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RADIATIVELY IMPORTANT TRACE SPECIES (RITS) 1990: TROPICAL PACIFIC OZONE MINIMUM EXPEDITION NUTRIENT, CHLOROPHYLL-A, AND PRIMARY PRODUCTIVITY DATA NOAA SHIP MALCOLM BALDRIGE, 3 JANUARY-18 FEBRUARY 1990

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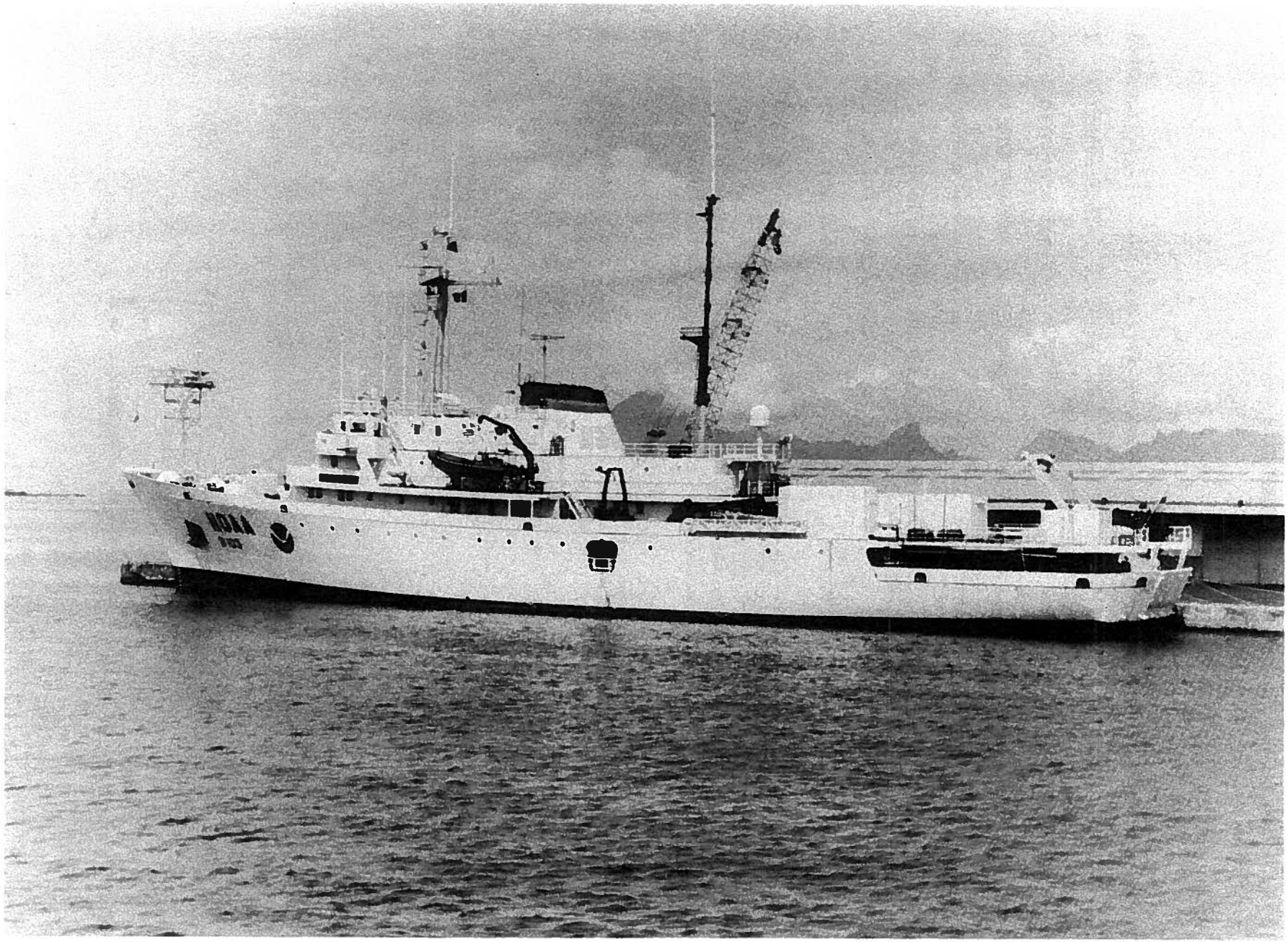

NOAA Ship MALCOLM BALDRIGE (R-103)

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During the period of 3 January-18 February 1990, a multi-faceted oceanographic research cruise called the RITS 1990 Tropical Pacific Ozone Minimum Expedition was made on the NOAA Ship MALCOLM BALDRIGE in the equatorial Pacific Ocean. The objective of the cruise was to study processes controlling radiatively important trace species in the region of the tropical Pacific ozone minimum in the central equatorial Pacific Ocean. Measurements from hydrocasts for nutrients, phytoplankton biomass, and primary productivity were made during this period. This report represents the hydrographic, nutrient, and biological data from this cruise.

Key words: productivity, chlorophyll, nutrients.

1. INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) Radiatively Important Trace Species (RITS) program objective is to understand the influence of oceanic chemical processes on the radiation balance of the Earth. The RITS 1990 Tropical Pacific Ozone Minimum Expedition (3 January-18 February 1990) was designed to study processes controlling radiatively important trace species in the boundary layer of the central equatorial Pacific Ocean.

The expedition was conducted aboard the NOAA Ship MALCOLM BALDRIGE in two consecutive legs (Figure 1). The objective of Leg I (Miami, Florida-Papeete, Tahiti) was to continuously obtain atmospheric samples while in transit. Stations were occupied every four days while in transit to perform CTD and bottle casts. Nutrient, chlorophyll, primary productivity and mercury profiles of the water column were made at these stations.

The objective of Leg II (Papeete, Tahiti-Pago Pago, American Samoa) was to maintain continuous air sampling, as well as occupy a hydrographic station approximately every day. Hydrographic stations included a CTD cast, and/or a Gó-Flo bottle cast, and a submarine photometer cast. An expandable bathy-thermograph (XBT) was released to provide temperature profiles at stations where only Go-Flo bottle casts were performed.

This report contains all available consecutive hydrographic, nutrient, chlorophyll-a, and primary productivity data from the Tropical Pacific Ozone Minimum Expedition, corresponding to cast, date, and station position.

2. INSTRUMENTATION

A. CTD System

The conductivity, temperature and depth (CTD) system consisted of a Mark III CTD manufactured by EG&G Ocean Products (formerly Neil Brown

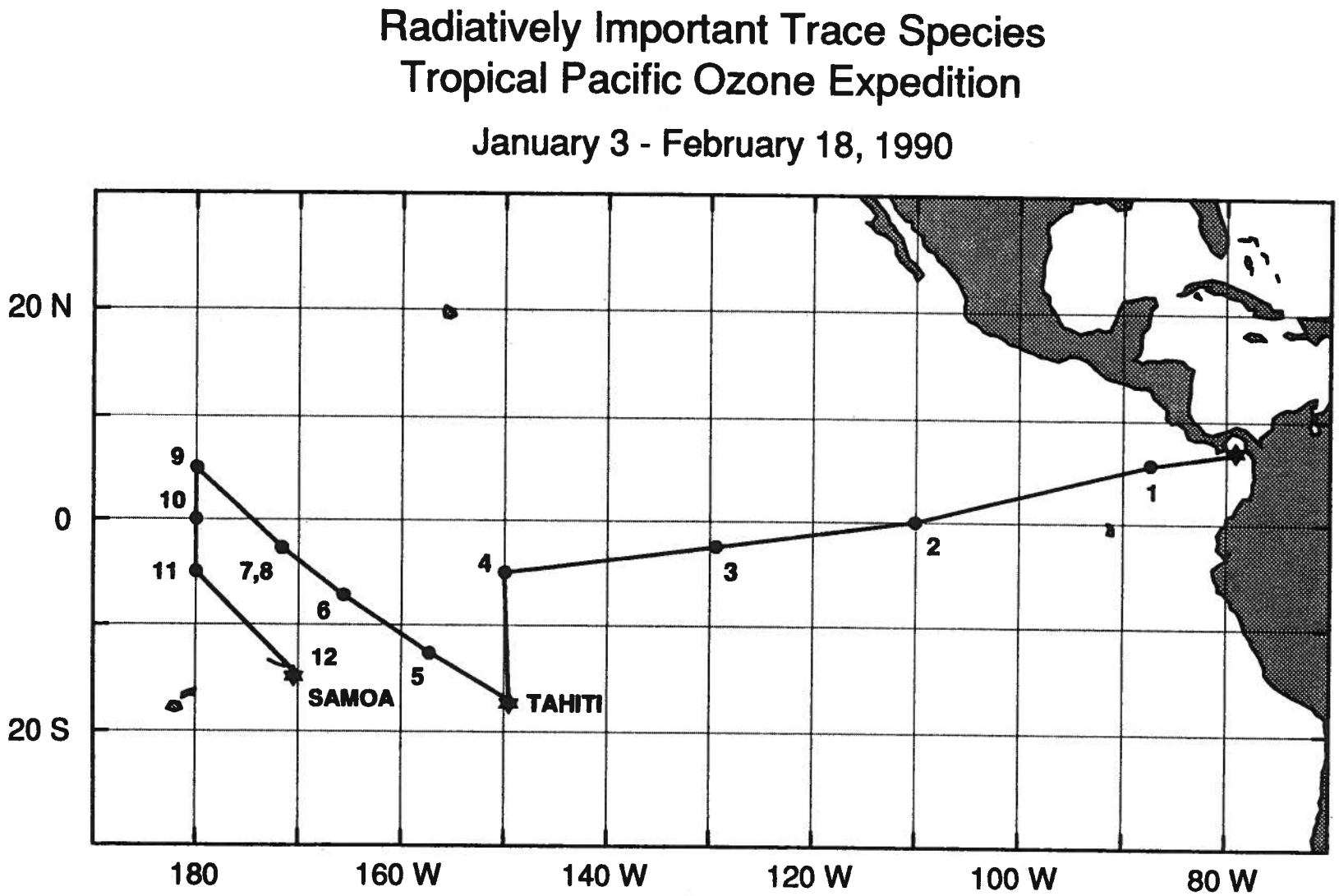

Figure 1. NOAA Ship MALCOLM BALDRIGE cruise track and station locations.

Instrument Systems Corp.), a General Oceanics Corp. rosette water sampling system, and a Micro-VAX based shipboard data acquisition system. As the CTD is lowered from the ship, it continuously transmits conductivity, temperature and pressure data up the cable where it is logged on 9-track magnetic tape by the computer. Measurements of all parameters are made 31.5 times per second to a resolution of 16 bits. The dissolved oxygen sensor, which is usually installed, was not operable during this expedition. Table 1 summarizes the standard ranges and resolutions.

Table 1

Variable	Range	Accuracy	Resolution
Pressure	0-6500 decibar	6.5 decibar	.1 decibar
Temperature	-32 to +32°C	.005°C (-3 to +32)	.0005°C
Conductivity	0-65 mmho	.005 mmho	.001 mmho
Dissolved Oxygen	0-2	.002	.0005

Following the cast, computer programs are run to edit and remove any bad data points (Mangum et al., 1980), compensate for sensor response time lags (Horne and Toole, 1980), and condense the data into 1-m depth averages. Additional programs are then available to print our high-resolution data as necessary.

Physical oceanographic parameters such as pressure, conductivity and temperature data used in this report are taken directly from the CTD casts. At several productivity stations temperature profiles were obtained from XBT drops.

3. NUTRIENTS

A. Data Collection and Field Operations

Data from both legs of this cruise are reported (Leg I: January 3-January 26, 1990; Leg II: January 29-February 18, 1990). During each leg, except casts 1 through 3, pressure, temperature, and salinity were measured at each station by means of a Neil Brown Instrument Mark III CTD equipped with a rosette multi-sampler rigged with standard 2.8 l Niskin bottles. Casts GF1 to GF6, GF8 and GF26 samples were obtained by oceanographic wire casts with 10 l Go-Flo Niskin bottles. Water samples with the rosette multi-sampler were collected at specified temperatures and depths chosen to sample maximum and minimum physical, chemical and biological properties of the water column. These were analyzed for salinity, dissolved oxygen, and inorganic nutrient concentrations. Seawater samples for dissolved oxygen were drawn first in order to minimize atmospheric contamination and temperature-induced changes.

These samples were collected in 250 ml amber bottles with ground glass stoppers and preserved with manganous sulfate and alkaline iodide reagents and were subsequently analyzed onboard ship using the modified Winkler titration method of Strickland and Parsons (1968). Nutrient samples were collected in aged 60 ml linear polyethylene bottles and analyzed for dissolved inorganic nitrate (NO_3^--N), nitrite (NO_2^--N), orthophosphate (PO_4^{-3}-P), silicate (SiO_4^{-2}-Si), and ammonium (NH_4^+-N). Analysis was performed only on specified CTD casts with a five-channel Technicon Auto-Analyzer (AA-II) aboard ship.

B. Nutrient Sample Analyses

The analytical procedures and methodologies used in the analysis of nitrate and nitrite are described by Armstrong et al. (1967). Essentially, the orthophosphate is the procedure described by Grasshoff (1965) and the silicate procedure is described by Strickland and Parsons (1968). These methodologies have been slightly modified by Technicon Corp. in order to adapt them properly to the auto-analyzer system used in these analyses as follows: nitrate and nitrite in water and seawater, Technicon Corporation (1977), nitrite in water and seawater, Technicon Corporation (1976), silicates in water and seawater (1977), and ammonium in water and seawater (1978).

The detection limits, standard deviation and coefficient of variation is given below in Table 2.

Table 2: Nutrient auto-analyzer performance characteristics.

Nutrient	Detection Limits (µg-at/L)	Standard Deviation (µg-at/L)	Coefficient of Variation (95% confidence level)
PO_4^{3-} -P	0.05	±0.06	1.9% at 2.0 µg-at/L
NO_3^- -N	0.4	±0.4	0.6% at 2.5 µg-at/L
NO_2^- -N	0.1	±0.05	0.95% at 1.0 µg-at/L
SiO_4^{2-} -Si	0.4	±0.4	1.0% at 25.0 µg-at/L
NH_4^+ -N	0.2	±0.3	0.31% at 8.0 µg-at/L

C. Station Data

See the following pages for station data.

NUTRIENT DATA

CRUISE: MB-RITS90 - LEG I

STATION: 1 CAST: GF-1 DATE(Z): 01/10/90 TIME(Z): 1542 POSITION: 5 39.7 N 87 33.7 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0001	24	< 0.40	< 0.10	< 0.40	< 0.05	999.99	7.21	99.99	99.999	T,S,NH4: N/A
0002	44	< 0.40	< 0.10	< 0.40	< 0.05	999.99	4.93	99.99	99.999	
0003	300	37.60	< 0.10	14.60	0.48	999.99	0.89	99.99	99.999	NO3;1:3 DIL
0005	700	38.84	< 0.10	30.75	2.85	999.99	0.40	99.99	99.999	NO3,PO4,SIO3;1:3DIL

STATION: 1 CAST: GF-2 DATE(Z): 01/10/90 TIME(Z): 1657 POSITION: 5 39.7 N 87 33.7 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0006	27	< 0.40	< 0.10	< 0.40	< 0.05	999.99	5.42	99.99	99.999	T,S,NH4: N/A
0007	110	3.13	< 0.10	0.67	0.17	999.99	6.03	99.99	99.999	T,S,NH4: N/A
0008	500	37.66	< 0.10	31.05	2.86	999.99	0.36	99.99	99.999	NO3,PO4,SIO3;1:3DIL

STATION: 2 CAST: GF-3 DATE(Z): 01/15/90 TIME(Z): 0035 POSITION: 0 1.8 N 110 4.5 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0010	300	25.14	< 0.10	16.05	1.65	999.99	2.14	99.99	99.999	T,S,NH4: N/A
0011	500	35.93	< 0.10	27.50	2.32	999.99	0.41	99.99	99.999	NO3;1:3DIL
0012	700	39.73	< 0.10	49.69	2.53	999.99	1.12	99.99	99.999	NO3,SIO3;1:3DIL

NUTRIENT DATA

CRUISE: MB-RITS90 - LEG I

STATION: 2 CAST: GF-4 DATE(Z): 01/15/90 TIME(Z): 0131 POSITION: 0 1.8 N 110 4.5 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0013	20	8.41	0.35	3.95	0.69	999.99	5.02	99.99	99.999	T,S,NH4
0014	40	8.96	0.36	4.32	0.70	999.99	4.51	99.99	99.999	NOT TAKEN
0016	150	28.26	< 0.10	15.15	1.32	999.99	2.80	99.99	99.999	

STATION: 3 CAST: GF-5 DATE(Z): 01/18/90 TIME(Z): 1640 POSITION: 2 27.4 S 129 30.2 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0017	100	6.02	0.31	< 0.40	0.65	999.99	5.22	99.99	99.999	T,S,NH4: N/A
0018	250	30.19	< 0.10	22.35	2.57	999.99	0.64	99.99	99.999	NO3;1:3 DIL
0019	400	28.19	0.13	22.16	2.40	999.99	1.80	99.99	99.999	T,S,NH4: N/A
0020	700	37.23	< 0.10	55.42	3.11	999.99	1.84	99.99	99.999	NO3,PO4,SIO3;1:3DIL

STATION: 3 CAST: GF-6 DATE(Z): 01/18/90 TIME(Z): 1748 POSITION: 2 27.4 S 129 30.2 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0021	10	6.38	0.36	< 0.40	0.66	999.99	5.64	99.99	99.999	T,S,NH4
0022	20	6.04	0.34	< 0.40	0.62	999.99	5.13	99.99	99.999	NOT TAKEN
0023	30	6.20	0.33	< 0.40	0.63	999.99	5.13	99.99	99.999	
0024	40	6.31	0.34	0.49	0.64	999.99	5.12	99.99	99.999	
0025	60	6.20	0.33	< 0.40	0.82	999.99	5.13	99.99	99.999	
0026	150	30.29	0.74	5.75	1.43	999.99	3.02	99.99	99.999	NO3;1:3DIL

NUTRIENT DATA

CRUISE: MB-RITS90 - LEG I

STATION: 4 CAST: 1 DATE(Z): 01/22/90 TIME(Z): 0548 POSITION: 4 59.5 S 150 0.4 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0027	0	5.32	0.15	2.09	0.64	999.99	5.97	26.72	35.639	NH4 NOT
0028	20	5.31	0.13	2.75	0.50	999.99	5.66	27.12	35.639	TAKEN
0029	30	5.33	0.14	2.64	0.47	999.99	5.50	27.06	35.639	
0030	50	5.44	0.15	2.90	2.00	999.99	5.55	27.05	35.640	T & S FROM
0031	70	5.49	0.13	2.35	0.80	999.99	5.69	27.05	35.639	CTD CAST
0032	100	6.84	0.20	3.84	0.53	999.99	5.33	26.87	35.607	
0033	175	6.87	0.52	3.20	0.56	999.99	4.24	21.78	35.961	
0034	250	27.95	< 0.10	15.79	1.47	999.99	1.00	12.37	34.899	
0035	350	35.58	< 0.10	31.37	2.18	999.99	1.35	10.43	34.803	NO3;1:3DIL
0036	500	42.25	< 0.10	42.45	1.84	999.99	1.22	8.10	34.666	NO3,SIO3;1:3DIL
0037	700	43.24	< 0.10	53.36	2.05	999.99	1.62	6.41	34.587	NO3,SIO3;1:3DIL
0038	900	43.98	< 0.10	70.07	1.93	999.99	2.51	4.89	34.570	NO3,SIO3;1:3DIL

STATION: 4 CAST: GF-8 DATE(Z): 01/22/90 TIME(Z): 2241 POSITION: 5 1.7 S 149 34.9 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0043	350	36.32	< 0.10	24.76	1.59	999.99	1.00	99.99	99.999	NO3;1:3DIL
0044	500	40.77	< 0.10	31.43	1.75	999.99	1.25	99.99	99.999	NO3;1:3DIL
0045	700	44.48	< 0.10	48.93	1.97	999.99	1.69	99.99	99.999	NO3,SIO3;1:3DIL
0046	900	41.76	< 0.10	70.58	1.59	999.99	2.45	99.99	99.999	NO3,SIO3;1:3DIL

NUTRIENT DATA

CRUISE: MB-RITS90 - LEG I

STATION: 4 CAST: 2 DATE(Z): 01/23/90 TIME(Z): 0037 POSITION: 5 1.7 S 149 34.9 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0047	0	5.86	0.19	2.09	0.48	< 0.20	5.79	30.19	35.536	T & S FROM
0048	10	6.00	0.18	1.66	0.36	< 0.20	5.74	27.06	35.536	CTD CAST
0049	20	5.87	0.18	2.13	0.35	0.45	5.70	26.91	35.561	
0050	30	5.69	0.18	1.62	0.36	0.28	5.69	26.89	35.566	PROBABLE NH4
0051	50	5.81	0.18	1.75	0.42	< 0.20	5.69	26.89	35.576	CONTAMINATION
0052	70	5.80	0.19	2.13	0.37	0.21	5.66	26.91	35.587	
0053	100	5.75	0.18	1.75	0.39	0.91	5.59	26.99	35.630	
0054	150	7.14	0.52	2.73	0.47	< 0.20	5.42	25.15	35.651	
0055	175	5.92	0.88	1.41	0.40	0.47	4.48	22.93	36.105	
0056	250	27.49	< 0.10	14.06	1.24	0.18	1.25	13.40	35.010	
0057	350	33.92	< 0.10	25.40	1.46	0.90	1.04	10.05	34.774	
0058	450	36.26	< 0.10	29.71	1.71	0.95	1.04	8.74	36.696	

NUTRIENT DATA

CRUISE: MB-RITS90 - LEG II

STATION: 5 CAST: 3 DATE(Z): 01/31/90 TIME(Z): 1923 POSITION: 12 38.5 S 157 19.1 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0059	0	< 0.40	< 0.10	< 0.40	0.29	999.99	999.99	29.05	35.736	T & S FROM
0060	10	< 0.40	< 0.10	< 0.40	0.45	999.99	6.31	28.49	35.736	CTD CAST
0061	20	< 0.40	< 0.10	< 0.40	0.22	999.99	6.20	28.49	35.740	
0062	30	< 0.40	< 0.10	< 0.40	0.21	999.99	6.27	28.49	35.748	SAMPLE 71, T & S
0063	50	< 0.40	< 0.10	< 0.40	0.30	999.99	6.26	28.49	35.823	NOT TAKEN
0064	70	< 0.40	< 0.10	0.50	0.23	0.34	6.48	27.90	36.229	
0065	90	< 0.40	< 0.10	0.73	0.26	0.20	6.33	27.15	36.262	O2 CALIBRATION
0066	100	< 0.40	< 0.10	0.44	0.25	< 0.20	6.19	26.72	36.320	PROBLEMS
0067	150	1.57	1.18	0.67	0.51	0.25	5.59	24.57	36.458	
0068	300	11.69	0.14	3.57	1.16	0.31	4.31	16.59	35.304	
0069	400	26.47	< 0.10	18.08	2.10	0.31	3.40	10.14	34.678	
0070	500	29.13	< 0.10	25.16	2.66	0.33	4.63	7.70	34.558	
0071	800	34.90	< 0.10	48.82	2.63	< 0.20	4.45	99.99	99.999	SIO3 - 1:1 DIL.

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NUTRIENT DATA

CRUISE: MB-RITS90 - LEG II

STATION: 6 CAST: 4 DATE(Z): 02/02/90 TIME(Z): 1959 POSITION: 7 9.5 S 165 41.7 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0072	0	0.44	< 0.10	< 0.40	0.22	< 0.20	6.90	32.11	35.527	T & S FROM CTD CAST
0073	10	0.50	< 0.10	< 0.40	0.22	< 0.20	6.70	28.80	35.527	NO2;1:1 DILUTION
0074	20	0.63	< 0.10	< 0.40	0.26	< 0.20	6.79	28.80	35.554	
0075	40	0.74	0.21	< 0.40	0.30	< 0.20	6.58	28.68	35.616	O2 CALIBRATION
0076	60	1.05	0.28	0.40	0.40	< 0.20	6.55	28.54	35.684	PROBLEMS
0077	80	1.30	0.28	0.40	0.40	< 0.20	6.59	28.47	35.713	
0078	100	1.79	1.32	0.44	0.57	0.20	6.28	28.04	35.753	
0079	120	1.99	2.83	< 0.40	0.57	< 0.20	5.84	26.79	35.870	
0080	150	5.46	0.56	< 0.40	0.78	0.37	5.78	25.45	36.113	

STATION: 7 CAST: 5 DATE(Z): 02/04/90 TIME(Z): 0942 POSITION: 2 39.4 S 171 40.3 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0088	0	2.60	0.14	< 0.40	0.39	0.40	6.78	28.18	35.215	CTD CAST
0089	20	3.14	0.20	< 0.40	0.68	999.99	6.75	28.09	35.215	
0090	50	2.99	0.20	< 0.40	0.57	999.99	6.70	28.01	35.269	O2 CALIBRATION
0091	75	2.52	< 0.10	< 0.40	0.39	999.99	999.99	27.94	35.386	PROBLEMS
0092	100	2.47	0.50	< 0.40	0.44	999.99	6.40	27.97	35.450	
0094	140	12.76	< 0.10	0.80	1.15	0.74	4.22	28.19	35.612	PROBABLE NH4
0095	160	20.10	< 0.10	14.20	2.20	999.99	3.16	27.39	35.611	CONTAMINATION
0097	300	28.05	< 0.10	16.80	1.79	0.38	3.42	10.68	34.791	
0098	400	28.05	< 0.10	18.68	1.98	0.42	3.45	10.37	34.776	
0099	500	20.70	< 0.10	13.78	2.01	999.99	3.26	8.91	34.694	
0087	800	39.14	0.10	40.94	2.80	< 0.20	2.69	99.99	99.999	SIO3;1:1DIL

NUTRIENT DATA

CRUISE: MB-RITS90 - LEG II

STATION: 9 CAST: 6 DATE(Z): 02/07/90 TIME(Z): 2008 POSITION: 5 13.7 N 179 35.4 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0100	0	< 0.40	< 0.10	< 0.40	0.12	< 0.20	7.74	29.12	34.545	T & S FROM
0101	30	< 0.40	< 0.10	< 0.40	0.15	< 0.20	7.66	28.84	34.602	CTD CAST
0102	50	< 0.40	< 0.10	< 0.40	0.57	999.99	7.64	28.63	34.656	
0103	70	< 0.40	< 0.10	< 0.40	0.27	0.75	7.52	28.56	34.662	O2 CALIBRATION
0104	90	< 0.40	< 0.10	0.57	0.20	0.27	7.47	28.53	34.682	PROBLEMS
0105	100	< 0.40	0.21	1.09	0.22	0.42	4.81	27.97	34.685	
0106	120	5.25	0.16	3.27	0.43	< 0.20	3.93	24.57	34.855	PROBABLE NH4
0107	150	10.91	< 0.10	6.40	0.66	< 0.20	3.63	19.94	34.867	CONTAMINATION
0108	250	40.66	< 0.10	31.43	2.40	0.31	1.27	10.16	34.675	
0109	350	41.79	< 0.10	33.68	2.61	999.99	1.69	8.96	34.659	
0110	500	45.83	< 0.10	46.90	2.56	< 0.20	1.57	7.84	34.619	NO3&SIO3;1:1DIL
0111	600	45.46	< 0.10	48.16	2.65	0.32	1.66	7.21	34.603	NO3&SIO3;1:1DIL

STATION: 10 CAST: 7 DATE(Z): 02/09/90 TIME(Z): 2017 POSITION: 0 14.0 N 179 28.2 W

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0112	0	< 0.40	< 0.10	< 0.40	0.24	< 0.20	4.86	29.28	34.828	T & S FROM
0113	20	< 0.40	< 0.10	< 0.40	0.24	0.21	4.79	29.21	34.828	CTD CAST
0115	70	0.47	0.17	< 0.40	0.29	< 0.20	4.79	28.75	35.141	
0116	90	0.92	0.22	< 0.40	0.37	< 0.20	4.84	28.71	35.180	
0117	110	1.52	0.41	0.82	0.48	999.99	4.77	28.51	35.219	
0118	150	2.60	0.68	0.78	0.56	< 0.20	4.95	28.31	35.411	
0119	200	19.87	< 0.10	13.08	1.77	< 0.20	3.36	16.19	35.029	
0120	250	26.33	< 0.10	24.72	1.93	< 0.20	4.03	13.07	34.747	
0121	300	33.91	< 0.10	27.43	2.60	< 0.20	2.66	11.79	34.847	
0122	450	32.75	< 0.10	30.69	2.33	< 0.20	1.40	9.31	34.705	NO3,PO4,SIO3;1:1DIL
0123	600	36.07	< 0.10	47.99	999.99	< 0.20	1.68	7.38	34.613	NO3,PO4,SIO3;1:1DIL

NUTRIENT DATA

CRUISE: MB-RITS90 - LEG II

STATION: 11 CAST: 8 DATE(Z): 02/12/90 TIME(Z): 1954 POSITION: 5 5.2 S 179 51.9 E

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0124	0	< 0.40	< 0.10	< 0.40	0.28	999.99	5.17	28.52	35.159	NH4 NOT
0125	20	0.44	< 0.10	< 0.40	0.43	999.99	5.15	28.64	35.159	TAKEN
0126	50	0.44	< 0.10	< 0.40	0.44	999.99	5.06	28.64	35.188	
0127	75	0.59	< 0.10	< 0.40	0.45	999.99	4.97	28.63	35.202	T & S FROM
0128	100	1.07	0.11	< 0.40	0.45	999.99	4.92	28.72	35.401	CTD CAST
0129	120	1.93	0.43	< 0.40	0.46	999.99	4.81	28.39	35.600	
0130	150	7.38	< 0.10	< 0.40	0.75	999.99	3.63	25.63	35.906	
0131	200	12.70	< 0.10	0.75	1.29	999.99	3.14	21.22	35.794	
0132	250	25.14	< 0.10	8.58	1.98	999.99	1.96	15.60	35.222	
0133	300	32.73	< 0.10	8.20	2.51	999.99	2.07	12.59	34.974	SIO3;1:1DIL
0134	500	38.73	< 0.10	25.57	2.84	999.99	2.57	8.09	34.641	SIO3;1:1DIL
0135	600	35.17	< 0.10	32.06	2.62	999.99	2.76	6.86	34.579	SIO3;1:1DIL

STATION: 11 CAST: GF-26 DATE(Z): 02/13/90 TIME(Z): 1919 POSITION: 5 5.2 S 179 51.9 E

SAMPLE #	DEPTH (M)	NO3	NO2	SIO3	PO4	NH4	O2 (ML/L)	TEMP (C)	SALINITY (0/00)	COMMENTS
		(MICROGRAM-ATOMS/LITER)								
0079	0	< 0.40	< 0.10	< 0.40	0.21	999.99	999.99	99.99	99.999	T,S,NH4,O2
0080	8	< 0.40	< 0.10	< 0.40	0.20	999.99	999.99	99.99	99.999	NOT TAKEN
0116	17	0.52	< 0.10	< 0.40	0.20	999.99	999.99	99.99	99.999	
0117	26	0.67	< 0.10	< 0.40	0.20	999.99	999.99	99.99	99.999	
0118	39	1.03	< 0.10	< 0.40	0.19	999.99	999.99	99.99	99.999	
0119	67	1.40	< 0.10	< 0.40	0.24	999.99	999.99	99.99	99.999	

4. CHLOROPHYLL-A AND PRIMARY PRODUCTIVITY

A. Methods

Hydrographic properties of the water column were recorded at each station with a Neil Brown Mark III conductivity-temperature-depth (CTD) profiler, fitted with a rosette multi-sampler. Water samples for salinity, oxygen, chlorophyll, and nutrient analyses were collected in 2.5 l Niskin bottles at nine depths on the CTD upcast. Individual sample depths varied in relation to the maximum hydrocast depth; however, all casts included at least four sample depths down to and including 100 m. Six additional samples were obtained from stations which included Go-Flo bottle casts (see below).

Chlorophyll concentrations were determined from duplicate 100 ml aliquots filtered through Whatman GF/F filters. Filters were frozen over a desiccant at -20°C in the dark. The fluorescence of 90% aqueous acetone extracts were measured in the laboratory with a Turner Designs fluorometer, after grinding the filters and extracting in the dark for 30 min. The fluorometer was calibrated with Sigma chlorophyll-a, following the method of Smith et al. (1981).

Water samples for productivity determinations were collected at six depths with 10 l Go-Flo bottles mounted on a Kevlar hydrowire. Sampling depths were selected on the basis of light extinction. Seawater samples were incubated at 100, 60, 32, 17, 7, and 1% of the incident I_o. Diffuse vertical attenuation coefficients k (in reciprocal meters) were estimated at all stations by measuring photosynthetically available radiation (PAR) with depth via a Lambda Instruments LI-190S 4π spherical collector.

Productivity measurements were made by the carbon-14 method, originally described by Steemann Nielsen (1952), with modifications of Fitzwater et al. (1982) to minimize trace metal contamination. All materials were acid-cleaned in dilute (0.1N) HCl, then rinsed copiously with Milli-Q (18MΩ) water. Incubation bottles were rinsed with the seawater sample prior to filling. Between incubations, sample bottles were rinsed with dilute HCl and three rinses of Milli-Q water. Samples were collected from the Go-Flo bottles in darkened 2 l acid-cleaned polycarbonate bottles. Approximately 250 ml of sample was transferred to each of three (two light, one dark) acid-cleaned polycarbonate bottles and inoculated with 5 µCi of $NaH^{14}CO_3$ with acid-cleaned Eppendorf pipettes. The isotope (Amersham Searle CFA.3) was prepared in a carrier solution of 0.3 g L^{-1} BIA grade Na_2CO_3.

The three incubation bottles were encased in elongate tubes of neutral density (PVC) screening simulating 100, 60, 32, 17, 7 and 1% of the incident I_o. Samples were incubated on deck for four to six hours in clear Plexiglas cylinders filled with circulating near-surface seawater. Samples were then transported to the laboratory in darkness, filtered through Whatman GF/F filters, and rinsed with filtered seawater without air exposure.

Filtrations were performed under a pressure differential of <50 mm Hg to minimize cell breakage (Goldman and Dennett, 1985). The filters were transferred to Nalgene scintillation bags, and acidified with 0.5N NCl. After 60 min, a 3 ml aliquot of Aquasol II scintillation cocktail was added to each bag (Hitchcock, 1986). Activity was measured aboard ship with a Tracor model 300 scintillation counter. Productivity (mg C m^{-3} h^{-1}) was calculated from the mean value of the two light bottles minus the dark bottle activity.

B. Station Data

See the following pages for station data.

CAST: GF-1 DATE: 1/10/90 POSITION: 05°39.70'N 87°33.90'W

DEPTH (m)	TEMPERATURE* (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
24	29.31		0.18	0.10	0.28
44	29.0		0.20	0.10	0.30

*Temperature data from XBT.

CAST: GF-2 DATE: 1/10/90 POSITION: 05°39.70'N 87°33.90'W

DEPTH (m)	TEMPERATURE* (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
27	29.30		0.15	0.08	0.23
110	28.53		0.18	0.13	0.31

*Temperature data from XBT.

CAST: GF-4 DATE: 1/15/90 POSITION: 00°01.80'N 110°04.50'W

DEPTH (m)	TEMPERATURE* (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
0			0.22	0.15	0.37
20			0.23	0.19	0.42
40			0.36	0.24	0.60

*Temperature, salinity not available

CAST: GF-6 DATE: 1/18/90 POSITION: 02°27.40'S 129°30.20'W

DEPTH (m)	TEMPERATURE* (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
10	25.23		0.19	0.14	0.33	100	0.45
20	25.23		0.18	0.14	0.32	60	0.74
30	25.23		0.17	0.15	0.32	32	0.99
40	25.22		0.21	0.17	0.38	17	0.93
60	25.22		0.21	0.17	0.38	7	0.31
100	25.19		0.20	0.16	0.36	1	0.26

*Temperature from XBT.

k (m^{-1}) = Not available, isolume depths estimates only.

CAST: GF-9 CTD-1 DATE: 1/22/90 POSITION: 05°01.70'S 149°34.20'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
05	27.03	35.57	0.11	0.10	0.21	100	0.55
20	26.91	35.56	0.17	0.14	0.31	60	0.48
40	26.89	35.58	0.17	0.12	0.29	32	0.56
60	26.89	35.58	0.19	0.17	0.36	17	0.42
80	26.92	35.60	0.22	0.20	0.42	7	0.53
100	26.99	35.63	0.14	0.12	0.26	1	0.07

k (m^{-1}) = Not Available

CAST: CTD-2 DATE: 1/23/90 POSITION: 05°01.70′S 149°34.90′W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
0	30.19	35.54	0.13	0.10	0.23
10	27.06	35.54	0.13	0.13	0.26
20	26.91	35.56	0.14	0.13	0.27
30	26.89	35.57	0.17	0.14	0.31
50	26.89	35.58	0.18	0.18	0.36
70	26.91	35.59	0.20	0.17	0.37
100	26.99	35.63	0.22	0.14	0.36
150	25.15	35.65	0.10	0.16	0.26
175	22.93	36.11	0.07	0.09	0.16

CAST: CTD-3 DATE: 1/31/90 POSITION: 12°38.50'S 157°19.10'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
0	29.05	35.70	0.06	0.07	0.13
10	28.49	35.74	0.06	0.06	0.12
20	28.49	35.74	0.08	0.04	0.12
30	28.49	35.75	0.06	0.06	0.12
50	28.49	35.84	0.07	0.05	0.12
70	27.90	36.22	0.09	0.08	0.17
90	27.15	36.26	0.16	0.14	0.30
100	26.72	36.34	0.28	0.30	0.58
150	24.57	36.46	0.20	0.22	0.42

CAST: CTD-4 DATE: 2/02/90 POSITION: 07°09.50'S 165°41.70'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
0	32.11	35.53	0.13	0.11	0.24
10	28.80	35.53	0.11	0.12	0.23
20	28.80	35.55	0.12	0.08	0.20
40	28.68	35.62	0.18	0.18	0.36
60	28.54	35.68	0.24	0.31	0.55
80	28.47	35.71	0.24	0.24	0.48
100	28.04	35.75	0.23	0.30	0.53
120	26.79	35.87	0.19	0.19	0.38
150	25.45	36.11	0.07	0.13	0.20

CAST: GF-12 DATE: 2/02/90 POSITION: 07°09.50'S 165°41.70'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
0	28.79	35.56				100	0.31
15	28.79	35.56				60	0.45
33	28.70	35.63				32	0.52
50	28.53	35.69				17	0.54
75	28.47	35.72				7	0.29
130	26.36	35.96				1	0.03

Chlorophyll data not available.

k (m^{-1}) = 0.035

CAST: GF-14 CTD-5 DATE: 2/04/90 POSITION: 02°51.80′S 171°46.46′W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
1	28.10	35.22	0.22	0.20	0.42	100	0.68
12	28.09	35.22	0.25	0.25	0.50	60	1.15
27	28.09	35.23	0.27	0.24	0.51	32	1.27
42	28.0	35.27	0.27	0.20	0.47	17	1.37
63	27.96	35.34	0.26	0.24	0.50	7	0.81
110	27.97	35.46	0.20	0.32	.53	1	0.69
150	25.85	35.87	0.22	0.27	0.49		

k (m^{-1}) = 0.042

CAST: CTD-6 DATE: 2/07/90 POSITION: 05°13.70'N 179°35.40'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
0	29.12	34.55	0.10	0.09	0.19
30	28.84	34.60	0.12	0.13	0.25
50	28.63	34.66	0.27	0.17	0.44
70	28.56	34.66	0.27	0.22	0.49
90	28.53	34.68	0.41	0.28	0.69
100	27.97	34.69	0.34	0.31	0.65
120	24.57	34.87	0.21	0.29	0.50
150	19.94	34.87	0.08	0.11	0.19

CAST: GF-15 CTD-6 DATE: 2/07/90 POSITION: 05°13.70'N 179°35.40'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
1	28.82	34.55	0.11	0.07	0.18	100	0.52
11	28.80	34.55	0.15	0.03	0.18	60	0.75
25	28.83	34.58	0.17	0.12	0.29	32	0.61
39	28.62	34.65	0.13	0.09	0.22	17	0.57
58	28.57	34.66	0.22	0.17	0.39	7	0.63
100	27.97	34.69	0.27	0.30	0.57	1	0.40

k (m^{-1}) = 0.046

CAST: CTD-7 DATE: 2/09/90 POSITION: 00°14.00'N 179°28.20'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL a (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
0	29.28	34.83	0.19	0.10	0.29
20	29.21	34.83	0.14	0.20	0.34
70	28.75	35.14	0.37	0.27	0.64
90	28.71	35.18	0.30	0.27	0.57
110	28.51	35.22	0.24	0.25	0.49
150	28.31	35.41	0.06	0.12	0.18

CAST: GF-19 CTD-7 DATE: 2/09/90 POSITION: 00°14.00'N 179°28.20'W

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
1	29.25	34.83	0.18	0.15	0.33	100	0.64
12	29.22	34.83	0.23	0.13	0.36	60	1.19
27	29.21	34.83	0.16	0.10	0.26	32	1.09
42	28.90	34.95	0.32	0.23	0.55	17	1.39
63	28.78	35.13	0.29	0.27	0.56	7	0.95
107	28.51	35.22	0.22	0.22	0.44	1	0.33

k (m^{-1}) = 0.043

CAST: GF-22 DATE: 2/10/90 POSITION: 00°35.70′N 179°09.50′W

DEPTH (m)	TEMPERATURE* (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
0	29.12		0.15	0.15	0.30	100	1.08
10	29.34		0.17	0.15	0.32	60	1.57
22	29.33		0.18	0.16	0.34	32	1.52
35	29.04		0.39	0.27	0.66	17	1.62
52	28.93		0.36	0.29	0.65	7	0.85
90	28.73		0.28	0.26	0.54	1	0.34

*Temperature from XBT.

k (m^{-1}) = 0.051

CAST: CTD-8 DATE: 2/12/90 POSITION: 05°05.20'S 179°51.90'E

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})
0	28.52	35.16	0.33	0.17	0.50
20	28.64	35.16	0.38	0.22	0.60
50	28.64	35.19	0.42	0.21	0.62
75	28.63	35.20	0.39	0.22	0.61
100	28.72	35.40	0.20	0.14	0.34
120	28.39	35.60	0.10	0.11	0.21
150	25.63	35.91	0.02	0.03	0.05

CAST: GF-24 CTD-8 DATE: 2/12/90 POSITION: 05°05.20′S 179°51.80′E

DEPTH (m)	TEMPERATURE (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
0	28.65	35.16	0.34	0.19	0.53	100	1.27
12	28.65	35.16	0.40	0.19	0.59	60	2.38
27	28.65	35.16	0.40	0.21	0.61	32	2.60
42	28.63	35.17	0.45	0.27	0.72	17	2.08
63	28.64	35.19	0.44	0.25	0.69	7	1.56
110	28.69	35.19	0.11	0.10	0.21	1	0.06

k (m^{-1}) = 0.042

CAST: GF-26 DATE: 2/13/90 POSITION: 05°23.80′S 179°28.50′E

DEPTH (m)	TEMPERATURE* (°C)	SALINITY (psu)	CHL *a* (mg m^{-3})	PHAEO (mg m^{-3})	TOTAL PIGMENT (mg m^{-3})	SAMPLE ISOLUME % (Sfc I_o)	PRIMARY PRODUCTIVITY (mgC $m^{-3}h^{-1}$)
0	27.86		0.36	0.18	0.54	100	1.73
8	28.74		0.38	0.17	0.55	60	1.87
17	28.75		0.37	0.20	0.57	32	3.81
26	28.75		0.37	0.21	0.58	17	2.38
39	28.68		0.43	0.29	0.72	7	1.77
67	28.65		0.40	0.28	0.68	1	0.95

*Temperature from XBT.

k (m^{-1}) = 0.069

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