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Biogeochemical data of the 52nd Japanese Antarctic Research Expedition in austral summer of 2010–2011

Takahiro Iida[1, 2*], Tsuneo Odate[1, 2], Jun Nishioka[3], Tomomi Takamura[1, 2] and Mitsuo Fukuchi[1]

1) National Institute of Polar Research, Research Organization of Information and Systems, 10–3 Midori-cho, Tachikawa, Tokyo 190-8518.
2) The Graduate University for Advanced Studies, 10–3 Midori-cho, Tachikawa, Tokyo 190-8518.
3) Institute of Low Temperature Science, Hokkaido University, Kita-19, Nishi-8, Kita-ku, Sapporo, Hokkaido 060-0819.

*Corresponding author: Takahiro Iida. E-mail: iida@nipr.ac.jp

1. Introduction

This report presents biogeochemical data obtained by the 52nd Japanese Antarctic Research Expedition in the austral summer of 2010–2011. The data include measurements of the temperature, salinity and inorganic nutrient concentrations of seawater shallower than 500 m in the Southern Ocean.

2. Sampling

Sampling was carried out during the 52nd Japanese Antarctic Research Expedition (JARE) on Japan Maritime Self-Defense Force icebreaker *Shirase* in the Southern Ocean. Vertical water samples were obtained along north–south transects (40°S–64°S) at 110°E (December 2010) and 150°E (March 2011) (Fig. 1 and Table 1). Samples of sea surface water were collected, pumped from an inlet at the bottom of the ship (about 10 m below sea level).

Vertical profiles of temperature and salinity were collected using a conductivity-temperature-depth (CTD) probe (SBE 19 plus, Sea-Bird Electronics, Inc., USA) with a water sampler (SBE 55 ECO, Sea-Bird Electronics, Inc., USA) to depths of 500 m. For the CTD sensors, the pre-cruise calibration was performed although salinity data were not calibrated with the water sample measurements.

Seawater samples deeper than 20 m were collected by using a standard 4 L Niskin bottle (Sea-Bird Electronics, Inc., USA) at predefined depths of 20, 50, 75, 100, 200, and 400 m for

Sts. L1–L10. Seawater was sub-sampled into a 10 mL polyethylene screw cap vial for measuring inorganic nutrient concentrations. Nutrient samples were immediately put into a deep-freezer (–80°C) and stored during the cruise.

Sea surface water (0 m) was collected with a 5 L polyethylene bucket, and was sub-sampled in the same manner as Niskin bottle samples for nutrients analysis.

Surface seawater was pumped from an inlet at the bottom of the ship (about 10 m below sea level). Water temperatures were measured using a temperature probe (SBE 38, Sea-Bird Electronics, Inc., USA) at the inlet of the bottom of the ship. Water salinity was measured using a salinity probe (SBE 45, Sea-Bird Electronics, Inc., USA) in a pathway of sample water. Water samples were collected in the same manner as Niskin bottle samples for nutrients analysis.

3. Analysis

The frozen samples were transferred to deep freezer (–80°C) at an onshore laboratory at National Institute of Polar Research immediately after the cruise. Then, these samples were transported in frozen condition to Hokkaido University for nutrient analysis. The frozen samples were melted shortly before analysis at room temperature.

Nutrient concentrations (NO_3, NH_4, NO_2, PO_4 and SiO_2) were determined by an auto-analyzer system; QuAAtro2-HR system (BL-TEC K.K., Japan), according to the joint global ocean flux study (JGOFS) spectrophotometric method (IOC / UNESCO, 1994).

4. Results

1. Vertical profiles of temperature and salinity were shown in Fig. 2.
2. Temperature and salinity for each defined depth were shown in Tables 2-1 and 2-2.
3. Nutrient concentrations, temperature, and salinity of the bottle samples were shown in Tables 3-1 to 3-10.
4. Nutrient concentrations, temperature, and salinity of the surface seawater samples were shown in Tables 4-1 and 4-2.

Acknowledgements

We express heartfelt thanks to the crew of the Japan Maritime Self-Defense Force icebreaker *Shirase*.

References

IOC/UNESCO (1994): Protocols for the Joint Global Ocean Flux Study (JGOFS) core measurements. Paris, UNESCO, vi, 170 p. (JFOFS report, no. **19**; Manuals and guides (Intergovernmental Oceanographic Commission), no. **29**). http://hdl.handle.net/1834/2795.

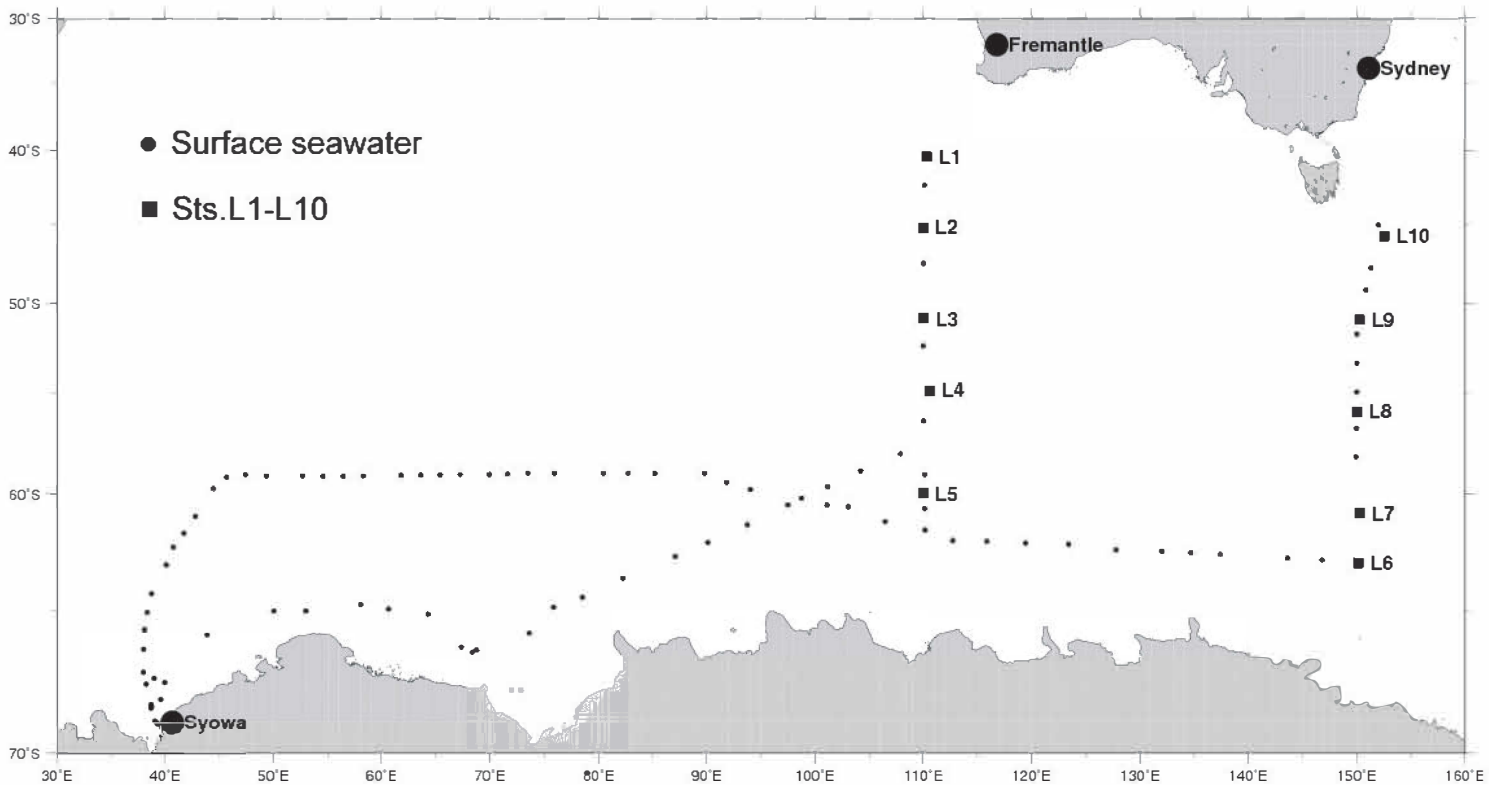

Fig 1. Location of the sampling station in the Southern Ocean in austral summer of 2010–2011.

Table 1. Sampling date, time, position, air temperature, wind speed and atmospheric pressure for each station.

Station	Date	Time (UTC)	Latitude (°S)	Longitude (°E)	Air temperature (°C)	Wind speed (m s^{-1})	Atmospheric pressure (hPa)
L1	2 December 2010	0:41	40°26.0′	110°11.6′	11.1	14.2	1016.6
L2	3 December 2010	0:53	45°12.1′	110°00.3′	10.7	7.7	1023.1
L3	4 December 2010	0:57	50°35.5′	110°00.9′	4.3	5.1	1024.1
L4	5 December 2010	0:57	54°53.5′	109°59.9′	2.5	3.0	1016.4
L5	6 December 2010	0:02	58°24.6′	110°00.3′	1.0	7.5	1006.1
L6	10 March 2011	20:01	63°02.7′	149°47.3′	2.6	10.2	988.2
L7	11 March 2011	6:11	60°53.3′	149°48.7′	3.6	12.9	998.9
L8	12 March 2011	7:05	55°58.5′	150°01.4′	6.2	13.5	998.4
L9	13 March 2011	5:02	50°57.7′	150°10.4′	9.4	9.2	1007.6
L10	14 March 2011	5:00	45°48.4′	151°58.1′	13.3	11.3	1023.5

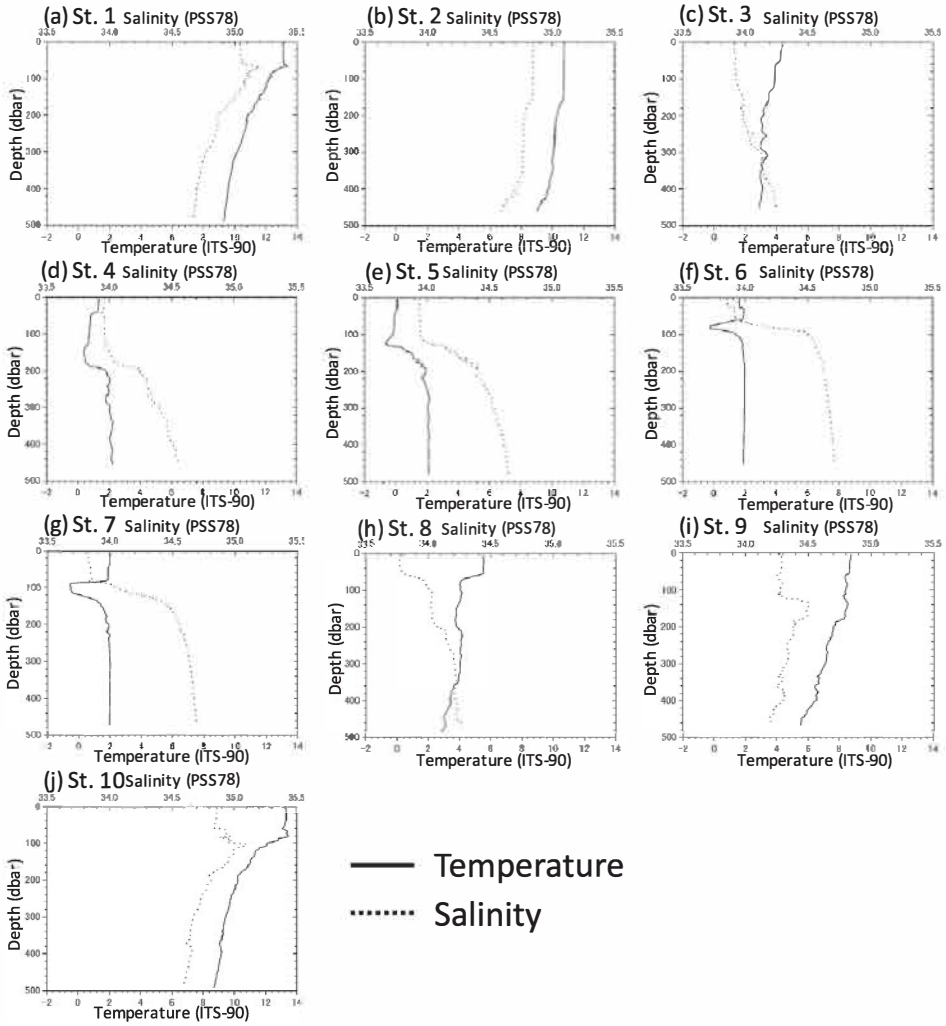

Fig. 2. Vertical profiles of temperature and salinity for each station.

Table 2-1. Temperature and salinity for Stn. L1–L5 in each depth.

L1			L2			L3			L4			L5		
Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)
10	13.1063	35.0448	10	10.7449	34.846	10	4.359	33.9178	10	1.3458	33.9613	10	0.0966	33.9445
20	13.1133	35.0444	20	10.7463	34.8456	20	4.3182	33.916	20	1.3099	33.9624	20	0.0904	33.9438
30	13.1265	35.0506	30	10.7455	34.8446	30	4.234	33.9183	30	1.3004	33.9591	30	0.083	33.9443
40	13.1074	35.0466	40	10.7425	34.8436	40	4.2139	33.9208	40	1.2001	33.9512	40	−0.011	33.9394
50	13.1586	35.0659	50	10.741	34.8435	50	4.1986	33.9245	50	0.8314	33.9558	50	−0.0732	33.9427
75	12.7584	35.1651	75	10.7403	34.8436	75	3.9195	33.9241	75	0.7873	33.9639	75	−0.0925	33.9458
100	12.1878	35.0906	100	10.7332	34.8425	100	3.9067	33.9294	100	0.7247	33.9676	100	−0.18	33.9495
125	12.0094	35.0743	125	10.729	34.8402	125	3.7911	33.9479	125	0.7001	33.9817	125	−0.682	34.0003
150	11.5849	34.9913	150	10.7218	34.8405	150	3.485	33.9794	150	0.3826	34.0028	150	1.0291	34.2222
175	11.2375	34.9387	175	10.4422	34.8027	175	3.3111	33.9761	175	0.4565	34.0414	175	1.313	34.3046
200	10.8489	34.8695	200	10.2724	34.7744	200	3.1916	33.9843	200	1.7835	34.2376	200	1.9047	34.4038
250	10.6016	34.8489	250	10.1468	34.7696	250	3.26	34.0618	250	1.9528	34.3177	250	2.0185	34.4826
300	10.1627	34.7833	300	10.0669	34.7615	300	3.3525	34.1328	300	2.0174	34.398	300	2.0605	34.5375
400	9.5719	34.6982	400	9.7367	34.711	400	3.0906	34.2154	400	2.1211	34.5105	400	2.0832	34.6165
488	9.2758	34.6655	460	9.0414	34.5905	451	2.9114	34.2546	455	2.2191	34.562	478	2.0874	34.6528

Table 2-2. Temperature and salinity for Stn. L6–L10 in each depth.

L6			L7			L8			L9			L10		
Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)	Depth (dbar)	Temp. (ITS-90)	Salinity (PSS78)
10	1.6205	33.853	10	1.9626	33.8287	10	5.5282	33.7731	10	8.7286	34.2886	10	13.308	34.862
20	1.6637	33.8659	20	1.9587	33.8281	20	5.5302	33.7689	20	8.6838	34.2892	20	13.312	34.8589
30	1.8889	33.924	30	1.9573	33.8291	30	5.5273	33.768	30	8.6559	34.2892	30	13.3113	34.8584
40	1.9107	33.9175	40	1.9283	33.831	40	5.508	33.7776	40	8.6472	34.2883	40	13.2897	34.8536
50	1.8878	33.9197	50	1.8511	33.846	50	5.5219	33.7894	50	8.6374	34.2836	50	13.2459	34.8456
75	−0.1919	34.0942	75	1.8454	33.8509	75	4.0917	33.9628	75	8.3815	34.2736	75	13.3413	34.9346
100	1.3842	34.4905	100	−0.5165	34.0568	100	4.0838	34.0145	100	8.4	34.2761	100	12.1538	34.9768
125	1.831	34.5626	125	0.327	34.2777	125	4.0689	34.0289	125	8.3343	34.3684	125	11.3276	34.9903
150	1.8686	34.59	150	1.4073	34.4579	150	3.7815	34.0243	150	8.4422	34.4988	150	11.0088	34.9488
175	1.9261	34.6141	175	1.768	34.5232	175	3.7381	34.0331	175	8.3211	34.4841	175	10.5532	34.856
200	1.9815	34.6318	200	1.8927	34.5621	200	3.8259	34.0705	200	7.6084	34.383	200	10.2153	34.8152
250	1.9564	34.6547	250	1.9198	34.6015	250	4.1011	34.159	250	7.2191	34.3351	250	9.7801	34.7402
300	1.9411	34.674	300	1.9711	34.6349	300	4.0402	34.2088	300	7.1168	34.3314	300	9.4283	34.6786
400	1.9059	34.7003	400	1.9681	34.6738	400	3.422	34.2243	400	6.4828	34.2933	400	9.1822	34.6595
450	1.8891	34.7119	471	1.9413	34.6946	485	2.8549	34.2644	467	5.5647	34.217	490	8.6915	34.5917

Table 3-1. Nutrient concentrations, temperature and salinity of the bottle samples at St. L1.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L1	0 (surface water)	4.10	0.47	0.13	0.43	0.56	12.950	ND
	20	3.88	0.52	0.12	0.49	0.57	13.115	35.045
	49	4.02	0.52	0.14	0.49	0.47	13.135	35.067
	74	5.01	0.50	0.47	0.57	1.18	12.819	35.158
	99	4.63	0.32	0.59	0.44	0.79	12.188	35.097
	197	10.46	0.12	0.18	0.88	2.10	10.883	34.860
	398	16.29	0.08	0.00	1.24	4.34	9.572	34.699

"ND" indicates the no data.

Table 3-2. Nutrient concentrations, temperature and salinity of the bottle samples at St. L2.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L2	0 (surface water)	10.36	0.21	0.24	0.80	2.86	10.750	ND
	20	11.70	0.09	0.29	0.99	3.72	10.746	34.845
	49	11.44	0.29	0.00	0.92	3.41	10.742	34.843
	74	10.00	0.18	0.24	0.84	2.94	10.740	34.844
	99	9.29	0.17	0.22	0.76	2.65	10.733	34.842
	198	13.98	0.08	0.04	1.09	4.37	10.306	34.779
	398	15.17	0.08	0.01	1.18	4.99	9.783	34.706

"ND" indicates the no data.

Table 3-3. Nutrient concentrations, temperature and salinity of the bottle samples at St. L3.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L3	0 (surface water)	26.34	0.31	0.29	2.04	11.35	4.400	ND
	20	24.25	0.73	0.35	1.85	10.29	4.324	33.916
	50	24.73	0.27	0.26	1.88	10.52	4.201	33.924
	73	23.85	0.39	0.23	1.81	10.07	3.918	33.924
	99	26.81	0.58	0.26	2.11	12.20	3.908	33.929
	198	26.11	0.13	0.15	1.95	17.95	3.223	33.987
	399	34.51	0.02	0.00	2.65	45.92	3.100	34.206

"ND" indicates the no data.

Table 3-4. Nutrient concentrations, temperature and salinity of the bottle samples at St. L4.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L4	0 (surface water)	27.55	0.27	0.28	1.94	27.55	1.700	ND
	20	31.64	0.25	0.34	2.45	34.67	1.310	33.962
	49	29.10	0.30	0.30	2.19	34.91	0.846	33.953
	74	28.57	0.37	0.29	2.19	35.07	0.788	33.964
	98	29.62	0.52	0.30	2.31	38.02	0.737	33.965
	199	30.38	0.03	0.02	2.26	51.72	1.763	34.230
	399	37.97	0.05	0.01	2.92	94.89	2.120	34.508

"ND" indicates the no data.

Table 3-5. Nutrient concentrations, temperature and salinity of the bottle samples at St. L5.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L5	0 (surface water)	30.31	0.39	0.29	2.09	34.60	0.700	ND
	20	28.32	0.19	0.29	2.14	34.84	0.511	33.968
	49	27.19	0.22	0.27	2.01	32.75	0.474	33.962
	74	30.46	0.31	0.31	2.33	37.97	0.445	33.964
	99	29.21	0.71	0.28	2.23	37.38	0.373	33.967
	198	37.71	0.00	0.02	2.92	84.82	1.336	34.301
	397	34.00	0.04	0.01	2.59	92.18	1.982	34.593

"ND" indicates the no data.

Table 3-6. Nutrient concentrations, temperature and salinity of the bottle samples at St. L6.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L6	0 (surface water)	21.61	0.62	0.42	1.51	13.38	1.65	ND
	20	22.32	0.59	0.43	1.58	13.62	1.66	33.87
	49	22.30	0.77	0.45	1.68	10.51	1.89	33.92
	74	27.29	2.10	0.31	2.34	51.55	0.04	34.01
	100	37.26	0.05	0.68	2.98	93.50	1.38	34.48
	199	0.00					1.98	34.63
	399	31.95	0.08	0.10	2.41	93.70	1.91	34.70

"ND" indicates the no data.

Table 3-7. Nutrient concentrations, temperature and salinity of the bottle samples at St. L7.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L7	0 (surface water)	21.95	0.51	0.53	1.54	12.07	2.070	ND
	20	22.01	0.49	0.56	1.54	12.09	1.958	33.829
	49	22.30	0.58	0.59	1.58	12.99	1.851	33.847
	74	22.15	0.62	0.62	1.56	13.00	1.844	33.848
	98	28.06	1.69	0.46	2.33	51.63	−0.544	34.057
	198	33.76	0.04	0.16	2.55	85.99	1.848	34.556
	398	32.35	0.11	0.15	2.45	92.60	1.971	34.674

"ND" indicates the no data.

Table 3-8. Nutrient concentrations, temperature and salinity of the bottle samples at St. L8.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L8	0 (surface water)	21.96	0.42	0.88	1.67	1.40	5.540	ND
	19	22.05	0.37	0.93	1.71	1.39	5.529	33.770
	49	24.06	0.42	1.09	1.90	2.26	5.519	33.787
	72	22.14	0.07	1.35	1.74	11.27	4.185	33.941
	98	25.46	0.09	0.26	1.93	14.12	4.046	34.015
	199	25.27	0.08	0.23	1.87	18.25	3.821	34.068
	397	28.55	0.08	0.25	2.12	33.86	3.390	34.222

"ND" indicates the no data.

Table 3-9. Nutrient concentrations, temperature and salinity of the bottle samples at St. L9.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L9	0 (surface water)	13.93	0.18	1.20	1.12	1.14	8.790	ND
	20	13.66	0.13	1.29	1.10	1.12	8.690	34.288
	50	13.51	0.15	1.43	1.10	1.09	8.638	34.284
	75	13.63	0.28	1.75	1.15	1.24	8.377	34.274
	99	13.26	0.26	2.06	1.15	1.27	8.402	34.278
	198	16.79	0.07	0.66	1.28	5.78	7.639	34.372
	398	22.12	0.08	0.77	1.68	12.04	6.556	34.311

"ND" indicates the no data.

Table 3-10. Nutrient concentrations, temperature and salinity of the bottle samples at St. L10.

Station	Collected depth (m)	Nutrient concentration (μ mol L^{-1})					Temperature (°C)	Salinity
		NO_3	NH_4	NO_2	PO_4	SiO_2		
L10	0 (surface water)	3.27	0.18	1.51	0.42	0.12	13.350	ND
	19	3.44	0.10	1.17	0.43	0.06	13.310	34.860
	49	3.76	0.10	1.00	0.44	0.02	13.244	34.847
	74	3.39	0.19	0.97	0.41	0.06	13.332	34.929
	97	8.19	0.08	0.59	0.69	1.51	12.499	34.940
	198	12.10	0.08	0.26	0.93	3.01	10.218	34.815
	399	16.50	0.09	0.23	1.22	5.16	9.187	34.661

"ND" indicates the no data.

Table 4-1. Sampling date, time, position, temperature, salinity, and nutrient concentration of the surface seawater during 2010.

Date & Time (GMT)	Latitude (deg)	Longitude (deg E)	Temp (deg C)	Salinity	Nutrient concentration (μM)				
					NO_3	NH_4	NO_2	PO_4	SiO_2
2010/12/2 11:56	42.23.3′	110.06.9′	11.4165	34.7347	10.09	0.32	0.20	0.80	2.98
2010/12/3 11:42	47.30.9′	110.00.5′	8.0644	34.2998	17.77	0.08	0.30	1.18	1.08
2010/12/4 11:53	52.25.8′	109.59.4′	2.9069	33.8805	31.15	0.30	0.35	2.10	20.54
2010/12/5 11:42	56.28.4′	110.00.0′	1.5396	33.8806	31.34	0.29	0.34	2.10	25.01
2010/12/7 11:56	61.16.5′	106.28.7′	−0.7621	33.6093	29.33	0.10	0.26	1.98	38.96
2010/12/7 23:28	60.36.5′	103.35.8′	−0.6765	33.9234	30.64	0.14	0.29	1.97	43.14
2010/12/8 5:15	60.31.8′	101.05.9′	−1.0192	33.8708	29.83	0.15	0.22	2.00	54.90
2010/12/8 11:26	60.13.1′	98.44.0′	−0.7783	33.9095	32.72	0.20	0.28	2.21	56.85
2010/12/8 23:11	59.48.8′	94.12.2′	0.2678	33.8597	33.99	0.14	0.36	2.25	36.88
2010/12/9 5:28	59.29.1′	91.47.7′	0.4244	33.8646	29.68	0.11	0.29	1.93	30.87
2010/12/9 11:38	59.03.0′	89.47.4′	−0.321	33.8414	32.09	0.07	0.29	2.09	50.24
2010/12/9 23:37	59.03.8′	85.11.8′	−0.49	33.8909	30.76	0.00	0.18	2.01	62.30
2010/12/10 6:11	59.03.0′	82.45.8′	−0.6811	33.8643	28.48	0.04	0.21	1.85	53.43
2010/12/10 12:36	59.03.4′	80.27.4′	−0.4939	33.7924	29.32	0.02	0.22	2.02	52.52
2010/12/11 0:46	59.03.1′	75.54.0′	−0.5817	33.8269	35.67	0.08	0.32	2.48	62.66
2010/12/11 7:16	59.03.1′	73.29.4′	0.0645	33.7055	29.24	0.01	0.21	2.03	42.35
2010/12/11 12:15	59.05.0′	71.34.9′	−0.2903	33.677	32.43	0.05	0.29	2.23	46.55
2010/12/11 16:56	59.06.7′	69.56.8′	−0.3811	33.7043	29.24 ND		0.16	2.00	44.65
2010/12/12 0:40	59.06.7′	67.14.0′	−0.4539	33.6878	28.31 ND		0.19	1.93	43.53
2010/12/12 6:11	59.07.8′	65.18.9′	−0.3168	33.6378	27.89 ND		0.11	1.89	43.17
2010/12/12 11:02	59.08.3′	63.34.8′	0.1632	33.7673	27.26	0.01	0.22	1.85	38.32
2010/12/12 16:05	59.08.8′	61.46.5′	−0.2425	33.7344	27.45 ND		0.21	1.83	42.36
2010/12/13 2:02	59.10.0′	58.16.8′	−0.3037	33.7606	27.52	0.00	0.21	1.84	42.15
2010/12/13 7:04	59.11.3′	56.25.6′	−0.5594	33.6949	26.22 ND		0.13	1.78	44.52
2010/12/13 12:08	59.11.6′	54.31.8′	−0.6188	33.7025	26.84 ND		0.20	1.83	46.94
2010/12/13 17:00	59.10.5′	52.41.7′	−0.5948	33.604	27.03 ND		0.23	1.85	44.30
2010/12/14 1:49	59.10.6′	49.20.0′	−0.8469	33.4942	25.78 ND		0.19	1.73	42.98
2010/12/14 7:08	59.06.4′	47.24.6′	−1.1156	33.5438	32.34	0.00	0.35	2.26	59.23
2010/12/14 12:08	59.15.4′	45.41.3′	−0.7914	33.3341	32.20 ND		0.26	2.21	54.90
2010/12/14 17:18	59.45.8′	44.28.8′	−1.6012	33.5758	29.06	0.17	0.34	2.02	54.99
2010/12/15 3:08	61.02.3′	42.46.8′	−1.5373	33.6209	27.15	0.12	0.34	1.82	51.67
2010/12/15 8:56	61.47.0′	41.42.8′	−1.5435	33.593	27.20	0.04	0.32	1.79	51.32
2010/12/15 13:37	62.23.0′	40.45.5′	−1.5446	33.696	27.49	0.07	0.33	1.83	55.77
2010/12/15 18:41	63.08.5′	40.05.1′	−1.6158	33.7312	27.42	0.05	0.29	1.85	55.86
2010/12/16 2:41	64.19.1′	38.44.4′	−1.3379	33.8791	28.15	0.23	0.35	1.86	59.45
2010/12/16 7:43	65.03.7′	38.20.2′	−1.7822	33.9464	29.35	0.04	0.23	1.98	64.72
2010/12/16 12:51	65.43.0′	38.05.4′	−1.7617	34.0513	30.57	0.03	0.22	2.06	67.36
2010/12/16 17:54	66.28.6′	38.00.8′	−1.7861	34.1025	30.79	0.03	0.23	2.11	68.85
2010/12/17 7:17	67.17.7′	37.59.6′	−1.8047	34.167	33.34	0.06	0.17	2.37	79.92
2010/12/17 15:49	67.30.4′	38.59.4′	−1.8429	34.145	38.76	0.09	0.23	2.80	96.67
2010/12/18 10:22	67.39.5′	39.58.0′	−1.765	33.9778	31.05	0.04	0.15	2.06	72.30
2010/12/18 17:33	68.14.1′	39.35.3′	−1.5218	34.1509	30.27 ND		0.08	2.08	65.33
2010/12/19 9:10	68.24.4′	38.43.3′	−1.6877	33.9024	30.19 ND		0.04	2.07	66.32
2010/12/22 7:00	68.57.3′	39.03.4′	−1.8099	33.9335	30.40	0.15	0.00	2.08	73.36
2010/12/24 6:34	68.57.7′	39.05.3′	−1.7904	33.9489	30.44	0.00	0.00	2.07	70.77
2010/12/28 5:17	69.00.6′	39.14.1′	−1.7648	33.9305	29.42 ND		0.02	2.00	70.31
2010/12/29 17:56	69.02.0′	39.17.2′	−1.7769	33.9273	29.99	0.01	0.04	2.02	72.35

Table 4-2. Sampling date, time, position, temperature, salinity, and nutrient concentration of the surface seawater during 2011.

Date & Time (GMT)	Latitude (deg)	Longitude (deg E)	Temp (deg C)	Salinity	Nutrient concentration (μ M)				
					NO_3	NH_4	NO_2	PO_4	SiO_2
2011/2/9 14:51	69.03.1′	39.20.6′	−0.4614	32.9966	29.59	0.12	0.05	2.04	73.77
2011/2/20 11:00	68.26.6′	38.43.2′	−1.5235	33.9178	29.05	0.28	0.13	2.01	64.66
2011/2/21 9:49	68.28.8′	38.45.4′	−1.751	33.7851	29.68	0.17	0.12	2.06	64.61
2011/2/23 19:15	67.42.5′	38.14.9′	−1.3231	33.6596	29.35	0.46	0.16	2.04	69.47
2011/2/24 19:50	65.56.6′	43.51.9′	−0.5262	33.7659	27.47	0.22	0.13	1.90	64.87
2011/2/25 9:23	65.00.1′	50.01.6′	−0.6611	33.6468	27.20	0.09	0.17	1.82	58.09
2011/2/25 15:46	64.59.5′	52.59.1′	−0.9576	33.5569	26.25	0.21	0.18	1.76	53.65
2011/2/26 2:30	64.44.4′	58.03.1′	−1.3922	33.0062	28.85	0.69	0.24	2.01	61.64
2011/2/26 8:01	64.55.5′	60.38.6′	−1.5099	33.085	26.83	0.59	0.21	1.85	56.34
2011/2/26 15:03	65.07.8′	64.15.9′	0.0551	33.7394	27.58	0.38	0.23	1.84	55.21
2011/2/27 2:53	66.22.4′	67.20.7′	−1.6382	33.3239	25.75	0.53	0.19	1.68	41.29
2011/2/27 15:24	66.33.7′	68.24.8′	−1.1836	33.5227	26.18	0.24	0.21	1.62	45.91
2011/2/28 15:40	66.30.0′	68.47.0′	−1.2194	33.5417	26.17	0.15	0.20	1.62	46.06
2011/3/1 1:36	67.55.2′	71.57.37′	−1.5845	34.1293	21.47	1.75	0.21	1.63	40.86
2011/3/1 7:36	67.55.2′	72.49.7′	−1.4632	34.0299	20.32	1.99	0.18	1.55	36.49
2011/3/1 16:14	65.51.2′	73.35.8′	−1.5833	33.1319	23.51	0.20	0.16	1.25	44.35
2011/3/2 1:37	64.51.2′	75.50.6′	−0.1399	33.522	23.69	0.21	0.17	1.44	39.62
2011/3/2 7:45	64.28.0′	78.30.4′	−0.0801	33.5906	23.01	0.52	0.17	1.53	36.07
2011/3/2 15:42	63.41.6′	82.15.1′	−0.1038	33.3786	20.55	0.29	0.17	1.27	27.40
2011/3/3 1:36	62.47.0′	87.04.8′	−0.1337	33.6131	22.36	0.73	0.16	1.46	34.49
2011/3/3 7:57	62.11.3′	90.05.9′	0.6125	33.6844	23.92	0.75	0.19	1.60	34.43
2011/3/3 15:35	61.24.7′	93.44.8′	0.9698	33.7788	24.76	0.80	0.21	1.70	33.48
2011/3/3 23:41	60.31.3′	97.29.7′	0.8186	33.7782	24.69	0.79	0.19	1.73	38.29
2011/3/4 7:36	59.41.0′	101.09.9′	1.4478	33.8249	25.43	0.73	0.26	1.72	24.73
2011/3/4 14:18	58.56.1′	104.12.2′	1.7154	33.8755	25.92	0.57	0.29	1.77	22.44
2011/3/4 23:38	58.06.6′	107.53.8′	1.9243	33.8823	25.92	0.65	0.30	1.72	19.87
2011/3/5 14:05	59.06.4′	110.08.0′	1.9374	33.8576	26.18	0.45	0.28	1.74	16.87
2011/3/6 5:44	60.40.5′	110.05.2′	1.8275	33.8561	26.10	0.39	0.27	1.81	17.17
2011/3/6 14:39	61.38.6′	110.10.0′	0.8522	33.659	22.47	0.46	0.30	1.51	22.16
2011/3/7 7:37	62.05.9′	112.42.5′	1.3431	33.7546	24.36	0.25	0.26	1.60	19.15
2011/3/7 13:36	62.08.3′	115.52.1′	1.1984	33.6908	23.34	0.14	0.25	1.52	21.16
2011/3/7 20:47	62.12.7′	119.26.4′	1.2086	33.7129	23.48	0.18	0.26	1.54	19.87
2011/3/8 4:52	62.16.0′	123.26.2′	1.1126	33.6924	24.53	0.26	0.25	1.66	17.69
2011/3/8 13:43	62.29.7′	127.47.8′	1.2311	33.7279	25.06	0.54	0.27	1.71	19.68
2011/3/8 22:29	62.33.7′	132.01.2′	1.5593	33.7691	25.54	0.58	0.28	1.75	16.57
2011/3/9 4:45	62.36.8′	134.41.4′	1.5033	33.7719	25.60	0.58	0.29	1.74	17.40
2011/3/9 11:18	62.42.0′	137.25.5′	1.782	33.7433	24.59	0.51	0.28	1.62	14.49
2011/3/10 3:42	62.50.7′	143.36.5′	1.718	33.8479	25.90	0.35	0.27	1.65	11.95
2011/3/10 11:15	62.55.9′	146.47.9′	2.0756	33.8017	26.31	0.43	0.29	1.77	16.71
2011/3/11 19:41	58.14.7′	149.55.4′	4.3745	33.7068	25.25	0.37	0.31	1.71	3.94
2011/3/12 2:32	56.51.2′	150.00.4′	3.3965	33.7779	26.47	0.34	0.28	1.78	15.06
2011/3/12 14:15	54.57.4′	150.01.0′	6.0726	33.8018	22.92	0.20	0.30	1.57	3.44
2011/3/12 19:56	53.24.1′	150.01.3′	6.0116	33.7587	23.11	0.26	0.29	1.57	2.01
2011/3/13 1:58	51.45.7′	150.02.2′	8.4867	34.1011	16.90	0.12	0.25	1.18	1.12
2011/3/13 13:55	49.10.0′	150.49.8′	11.546	34.5706	8.82	0.00	0.19	0.69	0.54
2011/3/13 19:54	47.47.6′	151.18.9′	11.8719	34.5901	7.93	0.01	0.19	0.63	0.23
2011/3/14 10:30	45.04.9′	152.00.0′	14.5534	35.0162	2.00	ND	0.10	0.27	0.04