FRUELA CRUISES DATA BASE

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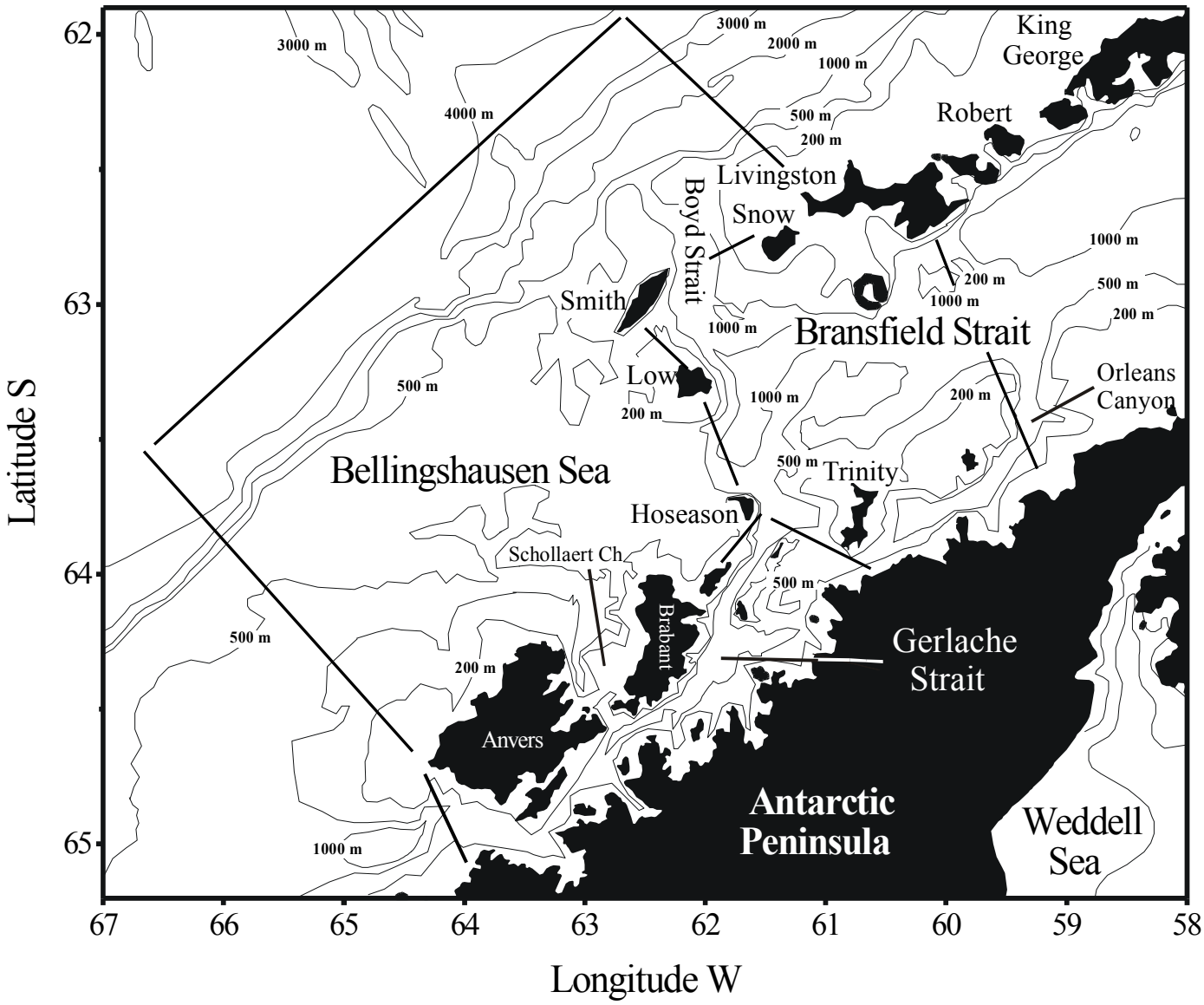
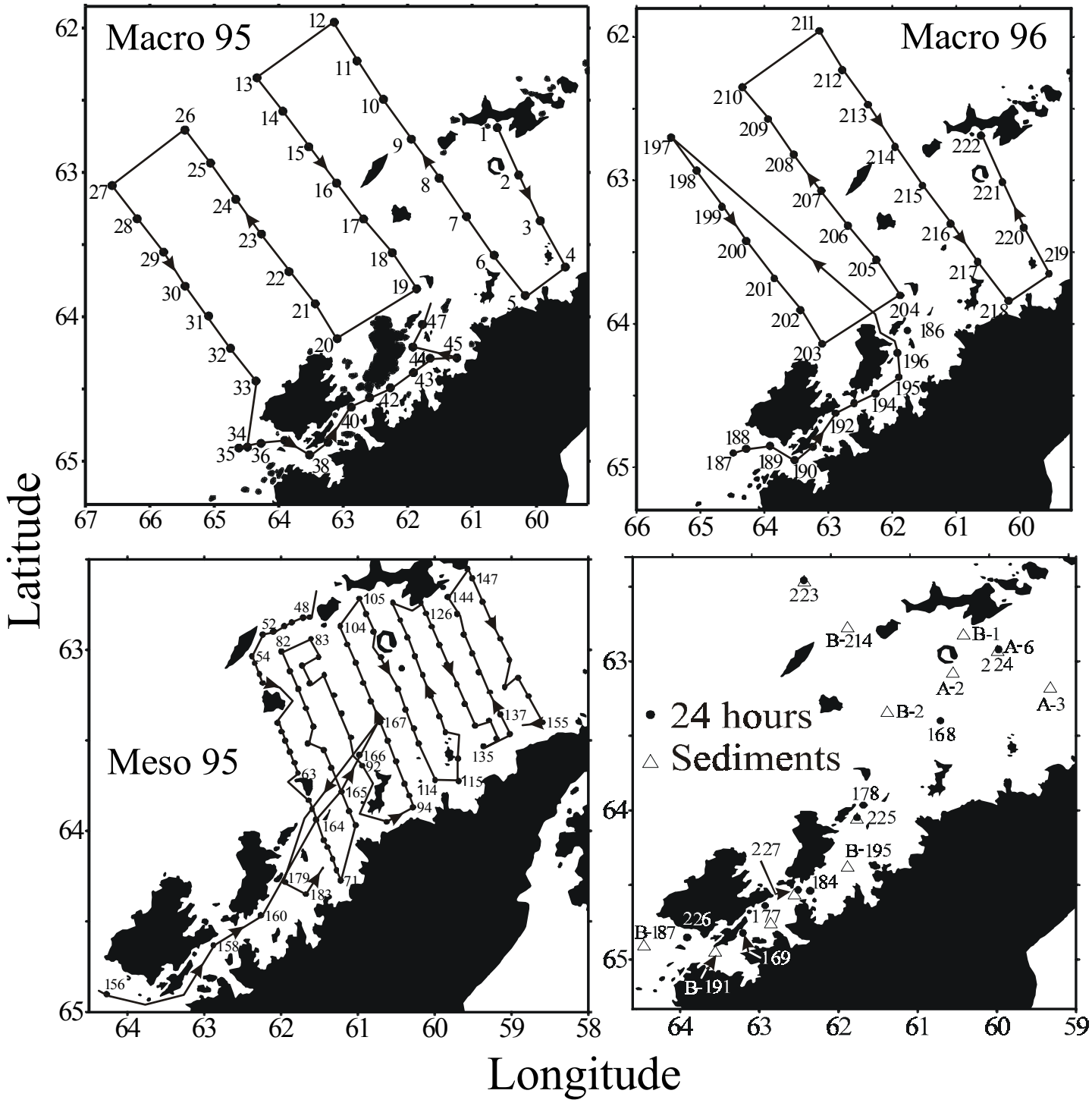
Study Area
Tracks and stations
Individual projects
Methods of the Data Base
FRUELA cruises Literature

1. MAP OF THE STUDIED AREA



2. MAPS WITH CRUISE TRACKS AND STATIONS



3. INDIVIDUAL PROJECTS WITHIN THE FRUELA CRUISES

Research Topic / Operation	Principal Investigator	Team on board	Cruise	Reference
Physics				
CTD – Macro and mesoescale distribution	Marc Antoni Garcia (UPC)	Marc Antoni Garcia	F96	(Garcia et al., 2001)
	Oswaldo López (UPC)	Oswaldo López	F95	
		Julia Figa (UPC)	F95	
		Manuel González (UPC)	F95	
		Joan Puigdefabregas (UPC)	F95	
		María Pilar Rojas (UPC)	F96	
CTD – Geostrophic circulation	Damià Gomis (UIB)	Damià Gomis	F95	(Gomis et al., 2001)
Chemistry				
Nutrient distribution and utilisation	Carmen González-Castro (IIM)	Carmen González-Castro	F95	(Castro et al., 2001)
		María José Pazo (IIM)	F96	
CO_2 system, pH and alkalinity	Aida Fernández-Rios (IIM)	Aida Fernández-Ríos	F96	(Álvarez et al., 2001)
	Gabriel Rosón (UV)	Gabriel Rosón	F95	
		Mª Victoria González (IIM)	F95	
		María Trinidad Rellán (IIM)	F96	
POC and DOC distribution	María Dolores Doval (IIM)	María Dolores Doval	F95	(Doval et al., 2001)
		Ramon Penín (IIM)	F95	
		Enrique Nogueira (IIM)	F95	
Phytoplankton				
Light and bio-optics	Félix López-Figueroa (UM)	Félix López-Figueroa (UM)	F95	(Figueroa, 2001)
		Belén Arbones (IIM)	F95	(Figueroa et al., 1997)
		María Luisa Villarinos (IIM)	F96	(Lorenzo et al., 2001)
				(Arbones et al., 2000)
Flow-citometry and size structure	Jaime Rodríguez (UM)	Jaime Rodríguez	F95	(Rodríguez et al., 2001b)
		Francisco Jiménez (UM)	F95	
		José María Blanco (UM)	F95	
Primary production and pigments (HPLC)	Emilio Fernández (UV)	Emilio Fernández (UV)	F95	(Varela, et al., 2001)
	Manuel Varela (IEO)	Manuel Varela (IEO)	F96	(Rodríguez et al., 2001a)
Gross primary production and microbial respiration (oxygen)	Pablo Serret (UO)	Pablo Serret (UO)	F95	(Serret et al., submitted)
		Emilio Marañón (UO)	F96	
		Natalia González (UO)	F96	
DOC release	Marta Estrada (ICM)	Marta Estrada	F95	(Morán and Estrada,)
Microbial ETS activity	Rosa Martínez (US)	Rosa Martínez	F95	(Morán et al., In press)
New and regenerated production (^{15}N)	Antonio Bode (IEO)	Antonio Bode (IEO)	F95	(Bode et al., 2001)
Heterotrophic microbes				
Protist abundance and bacterivory	Dolors Vaqué (ICM)	Dolors Vaqué	F95	(Pedrós-Alió et al., 2001)
		Núria Guixa-Boixereu (ICM)	F96	(Vaqué et al., 2001)
Prokaryotes abundance and production, Viruses and prokaryotic lysis	Carles Pedrós-Alió (ICM)	Carles Pedrós-Alió	F96	(Guixa-Boixereu et al., 2001)
		Josep M. Gasol (ICM)	F95	

Research Topic Operation	Principal Investigator	Team on board	Cruise	Reference
Meso y macrozooplankton				
Mesozooplankton composition, abundance and grazing	Florentina Álvarez-Marqués (UO)	Florentina Álvarez-Marqués	F95	
	José Luis Acuña (UO)	José Luis Acuña	F96	(Cabal et al., 2001)
		Jesús Alberto Cabal (UO)	F96	
		Mario Quevedo (UO)	F96	
		Jorge Álvarez-Sostres (UO)	F96	
		Ricardo Anadón	F95	
Copepod egg and faecal pellet production	Albert Calbet (ICM)	Albert Calbet	F96	(Calbet and Irigoien, 1997)
		Xavier Irigoien (ICM)	F96	
Mesozooplankton respiration, ETS activity	Santiago Hernández-León (ULP)	Santiago Hernández-León	F96	
		Irene Lidia Montero (ULP)	F96	
Bioacustics	Arturo Castellón (ICM)	Arturo Castellón	F96	
Macrozooplankton and fish larvae	Fracesc Pagés (ICM)	Fracesc Pagés	F96	
		Rafael González-Quirós (UO)	F96	
PC and PON export (drifting sediment trap)	Ricardo Anadón (UO)	Ricardo Anadón	F95-F96	(Anadón et al., 2001)
Sediment				
Sediment carbon burial, bioaccumulation and paleoclimatology	Jorge Guillén (ICM)	Jorge Guillén (ICM)	F96	(Masqué et al., 2001)
		Marcelli Farran (ICM)	F96	(Bárcena et al., 2001)
		Pere Masqué (UAB)	F96	
Moorings				
Current meters and sediment traps	Albert Palanques (ICM)	Albert Palanques		(Palanques et al., 2001)
Deposition of carbon and nitrogen		Pere Puig (ICM)		(Isla et al., submitted)
		Marc Garcia (UPC)		
Technicians				
CTD, LHPR, Bioness	Pedro Jornet (UGBOIP)	Pedro Jornet	F95-F96	
	Mario Manríquez (UGBOIP)	Mario Manríquez	F96	
		María Isabel Lloret (ICM)	F95	
		Fernando Uceta (UGBOIP)	F95	
Computing		Miguel Pancorbo (UGBOIP)	F96	
		Zacarías Garcia (UGBOIP)	F95	

ICM Institut de Ciències del Mar (CSIC)- Barcelona; **IEO** Instituto Español de Oceanografía, Laboratorio Costero de A Coruña - A Coruña; **IIM** Instituto de Investigacions Mariñas (CSIC) - Vigo; **UAB** Universitat Autònoma de Barcelona - Barcelona; **UGBOIP** Unidad de Gestión de Buques Oceanográficos e Instalaciones Polares - Barcelona; **UIB** Universidad de las Islas Baleares - Palma de Mallorca; **ULP** Universidad de Las Palmas - Las Palmas de Gran Canaria; **UM** Universidad de Málaga - Málaga; **UO** Universidad de Oviedo - Oviedo; **UPC** Universitat Politècnica de Catalunya (LIM) - Barcelona; **US** Universidad de Santander; **UV** Universidad de Vigo - Vigo.

4. FRUELA 95 STATIONS AND DEPTHS

FRUELA 95											
CAST	STATION	DATE	HOUR GMT	LATITUDE			LONGITUDE			DEPTH	
										CAST	STATION
1	1	3-12	13:18	62	41	33	60	36	33	208	230
				62	41	34	60	36	26		237
2	2	3-12	22:03	63	1	2	60	16	43	810	866
				63	0	58	60	16	36		862
3	3	4-12	0:38	63	20	5	59	56	27	357	382
				63	20	6	59	56	45		408
4	4	4-12	5:41	63	39	27	59	33	3	287	284
				63	39	25	59	33	7		300
5	5	4-12	9:01	63	51	6	60	10	37	198	300
				63	51	20	60	11	26		201
6	6	4-12	12:11	63	34	29	60	39	28	688	786
				63	34	15	60	41	13		650
7	7	4-12	15:10	63	18	29	61	5	0	620	709
				63	18	24	61	4	12		615
8	8	4-12	17:42	63	2	32	61	30	55	522	565
				63	2	38	61	30	17		562
9	9	5-12	7:35	62	46	10	61	56	50	330	734
				62	46	12	61	56	1		359
10	10	5-12	9:56	62	29	56	62	22	47	359	387
				62	30	4	62	22	53		390
11	11	5-12	13:08	62	13	58	62	47	17	1192	1527
				62	13	34	62	47	29		1123
12	12	5-12	16:02	62	57	51	63	8	29	1832	1856
				62	57	31	63	8	26		1625
13	13	6-12	2:24	62	20	59	64	20	37	2797	3106
				62	21	15	64	20	34		3070
14	14	6-12	6:35	62	34	50	63	56	23	4043	4097
				62	34	39	63	55	36		3967
15	15	6-12	10:36	62	49	30	63	32	13	1986	2000
				62	49	22	63	32	33		2283
16	16	6-12	14:45	63	4	37	63	6	15	562	610
				63	4	44	63	6	1		609
17	17	6-12	16:49	63	19	29	62	41	0	162	195
				63	19	32	62	41	9		188
18	18	6-12	19:19	63	33	33	62	14	27	279	288
				63	33	43	62	14	23		300
19	19	6-12	21:00	63	48	31	61	51	55	149	174
				63	48	31	61	51	57		176
20	20	7-12	1:21	64	9	1	63	5	55	629	664

				64	9	8	63	6	11		674
21	21	7-12	3:45	63	54	52	63	26	6	387	419
				63	55	1	63	26	13		415
22	22	7-12	5:56	63	41	15	63	50	47	211	241
				63	41	15	63	50	48		241
23	23	7-12	8:09	63	25	54	64	16	17	224	256
				63	25	49	64	16	22		252
24	24	7-12	10:41	63	11	10	64	40	7	2762	2832
				63	11	28	64	39	57		2819
25	25	7-12	17:39	62	56	1	65	3	56	3215	3263
				62	55	32	65	5	11		3303
26	26	8-12	0:05	62	42	31	65	27	42	3184	3240
				62	43	22	65	28	41		3250
27	27	8-12	5:32	63	5	36	66	35	26	3327	3374
				63	5	33	66	37	9		3399
28	28	8-12	12:16	63	19	21	66	12	4	3281	3364
				63	20	51	66	8	28		3327
29	29	8-12	17:37	63	33	3	65	47	26	3216	3215
				63	33	26	65	47	37		3216
30	30	8-12	22:30	63	47	18	65	27	37	385	422
				63	47	5	65	28	2		419
31	31	9-12	0:28	63	59	59	65	5	39	415	447
				63	59	56	65	6	8		447
32	32	9-12	2:43	64	13	2	64	45	0	497	526
				64	12	56	64	45	19		526
33	33	9-12	4:51	64	26	57	64	21	33	97	126
				64	26	56	64	21	18		123
34	34	9-12	8:25	64	54	6	64	29	20	740	726
				64	54	12	64	29	20		798
35	34.1	9-12	12:19	64	54	30	64	29	2	889	900
				64	54	26	64	29	16		798
36	35	10-12	0:32	64	54	46	64	37	24	838	866
				64	55	4	64	37	47		878
37	36	10-12	2:40	64	52	53	64	16	48	543	590
				64	52	55	64	17	34		568
38	37	10-12	5:05	64	51	28	63	54	47	372	390
				64	51	30	63	54	36		367
39	38	10-12	7:39	64	57	29	63	31	36	363	309
				64	57	31	63	31	38		388
40	39	10-12	9:20	64	52	1	63	14	14	306	334
				64	51	58	63	14	14		334
41	39.1	10-12	12:08	64	51	58	63	13	56	290	322
				64	52	2	63	13	49		315
42	40	10-12	17:15	64	37	50	62	52	54	296	530
				64	37	34	62	53	25		350

43	41	10-12	19:04	64	33	56	62	35	45	767	813
				64	34	1	62	35	40		810
44	42	10-12	21:43	64	29	40	62	16	4	739	734
				64	29	39	62	16	4		739
45	453	10-12	23:15	64	23	13	61	54	57	619	606
				64	23	6	61	54	54		587
46	44	11-12	1:45	64	17	16	61	39	10	652	664
				64	17	12	61	39	30		668
47	45	11-12	3:14	64	17	1	61	14	7	258	300
				64	16	58	61	14	19		280
48	46	11-12	5:42	64	12	53	61	55	10	445	572
				64	12	53	61	55	1		559
49	47	11-12	9:10	64	3	9	61	46	3	300	1004
				64	3	1	61	45	50		1001
50	47.1	11-12	11:25	64	3	1	61	45	3	1078	1078
				64	3	1	61	45	20		1024
51	48	12-12	17:28	64	49	28	61	37	55	49	55
				64	49	33	61	38	10		69
52	49	12-12	17:56	62	49	45	61	42	26	66	85
				62	49	49	61	42	42		86
53	50	12-12	18:37	62	51	10	61	51	33	163	170
				62	51	11	61	51	56		163
54	51	12-12	19:13	62	52	32	61	57	41		776
				62	52	46	61	58	10		763
55	52	12-12	20:16	62	54	3	62	5	44	735	771
				62	54	18	62	6	18		782
56	53	12-12	21:24	62	55	8	62	14	6	761	808
				62	55	12	62	14	2		805
57	54	12-12	22:45	63	2	12	62	22	55	742	790
				63	2	3	62	22	50		777
58	55	12-12	23:57	63	4	55	62	20	23	239	253
				63	4	48	62	20	18		277
59	56	13-12	0:42	63	8	18	62	16	58	355	391
				63	8	21	62	16	59		377
60	57	13-12	1:27	63	11	10	62	14	9	136	162
				63	11	11	62	14	9		155
61	58	13-12	3:36	63	24	42	62	2	8	25	47
				63	24	45	62	2	8		49
62	59	13-12	4:15	63	27	29	61	59	42	92	120
				63	27	33	61	0	1		120
63	60	13-12	4:59	63	30	29	61	56	55	195	226
				63	30	32	61	56	55		227
64	61	13-12	5:52	63	34	9	61	53	2	1252	1336
				63	34	16	61	53	34		1280
65	62	13-12	7:23	63	37	59	61	49	23	1210	1280

				63	38	2	61	49	53		1254
66	63	13-12	8:48	63	41	1	61	46	53	377	415
				63	41	3	61	46	47		377
67	64	13-12	10:38	63	50	1	61	38	17	585	615
				63	49	57	61	38	21		580
68	65	13-12	11:33	63	53	1	61	35	54	1053	1112
				63	53	4	61	35	39		1112
69	66	13-12	13:15	63	56	46	61	32	52	154	198
				63	56	47	61	32	43		180
70	67	13-12	14:22	64	3	19	61	26	16	385	382
				64	3	25	61	26	22		379
71	68	13-12	16:26	64	5	57	61	23	32	681	695
				64	6	14	61	23	4		722
72	69	13-12	17:36	64	9	36	61	19	29	460	469
				64	9	33	61	19	8		484
73	70	13-12	18:38	64	13	22	61	16	46	402	421
				64	13	29	61	16	45		444
74	71	13-12	19:17	64	16	50	61	13	37	195	201
				64	16	50	61	13	26		212
75	72	13-12	21:15	63	58	31	61	1	39	304	371
				63	58	16	61	1	29		265
76	73	13-12	22:42	63	53	48	61	6	52	328	353
				63	53	48	61	6	43		350
77	74	14-12	0:01	63	47	17	61	12	54	557	579
				63	47	17	61	13	9		584
78	75	14-12	1:36	63	39	32	61	20	42	641	668
				63	39	45	61	20	40		680
79	76	14-12	2:53	63	33	33	61	26	34	852	868
				63	33	31	61	26	17		878
80	77	14-12	5:05	63	31	17	61	39	1	1300	1375
				63	30	45	61	38	55		1336
81	78	14-12	8:21	63	25	53	61	34	31	1080	1147
				63	26	3	61	34	31		1147
82	78.1	14-12	10:39	63	26	1	61	34	2	103	1147
				63	26	5	61	34	23		1145
83	79	14-12	11:59	63	19	54	61	40	23	927	984
				63	20	5	61	40	34		987
84	80	14-12	14:07	63	13	15	61	46	15	950	1040
				63	13	35	61	47	7		990
85	81	14-12	15:33	63	7	17	61	52	59	945	1016
				63	7	30	61	53	19		984
86	82	14-12	17:31	63	0	58	61	59	5	817	900
				63	1	2	61	59	9		817
87	52	14-12	19:23	62	54	11	62	6	16	730	779
				62	54	9	62	6	47		777

88	49	14-12	21:35	62	49	44	61	42	39	65	93
				62	49	41	61	42	43		94
89	83	14-12	22:30	62	56	49	61	36	27	232	260
				62	56	46	61	36	41		263
90	84	14-12	23:34	63	2	49	61	30	33	527	570
				63	2	44	61	30	26		569
91	85	15-12	0:56	63	5	25	61	43	36	592	638
				63	5	24	61	43	39		637
92	86	15-12	2:02	63	11	28	61	37	9	449	482
				63	11	27	61	37	8		482
93	87	15-12	3:06	63	8	48	61	26	5	590	629
				63	8	47	61	25	59		620
94	88	15-12	4:26	63	15	15	61	18	17	1159	1224
				63	15	16	61	18	17		1222
95	89	15-12	6:05	63	21	24	61	12	22	929	948
				63	21	25	61	12	44		988
96	90	15-12	7:49	63	29	12	61	5	34	567	615
				63	29	12	61	5	49		605
97	91	15-12	9:13	63	35	5	60	58	47	594	640
				63	35	4	60	58	47		636
98	92	15-12	10:20	63	38	52	60	56	8	95	124
				63	38	53	60	56	3		125
99	93	15-12	13:39	63	57	19	60	37	45	446	491
				63	57	21	60	37	51		492
100	94	15-12	15:27	63	52	34	60	16	33	509	558
				63	52	36	60	16	25		543
101	95	15-12	16:55	63	48	47	60	19	54	630	676
				63	48	45	60	20	7		676
102	96	15-12	17:59	63	44	48	60	23	27	679	712
				63	44	54	60	23	12		731
103	97	15-12	19:30	63	31	21	60	30	0	365	408
				63	38	23	60	30	6		388
104	98	15-12	21:54	63	30	28	60	36	32	366	432
				63	30	18	60	36	6		386
105	99	16-12	23:05	63	24	8	60	42	56	394	416
				63	23	59	60	42	38		435
106	100	16-12	0:49	63	17	11	60	49	54	478	514
				63	17	16	60	50	10		524
107	101	16-12	2:00	63	11	7	60	55	35	798	824
				63	11	16	60	55	32		842
108	102	16-12	4:05	63	4	36	61	1	58	389	334
				63	4	48	61	2	12		449
109	103	16-12	5:13	62	58	33	61	8	18	250	281
				62	58	35	61	8	1		278
110	104	16-12	6:52	62	52	39	61	13	46	104	134

				62	52	57	61	14	20		127
111	103.1	16-12	8:36	62	58	32	61	8	4	247	277
				62	58	35	61	7	58		277
112	105	16-12	10:56	62	43	14	60	58	52	31	48
				62	43	16	60	59	10		48
113	106	16-12	11:50	62	58	28	60	53	17	155	189
				62	58	24	60	53	21		186
114	107	16-12	12:48	62	54	24	60	47	35	95	123
				62	54	26	60	47	34		122
115	108	16-12	14:05	63	2	48	60	41	41	151	207
				63	2	53	60	41	31		184
116	109	16-12	14:51	63	6	25	60	25	33	554	600
				63	6	25	60	34	48		593
117	110	16-12	16:18	63	13	2	60	28	54	580	633
				63	13	2	60	28	30		629
118	111	16-12	17:48	63	20	4	60	22	38	370	410
				63	20	9	60	22	48		407
119	112	16-12	19:08	63	26	23	60	16	16	565	558
				63	26	30	60	16	42		590
120	113	16-12	20:19	63	31	13	60	12	2	80	120
				63	31	21	60	12	13		118
121	114	16-12	23:08	63	43	34	59	59	44	718	762
				63	43	32	59	59	32		767
122	115	17-12	0:43	63	43	59	59	42	36	681	733
				63	44	7	59	42	34		726
123	116	17-12	2:17	63	36	22	59	41	51	715	755
				63	36	22	59	41	47		756
124	117	17-12	4:13	63	27	50	59	51	35	103	129
				63	27	52	59	51	45		129
125	118	17-12	5:15	63	22	8	59	56	14	189	218
				63	22	9	59	56	11		217
126	119	17-12	6:08	63	15	46	60	2	43	814	869
				63	15	54	60	2	44		867
127	120	17-12	8:05	63	8	53	60	9	0	738	783
				63	8	48	60	8	46		784
128	121	17-12	9:25	63	2	35	60	15	21	109	909
				63	2	28	60	15	5		908
129	121.2	17-12	10:47	63	1	59	60	13	15	856	908
				63	1	52	60	12	25		911
130	122	17-12	12:41	62	56	1	60	21	15	829	866
				62	56	4	60	20	59		871
131	123	17-12	14:13	62	50	22	60	26	57	456	479
				62	50	28	60	26	54		482
132	124	17-12	15:40	62	44	41	60	32	50	409	434
				62	44	45	60	32	48		447
133	125	17-12	17:28	62	44	52	60	10	41	103	121
				62	44	54	60	10	41		125
134	126	17-12	18:20	62	48	7	60	6	56	809	840
				62	47	55	60	6	55		839
135	127	17-12	19:30	62	52	40	60	2	14	990	1035

				62	52	40	60	2	7		1035
136	128	17-12	21:11	62	58	50	59	56	16	937	969
				62	59	3	59	56	26		992
137	129	17-12	22:36	63	5	9	59	50	5	842	894
				63	5	24	59	50	30		899
138	130	18-12	0:07	63	11	49	59	42	49	305	344
				63	11	55	59	42	35		336
139	131	18-12	1:21	63	18	18	59	36	2	216	235
				63	18	17	59	35	47		248
140	132	18-12	2:28	63	25	36	59	28	4	908	930
				63	25	38	59	27	37		969
141	133	18-12	3:50	63	23	55	59	17	10	359	407
				63	24	0	59	17	0		387
142	134	18-12	5:12	63	29	56	59	11	47	463	498
				63	30	0	59	11	39		496
143	135	18-12	6:18	63	32	20	59	21	57	283	334
				63	32	30	59	21	47		317
144	137	18-12	7:51	63	28	10	59	1	29	222	249
				63	28	5	59	1	24		251
145	138	18-12	8:58	63	21	47	59	8	25	92	119
				63	21	44	59	8	31		119
146	138.1	18-12	10:11	63	21	37	59	8	34	90	117
				63	21	37	59	8	37		116
147	139	18-12	11:41	63	14	34	59	16	25	787	821
				63	14	40	59	16	26		817
148	140	18-12	13:27	63	7	49	59	25	31	731	760
				63	7	49	59	25	31		763
149	141	18-12	15:19	63	1	20	59	30	43	834	866
				63	1	20	59	30	43		888
150	142	18-12	16:40	62	55	3	59	37	14	885	940
				62	55	3	59	37	14		942
151	143	18-12	18:45	62	48	33	59	42	24	954	1049
				62	48	33	59	42	24		1049
152	144	18-12	20:20	62	42	57	59	49	35	1100	1188
				62	42	57	59	49	35		1170
153	145	18-12	22:37	62	39	35	59	53	20	144	149
				62	39	35	59	53	20		179
154	146	19-12	0:05	62	33	25	59	34	36	349	341
				62	33	25	59	34	36		401
155	147	19-12	1:05	62	36	41	59	30	57	852	850
				62	36	41	59	30	57		909
156	148	19-12	2:45	62	44	28	59	22	27	1374	1491
				62	44	28	59	22	27		1282
157	149	19-12	4:39	62	50	44	59	15	34	1123	1236
				62	50	44	59	15	34		1104
158	150	19-12	6:18	62	56	46	59	8	41	690	740
				62	56	46	59	8	41		738
159	151	19-12	8:04	62	3	49	59	1	35	300	332
				62	3	49	59	1	35		332
160	154	19-12	9:24	63	12	42	59	55	0	198	247

				63	12	42	59	55	0		232
161	152	19-12	10:27	63	9	49	58	54	18	107	134
				63	9	49	58	54	18		134
162	153	19-12	11:28	63	15	47	58	46	36	65	92
				63	15	47	58	46	36		93
163	155	19-12	13:08	63	24	16	58	35	18	431	473
				63	24	16	58	35	18		471
164	99	19-12	19:29	63	24	6	60	42	47	384	422
				63	24	6	60	42	47		417
165	74	19-12	22:55	63	47	20	61	13	15	590	613
				63	47	20	61	13	15		645
166	38	20-12	10:56	64	57	36	63	31	48	353	370
				64	57	36	63	31	48		388
167	37	20-12	14:28	64	51	27	63	54	59	387	406
				64	51	27	63	54	59		419
168	36	20-12	17:10	64	54	20	64	15	56	1033	1114
				64	54	20	64	15	56		1053
169	36/37	20-12	19:09	64	52	4	64	6	10	231	230
				64	52	4	64	6	10		231
170	156.1	21-12	2:20	64	57	35	63	32	10	376	340
				64	57	35	63	32	10		376
171	156.1	21-12	3:54	64	57	38	63	32	2	100	347
				64	57	38	63	32	2		316
172	156.2	21-12	6:12	64	57	34	63	31	59	327	368
				64	57	34	63	31	59		353
173	156.3	21-12	8:38	64	57	28	63	31	42	370	414
				64	57	28	63	31	42		382
174	156.4	21-12	11:06	64	57	42	63	31	50	314	353
				64	57	42	63	31	50		346
175	156.5	21-12	13:57	64	57	35	63	31	34	334	364
				64	57	35	63	31	34		365
176	156.6	21-12	17:00	64	57	35	63	31	38	321	376
				64	57	35	63	31	38		321
177	156.7	21-12	20:09	64	57	27	63	31	10	314	394
				64	57	48	63	31	10		314
178	156.8	21-12	23:11	64	57	33	63	32	23	317	334
				64	57	58	63	32	23		317
179	156.9	22-12	1:56	64	57	36	63	32	1	351	350
				64	57	27	63	32	1		351
180	157	22-12	18:11	64	49	25	63	11	48	362	385
				64	49	8	63	11	48		336
181	158	22-12	20:36	64	38	3	62	52	48	606	622
				64	38	7	62	52	48		626
182	159	22-12	23:13	64	33	56	62	35	45	775	797
				64	33	51	62	35	45		818
183	160	23-12	1:35	64	28	15	62	15	29	666	740
				64	27	59	62	15	29		704
184	161	23-12	3:38	64	23	26	61	55	26	564	597
				64	23	28	61	55	26		559
185	162	23-12	5:30	64	12	55	61	55	38	559	571

				64	12	56	61	55	38		566
186	163	23-12	7:31	64	2	53	61	45	29	1076	1029
				64	2	45	61	45	29		1094
187	164	23-12	9:25	63	56	53	61	32	37	84	115
				63	56	53	61	32	37		213
188	165	23-12	11:35	63	47	16	61	12	58	548	590
				63	47	16	61	12	58		594
189	166	23-12	14:20	63	35	1	60	58	44	586	630
				63	34	60	60	58	44		628
190	167	23-12	16:44	63	24	2	60	42	10	402	442
				63	24	2	60	42	10		444
191	168.1	26-12	2:00	63	24	9	60	42	53	383	414
				63	24	10	60	42	53		415
192	168.1	26-12	2:57	63	24	39	60	42	52	103	397
				63	24	43	60	42	52		396
193	168.2	26-12	8:04	63	25	26	60	41	11	338	379
				63	25	28	60	41	11		377
194	168.3	26-12	14:16	63	24	28	60	37	16	413	450
				63	24	28	60	37	16		444
195	168.4	26-12	20:11	63	25	15	60	36	10	361	414
				63	25	24	60	36	10		398
196	168.5	27-12	2:18	63	24	28	60	33	16	340	382
				63	24	30	60	33	16		370
197	169.1	28-12	2:10	64	49	53	63	12	21	263	308
				64	50	4	63	12	21		287
198	169.1	28-12	3:08	64	49	29	63	11	57	111	338
				64	49	26	63	11	57		338
199	169.2	28-12	8:16	64	49	37	63	13	26	224	227
				64	49	33	63	13	26		238
200	169.3	28-12	14:09	64	48	54	63	13	50	119	150
				64	48	54	63	13	50		148
201	169.4	28-12	17:59	64	49	1	63	14	13	98	119
				64	49	2	63	14	13		117
202	169.5	29-12	2:01	64	47	42	63	12	8	122	166
				64	47	28	63	12	8		137
203	170	29-12	13:45	64	38	13	62	45	55	163	183
				64	38	20	62	45	55		166
204	171	29-12	14:45	64	36	32	62	47	18	645	707
				64	36	26	62	47	18		676
205	172	29-12	16:22	64	31	56	62	40	20	472	514
				64	31	53	62	40	20		494
206	173	29-12	17:45	64	32	22	62	45	48	444	460
				64	32	29	62	46	25		469
207	174	29-12	19:27	64	31	48	62	28	54	568	591
				64	31	45	62	28	12		601
208	175	29-12	21:24	64	34	25	62	26	10	520	552
				64	34	26	62	26	13		534
209	176	29-12	22:40	64	33	54	62	35	54	783	830
				64	33	56	62	35	48		838
210	177.1	29-12	2:45	64	38	51	62	55	19	573	598

				64	38	43	62	55	9		594
211	177.1	30-12	3:54	64	38	44	62	55	39	101	642
				64	38	40	62	54	32		611
212	177.2	30-12	8:07	64	38	44	62	53	56	623	673
				64	38	33	62	53	46		629
213	177.3	30-12	14:21	64	37	26	62	47	44	675	734
				64	37	10	62	47	37		672
214	177.4	30-12	21:55	64	36	17	62	45	0	628	632
				64	36	32	62	44	56		635
215	177.5	31-12	1:54	64	36	3	62	44	59	550	593
				64	36	2	62	45	0		592
216	178.1	2-1	2:05	63	58	0	61	41	0	1124	1170
				63	58	5	61	41	19		1180
217	178.1	2-1	3:37	63	58	21	61	41	57	112	1188
				63	58	24	61	42	7		1190
218	178.2	2-1	8:00	63	58	26	61	44	15	1108	1170
				63	58	35	61	44	33		1171
219	178.3	2-1	14:02	63	57	50	61	40	32	1107	1158
				63	57	57	61	40	22		1169
220	178.4	3-1	20:08	63	57	37	61	35	59	889	933
				63	57	54	61	35	45		944
221	178.5	3-1	1:55	63	56	29	61	37	58	1101	1157
				63	56	27	61	38	2		1158
222	179	3-1	10:05	64	17	5	61	56	37	690	727
				64	16	58	61	56	15		705
223	180	3-1	11:35	64	18	7	61	42	18	983	999
				64	18	3	61	42	38		1036
224	181	3-1	12:41	64	19	2	61	48	13	889	940
				64	18	58	61	48	23		908
225	182	3-1	13:52	64	20	8	61	43	56	720	704
				64	20	7	61	44	0		715
226	183	3-1	15:07	64	21	9	61	40	7	402	870
				64	21	12	61	40	14		403
227	184.1	4-1	2:43	64	32	57	62	21	28	691	708
				64	32	54	62	21	41		681
228	184.1	4-1	4:01	64	32	48	62	21	28	100	673
				64	32	47	62	21	25		675
229	184.2	4-1	7:56	64	33	20	62	20	2	579	687
				64	33	23	62	20	4		683
230	184.3	4-1	14:20	64	33	16	62	16	50	481	488
				64	33	19	62	16	50		493
231	184.4	4-1	19:58	64	33	39	62	16	5	626	662
				64	33	46	62	16	14		639
232	184.4	4-1	22:00	64	33	56	62	15	46	60	635
				64	34	3	62	15	58		598
233	184.5	5-1	1:57	64	34	3	62	16	50	508	590
				64	33	59	62	17	5		612

5. FRUELA 96 STATIONS AND DEPTHS

FRUELA 96

CAST	STATION	DATE	HOUR GMT	LATITUDE			LONGITUDE			DEPTH CAST	DEPTH STATION
234	185	18-1	13:55	63	11	4	59	22	7	206	792
			14:30	63	11	31	59	22	18		786
235	186	19-1	2:47	64	3	9	61	45	50	1004	1027
			3:47	64	3	6	61	45	56		1008
236	187		17:21	64	54	18	64	28	57	726	678
			18:17	64	53	47	64	29	27		590
237	187.2	20-1	2:09	64	54	33	64	29	6	100	970
			2:34	64	54	43	64	29	12		1007
238	188		4:08	64	52	55	64	16	39	596	621
				64	52	53	64	16	44		594
239	189		5:40	64	51	24	63	54	39	100	409
				64	51	20	63	54	52		414
240	190		9:29	64	57	31	63	31	24	334	354
			9:54	64	57	37	63	31	24		353
241	191		11:01	64	51	58	63	14	21	302	320
			11:37	64	52	15	63	14	25		314
242	192		14:48	64	37	51	62	52	38		529
			15:27	64	37	37	62	52	20		526
243	193		16:35	64	33	51	62	35	31	772	815
			17:28	64	34	1	62	35	32		809
244	194		21:24	64	29	34	62	15	38	721	765
			22:00	64	29	34	62	15	32		750
245	195		23:20	64	22	49	61	53	58	515	544
			23:57	64	22	47	61	54	7		554
246	195.2	21-1	2:40	64	22	35	61	53	6	103	
			3:15	64	22	35	61	52	23		
247	196		4:40	64	12	36	61	55	5	620	627
			5:00	64	12	36	61	55	6		627
248	197	22-1	20:15	62	42	25	65	27	34	3163	3236
			22:41	62	43	38	65	26	36		3266
249	198		3:14	62	56	16	65	3	30	3196	3250
			5:48	62	56	38	65	3	23		3258
250	199		10:20	63	11	19	64	39	46	2742	2784
			12:20	63	12	10	64	39	38		2810
251	200		14:15	63	25	55	64	16	37	234	272
			14:40								
252	201		21:15	63	41	21	63	50	32	215	240
			22:02	63	41	14	63	50	14		240
253	201.2	23-1	1:44	63	41	18	63	50	52	218	242
			2:18	63	41	13	63	51	6		236
254	202		4:34	63	54	51	63	26	2	393	420
			5:02	63	54	56	63	26	10		
255	203		7:00	64	8	54	63	5	50	615	634
			7:47	64	8	35	63	5	26		622
256	204		13:38	63	48	27	61	52	4	165	187
			14:19	63	48	28	61	53	6		204
257	205		19:30	63	33	35	62	14	22	260	280

			19:59	63	33	28	62	13	43		284
258	206		22:42	63	19	25	62	41	2	162	189
			23:09	63	19	26	62	40	45		184
259	207	1-1	2:31	63	4	40	63	6	31	570	597
			3:15	63	4	37	63	8	27		619
260	208			62	49	27	63	32	14	1918	1969
			7:29	62	49	34	63	32	20		1998
261	209		14:25	62	34	51	63	56	13	4042	4083
			17:22	62	35	11	63	55	57		4086
262	210		19:54	62	21	9	64	20	15	2756	2780
			22:18	62	21	48	64	19	14		2798
263	211	25-1	4:49	61	57	57	63	8	24	3768	3836
			7:54	61	58	4	63	8	20		3838
264	212		15:24	62	14	3	62	46	46	3978	4034
			18:33	62	14	19	62	46	35		3933
265	213		20:30	62	28	58	62	22	45	358	388
			21:08	62	30	19	62	23	8		398
266	214	26-1	1:10	62	46	11	61	57	6		412
			1:42	62	46	11	61	56	47		441
267	215		5:31	63	2	23	61	31	7	524	560
			6:17	63	2	45	61	29	28		540
268	216		9:57	63	18	30	61	5	15	704	722
269	217		12:56	63	34	30	60	39	37	706	734
			13:50	63	34	42	60	39	2		750
270	218		17:20	63	51	6	60	10	41	215	232
			17:45	63	51	8	60	10	36		244
271	219		20:21	63	39	25	59	32	56	217	235
			20:48	63	39	28	59	32	44		198
272	220	27-1	0:15	63	20	3	59	56	33	341	394
			0:46	63	20	13	59	56	24		
273	221		4:29	63	1	0	60	16	37	810	862
			5:20	63	0	28	60	16	0		
274	222		8:26	62	41	35	60	36	34	233	254
			9:01	62	41	40	60	36	34		261
275	223	28-1	2:41	62	27	55	62	26	2	1138	1180
				62	27	59	62	26	3		
276	223.1		8:30	62	28	7	62	25	14	916	1032
			9:25	62	28	45	62	24	59		
277	223.2		14:11	62	28	16	62	23	34	836	875
			15:05	62	27	41	62	23	8		940
278	223.3		20:00	62	27	29	62	23	12	1031	1040
			21:04	62	27	22	62	23	0		1062
279	223.4	29-1	2:00	62	26	56	62	23	20	1238	1282
			3:20	62	26	25	62	24	13		1360
280	224		19:57	62	55	33	59	58	37	1023	1065
281	224.1	30-1	2:04	63	1	5	60	16	57	824	863
			3:10	63	1	14	60	16	54		866
282	224.2		8:00	62	59	28	60	13	8	952	997
			9:01	62	59	9	60	13	8		
283	224.3		13:56	62	55	48	60	7	33	1011	1010
			15:07	62	55	4	60	4	56		1010
284	224.4		20:02	62	51	34	59	57	21	757	894

			21:04	62	51	23	59	55	22		
285	224.5	31-1	2:36	62	46	58	59	46	55	978	1036
			3:42	62	46	38	59	44	10		1202
286	225.1		2:44	64	3	6	61	45	49	1022	1053
			3:49	64	3	39	61	46	56		
287	225.2		8:25	64	3	5	61	46	45	1121	1170
			8:31	64	3	2	61	46	40		1156
288	225.3		14:01	64	2	55	61	46	47	1087	1138
			15:12	64	2	51	61	47	18		
289	225.4		20:01	64	2	43	61	45	57	1072	1124
			21:06	64	2	23	61	46	29		1144
290	225.5	2-1	2:20	64	2	17	61	46	50	1092	1150
291	226	3-1	2:16	64	51	25	63	54	42	30	410
			2:34	64	51	17	63	55	27		408
292	226.1		3:16	64	51	25	63	55	46	360	379
293	226.2		8:51	64	51	13	63	54	51	384	402
				64	51	10	63	54	53		406
294	226.3		14:00	64	51	44	63	58	32	492	502
				64	51	34	63	59	6		461
295	226.4		20:00	64	52	39	63	58	58	167	194
			20:27	64	52	53	63	58	40		290
296	226.5		22:16	64	50	33	63	55	27	325	336
			22:48	64	50	16	63	54	34		
297	226.6	4-1	2:08	64	50	39	64	1	46	379	414
			2:39	64	50	44	64	1	41		380
298	227.1		20:03	64	32	26	62	30	26	740	770
			20:58	64	32	21	62	29	54		753
299	227.2	5-1	1:05	64	32	34	62	31	8	763	785
			2:08	64	32	29	62	31	23		739
300	227.3		8:02	64	32	5	62	28	47	670	689
			8:50	64	31	60	62	28	27		701
301	227.4		14:10	64	30	5	62	22	39	647	672
			14:59	64	30	2	62	22	11		681
302	227.5		19:50	64	20	26	62	18	55	567	599
				64	8	13	62	18	45		

6. CTD METHODS

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Surface-to-bottom CTD cast was performed with a GO MkIIIC WOCE probe provided with extra dissolved oxygen, fluorescence and light transmission sensors. Water samples were obtained routinely at 24 levels with a GO Rosette equipped with 10 l Niskin bottles. Some of the Niskin bottles carried RTM SiS 4002 digital reversible thermometers. Salinity was obtained from water samples by means of a Guildline Autosal 8600 B. The θ has been derived from CTD profiles. Calibration of CTD after the FRUELA cruises is annexed as GIF file

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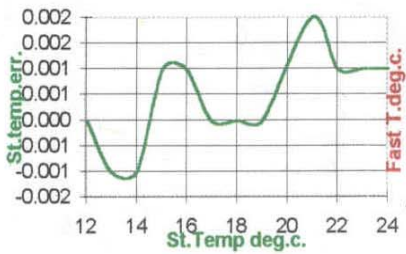
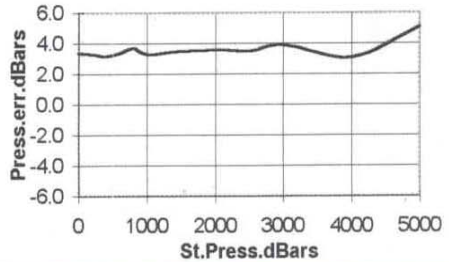
CTD MK3 SPAIN : IM960510

St.Temp atb1250-X	Temp.Sens. Y	Temp.err. Y-X(deg.c.)	St. Temp. atb1250-X	T.fast Sens. Y	T.fast err. Y-X(deg.c.)	St.Cond. atb1250-X	Cond.Sens. Y	Cond.err. Y-X(mmho/c	St.press. D.W.T.-X	Press.Sens. Y	Press.err. Y-X(dBars)
24.051	24.052	0.001	24.051	24.067	0.016	55.092	55.092	0.000	0	3.4	3.4
23.043	23.044	0.001	23.043	23.050	0.007	53.993	53.994	0.001	200	203.3	3.3
22.008	22.009	0.001	22.008	22.009	0.001	52.865	52.868	0.003	400	403.2	3.2
20.993	20.995	0.002	20.993	20.992	-0.001	51.767	51.773	0.006	600	603.4	3.4
19.018	19.018	0.000	19.018	19.014	-0.004	49.649	49.655	0.006	800	803.7	3.7
18.052	18.052	0.000	18.052	18.046	-0.006	48.624	48.626	0.002	1000	1003.3	3.3
16.999	16.999	0.000	16.999	16.994	-0.005	47.515	47.513	-0.002	1500	1503.5	3.5
16.002	16.003	0.001	16.002	15.999	-0.003	46.466	46.469	0.003	2000	2003.6	3.6
15.063	15.064	0.001	15.063	15.062	-0.001	45.487	45.489	0.002	2500	2503.5	3.5
14.024	14.023	-0.001	14.024	14.024	0.000	44.410	44.412	0.002	3000	3003.9	3.9
13.000	12.999	-0.001	13.000	13.000	0.000	43.360	43.361	0.001	4000	4003.1	3.1
12.047	12.047	0.000	12.047	12.048	0.001	42.387	42.389	0.002	5000	5005.1	5.1
Aver.err:	**0.0005**		**Aver.err:**	**0.0004**		**Aver.err:**	**0.0022**		**Aver.err:**	**3.45**	
St.dev.:	**0.0009**		**St.dev.:**	**0.0063**		**St.dev.:**	**0.0024**		**St.dev.:**	**0.23**	
a:	**b:**	**@:**	**a:**	**b:**	**@:**	**a:**	**b:**	**@:**	**a:**	**b:**	**@:**
-0.0010	1.0001	0.0000	-0.0095	1.0005	0.0000	-0.0002	1.0000	0.0001	3.41	1.00	41.46

Data could be corrected according to best fit least square method:**Y=a+bX**





Sensors	Range:	Accuracy:	Resolution:	Time costant:
Temp.	'-3/32 deg.c.	+-0.002deg.c.	+-0.0005deg.c.	200 msec.
FastT.	-2/32deg.c.	+-0.1deg.c.	+-0.0005deg.c.	30msec.
Cond.	0/65mmho/cm	+-0.002mmho/cm	+-0.0001mmho/cm	30msec.
Press.	0/7000dBars	0.014%f.s.	0.0015%f.s.	-

CAL. Date: 25/06/96

CAL.File: IM960510.C03

Cruise Ref21/6 Drake

TESTED BY:

7. CHEMICAL METHODS

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A Metrohm E-654 pH-meter equipped with a Ross (Orion 81-04) combined glass electrode was used to determine **pH** on the NBS scale. The temperature was measured using a platinum resistance thermometer and finally pH was referred to a standard temperature of 15°C (pH_{15}) according to Pérez and Fraga (1987a). The method has a shipboard precision of ±0.002 pH_{15} (Ríos and Rosón, 1996) and an accuracy of ±0.004 pH_{15} using samples of Certified Reference Material (CRMs) provided by Dr. Dickson from the Scripps Institution of Oceanography (Ríos and Pérez, 1999; Ríos and Rellán, 1998).

Alkalinity was determined by automatic potentiometric titration with HCl at a final pH of 4.44 (Pérez and Fraga, 1987b). The electrodes were standardised using an NBS buffer of pH 7.413 and checked using an NBS buffer of 4.008. This method has a precision of 0.1% (Pérez and Fraga, 1987b), and an accuracy of ±1.4µmol.kg^{-1} (Ríos and Pérez, 1999; Ríos and Rellán, 1998).

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Nutrient samples were filtered through 0.45 µm Millipore filter prior to analysis and were analysed within 12 h after collection; and were stored in the refrigerator prior to analysis and in the dark. Nutrient concentrations were determined by segmented flow analysis with Technicon AAII systems, following Hansen and Grasshoff (1983) with some improvements (Mouriño and Fraga, 1985; Álvarez-Salgado *et al*., 1992). The analytical error was ±0.05 µmol·kg^{-1} for nitrate, ±0.05 µmol·kg^{-1} for silicic acid and ±0.01 µmol·kg^{-1} for phosphate. **Dissolved oxygen** was determined by Winkler potentiometric titration. The estimated analytical error was ±1 µmol·kg^{-1}. Oxygen saturation was calculated following Benson and Krause equation (UNESCO, 1986). **Chlorophyll *a*** was measured using 90% acetone extraction in a 10,000 R Turner fluorometer (Yentsch and Menzel, 1963). The precision was ± 0.05 mg·m^{-3}. **Particulate organic matter** (filtration volume 1 l) was collected on Whatman GF/F filters and analyses were performed in a PE 2400 elemental analyser, with a precision of ±0.04 µmol·kg^{-1} for nitrogen and ±0.1 µmol·kg^{-1} for carbon.

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Seawater samples for **DOC** analysis were collected with 100 ml polyethylene syringes with teflon plunger tips and filtered by hand through Whatman Puradisc GF/F disposable filter devices (0.7µm pore size) on polypropylene housing. The filtrate was drawn eventually into 50 ml polyethylene containers. The filtering system and the containers used for DOC had been previously soaked on 0.1 N HCl, and rinsed with Milli-Q water. In addition, the containers were rinsed three times with 50 ml of sample. Samples were immediately stored at -70ºC until analysis in the base laboratory, eight months later. This storage technique has demonstrated no artefactual results on the micromolar scale (Hansell and Carlson, 1998b).

DOC determination was performed by high temperature catalytic oxidation (HTCO) with a commercial Shimadzu TOC-5000. The combustion quartz tube was filled with a 0.5% Pt on Al_2O_3 catalyst. Three to 5 replicate injections of 200 µl were performed per sample. The concentration of DOC was determined by subtracting the average peak area from the instrument blank area and dividing by the slope of the standard curve. The instrument blank is the system blank plus the filtration blank. The system blank was determined by subtracting the DOC in UV-Milli-Q to the total blank. Measurements made with the high sensitivity catalyst (Pt on silica wool) produced values <2 µmol C l^{-1} for fresh UV-Milli-Q water. The filtration blank (determined by filtering UV-Milli-Q water through the filtration system) was <2 µmol C l^{-1}. Before sample analyses, the catalyst was washed by injecting UV-Milli-Q, for at least 12 h, until the system blank was low and stable. The system blank was <8 µmol C l^{-1}. The device was standardized with Potassium Hydrogen Phthalate (KHP). The coefficient of variation (C.V.) of the peak area for the 3-5 replicate analyses of each sample was ~1%. The accuracy of our HTCO system has been tested within the international intercalibration exercise conducted by J. Sharp (Univ. of Delaware), with very satisfactory results (within ±10%; J. Sharp, pers. com.).

8. CHLOROPHYLL a, PRIMARY PRODUCTION AND COMMUNITY METABOLIMS METHODS

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Samples were obtained with PVC Niskin bottles in a CTD rossete system (no trace metal clean) at depths of 100, 50, 25, 10 and 1% of surface PAR. Particulate material was concentrated by filtration of 100-250 ml of seawater and pigments were extracted in 90% acetone (Parsons *et al*., 1984) for 24 h in dark at 4° C. Chlorophyll a concentration was measured fluorimetrically on board, using a Turner Designs fluorometer. No sonication or destruction of filters was carried out. Samples for chlorophyll and primary production (after incubation) measurements were size fractionated by sequential filtration through Nucleopore 10 µm, Nucleopore 2 µm and Whatman GF/F filters, under vacuum pressures lower than 250 mm Hg.

The method followed for the C^{14} uptake experiments was based on that described in the JGOFS protocols. Water samples from each sampled depth were poured into three clear 300 ml polycarbonate bottles. In addition, a dark bottle was used for the 100%, 25% and 1% levels. Each bottle was inoculated with 740 kBq (20 µCi) of C^{14} labelled sodium bicarbonate and incubated for 24 h in a deck incubator refrigerated with surface water. The different light regimes of the sampling depths were simulated using neutral density filters. For some stations, two sets of data were obtained, one from on deck incubations and the other from *in situ* incubations. Correlation between the two data sets was very good ($n=25$; $r^2= 0.98$; $p<0.0001$). Following incubation, samples were sequentially filtered (see previous section) and the filters were placed into scintillation vials and exposed to concentrated HCl fumes for 12 h. The incorporated radiocarbon was determined using a Beckman Liquid Scintillation Counter.

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Rates of O_2 production and consumption by the planktonic community were determined by *in vitro* changes of seawater O_2 concentration in transparent (“light”) and dark

bottles incubated *in situ* during 24 hours. Sampling and incubation were carried out at the same depths of ^{14}C experiments. Twelve 250 ml, gravimetrically calibrated, borosilicate bottles were carefully filled from every Niskin bottle by means of a silicone tube, overflowing more than 500 ml. Filled bottles were immediately closed and kept, in darkness, into a deck incubator refrigerated with surface water. An initial set of four dark bottles was fixed at once, the remaining (four dark, covered with aluminium foil, and four transparent or "light" bottles) were attached to a buoy at the depths of origin of the sampled water. Dissolved oxygen concentration was determined following the method described above. Data were available only for 4 stations of the FRUELA 95 cruise, two in tje Gerlache Strait and two in the Bransfield Strait. Fixing and storage procedures, reagents and standardisation followed the recommendations by Grasshoff *et al*. (1983). Dissolved oxygen concentration was measured through automated precision Winkler titration performed with a Metrohm 716 DMS Titrino, using a potentiometric end point. Aliquots of fixed samples were delivered by a 50 ml overflow pipette.

9. PHOTOSYNTHESIS, PRIMARY PRODUCTION AND PHYTOPLANKTON GROWTH RATES METHODS

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Phytoplankton light absorption coefficients (PhytopAbsortCoeff.xls)

Phytoplankton light absorption coefficients [$a_{ph}(\lambda)$, m^{-1}] were determined by filtering seawater volumes of 1 to 4 litres through 25 mm Whatman GF/F filters. The optical density spectra of concentrated material were measured on a Kontron UVIKON 860 dual-beam spectrophotometer at 1 nm bandwidth from 400 to 750 nm using a wet GF/F filter as a blank. Phytoplankton pigments were extracted in methanol (Kishino et al. 1985) and the optical density of non-algal material retained on the filters was determined in the same way. Absorbance at 750 nm was subtracted from all other wavelengths in the spectra. The correction for pathlength amplification on filters was done following the methodology of Arbones et al. (1996).

Photosynthesis-irradiance relationships (FotoParam.xls)

Fourteen subsamples collected in 75 ml Corning tissue culture flasks were inoculated with 3.70 x 10^5 Bq (10 µCi) of ^{14}C-labelled bicarbonate and placed in linear incubators illuminated by tungsten-halogen lamps (50 W, 12 V) of a known light spectra. The flask at the end of the incubator was covered with aluminium foil and used to check dark carbon fixation. A digital temperature refrigeration unit was used to maintain the samples at ambient temperature. The PAR (E_{PAR}) at the position of each bottle in the incubators was measured with a Li-Cor cosine sensor LI-190SA. After 2 h of incubation, samples were filtered through 25 mm Whatman GF/F filters. The filters were exposed to concentrated HCl fumes for 12 h to eliminate unincorporated ^{14}C. The external standard and the channel ratio methods were used to calculate disintegrations per minute (dpm).

Because photoinhibition was not observed, the broadband photosynthetic parameters, P_m^B [mg C (mg Chl)$^{-1}$ h^{-1}] and α^B [mg C (mg Chl)$^{-1}$ h^{-1} (µmol m^{-2} s^{-1})$^{-1}$] were estimated by fitting the data to the model of Webb et al. (1974):

$$P_z^B = P_m^B\left[1 - \exp(-\alpha^B \cdot E_{PAR} / P_m^B)\right] \qquad (1)$$

where P_z^B [mg C (mg Chl)$^{-1}$ h^{-1}] is the Chl-specific rate of photosynthesis at each sampled depth.

The spectral quality of the incident light did not change along the incubators (Figueiras et al., 1999) and therefore the spectral irradiance $E_q(\lambda)$ at each location in the incubators was deduced by multiplying the normalised spectra of the tungsten-halogen lamp $E_N(\lambda)$ by the corresponding E_{PAR} at each location:

$$E_q(\lambda) = E_N(\lambda) \cdot E_{PAR} \qquad (2)$$

where

$$E_N(\lambda) = E(\lambda) / \int_\lambda E(\lambda) d(\lambda) \qquad (3)$$

The light absorbed by phytoplankton (E_{PUR}, µmol photons m^{-3} s^{-1}) at each position in the incubators was calculated following Dubinsky (1980):

$$E_{PUR} = \int_{400}^{700} a_{ph}(\lambda) \cdot E_q(\lambda) d(\lambda) \qquad (4)$$

The maximum quantum yield of carbon fixation [ϕ_m mol C fixed (mol photons absorbed)$^{-1}$] was estimated by fitting the photosynthetic rates P (mg C m^{-3} h^{-1}) to the photosynthetic radiation absorbed by phytoplankton E_{PUR} (µmol photons m^{-3} s^{-1}):

$$P_z = P_m \left[1 - \exp(-\phi'_m \cdot E_{PUR} / P_m)\right] \qquad (5)$$

where $\phi_m = 0.0231 \cdot \phi'_m$. The factor 0.0231 converts milligrams of carbon to moles, µmol of photons to moles and hours to seconds.

From equation (1) the spectral light saturation parameter for light absorbed by phytoplankton [$E_{kPUR} = P_m / \phi'_m$, (µmol photons m^{-3} s^{-1})], is analogous to the saturation parameter for PAR radiation [$E_{kPAR} = P_m^B / \alpha^B$, (µmol photons m^{-2} s^{-1})] derived from broad band photosynthesis – irradiance relationships.

Primary production (PrimaryProd.xls)

Primary production (PP) was integrated to the depth of 1% of surface irradiance ($Z_{1\%}$):

$$PP = D \int_0^{Z_{1\%}} Chl(z) \cdot P_m^B(z) \cdot \left[1 - \exp(-E_{PUR}(z) / E_{kPUR}(z))\right] dz \qquad (6)$$

where D is the daylength.

Gross phytoplankton growth rates (GrowthRates.xls)

Gross phytoplankton growth rates ($\mu + r$, day^{-1}) were calculated as:

$$\mu + r = \ln\left[1 + \frac{dC/dt}{C}\right] \qquad (7)$$

where dC/dt is the daily integrated primary production (mg C m^{-3} d^{-1}) at each depth:

$$dC/dt = D \cdot Chl \cdot P_m^B \left[1 - \exp(E_{zPUR} / E_{kPUR}\right] \qquad (8)$$

and C (mg C m^{-3}) is the phytoplankton carbon estimated from the slope of the linear regression (model II) between particulate organic carbon POC and Chl.

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10. PHYTOPLANKTONIC DOC AND POC PRODUCTION METHODS

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Time-course incorporation of carbon into the dissolved and particulate fractions was measured by the ^{14}C-technique (Steeman-Nielsen, 1952). Water for incubations was collected from surface (5 m depth), and at some stations also from 10-15 m depth, in 12 l Niskin bottles attached to a rosette sampler. Aliquots (70 ml) were introduced in sterile polystyrene tissue culture bottles (Corning). The bottles were inoculated with 0.3 to 0.7 MBq (8.4 to 19 µCi) of ^{14}C-bicarbonate and incubated under constant light conditions. Surface samples were incubated under 90-100 µmol photons m^{-2} s^{-1} except for samples from stations 8, 17 and 29, which were incubated under 50 µmol photons m^{-2} s^{-1}. In both cases saturation was achieved. Samples from 10-15 m depth were incubated under 9 µmol photons m^{-2} s^{-1} to match the decreased irradiance at these depths (on average 7% ± 4% of surface values, Figueroa et al., 2002). Incubations were made in controlled-temperature baths fixed at *in situ* temperature (± 0.5°C). Part of the bottles (dark bottles) were covered with aluminium foil.

We used Whatman GF/F filters for separating the particulate and dissolved fractions of primary production. Four dark bottles (time-zero bottles) were processed immediately at the beginning of the experiment, in the same way as the dark bottles of the subsequent sampling times. In these samplings, aliquots of 5 ml were taken from two light and two dark bottles for determination of total labelled organic carbon (TOC) and the remaining 65 ml were filtered on GF/F filters for determination of total labelled POC. Aliquots of 5 ml from the remaining two light and two dark bottles were also filtered on GF/F filters and the filtrate collected for determination of labelled DOC. The remaining 65 ml were filtered on Nuclepore polycarbonate 0.8 µm or 2 µm filters (data not shown). Filtration through GF/F filters for DOC sampling was made by gravity. In the other cases, filtration pressure did not exceed 100 mm Hg. Filters were treated with concentrated HCl fumes for ca. 12 h before addition of 4.5 ml of ReadySafe liquid scintillation cocktail. Liquid samples (with labelled TOC or DOC) were acidified with 1 ml HCl 6M

and left open in an orbital shaker for 12 h before adition of 15 ml of scintillation cocktail. Radioactivity was measured in a Beckman LS6000LL liquid scintillation counter. The time-zero values were subtracted from all subsequent samples for correction of abiotic incorporation. Dark bottle values after time-zero blank substraction were on average 4% ± 1% (SE) of the light bottle values for POC measurements, 24% ± 4% of those for DOC and 16% ± 3% of those for TOC, and did not increase appreciably during the experiments. These dark bottle values were not subtracted, following the recommendation of Watanabe (1980). In each experiment, the radioactivity of the ^{14}C-bicarbonate solution added to the incubation bottles was determined in 20 µl aliquots.

Carbon exchange model and compartmental analysis

A simple 3-compartment carbon exchange model for obtaining steady-state rates of production of POC and DOC was used. The equations defining the rates of change of carbon in the compartments are:

$$dC_1/dt = -k(2,1)\ C_1 + k(1,2)\ C_2 - k(3,1)\ C_3 \quad (1)$$

$$dC_2/dt = k(2,1)\ C_1 - k(1,2)\ C_2 + k(2,3)\ C_3 \quad (2)$$

$$dC_3/dt = k(3,1)\ C_1 - k(2,3)\ C_3 \quad (3)$$

where C_i is the carbon concentration in pool i and k(i,j) is the fractional rate constant of flux from C_j to C_i. k(2,1) is the constant of particulate carbon production and would reflect only photosynthetically produced carbon. k(1,2) is considered the constant of respiration of synthesized POC, inferred from its influence on PO^{14}C kinetics. k(3,1) is the constant of dissolved carbon production. No distinction is possible between active excretion by phytoplankton and other sources of labelled DOC release, such as cell lysis. k(2,3) is the constant of heterotrophic assimilation of recently released DOC. The inverse of the rate constant k(2,3) is the turnover time of the photosynthetically produced DOC pool (Lancelot, 1979).

The performance of alternative 3-compartment carbon exchange models was first evaluated by the residual sum of squares (RSS) after fitting to data, as a measure of the remaining unexplained variance. The model which minimized the average RSS for all experiments was chosen. Least-squares non-linear fitting of the model to actual measurements of DO^{14}C and PO^{14}C was made with a computer program especially designed for such compartmental analysis (SAAM II, SAAM Institute, Washington). Data were weighted by the inverse of the standard deviation of duplicates. These analyses yielded estimates of the rate constants of flux between compartments (k(i,j), in

units h^{-1}) and of their variance and total remaining unexplained variance. Once the model was fitted to a set of data, it was possible to derive the DOC and POC production rates (mg C m^{-3} h^{-1}) from the estimates of the rate constants and the concentration of dissolved inorganic carbon (DIC) at each sampling site. No isotopic discrimination factor was considered for the conversion of dpm to carbon units. Percent extracellular release (PER) was calculated as the ratio of DOC production rate to the sum of POC and DOC production rates.

11. PROKARIOTIC PRODUCTION AND ABUNDANCE METHODS

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Samples for determination of prokaryotic abundance (10 to 20 mL) were filtered through 0.2 µm pore diameter black polycarbonate filters and stained with DAPI (1 µg mL^{-1} final concentration) for 5 min before sucking the filters dry (Porter and Feig 1980). Filters were then mounted on microscope slides with non-fluorescent oil (R.P. Cargille Lab., Inc.) and stored frozen until counted. Filters were counted by epifluorescence microscopy with a Nikon Diaphot microscope. About 200-400 prokaryotic cells were counted per sample.

Prokaryotic heterotrophic production was determined by ^{3}H-leucine incorporation (Kirchman et al. 1985) as modified for micro-centrifugation by Smith & Azam (1992). Aliquots of 1.2 mL were dispensed into 2 mL microcentrifuge tubes with a step pipette. Control tubes received 133 µL of 50% TCA and were vortexed. Next, 48 µL of a 1µM solution of ^{3}H-leucine was added to the tubes providing a final concentration of 40 nM (which was found to be saturating in these waters). At least four replicates and two killed controls were incubated per sample. After vortexing, tubes were placed in whirl-pack plastic bags and these were incubated in the dark in a water bath, at temperatures close to *in situ*, for 2 to 4 hours. Incubations were stopped with 133 µL of 50% TCA and vortexing. Next, tubes were spun in a microcentrifuge for 10 min at 16000 *g*. Liquid was aspirated with a Pasteur pipette connected to a vacuum pump, taking care not to leave any droplets, especially around the cap. Pellets were rinsed with 1.5 mL of 5% TCA, vortexed and spun again. Supernatant was sucked again and 0.5 mL of scintillation cocktail were added. The tubes were counted within standard 20 mL scintillation vials in a Beckman scintillation counter on board. Counts were repeated after 48 hours of adding cocktail. These second sets of counts were less variable and had lower blanks than the initial counts. Dpm were calculated by the instrument using the H number.

Prokaryotic heterotrophic production (PHP) was calculated from leucine incorporation (Leu) according to the equation

$$PHP = Leu*CF$$

Where CF is a conversion factor expressed in KgC mol^{-1}. These conversion factors were empirically derived for different samples (see below). From these estimates of production and those of prokaryotic biomass, specific growth rates (μ) were calculated as

$$\mu = [Ln (1 + PHP/PB)] / t$$

Where PB is prokaryotic plankton biomass and t is the time over which the PHP is considered.

12. FLAGELLATES, PROTOZOA AND BACTERIVORY METHODS

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Prokaryotes and nanoflagellate abundance and biomass

Six samples of 100 ml (preserved with glutaraldehyde, 1% final concentration) for prokaryotes and nanoflagellates were taken from surface to below the deep chlorophyll maximum (DCM) at 10 -20 m intervals in each one of the indicated stations (Fig. 1). Water subsamples of 10 - 20 ml for prokaryotes and 30-50 ml for nanoflagellates were filtered throughout 0.2 µm and 0.6 µm polycarbonate filters respectively, and stained with DAPI (4, 6 - diamidino-2- phenylindole, Porter and Feig 1980), at a final concentration of 5 µg ml^{-1} (Sieracki et al. 1985). Abundance of these microorganisms was determined by epifluorescence (Nikon Optiphot) microscopy. Nanoflagellate showing red-orange fluorescence, and /or plastidic structures, were considered phototrophic forms (PNF), while colorless nanoflagellates were counted as heterotrophic (HNF).

Prokaryotic size was determined after measurement of approximately 300 cells from two stations from Bransfield Strait and Bellingshausen Sea with an image analysis system attached to the microscope. We custom modified the software NIH -image to prokaryotic size. The characteristics of the system, the calibration with latex beads and the choice of filters to process the images are detailed in Massana et al. (1997). Prokaryotic biomass was calculated using the carbon to volume relationship derived by Norland (1993) from the data of Simon and Azam (1989).

$$\text{pg C cell}^{-1} = 0.12 \times (\mu\text{m}^3\ \text{cell}^{-1})^{0.7}$$

Nanoflagellate size was determined measuring lengths and widths under the epifluorescence microscope, with a calibrated micrometric eyepiece. From 50 to150 cells (heterotrophic plus phototrophic) were measured per sample. Cell volumes were estimated by assuming the nearest geometrical figure. Carbon content was estimated using a literature volume to carbon factor of 0.22 pg C

μm^{-3} (Børsheim and Bratbak 1987).

Ciliate and large dinoflagellate biomass

Ciliate and large dinoflagellate abundance and biomass was examined in single 1 l samples which were preserved in a 1% final concentration of acidic Lugol solution. One liter sample was settled down for 48 h., then, the supernatant was gently removed until reaching 200 ml. This concentrate was sedimented in 100 ml chambers for at least 48 hours before enumeration, at 200x or 400x magnification, using an inverted microscope attached to a video camera. Enumeration and sizing was performed from the images recorded in the videotape. Ciliate and dinoflagellate average size was determined after measuring all cells recorded per sample (from 44 to around 400 cells) using the software NIH-Image. Ciliate volume was measured by adjusting each cell to the nearest geometric shape. To avoid the probable underestimation of cell volume due to fixation with Lugol's solution (Leaky et al. 1994a, Stoecker et al. 1994), the average cell volume for each identified group was converted to carbon equivalents using the factor experimentally derived for Lugol's fixed marine oligotrichs, 0.2 pg C μm^{-3} (Putt and Stoecker 1989). Carbon weight for tintinnids was estimated using the experimentally determined factor of 0.053 pg C μm^{-3} (Verity and Langdon, 1984).

Grazing, prokaryotic

Water samples were collected at one depth (coinciding with the depth of maximal chlorophyll *a* concentration) in representative selected stations. Estimates of grazing on prokaryotes by protists (HNF, ciliates, dinoflagellates....) were determined by disappearance of fluorescent minicells (*E. coli* strain X-1488, Genetic Stock Center, Yale University), following the Pace et al. (1990) technique. In each determination, 4 l samples were taken from the surface (5 m to 20 m), and divided in two parts. 2 l were filtered through 0.8 µm polycarbonate filters (to avoid prokaryotic predators, and used as controls) and the other 2 l through 50 µm net mesh (to eliminate predators larger than 50 µm, e.g. naupliae). Fluorescent minicells were added to the corresponding samples at 20 % -30 % of natural prokaryotic concentrations. Average volume of the used minicells was 0.065 μm^3, rather similar to the average volume of natural prokaryotes (0.054 μm^3). Incubations were run in the dark at *in situ* temperature, which ranged from -1.19 to 2.5 ^oC and for 48 h. Minicell, natural prokaryotes, HNF, ciliate and large dinoflagellate abundance and biomass were determined at the beginning of the experiment and at 48 hours by epifluorescence microscopy.

Calculations of consumed prokaryotes l^{-1} d^{-1} was obtained following the mathematical model of Salat and Marrasé (1994)**:**

$$g = -(1/t)* \text{Ln} (Mi_t/Mi_o);$$

g: grazing rate d^{-1}; t: incubation time; Mi_t: number of minicells at final time; Mi_o: number of minicells at initial time.

$$a = (1/t)* \text{Ln} (PN_t/PN_o)$$

a: net growth rate d^{-1}; t: incubation time; PN_t: Prokaryotic number at the end of the experiment, PN_o: Prokaryotic number at the beginning of the experiment.

$$G = (g/a)* (PN_t- PN_o)$$

G: Total grazing (Prokaryotes consumed l^{-1} d^{-1})

Grazing was expressed as grazed biomass with total grazing plus the averaged biomass of "in situ" prokariotes.

13. MESOZOOPLANKTON ABUNDANCE, BIOMASS, GUT CONTENT AND GRAZING METHODS

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Zooplankton samples were collected by 200-0 m vertical tows of a modified triple-ring WP2 net with 0.125 m^2 mouth area and 200 µm mesh size. Cod end contents were immediately fractionated into three size fractions, 200-500 (small), 500-1000 (medium), and >1000 µm (large), using sieve cups equipped with Nitex screens

Samples for taxonomic analysis were preserved in 2-4% sodium borate-buffered formalin, and later examined under a stereomicroscope to assess the species composition and abundance. We did not include Actinopoda and Foraminifera in our taxonomic analysis, in spite of their high densities in some stations, because our sampling method was not adequate for these groups. Similarly, the abundance data of large size zooplankton (Euphausiids and Salps) must be considered with caution because of potential net avoidance or extremely aggregated distributions. Samples for biomass analysis were rinsed with 0.2 µm filtered seawater, filtered onto pre-combusted (450 °C, 24 h), pre-weighed Whatman GF/A filters and dried at 60 °C during 24 h; their dry weight was measured with a Sartorius microbalance. After grinding each sample in a mortar, the CNH content of a subsample was measured with a Perkin Elmer CNH 2400-II analyzer.

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For the analysis of gut pigment contents, zooplankton from the different size fractions was rinsed by immersion in filtered (0.2 µm) seawater, filtered onto 45 mm diameter sharkskin filters (Head, 1986), and stored at -60 ºC in the dark. The whole procedure was completed in less than 5 min. Animals for gut evacuation experiments were collected using a WP2 net equipped with closed, soft plastic cod ends. Cod end contents were size fractionated as above and introduced in a cooler filled with filtered

seawater from the same station. Subsamples were filtered and stored (as above) during 45 min for copepods and 3 h for euphausiids. Sampling interval was 5 min during the first 30 minutes for both groups, with additional sampling at 45 min for copepods and at 45, 60, 90, 120 and 180 min for euphausiids.

Animals were picked from the frozen filters, within 1 year of collection, under a dim light stereomicroscope. The number of copepods picked varied between 1 and 50, and was typically greater than 10. When the number was large enough, duplicate samples were taken. Euphausiids were analysed independently, except for a few small animals which were pooled in groups. No attention was paid to species or development stage, but carnivorous species were avoided. Animals were placed in 25 ml glass vials with 5 ml of 90 % acetone and pigments were extracted overnight, in the dark, at 4 ºC. Fluorescence was measured in a Turner Designs II fluorometer before and after acidification (Mackas and Bohrer, 1976). Pigment concentration was estimated as chlorophyll *a* equivalents (Chl *a)*. No correction for background fluorescence or pigment destruction was applied.

We used the gut pigment technique (Mackas and Bohrer, 1976) to measure grazing rates of herbivorous crustacean zooplankton. Individual ingestion rate was calculated as

$$I = GPC \times k$$

where I is ingestion rate (ng Chl *a* ind^{-1} day^{-1}) , GPC is individual gut pigment content (ng Chl *a* ind^{-1}) and k (d^{-1}) is the gut evacuation rate, represented by the slope of the exponential decay in gut contents with time obtained in the gut evacuation experiments (Mackas and Bohrer, 1976). Population grazing rates of each zooplankton category were calculated as individual ingestion (calculated by equation above) times population densities. Chlorophyll a values were converted into C using a C:Chl factor of 60.

CRUISE: 1 stands for first cruise (3 December 1995 to 5 January 1996) 2 stands for second cruise (17 January 1996 to 5 February 1996)
GRP: 1, 2 and 3 stand for the 3 groups of stations defined according to the community structure
sta: each number represents one station
rep: In some stations, we sampled several times consecutively to examine diel variations. Each each number represents the position within a series of samples corresponding to a diel cycle station
con1000: individual gut contents in > 1000 µm zooplankton. Units: ng chla $indv^{-1}$

con500: individual gut contents in 500-1000 µm zooplankton. Units: ng chla $indv^{-1}$
coneuf: individual gut contents in euphausiids. Units: ng chla $indv^{-1}$
con200: individual gut contents in 200-500 µm zooplankton. Units: ng chla $indv^{-1}$
gpt1000: Gut passage time of >1000 µm zooplankton. Units: days
gpt500: Gut passage time of 500-1000 µm zooplankton. Units: days
num200: areal density of 200-500 µm zooplankton. Units: $indv.m^{-2}$
num1000: areal density of >1000 µm zooplankton. Units: $indv.m^{-2}$
num500: areal density of 500-1000 µm zooplankton. Units: $indv.m^{-2}$
numeuf: areal density of euphausiids. Units: $indv.m^{-2}$
pin200: Total ingestion rate of 200-500 µm zooplankton. Calculated as individual content times nareal density divided by gut passage time. Units: ng Chla m^{-2} day^{-1}
pin1000: Total ingestion rate of >1000 µm zooplankton. Calculated as individual content times nareal density divided by gut passage time. Units: ng Chla m^{-2} day^{-1}
pin500: Total ingestion rate of 500-1000 µm zooplankton. Calculated as individual content times nareal density divided by gut passage time. Units: ng Chla m^{-2} day^{-1}
pineuf: Total ingestion rate of euphausiids. Calculated as individual content times nareal density divided by gut passage time. Units: ng Chla m^{-2} day^{-1}
chla: areal chlorophyll concentration. Units: mg Chla m^{-2}
Prodint: Integrated primary production. Units: $mgCm^{-2}$ day^{-1}
%CLH: daily chlorophyll percent removal by the zooplankton community (all fractions summed).
%PP: daily primary production percent removal by the zooplankton community (all fractions summed).
%clh200: daily chlorophyll percent removal by the 200-500 µm zooplankton size fraction.
%clh500: daily chlorophyll percent removal by the 500-1000 µm zooplankton size fraction.
%clh1000: daily chlorophyll percent removal by the >1000 µm zooplankton size fraction.
%clheuf: daily chlorophyll percent removal by euphausiids.
%pp200: daily primary production percent removal by the 200-500 µm zooplankton size fraction.
%pp500: daily primary production percent removal by the 500-1000 µm zooplankton size fraction.
%pp1000: daily primary production percent removal by the >1000 µm zooplankton size fraction.
%ppeuf: daily primary production percent removal by euphausiids.

14. DOWNWARD PARTICLE FLUXES METHODS

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Drifting sediment traps were deployed during diel cycles as part of the FRUELA 95 (spring) and FRUELA 96 (summer) cruises. The trap array consisted in four individual MULTITRAP baffled and unscreened collectors (60 mm diameter mouth and 640 mm long). The traps were placed at a depth of between 60 and 65 m, and filled with filtered (Whatman GF/F) seawater, supplemented with NaCl (5 g L^{-1}) to avoid losses of materials due to turbulence. The salt solution was sterilised after the NaCl addition and filtered through Whatman GF/F filters right before deployement. In the present data, swimmers were not removed. Nevertheless, visual observation of the bottom of the traps did not show the presence of meso- or macrozooplanktonic organisms. Preservatives to avoid degradation of sinking materials were not used. While, in a recent paper, Nodder and Alexander (1999) reported significant underestimates (> 60 %) of vertical carbon flux when traps were filled with concentrated brine (> 50 ‰), we used a less concentrate brine (39 ‰ aprox.) that was not expected to produce significant effects.

After gently shaking the sample to avoid particulate breakage (fecal pellets are particularly sensitive), the trapped material was split for different analyses. Half of the volume of each trap was filtered through Whatman GF/F filters and PC and PON measured using a Perkin-Elmer 2400 Elemental Analyser. Previously the filters were dried at 60 ºC during 24 hours.

Sub-samples of different volumes were used to determine the concentration of photosynthetic pigments, to identify and count phytoplankton and fecal pellets and to measure carbon incorporation rates by heterotrophic prokaryotes and phytoplankton cells accumulated in the traps.

Chlorophyll *a* was measured after extraction with 90 % acetone using a 10.000 R Turner Design fluorometer.

The C assimilation of the sedimented phytoplankton cells was measured by the ^{14}C method (see Varela et al., 2002), in short-term incubations (1 hour) at saturating light. This measurement was used as an estimate of the viability of the sedimented

primary producers. Absolute rates were normalised to total photosynthetic biomass in the traps by dividing them by the trap carbon concentration.

The microbial consumption of the sedimented carbon was measured as the rate of ^{3}H-leucine incorporation in sub-samples of each trap enclosed in Eppendorf vials. A subsample of the filtered salt solution used to fill the traps before deployment was used as a control for the determination of prokaryotic activity, which was always statistically not different from 0. Leucine incorporation was converted to biomass production using the theoreticaly calculated conversion factor of 3.1 kg C mol leucine^{-1} and a prokaryotic growth efficiency [BP/(BP+Resp)] of 33 %. The results were expressed as carbon processed per amount of carbon sedimented.

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A mooring line equipped with two sequential sediment traps was deployed south of Livingston Island and west of Deception Island at 1000 m depth. One sediment trap was placed 30 meters above bottom (mab), and the other trap was installed in mid-depth waters, 500 mab.

The sediment traps used in this study were Technicap model PPS3. The traps' sample-collecting hull is cylindrical and has an inner diameter of 40 cm. These traps incorporate a carousel with 12 sampling bottles, which is controlled by a programmable motor to preset variable sampling intervals for each of the 12 sampling tubes (Heussner *et al*., 1990). The sampling period comprised almost a complete year (345 days) from March 1st 1995 to February 15th 1996. In this experiment, the sample collecting interval was set to different time intervals: 60 days during late autumn-winter months (from April to September), 30 days in March and October and 15 days in spring and summer months (from November to February) in order to have a higher resolution during the spring and summer months.

Before the trap deployments, the sampling tubes were rinsed and filled with a 5% (~1.7 M) formalin solution prepared from Carlo Erba analytical grade 40% formaldehyde mixed with 0.2 µm filtered seawater to avoid the degradation of organic matter in the trapped particles. The solution was buffered (7.5<pH< 8) with Carlo Erba analytical grade sodium borate. After the trap recovery, the pH was checked and it indicated that the solutions remained buffered.

The total sample was divided into several aliquots to obtain different subsamples for analyzing total mass flux, major constituents: organic carbon, calcium carbonate and nitrogen. Zooplankton organisms, also called “swimmers”, were removed by hand picking under a dissecting microscope.

Sample dry weight was determined using three subsamples filtered onto 47 mm diameter, 0.45 μm preweighed Millipore filters rinsed with distilled water and dried at 40º C for 24 hours. Total mass flux was calculated from the sample dry weight, the collecting trap area and the sampling interval.

For carbon and nitrogen analyses, four subsamples were filtered onto 47 mm diameter preweighed Whatman GF/F glass microfiber filters that had previously been combusted at 550ºC for 24 hours. Two subsamples were used to determine the total carbon (TC) and nitrogen percentages in a LECO CN 2000 analyzer. Another two subsamples were digested with HCl in a LECO CC 100 digestor and the resulting CO_2 was analyzed in the same CN analyzer and assigned to inorganic carbon (IC) content, which is used to calculate the calcium carbonate ($CaCO_3$) percentage.

15. SEDIMENT ACCUMULATION RATES METHODS

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Bottom sediments were collected using a multiple corer (Bowers and Connelly) designed to recover up to 8 replicates of 10 cm diameter. All studied samples presented a layer of clear sea water over the top of the sediment, thus indicating that very low, if any, disturbance of the samples were induced due to insertion of the tube. Three cores (A3, A6 and B2) were selected for 210Pb analysis.

Sediment core lengths ranged from 34 to 40 cm. One core from each station was subsampled at 0.5 to 2-cm intervals from top to bottom and sections were stored and frozen in sealed plastic bags until analysis. The outer 2 mm ring was removed from each section to discard the sediment possibly smeared downward during core insertion. For each section, wet and dry masses were determined before and after drying samples at 40ºC, and dry bulk densities were calculated. About half of the sample was homogenised to carry out carbon, nitrogen and radionuclide analyses, which included ^{210}Pb and gamma-emitters.

Radiometric analysis

210Pb analyses of the sediment samples were performed following the methodology described by Sanchez-Cabeza *et al.* (1998), by total digestion of 200-300 mg sample aliquots. 209Po was added to each sample before digestion as internal tracer. After digestion, samples were made 1 N HCl and 209Po and 210Po were deposited onto silver disks at 60-70 ºC for 8 hours while stirring. Polonium isotopes were counted with á-spectrometers equipped with low background SSB detectors (EG&G Ortec). Due to the elapsed time span between sediment sampling and analyses, 210Pb was assumed to be in radioactive equilibrium with 210Po (half-life = 138 d) in the sediment samples.

Some dried and homogenised samples of each core were counted by gamma spectrometry in calibrated geometries for 2-3 105 seconds. This was done by using a high purity intrinsic Ge detector, surrounded by a 12 cm lead shield, lined with 1 cm copper and 2 mm cadmium, and linked to an 8K MCA. Spectra were analysed with a modified version of the SAMPO family of programs (Koskelo *et al*., 1981). 226Ra activities were determined through 214Pb (351.92 keV) and 214Bi (609.4 keV) lines of

gamma emissions, assuming secular equilibrium with ^{226}Ra. No ^{137}Cs was detected along the cores by gamma spectrometry, due to the combined effects of low concentrations and small amounts of sample available.

Filters containing SPM for ^{210}Pb and ^{210}Po analyses were digested using *aqua regia* after addition of ^{209}Po, while precipitates were centrifuged in order to reduce volumes. All samples were made 1 N with HCl and the same procedure described for sediment samples was followed. As analyses were carried out within 3 months after sample collection, equilibrium between ^{210}Po and ^{210}Pb was not yet reached. One year after the first analyses, samples were reanalysed for ^{210}Po, present by *in situ* disintegration of ^{210}Pb, thus permitting us to determine both ^{210}Pb and ^{210}Po activities at the sample collection date after appropriate decay corrections.

Chemical recoveries of all radiochemical separations ranged from 85 to 100%. For each batch of 10 samples, a reagent blank analysis was also carried out and subtracted for activity determination.

Sediment accumulation rates

We used a one-dimensional advection-diffusion model (Goldberg and Koide, 1962) to calculate the sedimentation rate (S, in mm y^{-1}) and the mixing coefficient (D_B, in cm^2 y^{-1}) that describes the intensity of particle reworking:

$$\frac{\partial A}{\partial t} = D_B \frac{\partial^2 A}{\partial x^2} - S\frac{\partial A}{\partial x} - \lambda A \qquad (1)$$

where A (Bq kg^{-1}) is the excess ^{210}Pb concentration at depth x (cm), and S and D_B are assumed to be constant. As D_B and S cannot be determined independently, a solution for D_B can be obtained if S is known or assumed to be negligible. Assuming steady state conditions and when mixing is not present, equation (1) can be solved under the boundary conditions of $A = A_0$ (x=0) and $A \rightarrow 0$ ($x \rightarrow \infty$), by means of the equation

$$A = A_0 e^{-\frac{\lambda}{S}x} \qquad (2)$$

This is usually done by least-squares fitting of the logarithm of excess ^{210}Pb versus depth for the strata below the SML. Then, the sedimentation rate were calculated by using equation (2) to determine D_B, also using least-square fitting for the SML:

$$A = A_0 e^{(S-\sqrt{S^2+4\lambda D_B})/2D_B)\cdot x} \qquad (3)$$

In this study we consider the ^{210}Pb profiles as a two layer system with an upper mixed layer extending to a distance L below the water-sediment interface (SML) and a second layer below L where no mixing takes place

Carbon and nitrogen

Total carbon (TC%) and nitrogen (N%) were measured in duplicate using a Leco CN 2000 analyser. Two subsamples were used to determine the total carbon percentage (TC%). Two other subsamples were digested with HCl in a LECO CC 100 digester and the resultant CO_2 was analysed in the LECO CN 2000 analyser and assigned to inorganic carbon content (IC%), which was used to calculate the calcium carbonate concentration ($CaCO_3$%). The difference between the two values was assumed to represent the percentage of organic carbon content (OC%).

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DEEP-SEA RESEARCH PART II

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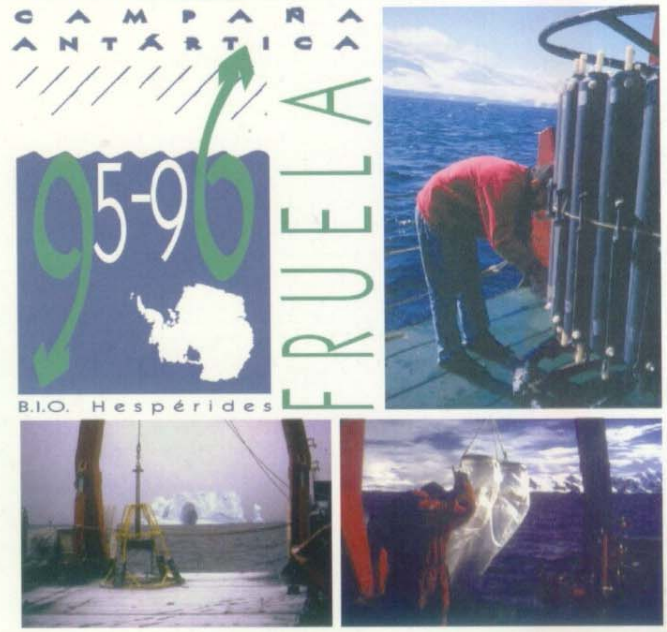
FRUELA – A Carbon Flux Study in the Antarctic Peninsula Area



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