<u>0.78</u>	<u>0.85</u>	<u>0.64</u>		<u>0.60</u>	<u>-0.58</u>	<u>0.80</u>	<u>-0.52</u>	<u>0.49</u>		<u>-0.59</u>	<u>-0.56</u>	<u>-0.38</u>
N/P Ratio		<u>0.19</u>		<u>-0.15</u>			<u>0.25</u>		<u>0.20</u>	<u>0.60</u>			<u>0.61</u>				<u>-0.18</u>	<u>-0.28</u>	<u>-0.23</u>
Si/P Ratio	<u>-0.21</u>	<u>-0.19</u>	<u>0.27</u>	<u>0.28</u>		<u>0.17</u>	<u>-0.45</u>	<u>-0.73</u>		<u>-0.58</u>			<u>-0.76</u>	<u>0.34</u>	<u>-0.34</u>		<u>0.50</u>	<u>0.51</u>	
N/Si Ratio	<u>0.20</u>	<u>0.30</u>	<u>-0.27</u>	<u>-0.34</u>		<u>-0.21</u>	<u>0.47</u>	<u>0.60</u>		<u>0.80</u>	<u>0.61</u>	<u>-0.76</u>		<u>-0.37</u>	<u>0.37</u>	<u>0.16</u>	<u>-0.51</u>	<u>-0.53</u>	<u>-0.28</u>
Diatom%	<u>-0.65</u>	<u>-0.17</u>	<u>0.20</u>	<u>0.20</u>	<u>0.64</u>		<u>-0.57</u>	<u>-0.56</u>	<u>-0.39</u>	<u>-0.52</u>		<u>0.34</u>	<u>-0.37</u>		<u>-0.92</u>	<u>-0.22</u>	<u>0.50</u>	<u>0.38</u>	<u>0.40</u>
<i>P. antarctica</i> %	<u>0.67</u>	<u>0.17</u>	<u>-0.20</u>	<u>-0.20</u>	<u>-0.58</u>	<u>-0.18</u>	<u>0.52</u>	<u>0.53</u>	<u>0.35</u>	<u>0.49</u>		<u>-0.34</u>	<u>0.37</u>	<u>-0.92</u>			<u>-0.50</u>	<u>-0.38</u>	<u>-0.42</u>
Green Flagellate%	<u>-0.19</u>	<u>0.30</u>	<u>-0.38</u>	<u>-0.44</u>	<u>-0.39</u>	<u>0.17</u>	<u>0.23</u>						<u>0.16</u>	<u>-0.22</u>				<u>-0.17</u>	
Phytin- <i>a</i> concentration	<u>-0.42</u>	<u>-0.25</u>	<u>0.16</u>	<u>0.22</u>	<u>0.43</u>	<u>0.27</u>	<u>-0.48</u>	<u>-0.62</u>	<u>-0.31</u>	<u>-0.59</u>	<u>-0.18</u>	<u>0.50</u>	<u>-0.51</u>	<u>0.50</u>	<u>-0.50</u>			<u>0.61</u>	<u>0.57</u>
Phide- <i>a</i> concentration	<u>-0.29</u>	<u>-0.22</u>	<u>0.25</u>	<u>0.29</u>			<u>-0.47</u>	<u>-0.56</u>	<u>-0.27</u>	<u>-0.56</u>	<u>-0.28</u>	<u>0.51</u>	<u>-0.53</u>	<u>0.38</u>	<u>-0.38</u>	<u>-0.17</u>	<u>0.61</u>		<u>0.23</u>
Chl- <i>a</i> concentration	<u>-0.45</u>					<u>0.23</u>	<u>-0.20</u>	<u>-0.30</u>	<u>-0.24</u>	<u>-0.38</u>	<u>-0.23</u>		<u>-0.28</u>	<u>0.40</u>	<u>-0.42</u>		<u>0.57</u>	<u>0.23</u>	

Table S5. Phytoplankton taxonomic composition (relative abundance) in the surface layer of the study area based on CHEMTAX calculation.

Station	Diatoms	Dinoflagellates	Cyanobacteria	<i>P. antarctica</i>	Cryptophytes	Greenflagellates
D1-07	82%	0%	0%	18%	0%	0%
D1-08	69%	0%	0%	23%	0%	8%
D1-10	87%	0%	0%	13%	0%	0%
D2-03	53%	0%	0%	47%	0%	0%
D2-06	80%	0%	0%	19%	0%	1%
D2-08	82%	0%	0%	18%	0%	0%
D2-10	75%	0%	0%	15%	0%	11%
D3-03	62%	0%	0%	32%	0%	6%
D3-05	66%	0%	0%	24%	0%	10%
D3-06	64%	0%	0%	29%	0%	8%
D3-08	71%	0%	0%	24%	0%	5%
D3-09	68%	0%	0%	27%	0%	5%
D4-03	47%	0%	0%	26%	5%	22%
D4-05	60%	0%	0%	29%	1%	11%
D5-03	58%	0%	0%	30%	0%	11%
D5-05	82%	0%	0%	11%	0%	7%
D5-06	89%	0%	0%	11%	0%	0%
D5-07	93%	0%	0%	7%	0%	0%
D5-08	91%	0%	0%	9%	0%	0%
D5-09	69%	0%	0%	31%	0%	0%
D5-11	69%	0%	0%	31%	0%	0%
D6-03	100%	0%	0%	0%	0%	0%
D6-04	98%	0%	0%	0%	0%	2%
D6-05	100%	0%	0%	0%	0%	0%
D6-06	100%	0%	0%	0%	0%	0%
DA-01	77%	5%	0%	17%	0%	1%
DA-03	60%	0%	0%	29%	0%	11%
DA-06	51%	0%	0%	46%	2%	1%
DA-08	78%	0%	0%	22%	0%	0%
DB-01	45%	7%	2%	38%	0%	9%
DB-03	49%	0%	0%	39%	0%	12%
DB-06	66%	0%	0%	34%	0%	0%
DB-08	59%	0%	0%	29%	0%	13%
DB-10	36%	0%	0%	32%	1%	32%
DC-02	82%	0%	0%	16%	0%	2%
DC-03	83%	0%	0%	16%	0%	0%

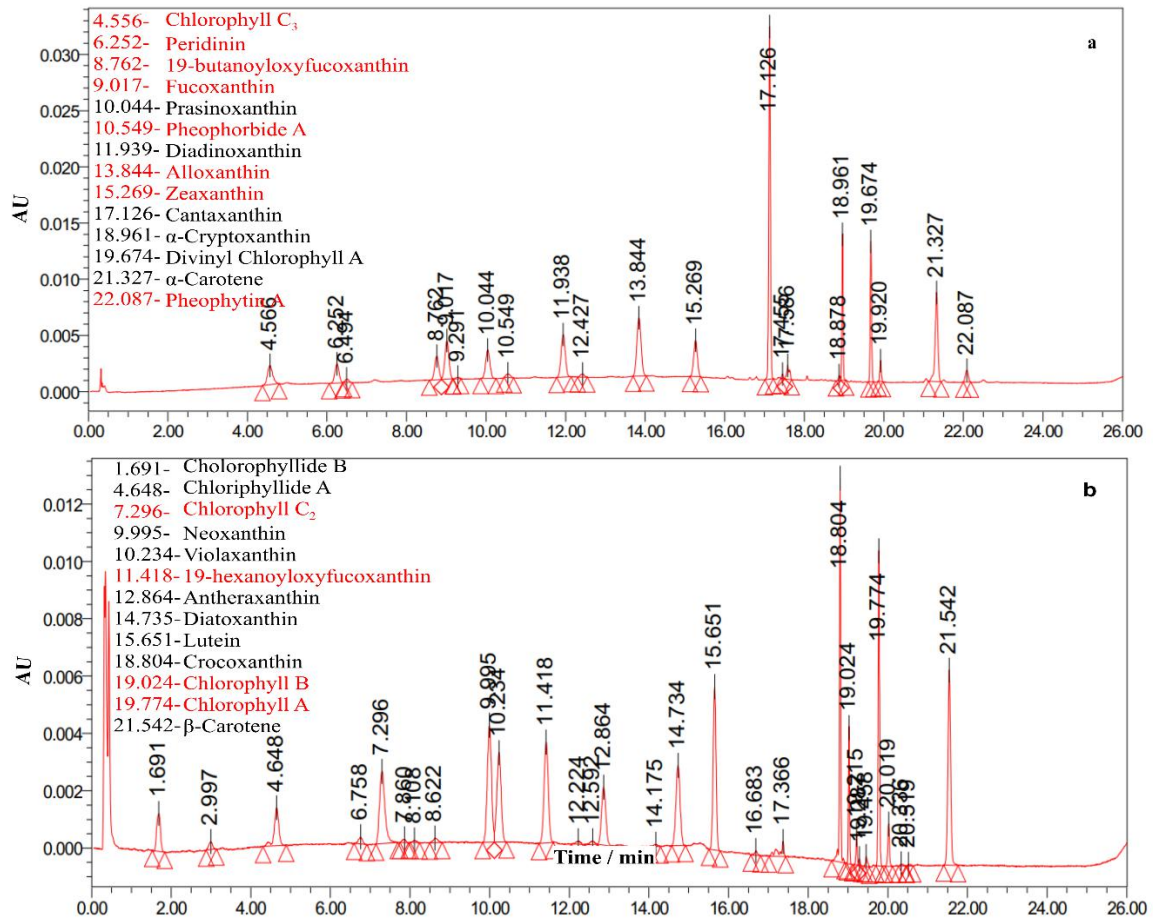


Fig. S1. Detailed retention time and chromatogram of pigments (used pigments in red font) measured by UPLC. (a) mixed standards-a; (b) mixed standards-b.

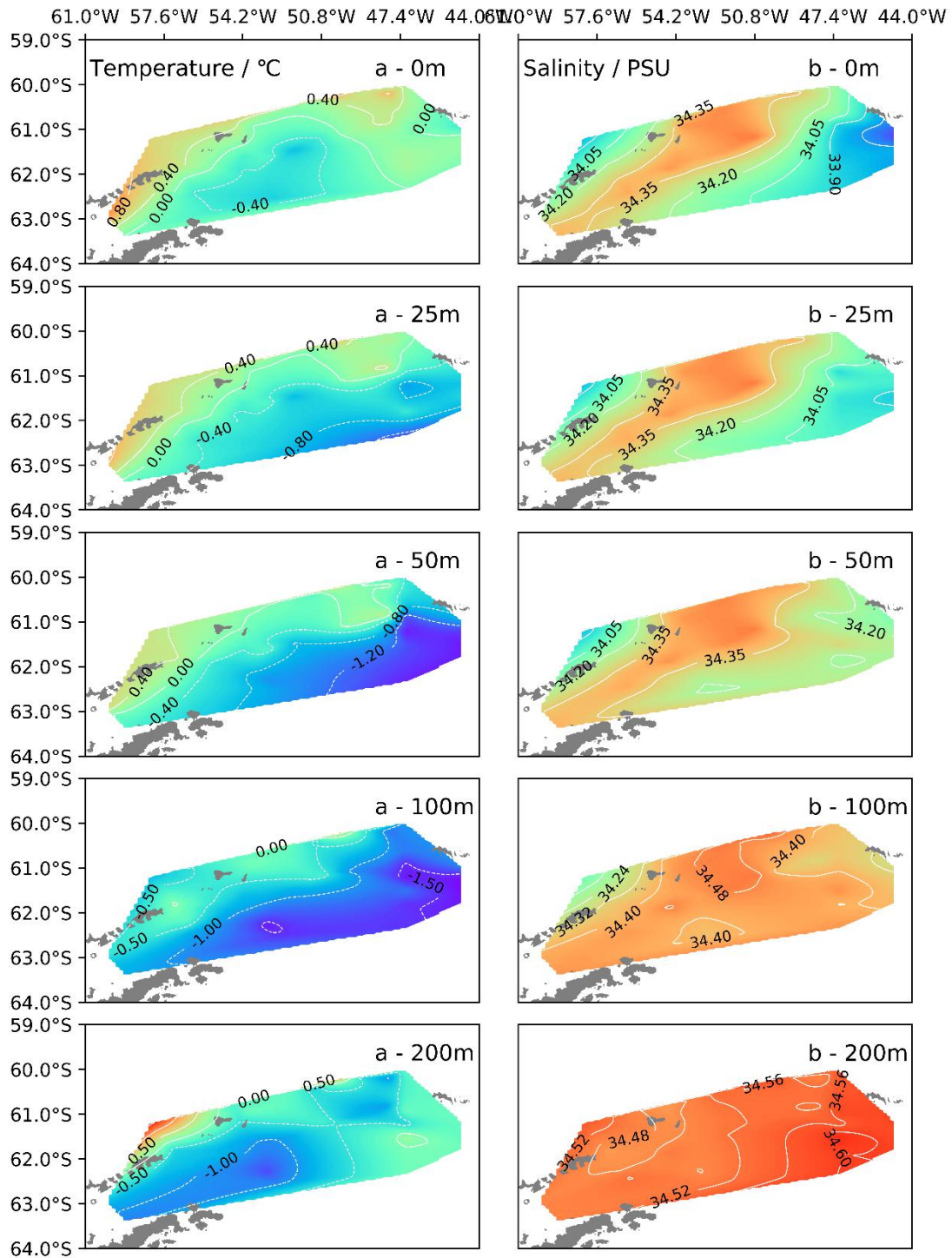


Fig. S2. Distribution of temperature (a) and salinity (b) across the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m).

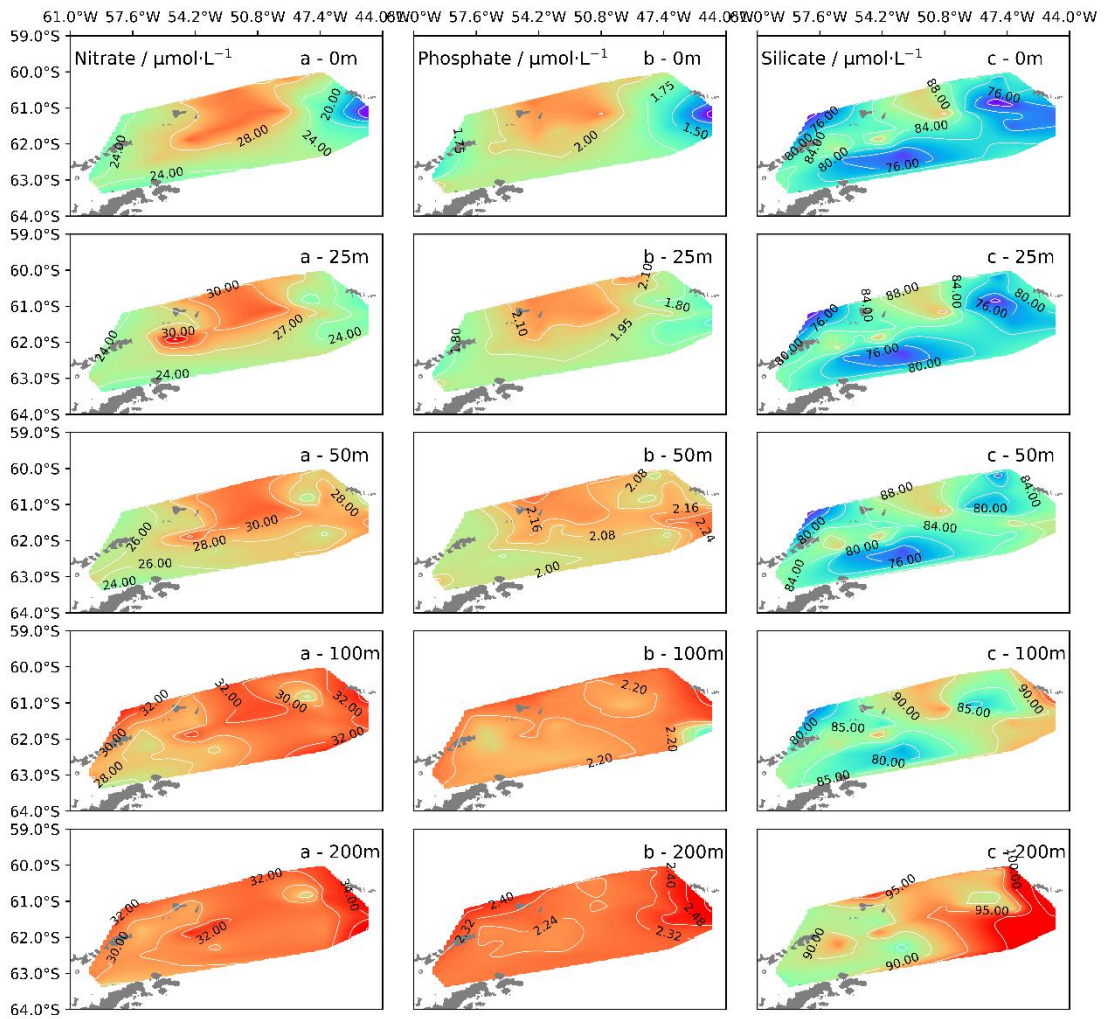


Fig. S3. Distribution of nitrate concentration (a), phosphate concentration (b) and silicate concentration (c) across the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m).

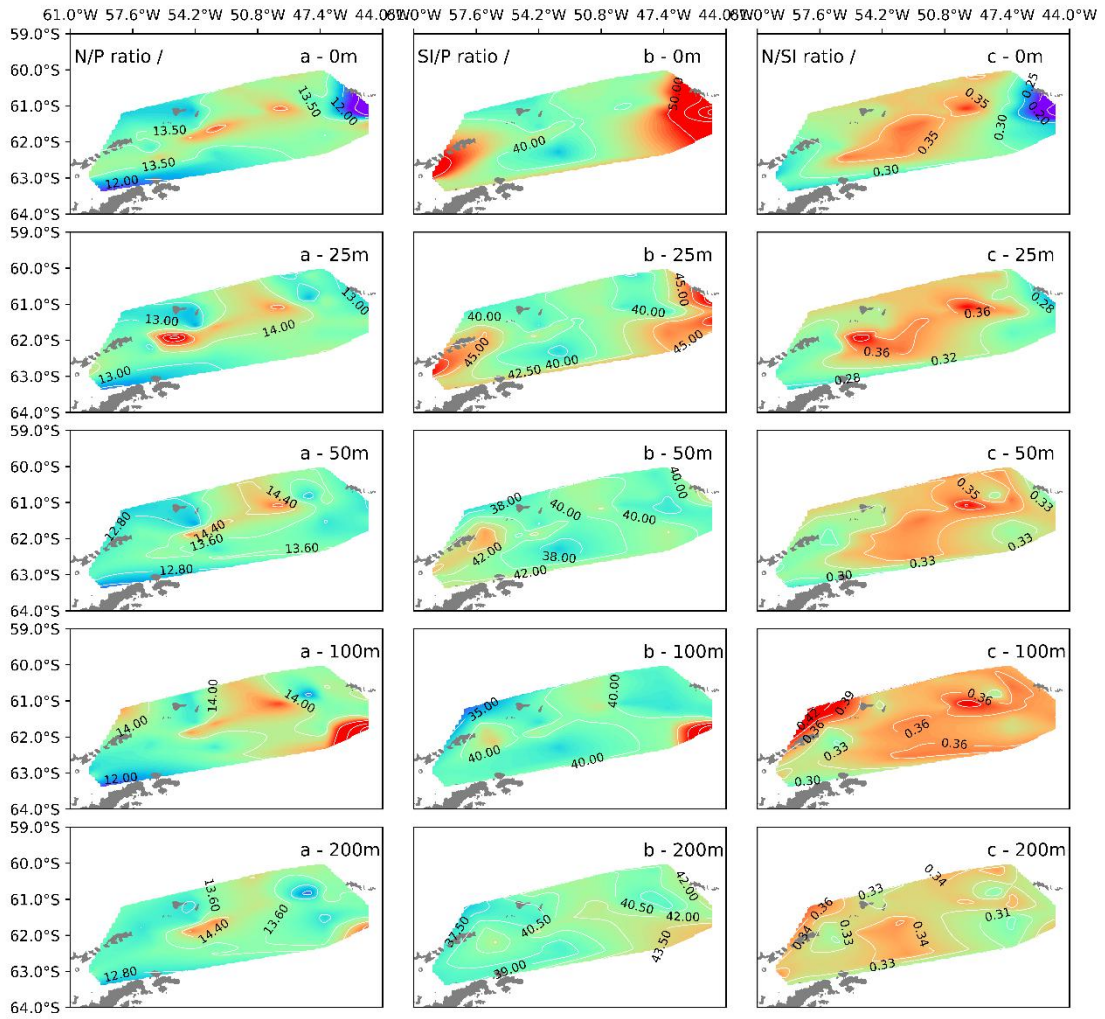


Fig. S4. Distribution of N/P ratios (a), Si/P ratios (b) and N/Si ratios (c) across the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m).

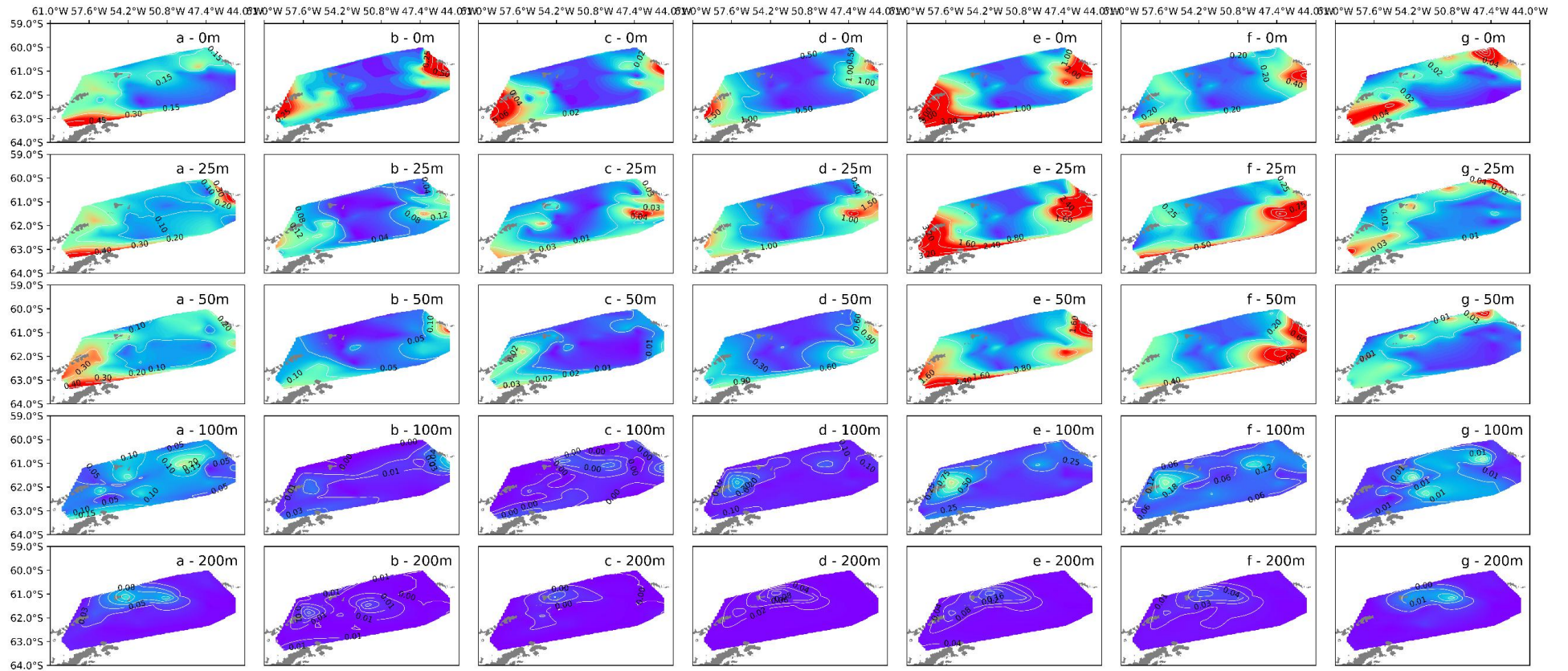


Fig. S5. Distribution of chlorophyll *a* (a), pheophorbide *a* (b), pheophytin *a* (c), fucoxanthin (d), chlorophyll *c*2 (e), chlorophyll *c*3 (f), and chlorophyll *b* (g) concentrations in the water column (i.e., 0 m, 25 m, 50 m, 100 m, 200 m, respectively).

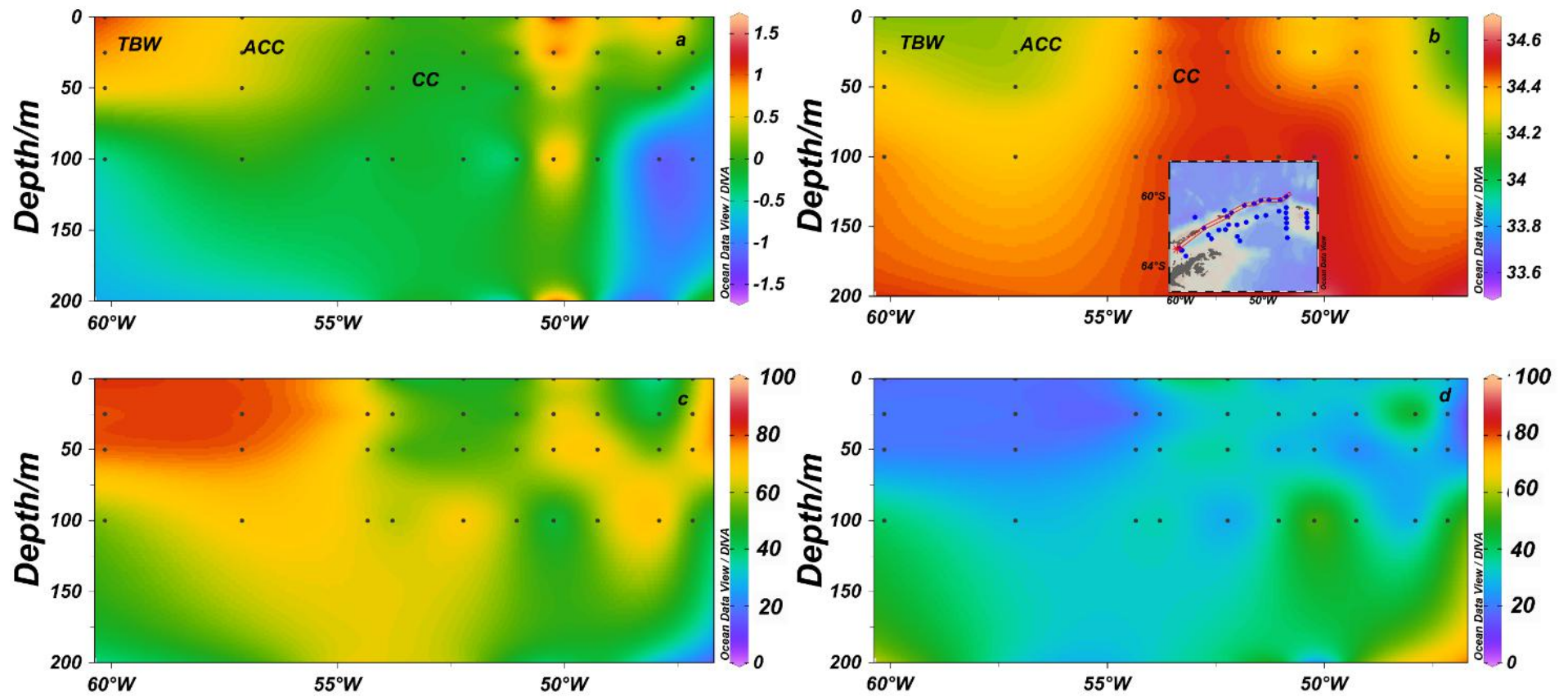


Fig. S6. The distributions of temperature (a), salinity (b), the percentage of diatoms (c) and *P. antarctica* (d) in Section L1. The location of Section L1 is shown in Plot b.

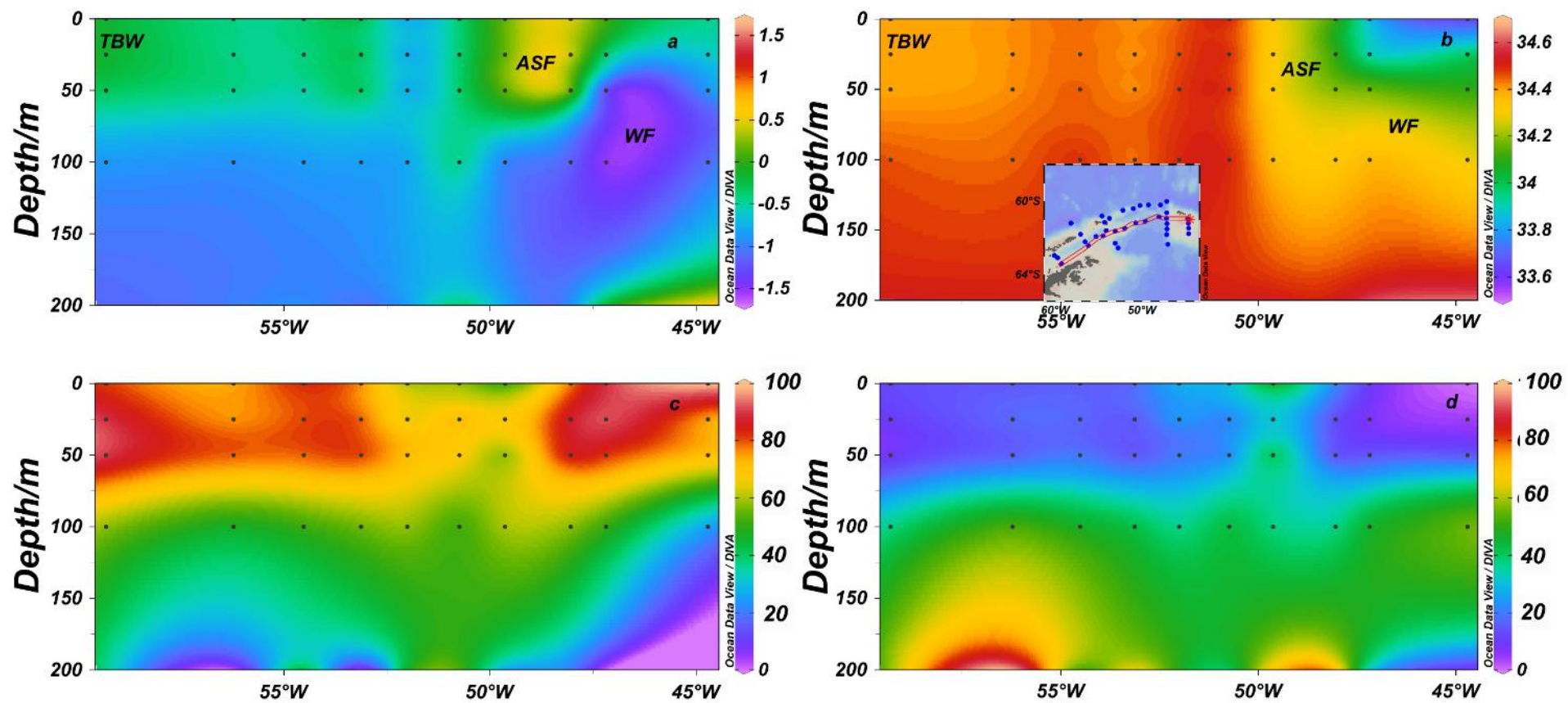


Fig. S7. The distributions of temperature (a), salinity (b), the percentage of diatoms (c) and *P. antarctica* (d) in Section L2. The location of Section L2 is shown in Plot b.