Institut für Meereskunde an der Universität Kiel

Forschungsbereich Ozeanzirkulation und Klima

Physikalische Ozeanographie II

Dr. W. Zenk

14 August 2001

Cruise Summary Report

Ship:	**FS METEOR** cruise no. 50, leg 4 (M50/4)
Dates:	**17 July – 12 August 2001**
Port Calls:	**Reykjavik / Iceland and Rendsburg / Germany**
Institute:	*Institut für Meereskunde an der Universität Kiel*
Observer:	Ireland: Ms Heather Cannaby
Number of Scientists:	24
Chief Scientist:	Dr rer nat Walter Zenk
Principal Project:	Sonderforschungsbereich SFB 460/ Special research initiative ***Thermohaline Circulation Variability in the North Atlantic*** **Subprojects A1 and A3**
Research areas:	North Atlantic: Denmark/Greenland Strait, Iceland Basin Charlie Gibbs Fracture Zone Western European Basin
To be submitted by	*Leitstelle METEOR,* *Institut für Meereskunde der Universität Hamburg*

0 Master

Kapitän Niels Jakobi

1 Scientific Crew

No.	Name	Speciality	Institute
1	Zenk, Walter, Dr.	Chief Scientist	IfMK
2	Afghan, Justine, D.	CO_2-Chemistry	IfMK/SIO
3	Bannert, Bernhard	UW Television	GEO/OKT
4	Bleischwitz, Marc	Tracer Physics	UBU
5	Bulsiewicz, Klaus	Tracer Physics	UBU
6	Cannaby, Heather	Costal Oceanography Observer from Ireland	NUI
7	Csernok, Tiberiu	Marine Physics	IfMK
8	Dombrowsky, Uwe	Marine Physics	IfMK
9	Friis, Karsten, Dr.	CO_2-Chemistry	IfMK
10	Fürhaupter, Karin	Geochemistry	GEO/MaLi
11	Greinert, Jens, Dr.	Geochemistry	GEO
12	Hauser, Janko, Dr.	Oceanography	IfMK
13	Karl, Gerhard	Meteorology	DWD
14	Lorbacher, Katja, Dr.	Hydrography	BSH
15	Lüger, Heike	CO_2-Chemistry	IfMK
16	Malien, Frank	Marine Chemistry	IfMK
17	Marzeion, Benjamin	Marine Physics	IfMK
18	Müller, Thomas, Dr.	Marine Physics	IfMK
19	Niehus, Gerd	Marine Physics	IfMK
20	Nielsen, Martina	Marine Physics	IfMK
21	Ochsenhirt, Wolf-Thilo	Meteorology	DWD
22	Schafstall, Jens	Marine Physics	IfMK
23	Steinfeld, Reiner	Tracer Physics	UBU
24	Steinhoff, Tobias	CO_2-Chemistry	IfMK

2 Participating Institutions

BSH
Bundesamt für Seeschiffahrt und Hydrographie, Bernhard-Nocht-Str. 78, 20597 Hamburg – Germany, e-mail: koltermann@bsh.d400.de

DWD
Deutscher Wetterdienst, Geschäftsfeld Schiffahrt, Bernhard-Nocht-Str. 76, 20359 Hamburg – Germany, e-mail: edmund.knuth@dwd.de

GEO
Geomar Forschungszentrum für Marine Geowissenschaften, Wischhofstr. 1-3, 24148 Kiel – Germany, e-mail: rkeir@geomar.de

IfMK
Institut Für Meereskunde an der Universität Kiel, Düsternbrooker Weg 20, 24105 Kiel – Germany, e-mail: fschott@ifm.uni-kiel.de

MaLi
MariLim, Büro für integrierte Meeres- und Küstenuntersuchungen, Wischhogstr. 1-3, Gebäude 11, 24148 Kiel – Germany, e-mail: tmeyer@mailim.de

NUI
National University of Ireland, Newcastle Road, Galway - Republic of Ireland, e-mail: peter.bowyer@nuigalway.ie

OKT
Oktopus, Gesellschaft für angewandte Wissenschaft, innovative Technologien und Service in der Meeresforschung mbH, Kieler Str. 51, 24594 Hohenwestedt – Germany, e-mail: schriever@biolab.com

SIO
Scripps Institution of Oceanography, University of California, San Diego, 9599 Gilman Drive, La Jolla, CA 92093-0210 – USA, e-mail: jdafghan@pacbell.net

UBU
Universität Bremen, Institut für Umweltphysik, Abt. Tracer-Oceanographie, Bibliothekstraße, 28359 Bremen – Germany, e-mail: mrhein@physik.uni-bremen.de

3 Research Program

The fourth and last leg was again conducted by the *Institut für Meereskunde an der Universität Kiel.* SFB subproject A3 proposed the revisit of the Iceland Basin to continue measurements of the water mass variability in the subpolar gyre in the eastern basins of the North Atlantic. Research subjects are Labrador Sea Water penetrating from the west and Overflow Water entering from the northeast. Labrador Sea Water is generated annually by wintertime convection. Part of this water mass is advected eastward underneath the North Atlantic Current and over the Mid-Atlantic Ridge in the region of the Charlie Gibbs Fracture Zone at ~ 53°N. Its further penetration into the eastern basin is strongly influenced by mixing with Mediterranean Water, Subpolar Mode Water, and Overflow Water. Through these processes the low salinity tongue of Labrador Sea Water looses its prime characteristic properties while progressing northward into the Iceland Basin.
Water mass transformation processes also change the original properties of Iceland Scotland Overflow Water penetrating the Iceland Basin from the Norwegian Sea along the way southward. Then this partially mixed overflow water leaves the Iceland Basin for the Irminger Basin through gaps in the Reykjanes Ridge. Other diluted fractions follow the Mid-Atlantic Ridge as a deep western boundary current towards the Azores.
We aimed to make quantitative observations of transport fluctuations of the mentioned water masses. Such estimates are most relevant for the dynamics of the larger scale circulation of North Atlantic Deep Water. Modified Overflow Water, occasionally also called Gibbs Fracture Zone Water, is a main constituent of North Atlantic Deep Water. After leaving the subpolar gyre this water mass follows the continental slope of the Americas finally reaching the Antarctic Circumpolar Current. North Atlantic Deep Water is an integral limb of the global circulation and thus has a major impact on the global climate.
In cooperation with SFB subproject A1 moored equipment for monitoring the Denmark Strait Overflow Water had to be deployed during the beginning of the cruise. Like the Iceland Scotland Overflow, the Denmark Strait Overflow is another source for North Atlantic Deep Water.
Spreading paths of Labrador Sea and Overflow Waters in the Iceland Basin are subject to strong pulsations and shifts. These variations will be captured by eddy-resolving accoustically tracked RAFOS floats. Additional drifter launches support the just initiated ARGO project. The international ARGO Information Center has started to manage a sustained network of freely drifting ocean observing platforms. Their data are an essential part of future "ocean weather forecast". Within the next five years a fleet of 3000 deep sea drifters is planned. While drifting at 1500 m depth they cycle every ten days between 2000 m and the surface and transmit their data ashore. This information is broadcast via internet to operational oceanographers world wide within a day after the drifters reach the surfaces. The initial European contribution to ARGO is funded under GYROSCOPE by the European Commission in Brussels.
The return leg to Germany involved a repeat of WOCE section A2 between the Mid-Atlantic Ridge and the approaches of the European continent off Ireland. This work was conducted in co-operation with the Federal Maritime and Hydrographic Agency (BSH) in Hamburg. We completed the eastern part of A2 after its westward section had already been recorded during leg 1 in mid May 2001.
As part of the SFB project in Kiel the repeat hydrographic survey delivered chemical and tracer data with high vertical resolution and special consideration of pertinent CO_2 signals.
In addition, a group of geochemists from GEOMAR investigated methane sources. The latter were discovered during an earlier METEOR cruise at the Mid-Atlantic Ridge just south of Charlie Gibbs Fracture Zone. The group searched for the position and strength of a source in the region of the rift valley at 51°N and will determine the ratio of the stable carbon isotopes of the methane in its home laboratory in Kiel. In continuation of the geochemical water sampling the localizing of the sources was conducted by the Ocean Floor Observation System OFOS. It is hoped that the analysis phase will reveal the generation process in more detail.

4 Narrative of the Cruise

The fourth and last leg was again conducted by the *Institut für Meereskunde an der Universität Kiel* (IFM). The majority of the scientific party arrived in Reykjavik on 16 July 2001. The day before the chief scientist and a small group of technicians had taken over the ship from Jürgen Holfort and his team. Larger preparations of submersible gear were necessary for the sophisticated series of deep-sea moorings to be launched in Denmark Strait. The German ambassador to Iceland, Herr Dr Hendrik Dahne, visited METEOR twice while in port.

On 17 July, 12:00, FS METEOR left Reykjavik and headed directly to the Denmark (or Greenland) Strait in good weather conditions and calm seas. On board were 24 scientists, technicians and students from eight institutions and companies plus two employees from the *Deutscher Wetterdienst (DWD).* After a transit of 27 hours we reached Sta. 307 on the afternoon of the next day. We were pleased to find the site without ice and started primery functionality and handling trials with the **O**cean **F**loor **O**bservation **S**ystem (OFOS) and acoustic release. This was a preparation exercise for the following deployment of the trawl resistant mooring V423_2 (SK). It comprises in a hexagonal concrete shield housing a modified acoustic Doppler current meter (ADCP). The device has been newly developed in Kiel to enable long-term observations of currents in bins of several hundred meters atop this near-bottom mooring. The test result was embarrassing because the auxiliary release for the joint deployment of the shielded ADCP and OFOS failed. It took several hours to reconstruct the OFOS frame for a spare release. Later in the evening we launched the extravagant mooring V423 under permanent observation and documentation with the OFOS. We are sure to have it set on a flat bottom as confirmed by a short Hydrosweep survey prior to the station work. Two additional moorings consisting of recording Pressure sensors and Inverted Echo Sounders (P/IES) were deployed on a section across the sill of Denmark Strait. A final more conventional ADCP mooring without a shield was set in the deep outflow channel where no fisheries activities are expected in contrast to the adjacent banks to both sites of the sill.

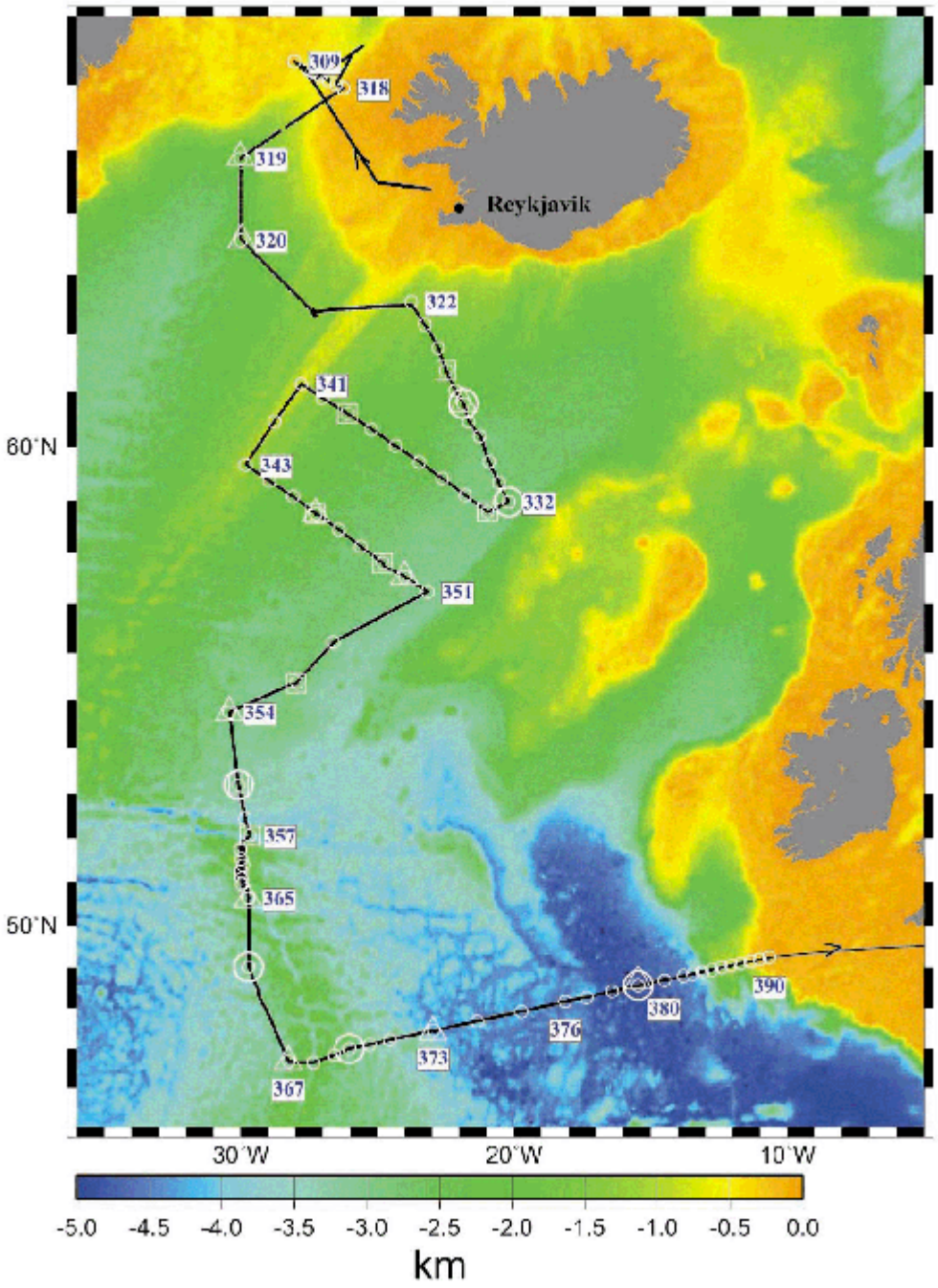
Mooring V421_1 (TK) was laid last summer by FS POSEIDON. While cautiously approaching the location on the afternoon of 19 July we realized that mooring TK apparently was situated just north of the closed ice margin as seen from our northern most position 66° 34.5' N, 25° 30.8' W. Hence, it was absolutely inaccessible for METEOR. Since more dense ice fields were drifting into the polar frontal region from the east, we were also unable to launch a prepared replacement mooring V421_2. Without delay METEOR reversed its direction by 180°. We returned to the sill of Denmark Strait and supplemented the until then incomplete cross-sill CTD section which includes lowered ADCP observations and regular water samples for analysis of numerous chemical substances including CFC, pCO_2, O_2 and nutrients. None of the ice barriers were forecast on the latest ices charts which we received from Greenland Command via IfM Kiel. After mid night of 19 July we had already settled the first phase of leg M50/4. The work load of the first phase was added relatively late in the planning stage of the expedition in due coarse of the emergency case of FS POSEIDON. A multi-month long repair phase of this ship urged a complete revision of all IfM ship plans on which the field work of SFB 460 relies heavily.

Over the next few days the METEOR cruised southwestward into the Irminger Basin. There we launched two APEX drifters. They are part of the internationally co-ordinated project ARGO. It aims at a future coverage of the world ocean with 3000 drifters for operational purposes. Our contribution at IfM Kiel is funded by the European Commission under GYROSCOPE. Initially METEOR carried ten APEX floats on board. Ten days later we received the first high quality up-cast CTD profiles from the first float cycles via satellite link from the CORIOLIS center in France.

The second phase of M50/4 began on 21 July in the northern Iceland Basin after the vain search for a surfaced and transmitting RAFOS float on the Mid Atlantic Ridge (MAR) the day before. The sampling sites were targeted to cover CTD section **I** between the ridge and the more southeastward situated outskirts of Maury Channel, the deepest part of the Iceland Basin (Sta. 322-332). Station were located at near-by mooring positions which have been occupied since last summer. They were launched at strategic locations to monitor fluctuations of the Iceland Scotland Overflow entering the abyss of the Iceland Basin. Moorings along section **I** are planned for recovery in 2002.
Two more cross sections of the Iceland Basin were sampled (**A:** Sta. 333-341 and **B:** 343-351). In addition to APEX floats we launched eight eddy-resolving RAFOS floats in total. They are ballasted for the depth levels of the Labrador Sea Water (3) and the Overflow Water (5), respectively, and continue here and at more southerly situated positions earlier Lagrangian observations in the Iceland Basin.
After repeat CTD/RO work north of Charlie Gibbs Fracture Zone (CGFZ) the remaining time was devoted to a detailed search for methane sources (Sta. 358-365) and to the subsequent repeat hydrographic section A2 of the **W**orld **O**cean **C**irculation **E**xperiment . The core work of the GEOMAR group on board concentrated on the meridionally oriented rift valley at 30°W south of the southern deep channel of the Fracture Zone. The expected occurrence of methane was confirmed at repeat and newly selected sampling sites. The 3-day sequence which included an intensive Hydrosweep survey of the valley, ended on 1 August with a 6 hour towed OFOS experiment showing excellent TV images from the eastern slope and the center of the rift valley.
After an additional station (366) for thorium samples METEOR reached the western end of the eastern half of WOCE A2. A series full depth CTD stations with lowered ADCP observations followed during the next five days. The 24 stations (367-390) were unevenly spaced with a more denser sampling on both sides of the crossed Western European Basin.
The scientific work was terminated on 7 August at midnight and METEOR headed for her destination in Germany. We reached the shipyard in Rendsburg at noon on 12 August 2001.

5 Further Remarks

We would like to thank Kapitän Jakobi and his crew for the excellent co-operation on board. The observer from the Republic of Ireland, Ms Heather Cannaby was of great help to the scientific party. We also appreciate the logistic support from the Icelandic Marine research Institute in Reykjavik. Financial support came from the *Deutsche Forschungsgemeinschaft* (SFB 460), Bonn, and from the European Commission (GYROSCOPE), Brussels.


309
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Reykjavik
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60°N
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Appendix 2

METEOR cruise M50/4 station and sample log
Reykjavik/Iceland - Rendsburg/Germany, 17-JUL-2001 to 12-AUG-2001
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Status: 08-AUG-2001, 18:20 UTC

List of abbreviations:

St : Station no.
C : CTD cast no., monotonically increasing during the cruise;
all casts to near bottom if not indicated else
Wd : Sounding/m, based on 1500 m/s
Inst depth: max. depth of instrument
Inst : (major) Type of instrumentation or mooring or equipment
x 1 vADCP : way point vessel mounted RDI ADCP, Ocean Surveyor
x 1 DVS : way point of on-line log DVS of underway data,
x 1 HS : way point of multibeam echosounder HYDROSWEEP
x 2 SBE1 : Sea-Bird 911 plus CTD, IFMK internal ID 1,
x 22x10 l bottle rosette
x 150 kHz RDI lADCP attached
x 3 float : RAFOS (RF) float with IFM Kiel and ARGOS (AR) identification
x 4 float : APEX (AP) float with IFM Kiel and ARGOS (AR) identification
x 5 mooring : VXXX with ARGOS watchdog WDXXXX
x 10 OFOS : under water TV
Additional sensors on from CTD/rosette:
Beckmann oxygen
RDI 150 kHz self-contained ADCP (attached to rosette, lADCP)

Samples taken
Abbr. Code remark
CFC: 1 CFC11, CFC12
O2 : 2 dissolved oxygen
CH4: 3 methane
CO2: 4 carbon dioxid system
nut: 5 nutrients SIO4, PO4, NO3, NO2
S : 6 salinity
Th : 7 thorium
He3: 8 3helium isotop

Date year 2001 MM DD	Time UTC hhmm	St	C	Latitude North DD MM.MM	Longitude East DDD MM.MM	Wd m	Inst. depth m	Inst. type	Samples 12345678	Remarks
07 17	1200	-9	-9	64 10.00	-021 -55.00	-9	-9	1	0	Sail from Reykjavik
07 17	1400	-9	-9	64 30	-025 -00	-9	-9	1	0	WP1
07 18	0317	-9	-9	64 30.13	-024 -59.66	-9	-9	1	0	TSG, DVS, vADCP on
07 18	1508	-9	-9	66 12	-027 -36	-9	4	1	0	Stop TSG
07 18	1525	307	-9	66 11.59	-027 -35.59	501	499	10	0	Test OFOS ok, Benthos release neg.
07 18	2050	307	-9	66 11.60	-027 -35.50	498	473	5	0	V423_2/SK/shield with ADCP 150kHz set, WD9243
07 18	2246	308	-9	66 14.00	-027 -45.00	487	472	5	0	V421_2/PIES06/shield set
07 18	2315	-9	-9	66 14.00	-027 -45.00	487	4	1	0	TSG restarted
07 19	0019	309	1	66 20.54	-028 -02.26	348	319	2	0	SBE1/ros
07 19	0219	310	2	66 13.86	-027 -31.25	502	477	2	12345000	SBE1/ros
07 19	0402	311	3	66 11.86	-027 -22.22	499	477	2	0	SBE1/ros
07 19	0513	312	4	66 09.97	-027 -13.74	515	489	2	0	SBE1/ros
07 19	0628	313	5	66 07.91	-027 -04.91	638	610	2	12045000	SBE1/ros
07 19	0811	314	6	66 03.52	-026 -46.89	533	519	2	0	SBE1/ros
07 19	1109	315	-9	66 07.60	-027 -16.20	582	544	5	0	V425_2/LR set, WD12618
07 19	1244	316	-9	66 06.50	-027 -10.50	625	610	5	0	V422_2/PIES05 set
07 19	1930	-9	-9	66 31.5	-025 -26.0	-9	-9	1	0	fail to recover V424_1 because of ice
07 19	2212	317	7	65 59.98	-026 -30.41	275	265	2	12345000	SBE1/ros
07 19	2359	318	8	65 56.98	-026 -14.84	308	294	2	02345600	SBE1/ros
07 20	1034	319	9	64 52.84	-029 -59.92	2062	2040	2	02345600	SBE1/ros
07 20	1212	319	-9	64 53.10	-030 -00.29	-9	1500	4	0	AP0313/AR12624 launched
07 20	2010	320	10	63 34.67	-029 -59.56	2173	2145	2	12305600	SBE1/ros
07 20	2157	320	-9	63 34.63	-029 -57.61	-9	1500	4	0	AP0323/AR12626 launched
07 21	0830	321	-9	62 21	-027 -20	-9	-9	3	0	chase RF/AR5464 start ISOW section
07 21	2200	322	11	62 33.10	-023 -45.77	1314	1280	2	12345600	SBE!/ros/lADCP
07 22	0142	323	12	62 10.04	-023 -16.11	1466	1461	2	12305000	SBE1/ros/lADCP
07 22	0545	324	13	61 45.89	-022 -46.15	1746	1741	2	12345600	SBE1/ros/lADCP
07 22	0936	325	14	61 21.97	-022 -29.59	1861	1833	2	12005600	SBE1/ros/lADCP
07 22	1114	325	-9	61 22.29	-022 -29.58	-9	1500	3	0	RF0534/AR05462 launched
07 22	1334	326	15	61 00.92	-022 -09.10	2040	2022	2	12305600	SBE/ros/lADCP
07 22	1640	327	16	60 46.90	-021 -51.02	2296	2266	2	12005670	SBE/ros/lADCP
07 22	1819	327	-9	60 46.89	-021 -51.00	-9	1500	4	0	AP0311/AR12622 launched
07 22	2018	328	17	60 27.19	-021 -39.62	2560	2535	2	12345600	SBE/ros/lADCP

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07 23 0020  329  18  60 11.91  -021 -15.02  2719 2703   2   12005600 SBE/ros/lADCP
07 23 0517  330  19  59 43.11  -020 -54.81  2834 2810   2   12345600 SBE/ros/lADCP
07 23 0942  331  20  59 19.97  -020 -33.11  2828 2817   2   12345600 SBE/ros/lADCP
07 23 1421  332  21  58 58.02  -020 -11.93  2828 2000   2   00000670 SBE/ros/lADCP
07 23 1648  332  22  58 58.06  -020 -11.89  2829 2805   2   12345600 SBE/ros/lADCP,
                                                                      end ISOW section
                                                                      start section A
07 23 2113  333  23  58 46.94  -020 -57.87  2871 2847   2   02305600 SBE/ros/lADCP
07 23 2327  333  -9  58 46.99  -020 -58.03    -9 2600   3   0        RF0532/AR04989 launched
07 24 0232  334  24  59 06.08  -021 -46.72  2883 2887   2   12345600 SBE/ros/lADCP
07 24 0740  335  25  59 24.99  -022 -37.03  2549 2525   2   12005600 SBE/ros/lADCP
07 24 1238  336  26  59 43.00  -023 -27.96  2357 2352   2   12345600 SBE/ros/lADCP
07 24 1722  337  27  60 00.98  -024 -20.21  2180 2150   2   12005600 SBE/ros/lADCP
07 24 2152  338  28  60 18.99  -025 -12.75  2123 2202   2   12345600 SBE/ros/lADCP
07 25 0236  339  29  60 36.00  -026 -06.16  2083 2092   2   12305600 SBE/ros/lADCP
07 25 0413  339  -9  60 36.07  -026 -06.15    -9 1500   3   0        RF536/AR05467 launched
07 25 0714  340  30  60 52.90  -027 -01.11  1431 1403   2   12045600 SBE/ros/lADCP
07 25 1054  341  31  61 07.76  -027 -46.73   842  834   2   12345600 SBE/ros/lADCP
                                                                      end section A
07 25 1615  342  32  60 27.87  -028 -45.99  1147 1128   2   02345600 SBE/ros/lADCP
                                                                      start section B
07 25 2227  343  33  59 40.06  -029 -48.95  1060 1067   2   12345600 SBE/ros/lADCP
07 26 0238  344  34  59 22.00  -028 -57.07  1801 1799   2   12045600 SBE/ros/lADCP
07 26 0719  345  35  59 04.07  -028 -05.09  2020 2000   2   12045600 SBE/ros/lADCP
07 26 1222  346  36  58 45.08  -027 -15.18  2231 2240   2   12305600 SBE/ros/lADCP
07 26 1406  346  -9  58 44.89  -027 -14.98    -9 1500   3   0        RF0537/AR05481 launched
07 26 1411  346  -9  58 44.89  -027 -14.94    -9 1500   4   0        AP0312/AR12623 launched
07 26 1820  347  37  58 27.00  -026 -24.96  2615 2589   2   12045600 SBE/ros/lADCP
07 26 2325  348  38  58 06.99  -025 -36.13  2711 2693   2   12305600 SBE/ros/lADCP
07 27 0543  349  39  57 48.07  -024 -47.94  2806 2775   2   12045600 SBE/ros/lADCP
07 27 0737  349  -9  57 47.97  -024 -47.56    -9 2600   3   0        RF0533/AR05460 launched
07 27 1127  350  40  57 32.01  -023 -59.99  2903 2887   2   12345600 SBE/ros/lADCP
07 27 1344  350  -9  57 31.78  -023 -59.65    -9 1500   4   0        AP0310/AR12614
07 27 1650  351  41  57 14.04  -023 -09.96  3055 3035   2   12345600 SBE/ros/lADCP
                                                                      end section B
07 28 0847  352  42  56 12.88  -026 -37.05  2992 2969   2   02045600 SBE/ros/lADCP
07 28 1923  353  43  55 23.61  -027 -56.50  2801 2773   2   02045600 SBE/ros/lADCP
07 28 2134  353  -9  55 22.34  -027 -57.04    -9 2600   3   0        RF0535/AR05463 launched
07 29 1040  354  44  54 45.94  -030 -25.10  2871 2844   2   00000600 SBE/ros/lADCP
07 29 1239  354  -9  54 45.80  -030 -25.18    -9 1500   4   0        AP0326/AR12629 launched
07 29 2116  355  45  53 12.01  -030 -04.97  3116 3095   2   12045670 SBE/ros/lADCP, C
07 29 2340  355  -9  53 12.25  -030 -05.03    -9 2600   3   0        RF0538/AR05482 launched
07 30 0356  356  46  52 26.42  -029 -50.19  3814 3792   2   12345600 SBE/ros/lADCP, F
07 30 0852  357  47  52 03.85  -029 -40.26  3722 3709   2   12305608 SBE/ros/lADCP, Z
07 30 1138  357  -9  52 03.52  -029 -39.76    -9 2600   3   0        RF0539/AR05486 launched
                                                                      start HS survey
07 30 1308   -9  -9  51 55.02  -029 -58.11    -9   -9   1   0        WP2, start HS1
07 30 1555  358  48  51 31.98  -029 -58.04  3749 3728   2   12345608 SBE/ros/lADCP
07 30 2247   -9  -9  50 54.50  -029 -57.99    -9   -9   1   0        WP3, end HS1
07 30 2343  359  49  50 57.06  -029 -57.66  3516 3508   2   12305608 SBE/ros/lADCP
07 31 0237   -9  -9  50 54.11  -029 -55.21    -9   -9   1   0        B, start HS2,
                                                                      HS with bad record
                                                                      HS record ok since 0445
07 31 0619  360  50  51 23.01  -029 -54.90  3768 3530   2   12345608 SBE/ros/lADCP
                                                                      WP4 skipped
07 31 1136   -9  -9  51 48.32  -029 -55.07    -9   -9   1   0        WP5, end HS2
                                                                      skip HS3 and HS4
07 31 1228  361  51  51 45.00  -030 -00.96  3276 3325   2   12305608 SBE/ros/lADCP
07 31 1522   -9  -9  51 48.99  -030 -01.00    -9   -9   1   0        WP6
07 31 1554   -9  -9  51 49.03  -029 -52.17    -9   -9   1   0        WP7, start HS5
                                                                      WP8 skipped
07 31 1700   -9  -9  51 39.91  -029 -52.19    -9   -9   1   0        WP9,end HS5, start HS6
07 31 1742   -9  -9  51 39.96  -030 -01.57    -9   -9   1   0        WP10,end HS6,start HS7
                                                                      skip WP11
07 31 2036   -9  -9  51 14.82  -030 -01.44    -9   -9   1   0        WP12, leave HS7
07 31 2050  362  52  51 14.98  -029 -59.57  3467 3520   2   12345608 SBE/ros/lADCP, ex PO171
07 31 2336   -9  -9  51 15.00  -030 -01.98    -9   -9   1   0        WP12a, on HS7 again
08 01 0009   -9  -9  51 10.00  -030 -02.00    -9   -9   1   0        WP13, end HS7
08 01 0026   -9  -9  51 09.58  -030 -04.92    -9   -9   1   0        WP14, start HS8
08 01 0146   -9  -9  51 21.28  -030 -05.27    -9   -9   1   0        WP15, end HS8
08 01 0204   -9  -9  51 20.95  -030 -08.00    -9   -9   1   0        WP16 start HS9
08 01 0324   -9  -9  51 09.92  -030 -07.99    -9   -9   1   0        WP17, break HS9
08 01 0418  363  53  51 05.88  -029 -57.95  4138 4109   2   12305608 SBE/ros/lADCP
08 01 0753   -9  -9  51 06.10  -030 -08.00    -9   -9   1   0        WP18, recover HS9
08 01 0815   -9  -9  51 10.00  -030 -08.00    -9   -9   1   0        WP17, end HS9
                                                                      end HS survey
08 01 0900   -9  -9  51 14.5   -029 -57.8     -9   -9   1   0        stop TSG
08 01 1051  364  -9  51 16.00  -029 -55.36  3625 3715  10   0        OFOS start bottom track
08 01 1100  364  -9  51 16.02  -029 -55.44  3634 3670  10   0        OFOS bottom track
08 01 1116  364  -9  51 15.98  -029 -55.59  3633 3631  10   0        OFOS bottom track
08 01 1130  364  -9  51 15.91  -029 -55.73  3607 3645  10   0        OFOS bottom track
08 01 1145  364  -9  51 15.94  -029 -55.87  3641 3650  10   0        OFOS bottom track
08 01 1200  364  -9  51 15.91  -029 -56.12  3707 3650  10   0        OFOS bottom track
08 01 1215  364  -9  51 15.91  -029 -56.20  3636 3695  10   0        OFOS bottom track
08 01 1230  364  -9  51 15.86  -029 -56.29  3606 3690  10   0        OFOS bottom track
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08 01 1245  364  -9  51 15.84  -029 -56.40  3585 3741  10   0        OFOS bottom track
08 01 1300  364  -9  51 15.80  -029 -56.54  3581 3724  10   0        OFOS bottom track
08 01 1315  364  -9  51 15.74  -029 -56.63  3689 3656  10   0        OFOS bottom track
08 01 1330  364  -9  51 15.70  -029 -56.74  3773 3586  10   0        OFOS bottom track
08 01 1345  364  -9  51 15.68  -029 -56.84  3786 3690  10   0        OFOS bottom track
08 01 1346  364  -9  51 15.68  -029 -56.84  3787 3689  10   0        End of bottom track
08 01 1405   -9  -9  51 15.70  -029 -57.00    -9   -9   1   0        TSG on
08 01 1814  365  54  50 37.80  -029 -42.92  3822 3840   2   12345608 SBE/ros/lADCP
08 01 2057  365  -9  50 36.88  -029 -43.80  3735 1500   4   0        AP0324/AR12627
08 02 0537  366  55  48 59.94  -029 -43.06  3025 2986   2   00000670 SBE/ros/lADCP
                                                                     start A2E
08 02 2016  367  56  46 39.94  -028 -14.96  3431 3420   2   12345600 SBE/ros/lADCP
08 02 2252  367  -9  46 40.00  -028 -15.04  3430 1500   4   0        AP0325/AR12628
08 03 0221  368  57  46 39.02  -027 -21.04  3864 3827   2   12305608 SBE/ros/lADCP
08 03 0758  369  58  46 49.88  -026 -33.92  2903 2791   2   12345600 SBE/ros/lADCP
08 03 1219  370  59  46 59.94  -026 -01.94  3257 3252   2   12045670 SBE/ros/lADCP
08 03 1725  371  60  47 05.98  -025 -16.90  3149 3127   2   12305600 SBE/ros/lADCP
08 03 2220  372  61  47 12.99  -024 -33.04  3487 3488   2   12345600 SBE/ros/lADCP
08 04 0659  373  62  47 26.89  -022 -56.98  4177 4176   2   12345600 SBE/ros/lADCP
08 04 0957  373  -9  47 25.08  -022 -57.74  4175 1500   4   0        AP0308/AR07567
08 04 1557  374  63  47 41.00  -021 -20.91  4109 4087   2   12345600 SBE/ros/lADCP
08 05 0037  375  64  47 54.96  -019 -43.95  4289 4378   2   12345600 SBE/ros/lADCP
08 05 0918  376  65  48 10.04  -018 -06.89  4417 4438   2   12345600 SBE/ros/lADCP
08 05 1500  377  66  48 15.98  -017 -20.86  4350 4369   2   10000600 SBE/ros/lADCP
08 05 2122  378  67  48 25.03  -016 -23.84  4792 4822   2   12305600 SBE/ros/lADCP
08 06 0414  379  68  48 33.04  -015 -26.93  4790 3010   2   00000670 SBE/ros/lADCP
08 06 0643  379  69  48 33.01  -015 -26.98  4788 4818   2   12345600 SBE/ros/lADCP
08 06 1001  379  -9  48 39.69  -015 -26.94  4788 1500   4   0        AP0309/AR12611
08 06 1354  380  70  48 40.98  -014 -30.00  4589 4603   2   10300600 SBE/ros/lADCP
08 06 1935  381  71  48 46.99  -013 -47.12  4501 4528   2   12345600 SBE/ros/lADCP
08 07 0015  382  72  48 50.14  -013 -26.82  4427 4452   2   10000600 SBE/ros/lADCP
08 07 0435  383  73  48 52.94  -013 -05.77  3650 3643   2   10340600 SBE/ros/lADCP
08 07 0828  384  74  48 56.04  -012 -45.02  2036 2025   2   00000600 SBE/ros/lADCP
08 07 1128  385  75  48 59.06  -012 -23.93  1341 1335   2   12345600 SBE/ros/lADCP
08 07 1418  386  76  49 02.04  -012 -03.14   982  980   2   10000000 SBE/ros/lADCP
08 07 1645  387  77  49 05.05  -011 -42.15  1129 1112   2   12305600 SBE/ros/lADCP
08 07 1917  388  78  49 07.99  -011 -20.98   469  446   2   00300000 SBE/ros/lADCP
08 07 2116  389  79  49 10.90  -011 -00.05   177  168   2   12045600 SBE/ros/lADCP
08 07 2319  390  80  49 13.98  -010 -38.84   158  145   2   0        SBE/ros/lADCP
                                                                     end A2E, last
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