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INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (of UNESCO)

WORLD METEOROLOGICAL ORGANIZATION

INTEGRATED GLOBAL OCEAN SERVICES SYSTEM (IGOSS)

Fourth Meeting of the SOOPIP *Ad hoc* Task Team on Quality Control for Automated Systems (TT/QCAS)

Cape Town, South Africa, 14-15 April 1997

SUMMARY REPORT

SC-97/WS/59

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1. ORGANIZATION OF THE MEETING

1.1 OPENING OF THE MEETING

1 The Fourth Meeting of the IGOSS SOOPIP Ad hoc Task Team on Quality Control for Automated Systems (TT/QCAS) was opened at 0945 hours on Monday 14 April 1997 in the headquarters of the Sea Fisheries Research Institute (SFRI), Cape Town, South Africa, by the Chair of the Ship-of-Opportunity Programme Implementation Panel (SOOPIP), Mr R. Bailey. He welcomed participants and introduced the Director of the SFRI, Dr A. Payne.

2 Dr Payne welcomed participants to SFRI, to Cape Town and to South Africa. He noted the multidisciplinary nature of the work of his institute which, although not directly involved in SOOP related activities, nevertheless had an interest in physical oceanography and was very pleased to be able to host the two meetings programmed for the week. He also indicated that other agencies in South Africa, including the Weather Bureau, were likely to be more directly interested in SOOP and in the use of SOOP data, and would participate in the meetings. Finally, he assured participants of the full support of the SFRI throughout the week, and wished everyone fruitful meetings and an enjoyable stay in South Africa.

3 The List of Participants in the session is given in Annex II.

1.2 ELECTION OF CHAIRMAN

4 The Meeting agreed that Mr Bailey should continue as interim Chair for the duration of the session, and that a new chair for the coming intersessional period should be elected at the end of the meeting.

1.3 ADOPTION OF THE AGENDA

5 The Meeting agreed a number of changes to the provisional agenda, and the Agenda finally adopted is given in I. It also agreed to review its terms of reference under agenda item 2.

1.4 WORKING ARRANGEMENTS

6 The Meeting agreed its hours of work and other necessary arrangements for the session. The documentation was introduced.

2. REVIEW OF ACTION ITEMS AND RECOMMENDATIONS FROM TT/QCAS-III

7 The Meeting first reviewed its terms of reference as contained in the general terms of reference for the SOOPIP. It agreed that it was concerned with all types of instrumentation and quality control relevant to an operational SOOP (including new technology such as eventually PALACE floats), but should not deal with research issues. The terms of reference should therefore be broad enough to allow treatment eventually of new operational instruments, but also should clearly define the limits of interest of the team. The terms of reference which were eventually agreed for proposal to SOOPIP for adoption are given in Annex III. It was also agreed to propose that the name of the task team should be changed to SOOP Task Team on Instrumentation and Quality Control (STT/IQC), to better reflect its true mission.

8 The Meeting then reviewed in detail the recommendations and action items agreed at TT/QCAS-III. These lists, with brief annotations to show the actions taken, are given in Annexes IV and V. Further follow-up actions arising from a number of these are included in the new action list for the next intersessional period which is given in Annex X.

3. REVIEW PROGRESS OF CONVERSION TO NEW BATHY CODE

9 The Meeting noted with interest, analyses presented by R. Keeley and the IGOSS Operations Co-ordinator showing the trends in the use of the new code (JJYY) since its formal introduction in November 1995. These analyses are given in Annex VI. It considered that these results were encouraging, and indicated eventual universal use of the full JJYY. It requested all task team members to arrange for the implementation of the full JJYY by all parties including their respective national navies. It noted new additions to the tables of recorder types and probes proposed by Japan, and requested that these be conveyed to WMO for updating of the tables.

4. RESULTS OF SPARTON PROBE EVALUATIONS

10 The Meeting noted the consolidated results of Sparton XBT-7 probe evaluations prepared by P. Rual and presented by C. Henin, which did not fit the previously pre-determined fall rate equation for this probe. These are given in Annex VII. It recognized that these results were based on too limited a sample of both probes and separate experiments to draw meaningful conclusions at this stage. It also considered that the error bars on the CTD depths should be known, to fully evaluate the comparisons.

11 It was agreed that further tests were required as soon as possible, as well as an individual willing to undertake the data analyses. It therefore requested A. Sy to consider making available the probes for the tests. R. Keeley offered to investigate the possibilities for both the tests and the evaluations to be done in Canada.

12 In a more general sense, the Meeting recognized that IGOSS and GOOS would eventually require a full instrument intercomparison and intercalibration programme, as an integral part of an operational ocean observing system. Such a programme, similar to that now in place for meteorological instruments under the World Weather Watch, would require additional resources, and the Meeting recommended that SOOPIP should make the requirement known to both IGOSS and GOOS, with a request for action to be taken to identify these resources, bearing in mind that the task team was the appropriate body to eventually organize and implement intercomparison tests, provided the necessary resources were available.

5. STATUS OF OTHER XBT EVALUATIONS

13 It was recalled that A. Sy had agreed to undertake evaluation of Sippican T-5 probes, provided the planned software package was delivered, as proposed at TT/QCAS-III. No action on this had been taken because of the continuing lack of the software, which was in turn due to lack of funding for preparation of the package. However, the task would be completed as soon as the software became available.

6. SIPPICAN RECORDERS

14 The Meeting noted with interest and appreciation a presentation by Ms R. Elgin (Sippican) of a draft new Windows 95 version of their recorder software. A number of proposals were made to Sippican to further improve the software, including in particular the inclusion of additional software modules (e.g. from the existing SEAS system) for the compilation of BATHY messages with the new IGOSS fall-rate equation and procedures recommended by the TT for pre-GTS insertion quality control.

15 Several participants reported on a problem which had appeared recently with Sippican Mk 12 recorders, but not other recorder types. This was an intermittent problem, in which the machine started recording while the probe was still in the launcher, and did not appear to be software dependent. Sippican agreed to investigate possible causes and propose/implement solutions.

7. STATUS OF XCTD EVALUATIONS

16 Evaluations of Sippican XCTDs were described by A. Sy and R. Bailey, and of TSK XCTDs by K. Mizuno. Summaries of these are given in Annex VIII. It was recognized that significant improvements had been effected in all XCTDs since the last meeting. However, some continuing problems were reported with the fall rate for the Sippican XCTD, which differed from specifications. Improvements were also suggested to the TSK XCTD fall rate equation. Some other problems noted, not necessarily with all XCTDs tested, included air bubbles, residual spiking, systematic temperature biases, mis-matching T-S, conductivity offsets. It was generally agreed that further systematic testing was required, including analysis of existing data, to improve reliability and in particular to arrive at an agreed standard fall rate equation, if XCTDs were to become cost effective operational instruments.

17 The Meeting noted with interest presentations by H. Iwamiya (TSK) and Ms R. Elgin (Sippican) on the respective status of development of their XCTDs. Summaries of these are given in Annex VIII. Of particular note were the different design of the TSK probe which eliminated the air bubble problem and provided greater fall rate stability, the new add-on "pressure point" facility with the Sippican probe, and the glueing of the probe afterbody, from September 1996, also with the Sippican probe. The offer of TSK to provide two boxes of their probes, together with the loan of a TSK converter, for testing purposes was appreciated by the meeting. The Meeting further noted the negotiations underway between Sippican and TSK, which might lead eventually to the marketing of a single XCTD and recorder by the two companies. It requested that the Chair of the TT should be kept informed of the progress of these negotiations.

18 It was recognized that national navies were large or potentially large users of XCTDs, although their interests centred generally on gross ocean features and not fine detail. It was nevertheless agreed that all members of the TT should continue to make representations to their navies for assistance and support in testing and evaluation projects (including further XBT evaluations). D. Wright was also requested to ensure that his revised test procedures document for XBTs was extended to cover XCTDs.

19 The Meeting recognized that K. Hanawa already had software developed for evaluating XBT fall rates, also applicable to XCTDs, and considered that it would be very valuable if this could be generalized to a widely useable form and made available to all interested agencies and individuals, as a means of generating reliable and comparable test results. K. Mizuno agreed to investigate this. At the same time, R. Bailey agreed to develop a specific proposal for a coordinated evaluation programme, in conjunction with Sippican, TSK and others. The programme would be directed in particular to the operational use of XCTDs.

8. THERMOSALINOGRAPHS

20 The Meeting noted with interest and appreciation a presentation by C. Henin on the evaluation and operational use of thermosalinographs (TSGs). A summary of this is in Annex IX. It was recognized in particular that TSGs give substantial improvements in accuracy over bucket measurements of salinity and temperature. However, TSGs were expensive devices, which would probably not be widely deployed, and further advice was required from bodies such as OOPC on spatial, temporal and accuracy requirements for surface salinity data for global climate modelling. In the context of modelling, the Meeting also recognized the potential value of recording precipitation data with SSS during TSG cruises.

21 In view of the operational nature of the French TSG activity, of the extensive practical experience now available to them from this work, and of the likely wide interest of others in implementing TSGs and applying this experience, the TT requested C. Henin to take the lead in the preparation of a **Best Practices Guide to TSGs**. It also reiterated the importance of obtaining an English version of the French TSG manual.

9. MODIFICATIONS TO THE TESAC AND TRACKOB CODES

22 The Meeting recognized a requirement to modify TESAC to allow for the encoding of data from XCTDs and PALACE floats as TESAC messages with appropriate information on probe and recorder type; and also for the inclusion of important quality control information relevant to CTDs. With regard to the former, it considered that the code group included in the new BATHY code would also be appropriate for TESAC, with the necessary additions being made to code tables 1170 and 4770. R. Keeley was requested to coordinate the preparation of and agreement on the necessary updates to these code tables and for the submission of the whole proposal to WMO for adoption by CBS. With regard to the CTD quality control concerns, the Meeting considered that these might possibly be covered by redefining the existing QC indicator k2 in TESAC. It therefore requested R. Keeley and A. Sy to coordinate the development of a specific proposal for modifications to k2, for presentation also to CBS.

23 The Meeting recognized that near-real-time surface salinity data, in particular from thermosalinographs, distributed on the GTS in TRACKOB code, were increasingly important to global climate studies and modelling under CLIVAR and GOOS/GCOS. It agreed that a proper management system for these data, similar to the GTSPP, was required, and recommended that the SOOPIP should take up this issue. It also agreed that some modifications were required to TRACKOB, to also include in it information on instrumentation and recorder types. R. Keeley and A. Sy were again requested to review TRACKOB and coordinate the development of a proposal for modifications, for eventual submission to CBS.

10. FUTURE WORK

24 The Meeting reviewed and agreed to a list of action items for the coming intersessional period. This list is given in Annex X. In addition, the Meeting charged the Chair with coordinating the preparation of a specific action plan for ongoing and new probe evaluations, which would specify the resources needed and a timetable for their completion. A decision on future meetings was left for discussion at the SOOPIP meeting which would follow immediately. Recommendations of the Task Team to SOOPIP are recorded in Annex XI.

11. ELECTION OF THE CHAIR

25 The Meeting elected Mr A. Sy to serve as Chair of the Task Team until the end of the next meeting.

12. CLOSURE OF THE MEETING

26 The Fourth Meeting of the SOOPIP Ad hoc Task Team on Quality Control for Automated Systems closed at 1715 hours on Tuesday 15 April 1997.

ANNEX I

AGENDA

1. **ORGANIZATION OF THE MEETING**
   - 1.1 OPENING OF THE MEETING
   - 1.2 ELECTION OF CHAIRMAN
   - 1.3 ADOPTION OF THE AGENDA
   - 1.4 WORKING ARRANGEMENTS
2. **REVIEW OF ACTION ITEMS AND RECOMMENDATIONS FROM TT/QCAS-III**
3. **REVIEW PROGRESS OF CONVERSION TO NEW BATHY CODE**
4. **RESULTS OF SPARTON PROBE EVALUATIONS**
5. **STATUS OF OTHER XBT EVALUATIONS**
6. **SIPPICAN RECORDERS**
7. **STATUS OF XCTD EVALUATIONS**
8. **THERMOSALINOGRAPHS**
9. **MODIFICATIONS TO THE TESAC AND TRACKOB CODES**
10. **FUTURE WORK**
11. **ELECTION OF THE CHAIR**
12. **CLOSURE OF THE MEETING**

ANNEX II

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ANNEX III

**TERMS OF REFERENCE OF THE *AD HOC* SOOP
TASK TEAM ON INSTRUMENTATION AND QUALITY CONTROL (STT/IQC)**

1. Provide advice on instrumentation deployed and quality control procedures applied in the Ship-of-Opportunity Programme (SOOP).

2. Determine and evaluate instrumentation precision and accuracies, including hardware and software.

3. Determine quality control standards for shipboard instrumentation.

4. Provide specifications for modifications to data transmission codes and general data formats, on the basis of the Task Team's findings.

5. Determine quality control procedures for submission of real-time data and the high resolution data on which they are based.

6. Report to the Ship-of-Opportunity Programme Implementation Panel (SOOPIP).

ANNEX IV

STATUS OF RECOMMENDATIONS FROM TT/QCAS-III

1. Operators, manufacturers and software generators must use the old form of the fall rate equations for the data submitted to the archives when no information is available on the probe type and recorder. If the information is available (whether it is using the old or new fall rate equation), this should accompany the data sent to the archives.

Most major data originators are successfully changing over to new JJYY code and submitting the required information. Some originators, including some navies, are using the new code but without the new information. Efforts are to be made to ensure the new information is included.

2. Manufacturers of XBTs change the fall-rate equation in their software.

Apart from Sippican, who are just about to release their latest software version which includes the new fall-rate equation, it is not known whether other manufacturers have implemented the new equations in their software.

3. IODE-XV to advise national archives to store the information on fall rate, probe type and recorder now required to accompany XBT data.

Addressed through GTSPP.

4. Joint Committee on IGOSS to recommend that each IGOSS National Representative provide information to the IGOSS Operations Coordinator concerning which national operators were notified about the new JJYY code form and when operators plan to implement the new code.

Reasonable success on this issue. Monitoring efforts on JJYY vs JJXX message numbers show marked decrease in the use of JJXX messages, but that this has leveled off without further improvement. It appears some originators, especially navies, have not changed over.

5. The Chairman to request the Joint Committee on IGOSS to revise Manuals and Guides 3 to bring its information up to date.

Done, but action left by Joint Committee on IGOSS to SOOPIP and TT/QCAS to provide recommendations on changes.

6. Operators to encode BATHY messages with temperatures at observed depths, not extrapolated to zero meters.

Partial implementation. Needs follow-up.

7. The Joint Committee on IGOSS to recommend changes be made in the TRACKOB code form to record information about instrumentation used.

Recommendations required from Products and Communications Committee and GTSPP.

8. The Task Team recommends that whenever a questionable profile is obtained using an XBT, a second drop be made to verify the profile.

Increasing implementation by originators wherever possible, but still limited.

ANNEX V

LIST OF ACTION ITEMS FROM TT/QCAS-III

1. The Chairman of TT/QCAS to send a letter to manufacturers formally requesting that they change the fall-rate equation in their software and include the probe, recorder type and fall rate coefficients into the headers of all their data files.

   Manufacturers have been notified.

2. The IGOSS Operations Coordinator to place information about the BATHY code change including the JCL, an example of the new code form, and WMO code tables should be included on the IGOSS Home Page.

   Done.

3. Task Team members to publish articles in their own agency and country newsletters publicizing the requirement for including probe and recorder type information.

   Done on an individual basis.

4. IGOSS Operations Co-ordinator to work with GTSPP to monitor the progress in converting to the new code form.

   Done.

5. Mr Pierre Rual and Mr Rick Bailey to prepare the covering letter and the article for distribution by the manufacturers (including publication in their newsletters).

   A note was published by Sippican in their newsletter.

6. The Chairman to submit a list of current membership of the TT/QCAS to the Joint Committee on IGOSS for approval.

   Done.

7. Mr Pierre Rual and Mr Darren Wright to prepare a set of standard test procedures for XBTs to be discussed at the next TT/QCAS meeting. This documentation to be provided to probe manufacturers for comment prior to the next meeting. Upon approval by the Task Team, this document will be submitted to IOC for publication as an IOC Guide.

   Done; a draft was presented at the meeting.

8. Sippican, TSK and Sparton to provide information about recommended XBT storage and deployment procedures to the Chairman by 14 November, 1995.

   New action item.

9. Mr Pierre Rual to write a proposal detailing the work carried out to date to develop the software to determine accurate fall rate coefficients, and comparing the high costs of this development against the nominal funds needed to deliver a commercial quality software package.

   Done.

10. Chairman to request Joint Committee on IGOSS to provide funds for consolidating the software to determine accurate fall rate coefficients.

    Done at IGOSS-VII but no result.

11. Dr Alexander Sy to co-ordinate the analysis of T-5 and Fast Deep data collected to date once the consolidation of analysis software is completed.

    Awaiting consolidation of software - see items 9 and 10.

12. Mr Pierre Rual to determine if the Service Hydrographique et Océanographique de la Marine (SHOM) has additional T-5 data.

    Done - SHOM has NO additional data.

13. Mr Pierre Rual to contact SHOM to obtain their extensive XCTD data set.

    See item 12.

14. Dr Sy, Mr Wright, and Ms Elgin to send their XCTD data to Mr Bailey by 1 December, 1995. Mr Bailey to co-ordinate with Dr Dean Roemmich to perform the analysis once the consolidated analysis software becomes available. The data should include instrument types, calibration information, locations and speed of vessel and other relevant information.

    Data collected - no action yet.

15. Dr Sy to request usable probe test data from Germany's Polar Research Institution and inform the Chairman of his success.

    No success.

16. In the event that Dr Sy cannot obtain these data, Mr Bailey to co-ordinate with Sparton of Canada to perform tests in the Southern Ocean. Sparton volunteered to contribute probes for this test.

    Probes were provided but no ship was available.

17. Mr Rual to perform the analysis of remaining Sparton data and, upon review by the Task Team, to publish preliminary results in the WOCE International Newsletter.

    Done.

18. The Chairman to inform the GOOS-Ocean Observation Panel for Climate and the CLIVAR Upper Ocean Panel of the need to decide what accuracy is required in the measurement of salinity.

    Done.

19. The Chairman to request funding for translation from French to English of the ORSTOM TSG Installation Manual (approximately 50 pages) from the Joint Committee on IGOSS.

    Canada will investigate possibility.

20. Mr Rual to ask Mr Henin to prepare guidelines on the operation of TSGs.

    Done.

21. Mr Rual to ask Mr Henin to prepare another document describing quality control procedures to be applied to TSG data.

    Done.

22. Mr Wright and Mr Rual to prepare general guidelines for the quality control procedures discussed above for review by TT/QCAS.

    Done.

23. The Chairman to request GE/OTA prepare a new code form for TESACs that will contain the information on instrumentation.

    SOOPIP item.

ANNEX VI

PROGRESS CHARTS OF THE CONVERSION TO THE JJYY BATHY CODE

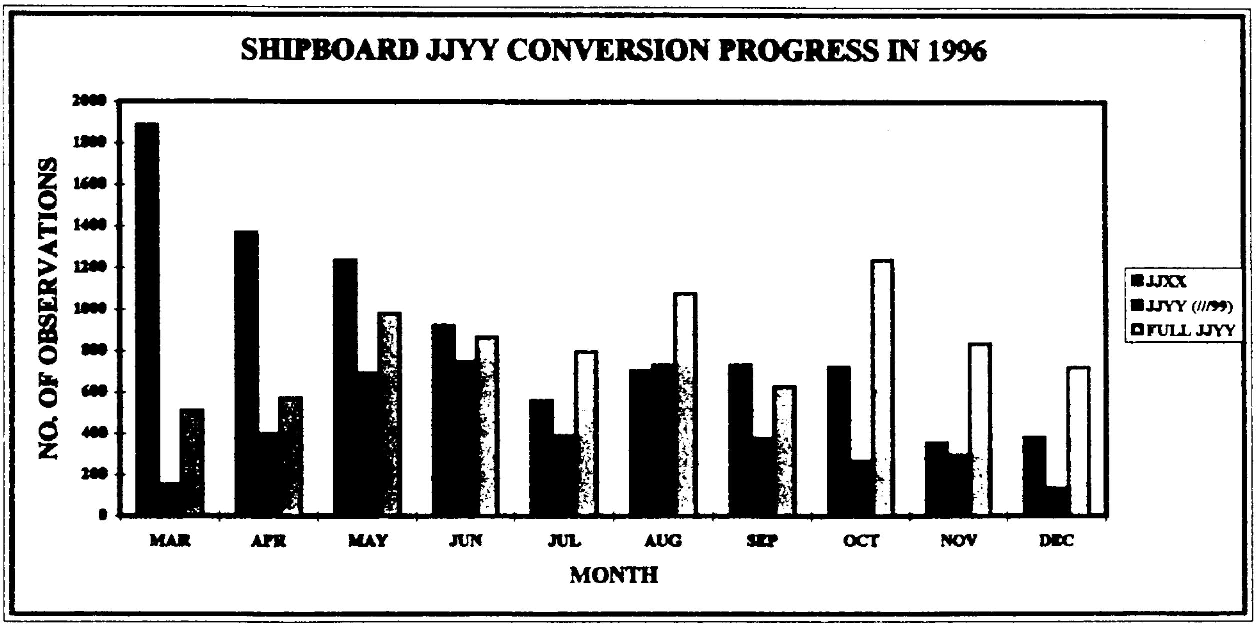
JJYY MONITORING WORKSHEET

Dec-96

	BUOYS:		
	JJXX	**JJYY-1**	**JJYY-2**
	0	**0**	**1922**
BUOY TOTAL:	**1922**		
	SHIPS:		
	JJXX	**JJYY-1**	**JJYY-2**
SHIP TOTAL:	**385**	**138**	**725**
TOTAL STATIONS:	**385**	**138**	**2647**
GRAND TOTAL:	**3170**		

SHIPBOARD ONLY
1996 BATHY MESSAGES RECEIVED

MONTH	JJXX	JJYY (///99)	FULL JJYY	TOTAL
MAR	1890	156	513	2559
APR	1372	403	574	2349
MAY	1240	696	985	2921
JUN	929	751	873	2553
JUL	564	394	799	1757
AUG	709	738	1080	2527
SEP	738	384	630	1752
OCT	728	269	1241	2238
NOV	359	298	836	1493
DEC	385	138	725	1248



TeamLinks Mail Message • Please fax to Bruce Hillard Page: 1

From: KEELEY (KEELEY@AM@OTTMED)
Date: 01/16/1997 11:57:10
To: 1 Mira Clark
Cc:
Subj: Please fax to Bruce Hillard

MEDS Report date (YYYYMMDD): 19970116

Start and end observation dates (YYYYMMDD): 19961201 19961231
Total number of stations: 3170
Total JJXX = 385 Total JJYY-1 = 138Total JJYY-2 = 2647
Column headings:
JJXX: The number of stations in JJXX format
JJYY-1: The number of stations with ///99
JJYY-2: The number of stations in full JJYY format

Call Sign	JJXX	JJYY-1	JJYY-2
21002	0	0	237
21004	0	0	247
22001	0	0	229
32303	0	0	23
32304	0	0	26
32305	0	0	21
32315	0	0	25
32316	0	0	21
32317	0	0	27
32318	0	0	20
32319	0	0	21
32320	0	0	20
32321	0	0	21
32322	0	0	23
3EJT9	0	0	2
3ETQ5	0	0	19
43001	0	0	25
43301	0	0	23
51006	0	0	15
51007	0	0	17
51008	0	0	16
51009	0	0	22
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51303	0	0	10
51304	0	0	31
51305	0	0	26
51306	0	0	26

[1502]

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51308	0	0	21
51309	0	0	25
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52002	0	0	16
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52012	0	0	26
52302	0	0	18
52309	0	0	22
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52312	0	0	10
52313	0	0	12
52315	0	0	16
52316	0	0	27
52317	0	0	26
52318	0	0	22
52320	0	0	18
9HVO3	6	1	0
9KKF	1	0	0
9VBL	0	0	45
9VVB	46	6	0
BMAD	0	0	20
BOAB	4	2	0
C6JY6	0	1	26
C6JZ2	0	0	17
C6LY4	0	0	71
C6MJ2	0	0	28
CG2676	0	0	1
CG2683	0	0	4
CGCB	0	0	10
CGDV	0	0	3
D5BC	19	2	0
D5NZ	0	0	1
DACF	0	0	48
DHCM	0	0	1
DYZJ	0	0	2
ELIL9	0	0	25
ELIS8	0	0	10
ELMF9	43	12	0
ELQN3	0	0	3
FHZI	0	0	2
FNDH	0	0	2
FNQC	0	0	2
FNWC	0	0	2
FNZQ	0	0	18
GYXG	0	0	13
HPEW	0	0	13
HZLL	29	6	0
J8JA4	0	0	20
JCCX	0	0	25
JDSS	0	0	1
JDWX	0	0	10

420

1922

BUOYS

SHIPS

need to add Japan-prototype recorder to code table.

TeamLinks Mail Message • Please fax to Bruce Hillard Page: 3

JFPQ	0	47	0
JGBB	0	0	15
JGQH	0	0	8
JITV	0	43	0
JIVB	0	0	36
JLVC	12	1	0
KGJB	4	1	0
KIRH	0	2	8
KRGB	0	0	34
KWAL	2	0	2
LAJV4	0	0	19
LATI4	0	0	18
MTQU3	0	1	56
NAVOCE	1	0	0
NDIB	3	0	0
NJFK	29	0	0
NNUD	8	0	0
NRWH	0	1	0
NZSK	64	0	0
P3FY5	12	1	0
PAGE	1	1	0
PGBB	0	0	9
PJJU	23	0	0
RV1	2	0	0
SEXQ	2	0	0
SEYD	2	0	0
SEZA	0	1	0
SHIP	12	2	24
V7AU4	43	4	0
VJDP	0	0	24
VKCN	6	2	0
VKLB	5	0	0
VKNG	6	0	0
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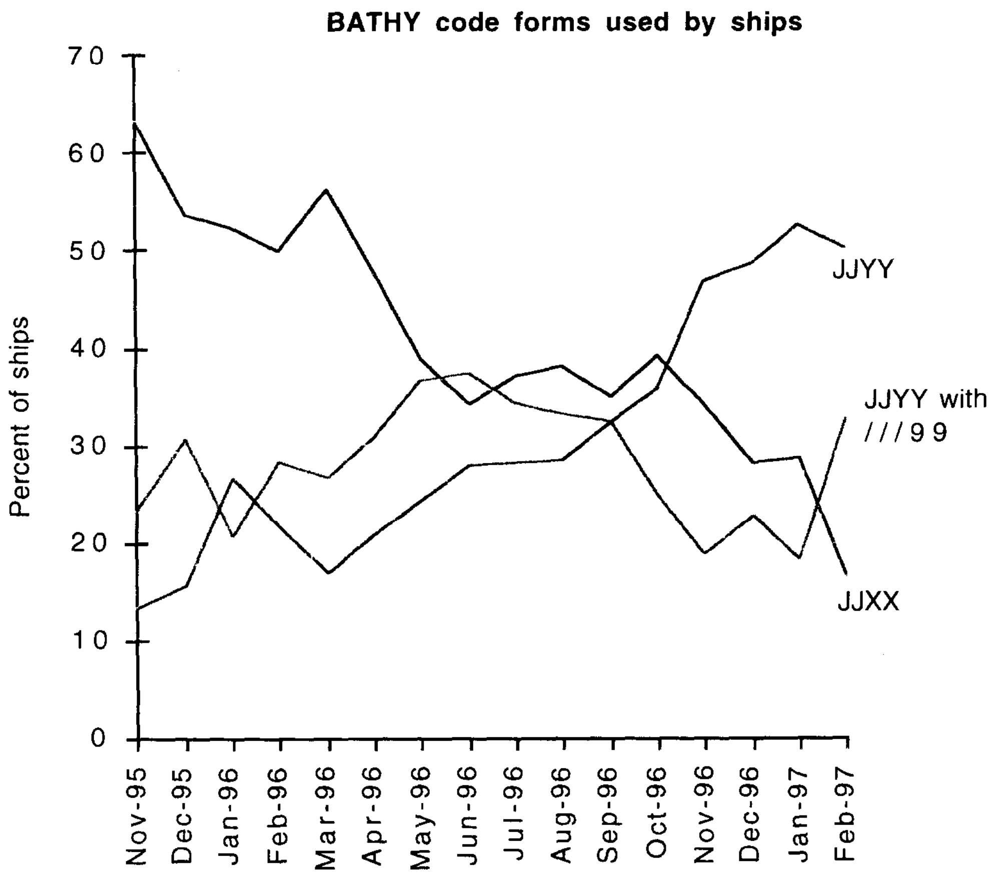
WSRL	0	1	16
WZJF	0	0	5


BATHY code forms used by ships
Percent of ships
70
60
50
40
30
20
10
0
Nov-95
Dec-95
Jan-96
Feb-96
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Apr-96
May-96
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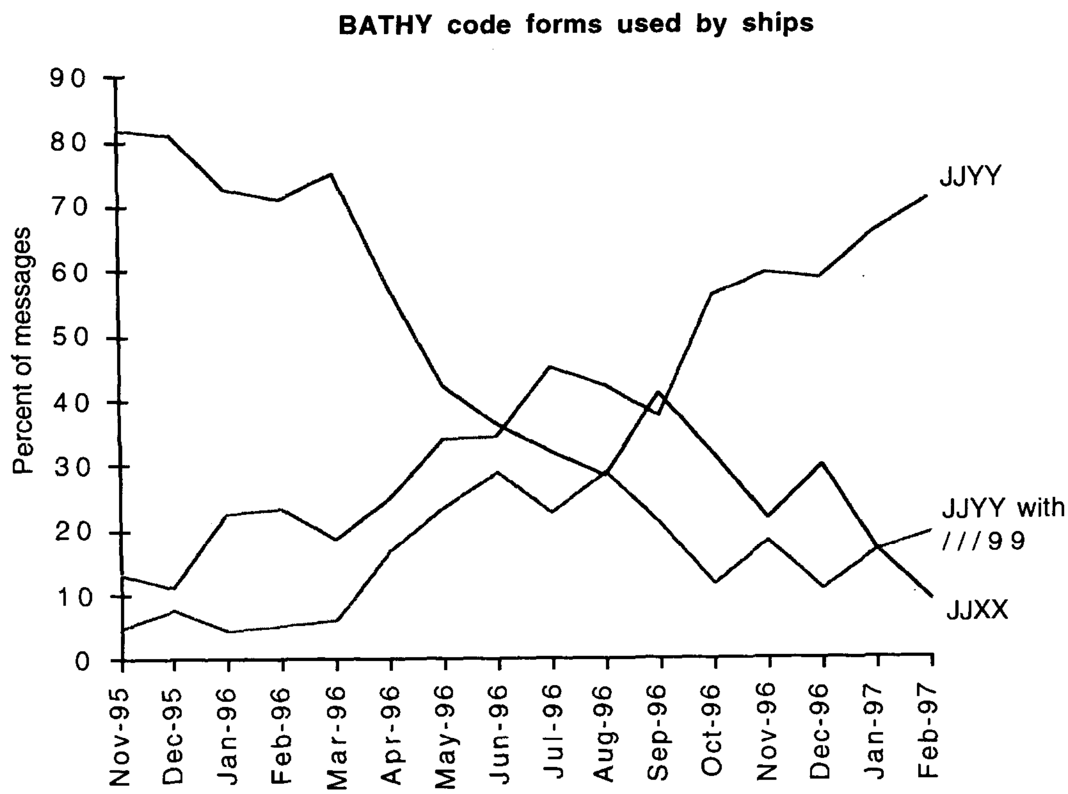
JJYY
JJYY with ///99
JJXX


BATHY code forms used by ships
Percent of messages
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80
70
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50
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30
20
10
0
Nov-95
Dec-95
Jan-96
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Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
JJYY
JJYY with ///99
JJXX

ANNEX VII

RESULTS OF SPARTON XBT-7 PROBE EVALUATIONS

Pierre Rual has perform an additional evaluation of A and B coefficients for the Depth Equation for two sets of Sparton probes following the procedure described in the WOCE Newsletter number 24 (October 1996).

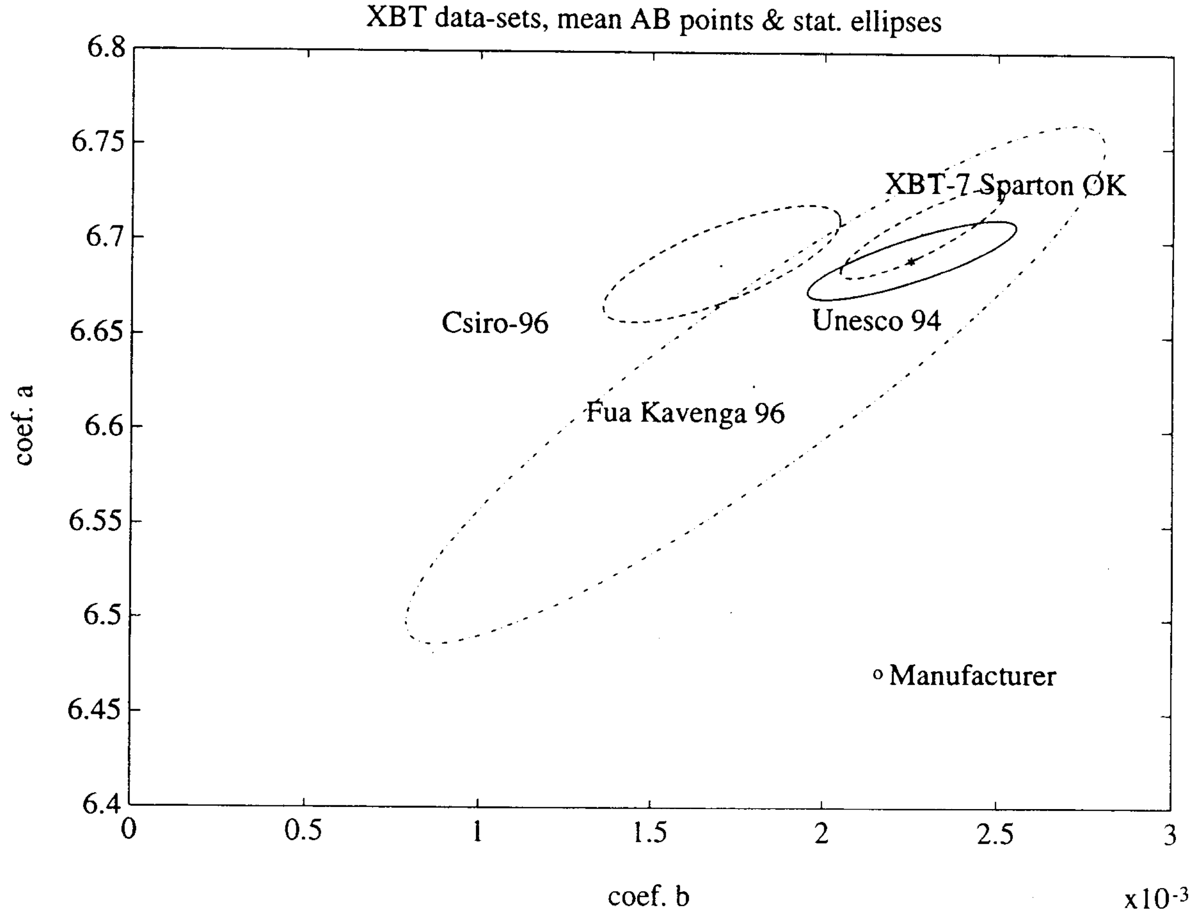
-Eleven probes were provided by CSIRO launch simultaneously with CTD profilest on R/V Franklin in the south-west of Australia. The accuracy of the depth sensor of CTD system is guarantee. The result of the process is presented on the graph as being the CSIRO-96 ellipse.

-Twelve Sparton probes were launched simultaneously with 12 Sippican T-7 XBT probes on the merchant vessel Kua Kavenga in the southwest Pacific ocean. The A and B coeff for the Spartons were determined relative to Sippican profiles taken as the reference. The result is shown on the graph as the Fua Kavenga ellipse.

It may be considered that the CSIRO-96 differs statistically from the test of 63 Sparton probes described in WOCE Newsletter number 24 (XBT7-Sparton ellipse) wich is very close to the new depth equation for Sippican (Unesco 94 ellipse)

Processing the Kua Kavenga profiles appear unefficient due to the low accuracy of the reference profiles.

The available number (74) of simultaneous profiles of Sparton XBT and CTD remains too weak.



ANNEX VIII

SUMMARIES OF XCTD PRESENTATIONS BY BSH, CSIRO, TSK AND SIPPICAN

A. BUNDESAMT FUR SEESCHIFFAHRT UND HYDROGRAPHIE (BSH)

For the investigation of heat flux or other important processes XBT probes alone do not satisfactorily meet the requirements. Therefore, XCTD probes were used as soon as they became available, and the first ocean crossing section was worked by container vessel "Köln Express" in February 1992. Up to now 5 complete sections with XCTD measurements have been sampled along line AX-3 (Fig. 1 a) to supplement the XBT programme of BSH (Fig. 1 b). First XCTD versus CTD comparisons showed that XCTD probes needed further design developments by the manufacturer (Sy, 1993); the following field tests in the North Atlantic in December 1994 and October 1995 verified significant instrumental improvements and the XCTD/MK12 system was found close to the point of meeting the claimed specification (Sy, 1996). Unsolved deficiencies still were the conductivity start-up problem and the reduced conductivity accuracy at low pressure caused by ordinary and micro air bubbles, an inaccurate depth fall rate equation responsible for depth errors in the range of -30 m at 900 m depth. Finally, the MK12 software, although easy to use, proved to be erratic to some extent.

The last complete high density AX-3 XCTD section (Δx = 25 nm) was carried out by R.V. "Gauss" of BSH in June 1996 (Fig. 2 a) and provided a suitable opportunity to check modifications of system's performance which had been introduced by the manufacturer. For data acquisition, the new preliminary version of Sippican's MK12 software (V 3.0.5.1-Beta) addressed most of those problems encountered previously. The probe handling procedure was changed such that prior to launch a solution with commercial wetting agent (Jet-Dry, used in dishwashers) was squeezed into the conductivity cell to overflow the cell and thus to prevent air bubbles to be trapped within the cell (R. Elgin, pers. comm.). To double the spatial resolution of the section to Δx = 12.5 nm T-5 and T-7 XBT probes were dropped at and between the XCTD launch positions (Fig. 2 b). Additionally, 800 m behind the vessel an undulating CTD fish was towed over the whole distance and 10 CTD stations were carried out for quality control purposes. Although the vessel manoeuvred accordingly at each launch position to keep the fish clear from the XBT or XCTD signal wire, possible premature wire breaks caused by the fish cannot be ruled out completely. The vessel's speed was 10 knots and the weather condition was good.

Along that section 72 XCTD and 145 XBT probes were launched of which 60 XCTDs (83 %) and 130 XBTs (90 %) passed the quality control and were used for the final data set (Fig. 3, 4). All XCTD probes were manufactured between September and December 1995. Only 3 XCTD probe malfunctions appeared: 1 probe was lost by wire break due to jammed wire, 1 probe got no contact at all and 1 probe came up with totally wrong values in both temperature and conductivity (Fig. 5 a).

Another source of data losses was caused by software errors: 2 profiles were lost by MK12 run-time errors, and the data of 1 profile were lost due to file-overwriting by data of the following drop. This problem occured because the sequence number was not properly updated by the system. For two more times we were able to observe directly this non-updating of the drop sequence number.

The data quality concerning noise level, spiking etc. was found to be good. A typical profile is presented in Fig. 5 b. A spiking problem caused by sensor mismatch of temperature and conductivity did not appear in the data. Figs. 6 a, b represent the worst cases of 4 noisy and 2 spiky measurements and Fig. 7 shows the typical conductivity start-up problem which, however, appeared only once, probably because the pre-launch wetting procedure was not carried out properly. An overview of all XCTD problems encountered is given below:

Total number of XCTD probes launched		72
Total number of profiles in final data set		60
Hardware problems:	jammed wire	1
	no contact	1
Conductivity start-up failures		1
Premature system starts by wetting procedure		2
Premature wire breaks:	at depths < 400 m	3
	at depths < 800 m	6
	at depths > 800 m	1
Data problems:	wrong measurement	1
	plenty large single spikes	2
	noisy traces	4
Fatal software errors with data loss		3

Our results show that the failure rate due to the conductivity start-up problem caused by ordinary air bubbles can be reduced to zero by application of a wetting agent prior to launch according to the procedure recommended by Sippican (Fig. 8). Although this procedure is simple it cannot be suggested to be used on ships-of-opportunity. The turn-on electrodes can get wet by this procedure which causes a premature start of the data acquisition procedure when the probe is loaded. Therefore, the conductivity cell should be wetted with the unloaded probe only.

We did not investigate if this procedure is also capable to solve the conductivity accuracy problem at low pressures (caused by micro air bubbles), because a detailed analysis of XCTD versus CTD measurements was not yet carried out. These CTD versus XCTD measurements will also contribute to the planned revision of the XCTD depth fall rate equation according the procedures suggested by Hanawa et al., 1995.

References:

Hanawa, K., P. Rual, R. Bailey, A. Sy and M. Szabados (1995): A new depth-time equation for Sippican or TSK T-7, T-6 and T-4 expendable bathythermographs (XBT). Deep-Sea Res. 42, 1423-1451.

Sy, A. (1993): Field Evaluation of XCTD Performance. WOCE Newsletter, **14**, pp 33 - 37.

Sy, A. (1996): Summary of field tests of the improved XCTD/MK-12 System. International WOCE Newsletter, **22**, 11-13.

Figures:

Fig. 1: The BSH AX-3 XBT/XCTD programme:
a) The 5 XCTD sections sampled between 1992 to 1996
b) Data distribution of XBT high density line since 1988

Fig. 2: Positions of measurements carried out with R.V. "Gauss" (cruise 279, leg 3) of BSH in June 1996 along AX-3:
a) XCTD
b) XBT

Fig. 3: XCTD sections of temperature, salinity and density

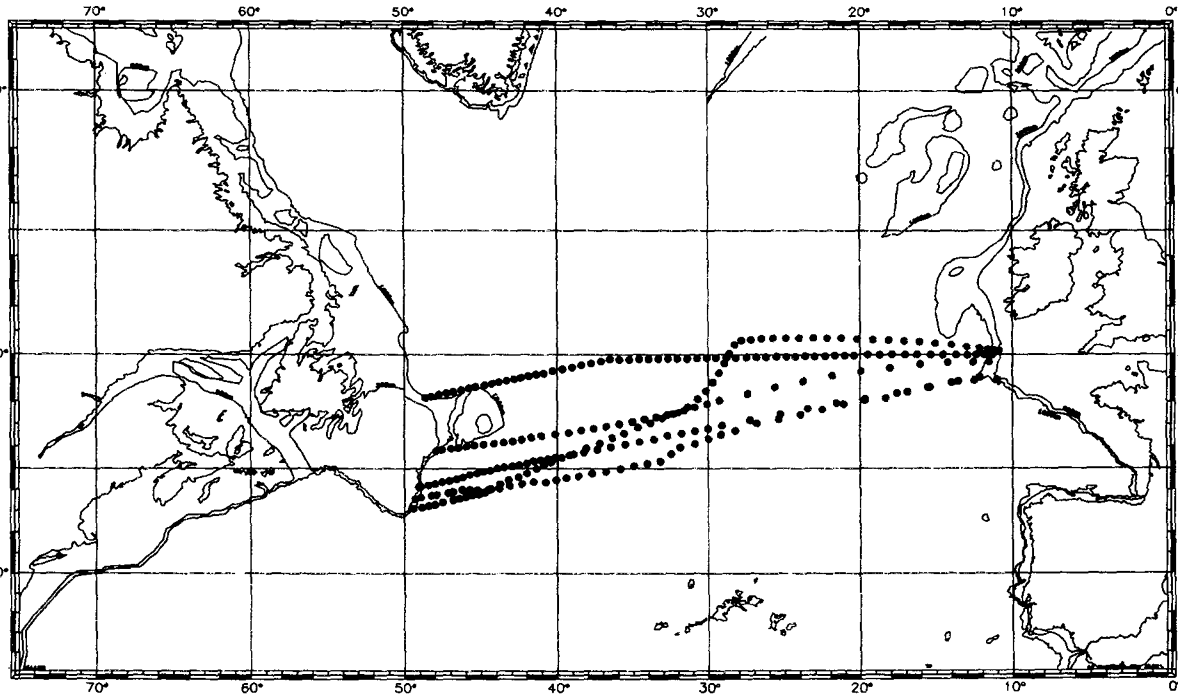
Fig. 4: XBT section (note the depth range of 2000 m)

Fig. 5: Sequence of 2 XCTD measurements (raw data):
a) Drop # 41 is erroneous
b) Traces of drop # 42 are of typical quality

Fig. 6: a) Worst case of 4 noisy measurements
b) Worst case of 2 spiky measurements

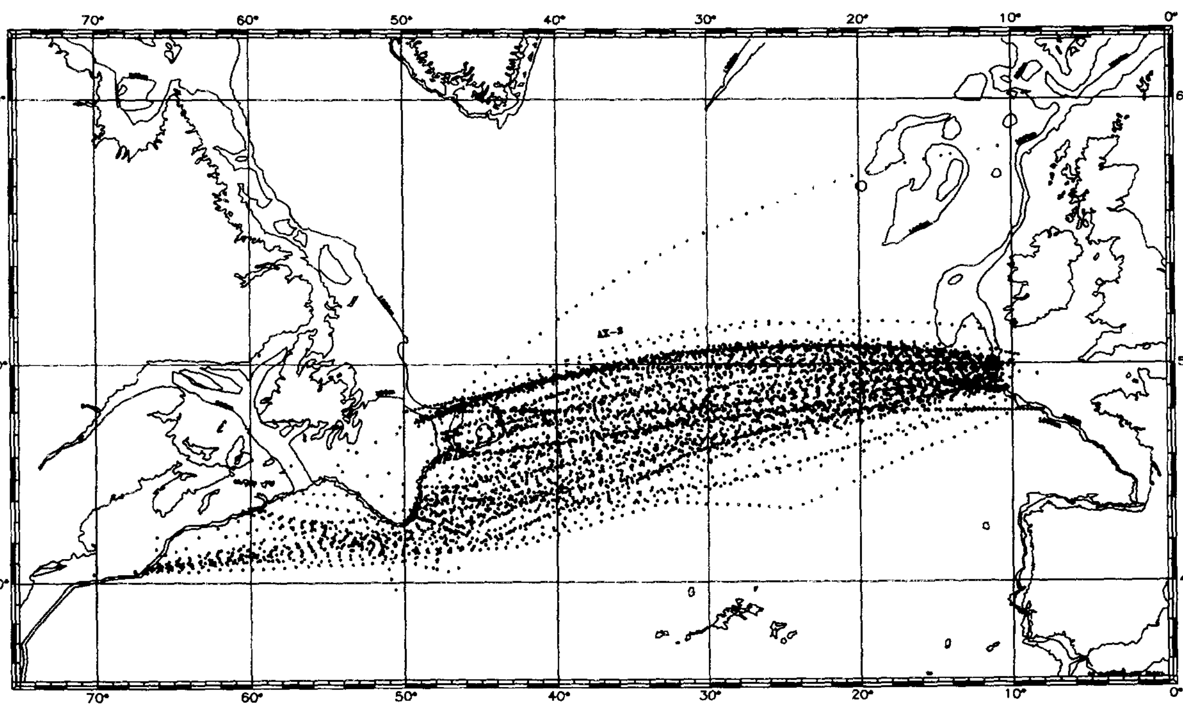
Fig. 7: Conductivity start-up problem at the upper 50 m which are typical for trapped ordinary air bubbles

Fig. 8: The pre-launch wetting procedure (according to Sippican)



CMS "Koeln EXPRESS" 172, 177, 195 / RV "Gauss" 226, 276 - XCTD 1992-1996 (AX-3)

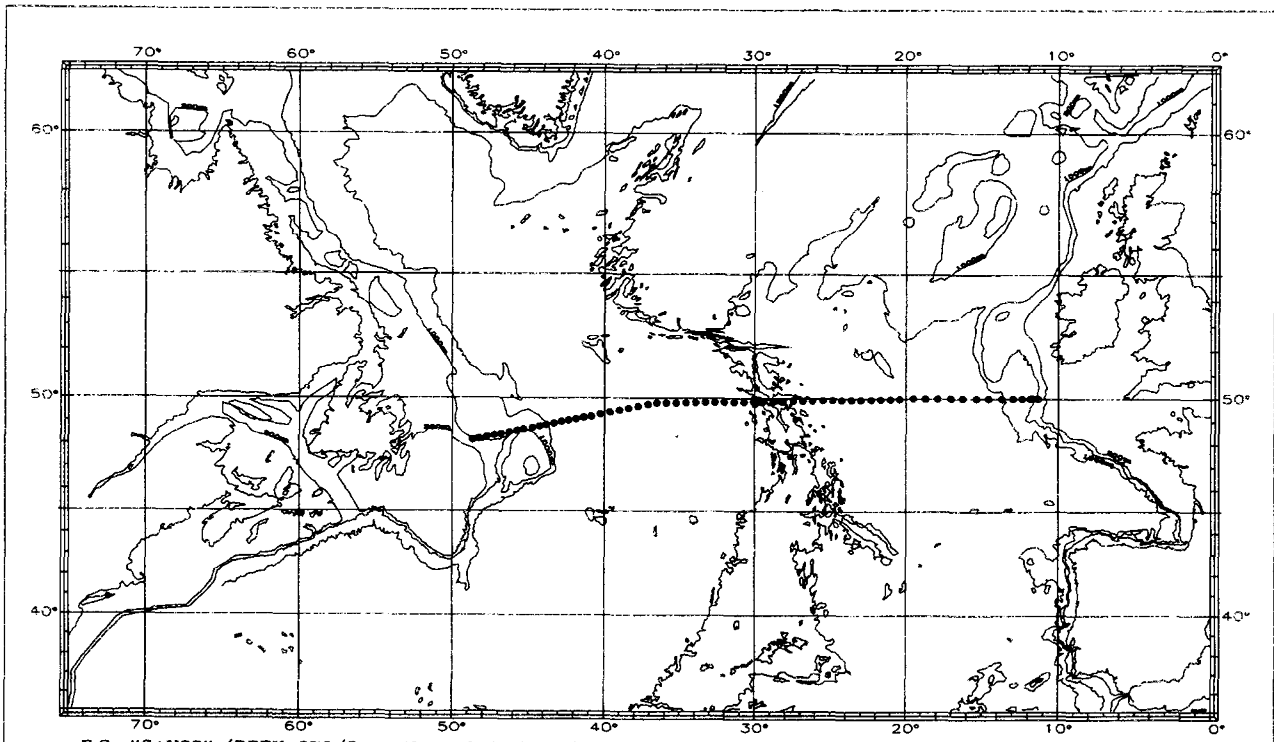
a)



" AX-3 " (20.5.1988 - 12.3.1997)

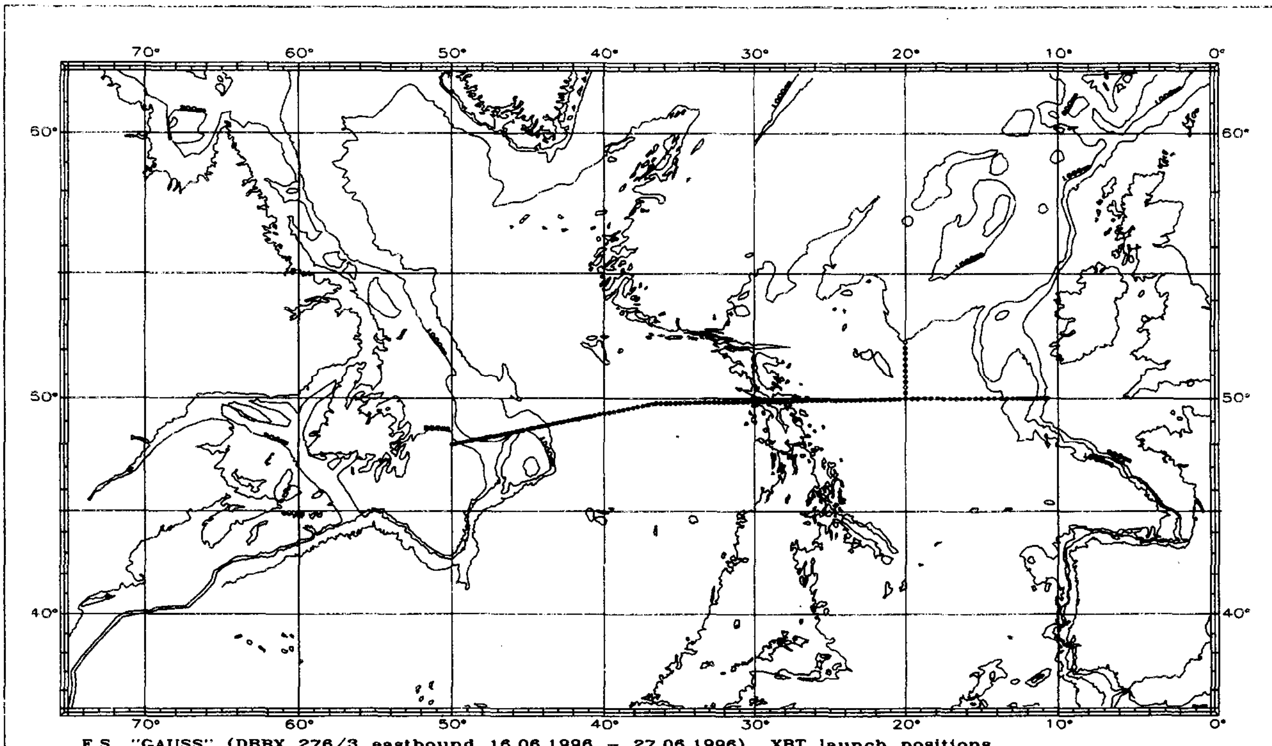
b)

Figure 1



F.S. "GAUSS" (DBBX 276/3 eastbound 16.06.1996 - 27.06.1996) XCTD launch positions

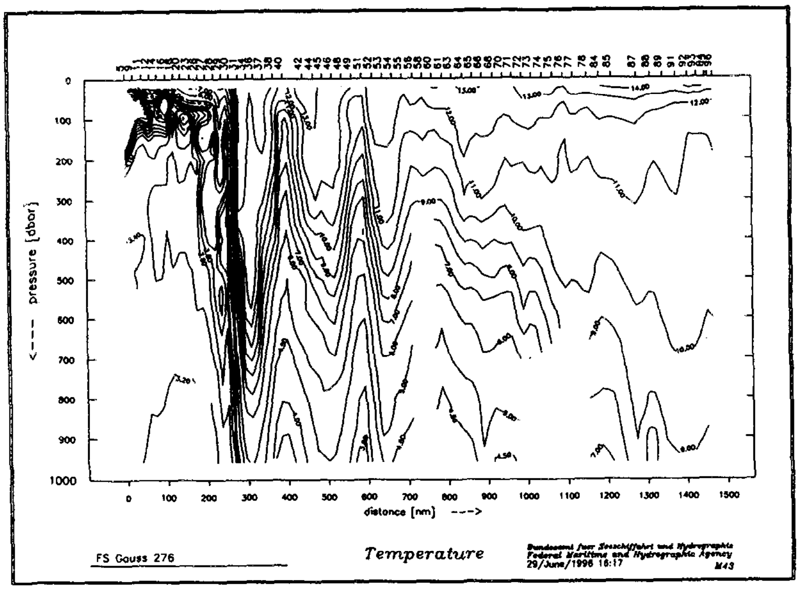
a)



F.S. "GAUSS" (DBBX 276/3 eastbound 16.06.1996 - 27.06.1996) XBT launch positions

b)

Figure 2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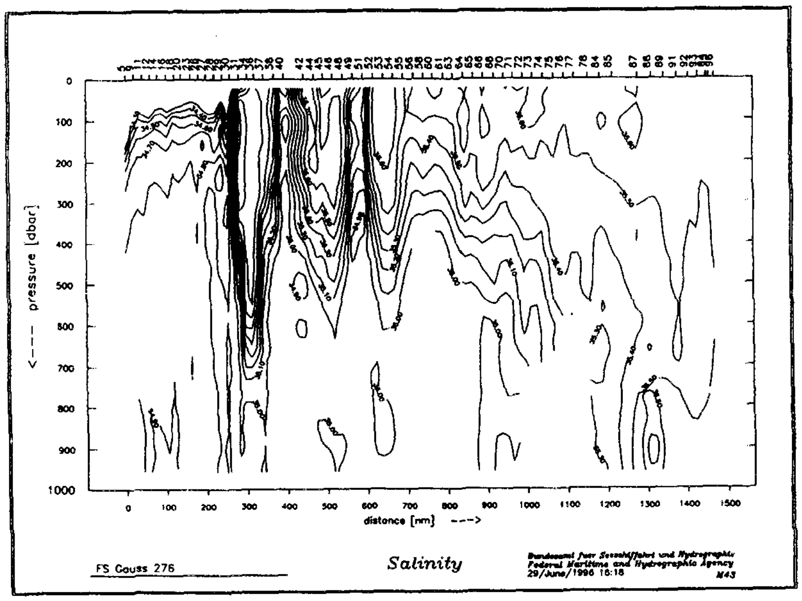
distance [nm] --->
FS Gauss 276
Temperature
Bundesamt fuer Seeschiffahrt und Hydrographie
Federal Maritime and Hydrographic Agency
29/June/1996 16:17
M43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distance [nm] --->
FS Gauss 276
Salinity
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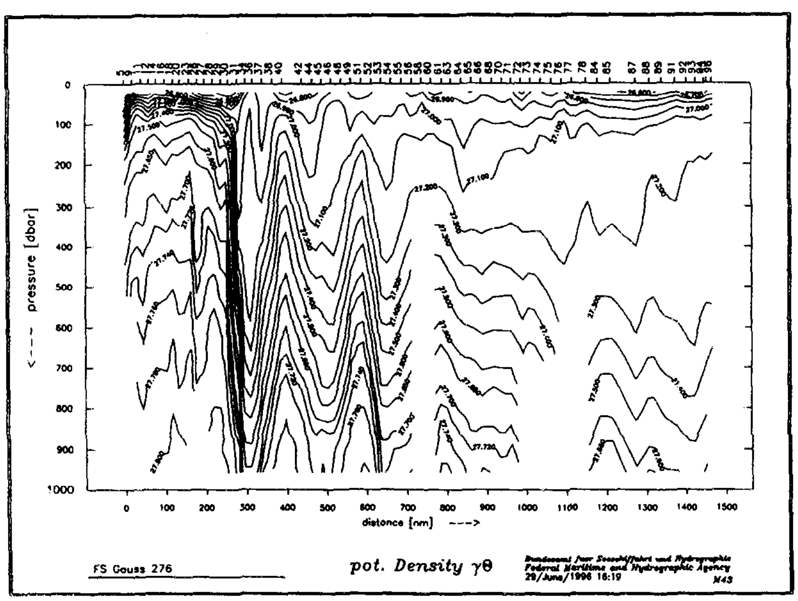
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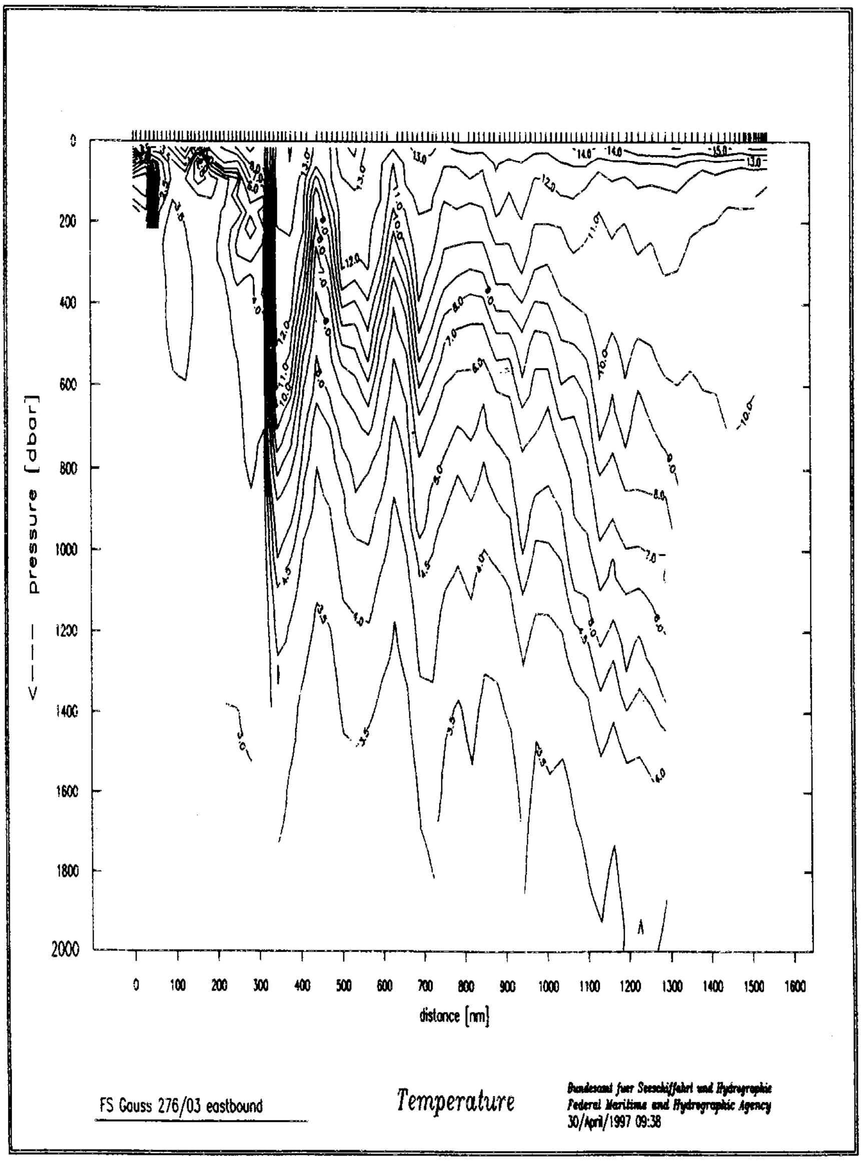
distance [nm] --->
FS Gauss 276
pot. Density γθ
Bundesamt fuer Seeschiffahrt und Hydrographie
Federal Maritime and Hydrographic Agency
29/June/1996 16:19
M43

Figure 3


pressure [dbar]
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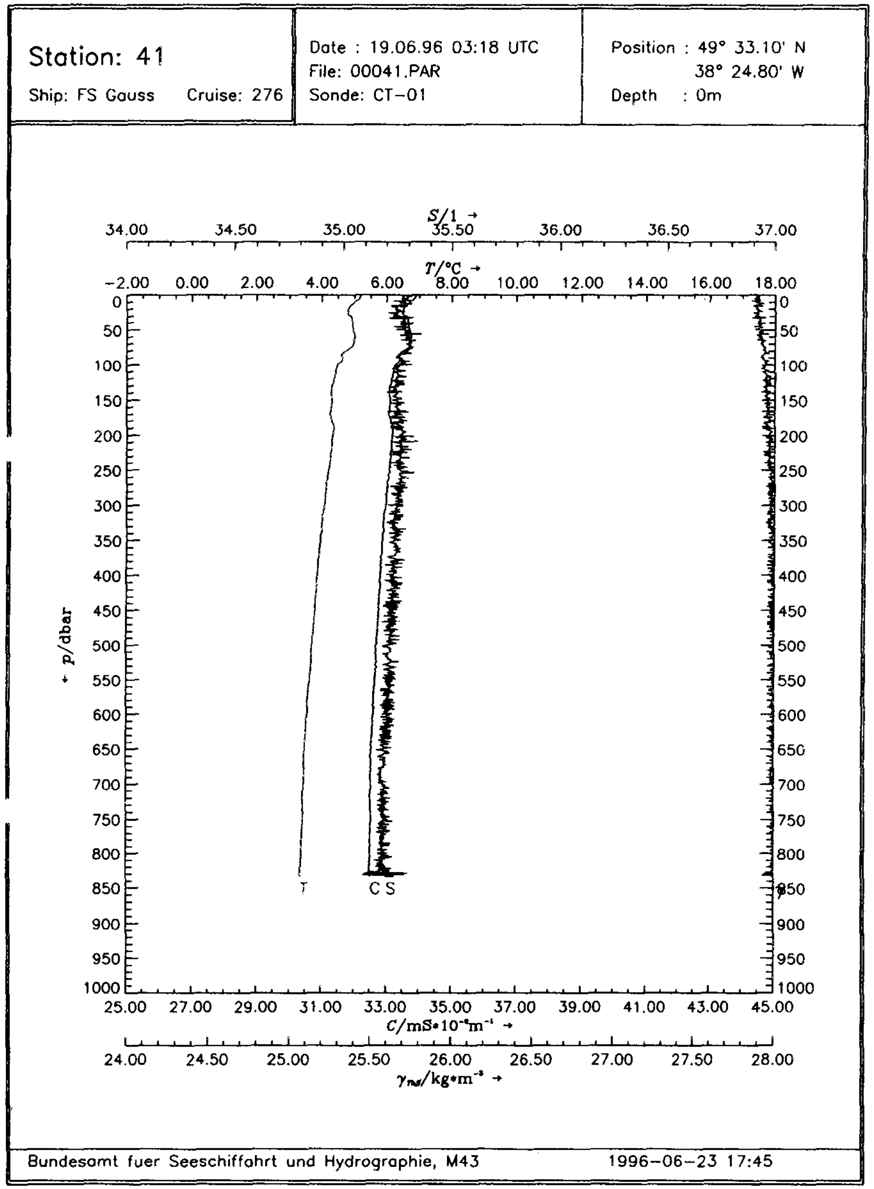
200
400
600
800
1000
1200
1400
1600
1800
2000
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
distance [nm]
FS Gauss 276/03 eastbound
Temperature
Bundesamt fuer Seeschiffahrt und Hydrographie
Federal Maritime and Hydrographic Agency
30/April/1997 09:38

Figure 4

a)

Station: 41
Ship: FS Gauss Cruise: 276
Date : 19.06.96 03:18 UTC
File: 00041.PAR
Sonde: CT-01
Position : 49° 33.10' N
38° 24.80' W
Depth : 0m
S/1 →
T/°C →
← p/dbar
C/mS*10⁻¹m⁻¹ →
γ/kg*m⁻³ →
T
C S
Bundesamt fuer Seeschiffahrt und Hydrographie, M43
1996-06-23 17:45

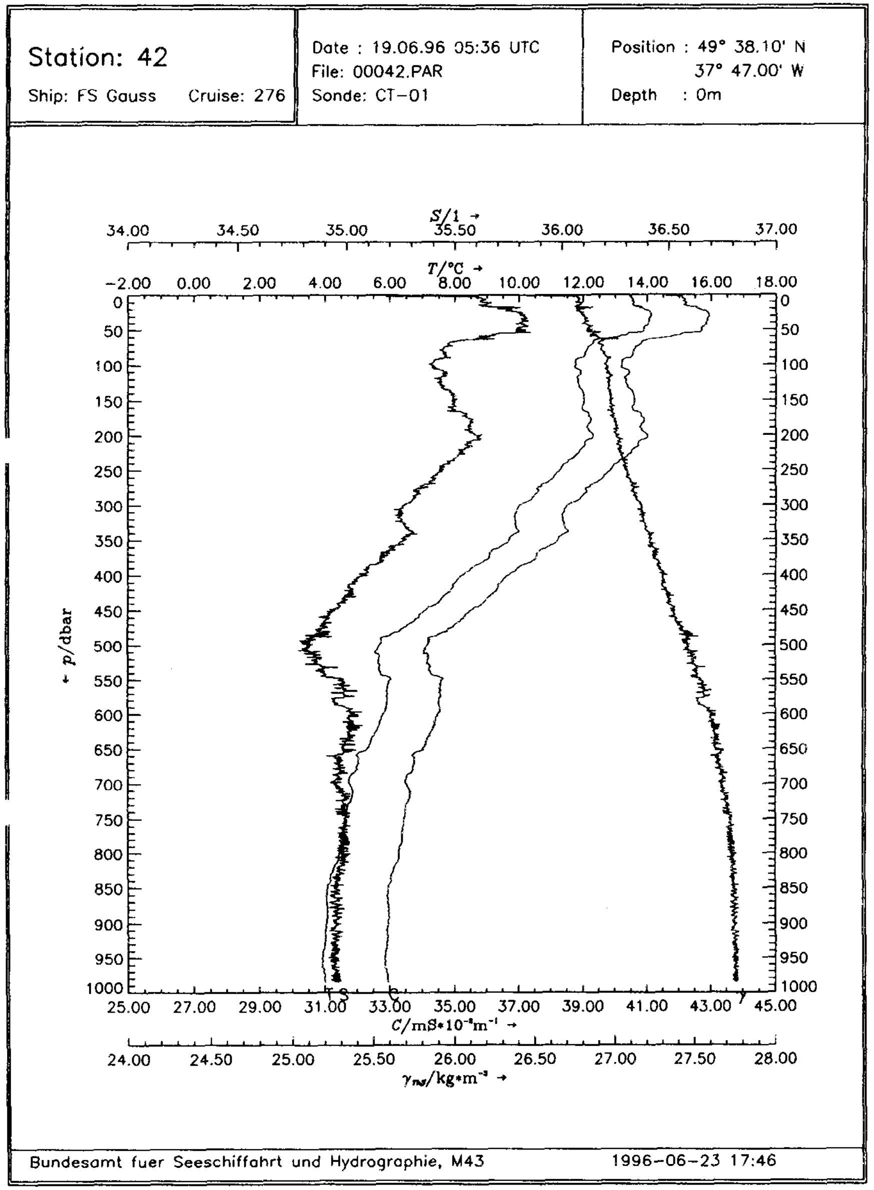
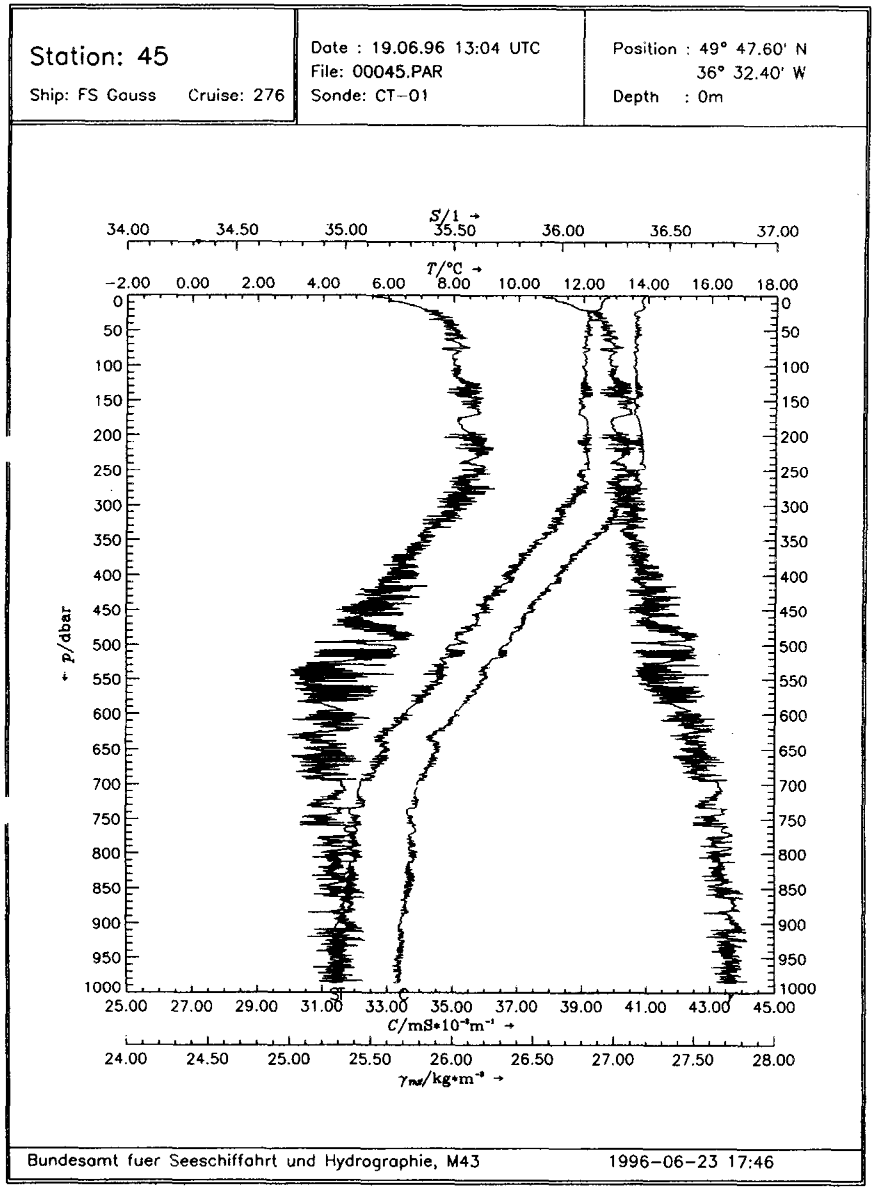
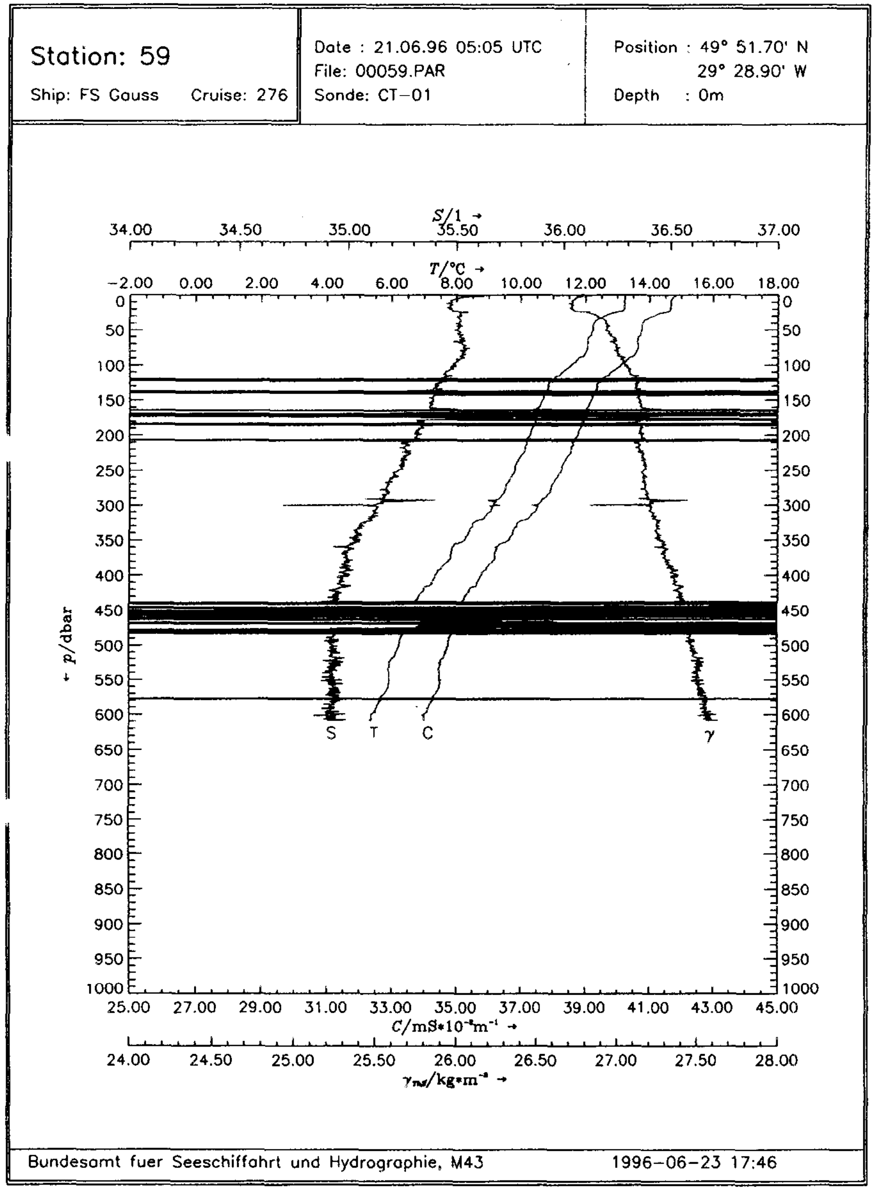
b)

Station: 42
Ship: FS Gauss Cruise: 276
Date : 19.06.96 05:36 UTC
File: 00042.PAR
Sonde: CT-01
Position : 49° 38.10' N
37° 47.00' W
Depth : 0m
S/1 →
T/°C →
← p/dbar
C/mS*10⁻¹m⁻¹ →
γ/kg*m⁻³ →
Bundesamt fuer Seeschiffahrt und Hydrographie, M43
1996-06-23 17:46

Figure 5

a)


Station: 45
Ship: FS Gauss Cruise: 276
Date : 19.06.96 13:04 UTC
File: 00045.PAR
Sonde: CT-01
Position : 49° 47.60' N
36° 32.40' W
Depth : 0m
S/1 →
T/°C →
← p/dbar
C/mS*10⁻³m⁻¹ →
γ/kg*m⁻³ →
S
C
γ
Bundesamt fuer Seeschiffahrt und Hydrographie, M43
1996-06-23 17:46

b)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Position : 49° 51.70' N
29° 28.90' W
Depth : 0m
S/1 →
T/°C →
← p/dbar
S T C γ
C/mS*10⁻³m⁻¹ →
γ/kg*m⁻³ →
Bundesamt fuer Seeschiffahrt und Hydrographie, M43
1996-06-23 17:46

Figure 6

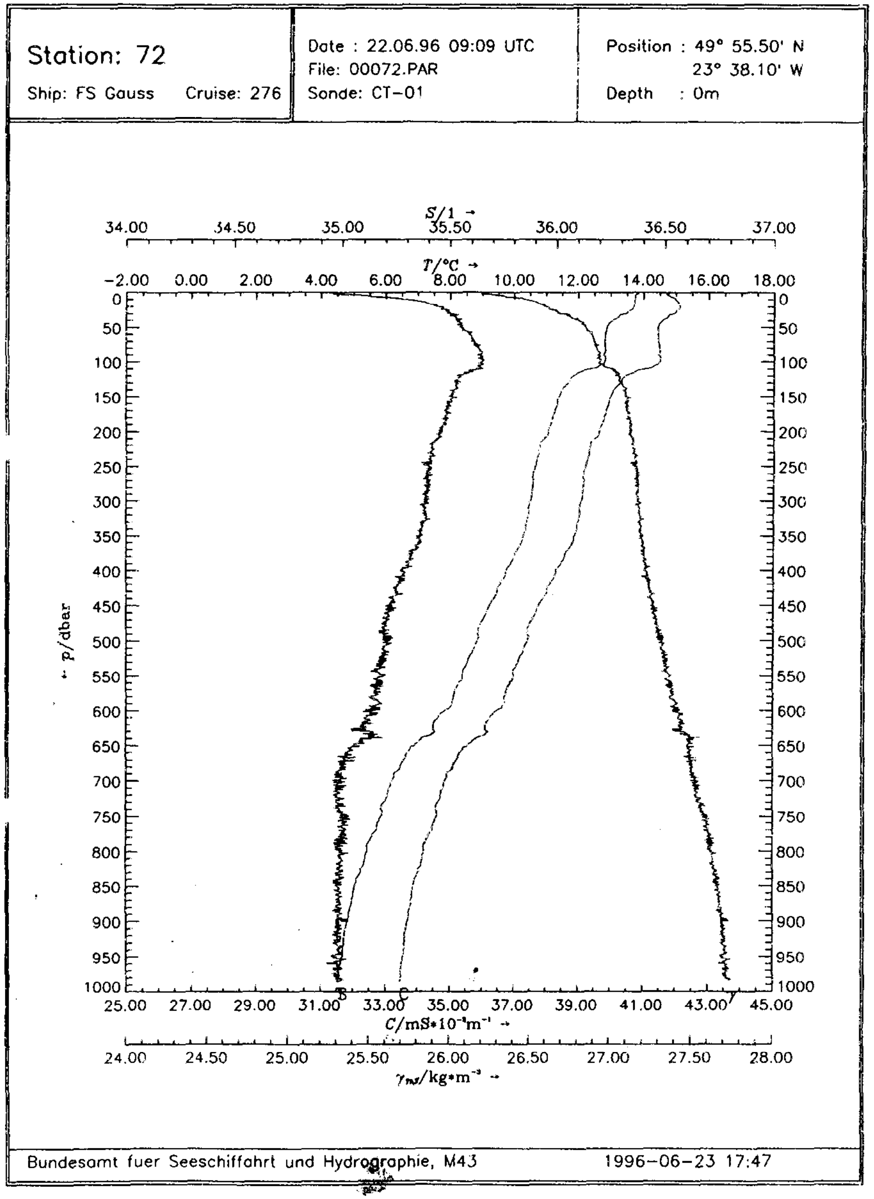


Figure 7

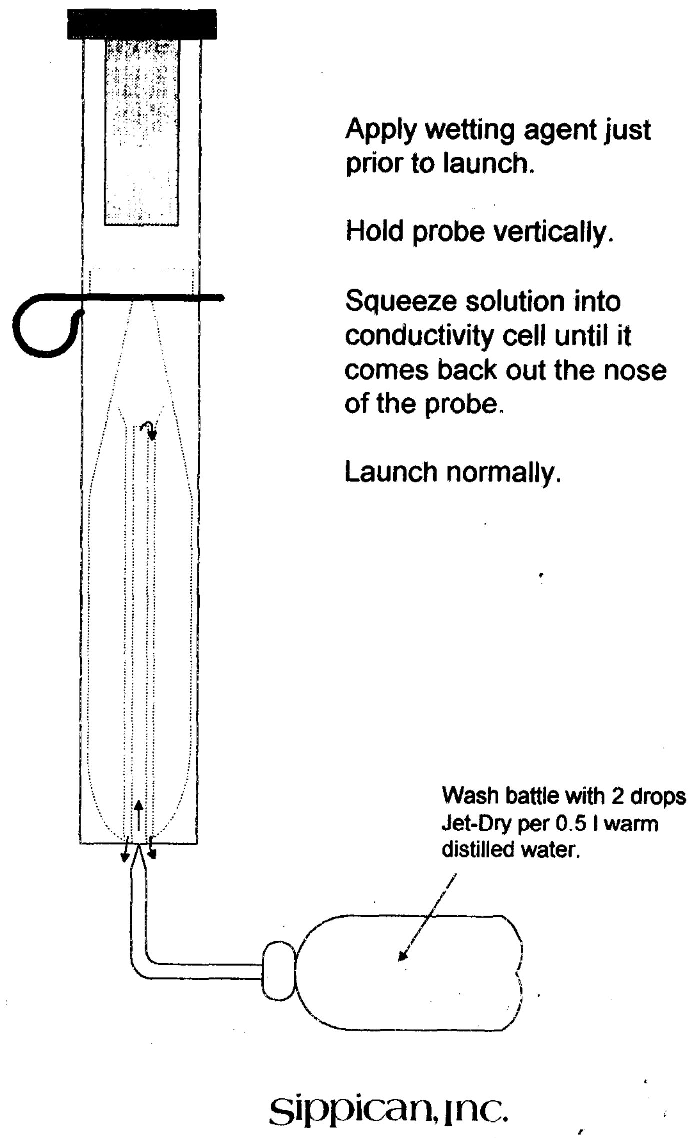


Figure 8

B. CSIRO

In 1995, there were three voyages undertaken by ships-of-opportunity participating in the CSIRO Division of Marine Research high-density XBT program to sample the region between Fremantle and Sunda Strait in the northeast Indian Ocean (Figure 1): two on the MV Encounter Bay (13-17 April 95 and 27 September-1 October 95) and one on the SS Flinders Bay (12-15 November 95). Temperature and conductivity were measured using Sippican XBTs and XCTDs with the MK12 system by a member of the CSIRO XBT group. All XCTD data show spikes to varying degrees. The Flinders Bay voyage experienced a high frequency oscillation of about 2.5 points per cycle (Figure 2) which is believed to be a modulation of a signal generated by electrical interference from the ship. These fluctuations were removed by a simple triangle weighted running mean filter [0.25 0.5 0.25].

After the major spikes in the XCTD dataset were removed, there still remained salinity spikes biased toward saltier water (Figure 3) which appeared in regions of strong thermal gradients. This is attributed to two factors: first, there is a lag between the time temperature is measured and the time conductivity is measured; second, there is a difference in response time of the two instruments. To correct for this, the conductivity measurements were shifted upward by 0.4 data points using a linear interpolation scheme. This number is an empirical estimate that best removes the salinity spikes in the mean (Figure 3). (The salinities from the smoothed Flinders Bay data also exhibited these salinity spikes; therefore, conductivity was also offset by 0.4 data points.)

Concurrent with the three XCTD voyages, three WOCE hydrographic cruises (during April, September, and November 1995) were occupied along approximately the same track. Each XCTD between Shark Bay and Christmas Island was compared with the two closest CTD stations. The salinity data were averaged into 0.5 degC temperature bins and the two fields subtracted (Table 1). Because of natural variability in the upper ocean, temperatures greater than 12 degC were not used in the analysis. Over 35 cast pairs, the mean difference is -0.007 psu with a standard deviation of 0.044 psu. The large standard deviation of 0.044 psu is attributed to the warmer temperature classes where natural variability may still occur; colder waters (T<9 degC) have a standard deviation less than 0.035 psu. The accuracy of the XCTD as specified by Sippican is about 0.03 psu.

Some profiles are capped by "fresh" water whose salinity decays exponentially with depth; however, the temperature profiles suggest a uniform mix-layer (Figure 4). Comparison with the closest CTD cast in a similar time period does not indicate the presence of a fresh cap. Bottle salinity samples taken at the surface tended to be positively biased by 0.1-0.2 psu. The exponential characteristic is consonant with a reduction in conductivity caused by a trapped air bubble. This occurred in 9 out of the 52 profiles. We have chosen to delete the exponential feature rather than extrapolate a mix-layer salinity to the surface.

Any fall-rate problem in the XCTDs (observed to be of approximately the same magnitude as the XBT error from the comparison of the XCTDs to the corresponding XBT profiles) is circumvented by utilizing only their temperature and salinity (conductivity) information. Since the XBT fall-rate is well-documented, salinity is inferred from the concurrent XBT temperatures using the derived XCTD T/S relationship. There were two cases in which the XCTD T/S was offset from the historical T/S curve (e.g. Table 1, case ebix1x_018). Both cases are obvious in the XCTD T/S curve, though the source of the error has yet to be determined.

Overall, the XCTD captures the variability in this region as it is larger than 0.05 psu. In particular, the dataset depicts variations of a strong salinity front south of Sunda Strait that separates the deep, salty South Java Current from the fresher water of the Indonesian Throughflow. This front has also been seen in CTD data taken as part of the JADE (1989) program.

In summary, although the XCTD generally performs well to temperature and salinity specifications, four flaws were found with the XCTD: 1) A fall rate error; 2) Trapped air bubbles at the surface leading to errors in the surface layer (0-100m) salinities; 3) Sensor mismatches leading to salinity spikes; and 4) Occasional constant salinity offsets. Bottle surface samples may help determine casts with a bubble problem or salinity offsets, keeping in mind their own possible bias. The use of a surfactant applied to the surface of the conductivity cells just prior to the deployment of the probe may alleviate the erroneous surface layer salinity problem in the future (personal communication with the manufacturers). Only temperature and salinity data are used from the XCTD to avoid any problems with the fall-rate. No attempt was made in this study to quantify the exact fall rate error.

CAPTIONS

Table 1. Comparison between XCTDs and CTDs. Salinity is averaged into 0.5 degC temperature bins.

Figure 1. Locations of XCTD casts for three cruises on ships-of-opportunity.

Figure 2. Example of raw XCTD temperature data from the different cruises. Each trace is offset by 5 degC. The last trace depicts November temperature that is despiked and then smoothed by a running mean triangle filter with weights [0.25 0.5 025].

Figure 3. S(0) shows salinity spikes occurring in regions of large temperature gradients. Conductivity is shifted up by 0.4 data points to remove salinity spikes in the mean (S(0.4)).

Figure 4. The "bubble problem." Surface salinity and temperature from XCTD (solid), CTD (dotted), and bottle (dashed). Typically, salinities in the top 50m are characterized by an exponential decay with depth resulting from a trapped air bubble. XCTD data (solid), CTD (dotted).

Table 1

Start Temp	6.0000	6.5000	7.0000	7.5000	8.0000	8.5000	9.0000	9.5000	10.0000	10.5000	11.0000	11.5000		
End Temp	6.5000	7.0000	7.5000	8.0000	8.5000	9.0000	9.5000	10.0000	10.5000	11.0000	11.5000	12.0000		
CRUISES													Mean	Std. Dev.
ebix12x 002 - FR0895 030 001	-0.0060	-0.0013	-0.0072	0.0047	-0.0002	-0.0120	0.0036	0.0081	-0.0134	-0.0207	-0.0467	-0.0613	-0.0127	0.0212
ebix12x 002 - FR0895 029 001	0.0066	0.0139	0.0093	0.0146	0.0044	-0.0192	-0.0154	-0.0097	-0.0173	-0.0302	-0.0452	-0.0625	-0.0126	0.0244
ebix12x 003 - FR0895 052 001	NaN	NaN	NaN	NaN	NaN	-0.0101	-0.0014	-0.0082	-0.0054	-0.0090	-0.0006	0.0074	-0.0039	0.0062
ebix12x 003 - FR0895 051 001	NaN	NaN	NaN	NaN	NaN	-0.0121	-0.0012	-0.0079	-0.0123	-0.0079	-0.0025	0.0081	-0.0051	0.0072
ebix12x 004 - FR0895 064 001	NaN	-0.0060	-0.0182	-0.0268	-0.0293	-0.0379	-0.0532	-0.0079	0.0076	-0.0034	-0.0335	0.0018	-0.0188	0.0189
ebix12x 004 - FR0895 063 001	NaN	-0.0058	-0.0171	-0.0259	-0.0314	-0.0394	-0.0655	-0.0890	-0.0931	-0.0192	-0.0128	-0.0025	-0.0365	0.0321
ebix12x 005 - FR0895 068 001	0.0113	0.0153	0.0274	0.0160	0.0072	-0.0039	-0.0152	0.0039	0.0080	0.0367	0.0089	0.0093	0.0104	0.0133
ebix12x 005 - FR0895 067 001	0.0355	0.0420	0.0400	0.0195	0.0000	-0.0069	0.0186	0.0455	0.0402	0.0422	-0.0242	-0.0528	0.0166	0.0315
ebix12x 007 - FR0895 069 001	0.0011	0.0083	-0.0027	0.0029	-0.0113	-0.0041	-0.0070	-0.0196	-0.0169	-0.0172	-0.0031	0.0418	-0.0023	0.0164
ebix12x 007 - FR0895 068 001	0.0037	0.0047	0.0198	0.0326	0.0295	0.0278	-0.0123	-0.0481	-0.0498	-0.0232	0.0140	0.0751	0.0061	0.0357
ebix12x 008 - FR0895 069 001	0.0034	0.0056	-0.0125	-0.0076	-0.0074	-0.0089	0.0293	0.0754	0.0713	0.0094	0.0067	-0.0050	0.0133	0.0302
ebix12x 008 - FR0895 070 001	0.0034	-0.0109	-0.0206	-0.0181	-0.0320	-0.0246	0.0197	0.0456	0.0363	-0.0105	0.0037	0.0024	-0.0005	0.0242
ebix12x 009 - FR0895 070 001	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0000
ebix12x 009 - FR0895 069 001	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0000
ebix12x 011 - FR0895 070 001	0.0088	0.0076	0.0109	0.0231	0.0056	-0.0139	0.0189	-0.0256	-0.0195	0.0427	0.0692	0.0559	0.0153	0.0291
ebix12x 011 - FR0895 069 001	0.0088	0.0242	0.0191	0.0336	0.0302	0.0019	0.0285	0.0042	0.0156	0.0626	0.0721	0.0485	0.0291	0.0223
ebix1x 008 - Fr0395 001	NaN	NaN	NaN	NaN	NaN	-0.0046	-0.0122	-0.0119	-0.0099	-0.0239	-0.0282	-0.0314	-0.0174	0.0102
ebix1x 008 - Fr0395 011	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	0.0000
ebix1x 018 - Fr0395 058	NaN	NaN	NaN	-0.0788	-0.1003	-0.0991	-0.1025	-0.1040	-0.1012	-0.1125	-0.1008	-0.1033	-0.1003	0.0090
ebix1x 018 - Fr0395 017	NaN	NaN	NaN	-0.0749	-0.1031	-0.1066	-0.1029	-0.1102	-0.1066	-0.1304	-0.1155	-0.1171	-0.1075	0.0150
ebix1x 021 - Fr0395 027	0.0368	-0.0077	-0.0266	-0.0332	-0.0223	-0.0050	-0.0124	0.0013	0.0038	0.0264	0.0519	0.0727	0.0071	0.0330
ebix1x 021 - Fr0395 025	0.0164	-0.0254	-0.0021	-0.0085	0.0137	0.0122	0.0059	0.0079	0.0063	0.0024	0.0056	0.0076	0.0035	0.0113
ebix1x 025 - Fr0395 034	NaN	-0.0165	-0.0190	-0.0074	-0.0196	-0.0169	-0.0194	-0.0117	-0.0104	-0.0449	-0.0531	-0.0418	-0.0237	0.0155
ebix1x 025 - Fr0395 033	NaN	0.0343	0.0243	0.0144	-0.0037	-0.0123	-0.0195	-0.0142	-0.0074	-0.0408	-0.0616	-0.0544	-0.0128	0.0307
ebix1x 026 - Fr0395 041	NaN	0.0100	0.0015	-0.0205	-0.0224	-0.0114	0.0078	0.0327	0.0126	0.0162	-0.0039	-0.0238	-0.0001	0.0181
ebix1x 026 - Fr0395 042	NaN	0.0077	-0.0009	-0.0224	-0.0242	-0.0133	0.0041	0.0340	0.0366	0.0575	0.0304	0.0284	0.0125	0.0267
ebix1x 027 - Fr0395 049	NaN	NaN	0.0267	0.0396	0.0541	0.0496	0.0693	0.0662	0.0718	0.0219	0.0441	0.0156	0.0459	0.0200
ebix1x 027 - Fr0395 050	NaN	NaN	0.0120	0.0436	0.0098	-0.0045	-0.0087	0.0004	0.0372	-0.0266	0.0113	0.0146	0.0089	0.0207
ebix1x 028 - Fr0395 053	NaN	NaN	NaN	0.0050	0.0048	0.0161	0.0090	-0.0869	-0.0993	-0.1526	-0.1852	-0.1978	-0.0763	0.0881
ebix1x 028 - Fr0395 052	NaN	NaN	NaN	0.0103	-0.0020	-0.0015	-0.0102	-0.0333	0.0077	0.0123	0.0286	-0.0074	0.0005	0.0173
ebix1x 029 - Fr0395 054	NaN	-0.0045	0.0029	-0.0040	0.0030	0.0231	-0.0250	0.0062	0.0042	-0.0087	-0.0127	-0.0165	-0.0029	0.0130
ebix1x 029 - Fr0395 053	NaN	-0.0009	0.0055	0.0036	0.0140	0.0146	0.0079	-0.0357	-0.1270	-0.1783	-0.1753	-0.2013	-0.0612	0.0893
fbix11x 011 - WOCE I10 1074	NaN	NaN	-0.0129	-0.0322	-0.0033	0.0239	0.0141	0.0242	0.0650	0.0231	-0.0007	-0.0518	0.0050	0.0329
fbix11x 011 - WOCE I10 1073	NaN	NaN	-0.0115	-0.0180	0.0098	0.0542	0.0478	0.0749	0.0830	0.0434	0.0204	0.0143	0.0318	0.0344
fbix11x 012 - WOCE I10 1074	NaN	NaN	NaN	0.0039	0.0015	0.0161	0.0295	0.0164	0.0591	0.0249	0.0275	-0.0717	0.0119	0.0356
fbix11x 012 - WOCE I10 1075	NaN	NaN	NaN	-0.0102	-0.0169	-0.0184	-0.0049	-0.0234	-0.0384	-0.0218	-0.0128	-0.0760	-0.0248	0.0214
fbix11x 014 - WOCE I10 1075	NaN	NaN	NaN	0.0074	0.0023	-0.0470	-0.0251	-0.0134	-0.0334	-0.0477	-0.0396	-0.0004	-0.0219	0.0216
fbix11x 014 - WOCE I10 1074	NaN	NaN	NaN	0.0215	0.0207	-0.0126	0.0093	0.0264	0.0641	-0.0010	0.0007	0.0038	0.0148	0.0223
Mean	0.0108	0.0047	0.0020	-0.0029	-0.0068	-0.0088	-0.0054	-0.0054	-0.0037	-0.0145	-0.0161	-0.0220	Total Mean:	-0.0074
Std. Dev.	0.0131	0.0163	0.0179	0.0283	0.0313	0.0320	0.0350	0.0449	0.0536	0.0555	0.0576	0.0636	Total St. Dev.:	0.0435

Figure 1

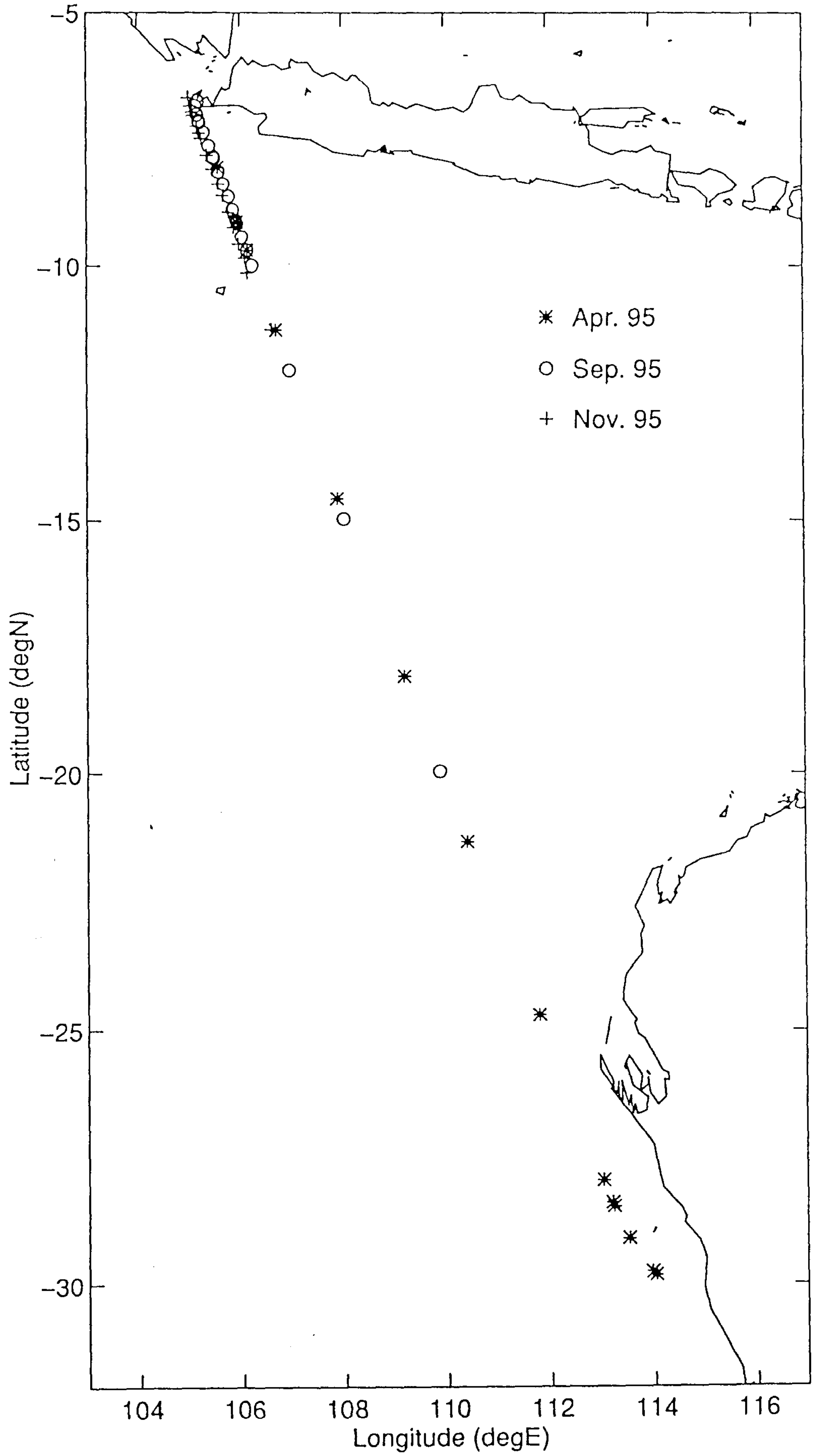

-5
-10
-15
-20
-25
-30
Latitude (degN)
104
106
108
110
112
114
116
Longitude (degE)
Apr. 95
Sep. 95
Nov. 95

Figure 2

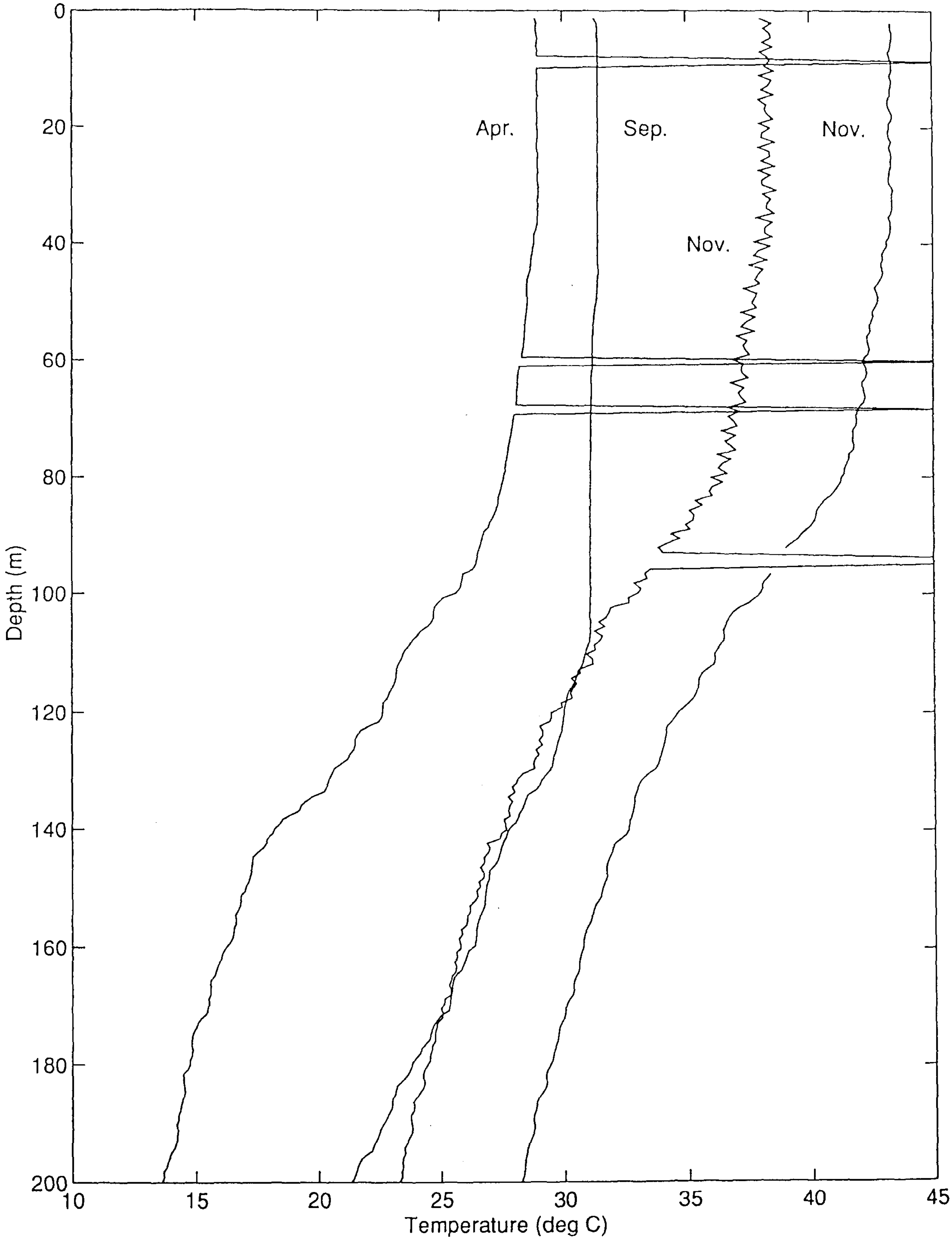

Apr.
Sep.
Nov.
Nov.
Depth (m)
Temperature (deg C)
0
20
40
60
80
100
120
140
160
180
200
10
15
20
25
30
35
40
45

Figure 3

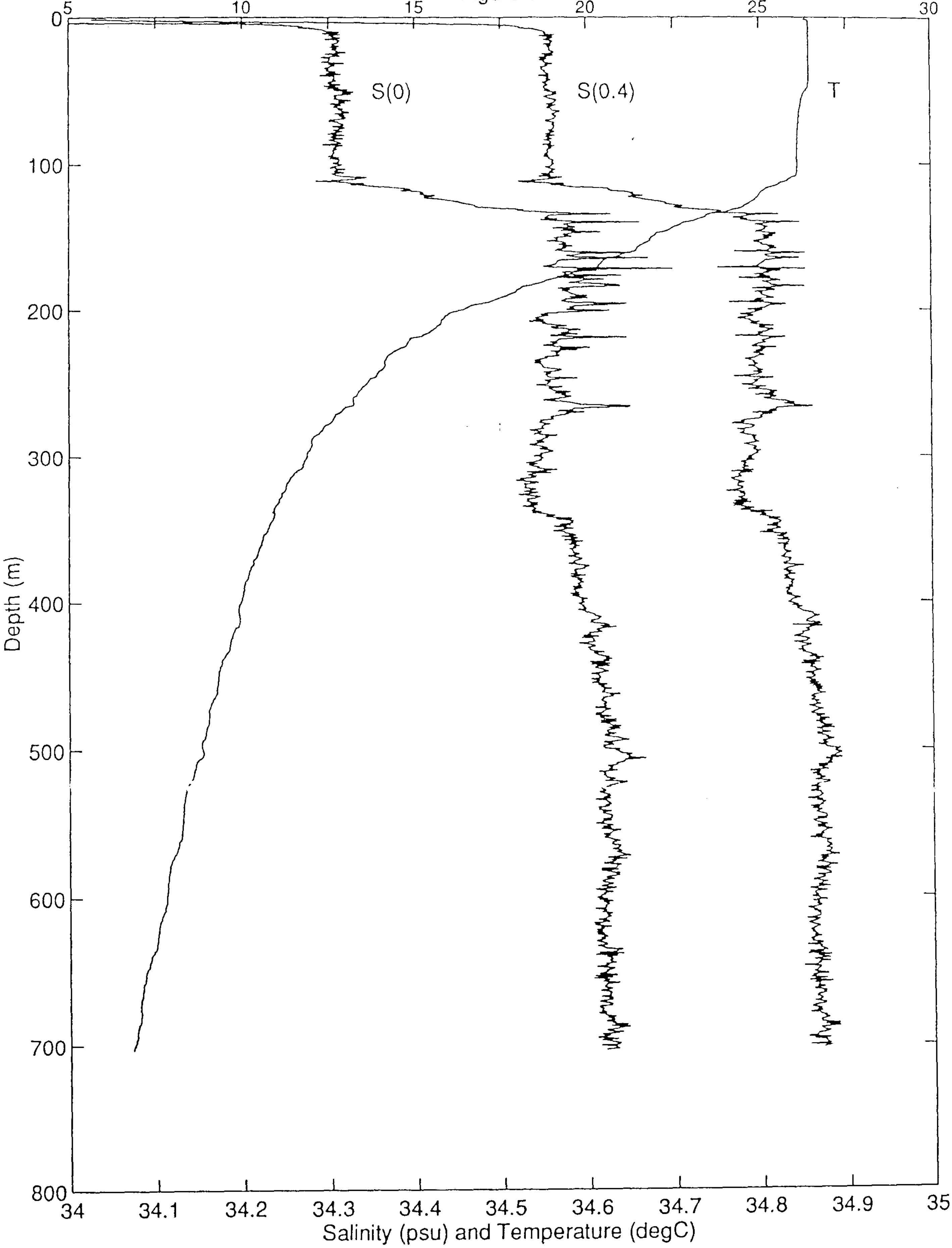
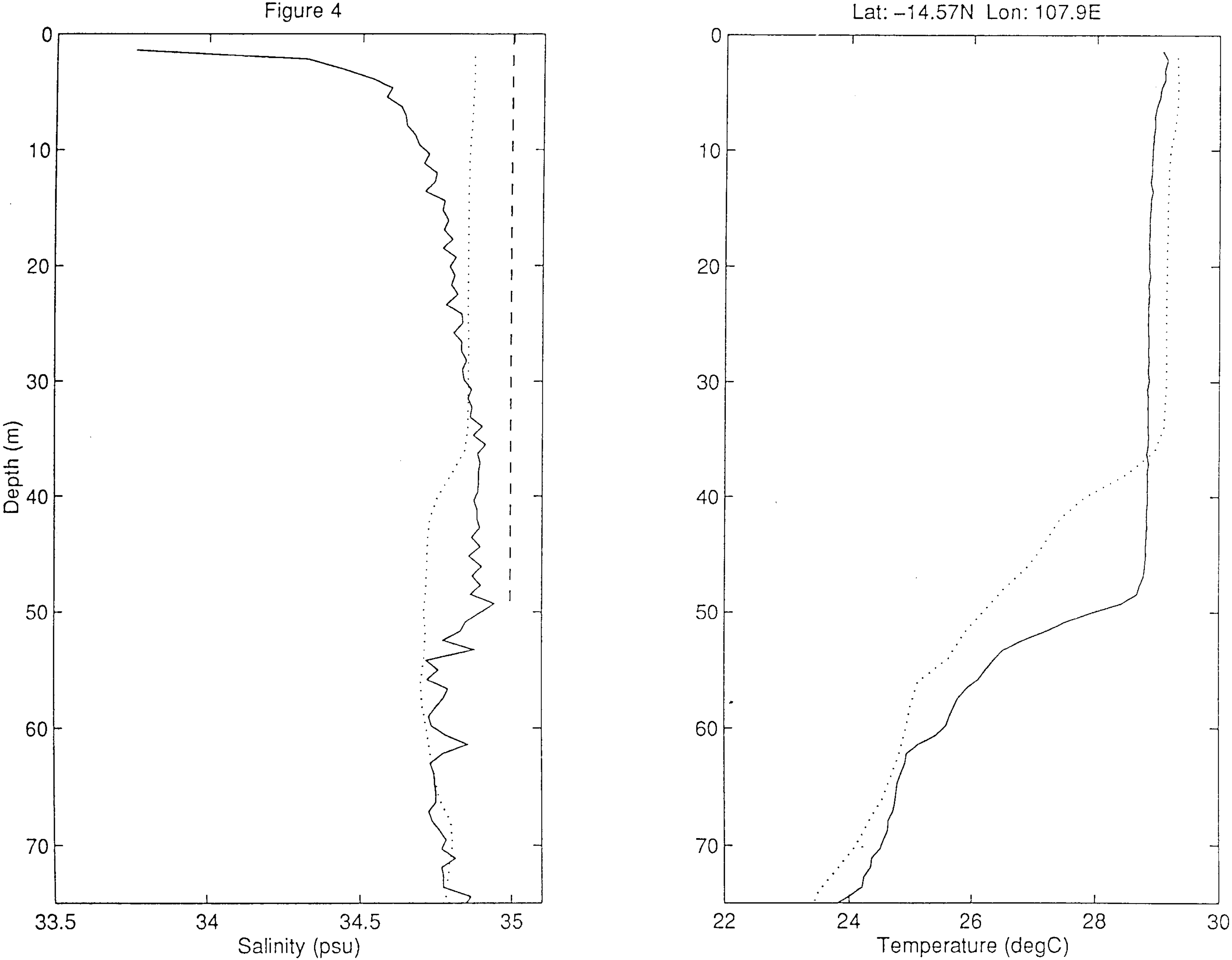

5
10
15
20
25
30
0
100
200
300
400
500
600
700
800
S(0)
S(0.4)
T
Depth (m)
34
34.1
34.2
34.3
34.4
34.5
34.6
34.7
34.8
34.9
35
Salinity (psu) and Temperature (degC)

Figure 4


Lat: -14.57N Lon: 107.9E
Depth (m)
Salinity (psu)
Temperature (degC)
0
10
20
30
40
50
60
70
33.5
34
34.5
35
22
24
26
28
30

C. TSK

Table 1. Specifications of XCTD (Vendor provided)

1. Depth

Range	0 – 1000m
Resolution	17cm
Accuracy	+/– 5m or +/– 2% of depth

2. Temperature

Range	–2 – 35°C
Resolution	0.01°C
Accuracy	+/– 0.02°C

3. Conductivity

Range	0 – 70mS/cm
Resolution	0.017mS/cm
Accuracy	0.03mS/cm

4. Data Sampling Interval

40 msec

5. Dimensions

Probe size	51mm(Dia.) x 379mm(L)
Probe weight	1.1kg
Canister	T–5 size

6. Ship Speed/Depth

12kt/1000m

30kt/400m

Table 2. Specification of XCTD field test

	Probe#	date/time	Position Lat.	Position Long.	Stn.	Max.D. (m)	ShipSpd. (Kt.)
<Experiment 1>							
	96110006	96/11/21 09:25	33-40.2N	141-59.2E	Test001	*330m	0
P1	96110007	96/11/21 09:35	33-40.4N	141-59.2E	Test001	*930m	0
P2	96110008	96/11/21 09:45	33-40.6N	141-59.4E	Test001	OK	0
	96110009	96/11/21 09:56	33-40.9N	141-59.5E	Test001	*840m	0
	96110010	96/11/21 10:05	33-41.1N	141-59.7E	Test001	OK	0
	96110011	96/11/21 10:14	33-41.3N	141-59.8E	Test001	OK	0
	96110012	96/11/21 12:06	33-43.1N	142-00.0E	Test002	*570m	0
P3	96110013	96/11/21 12:15	33-43.2N	142-00.2E	Test002	OK	0
	96110014	96/11/21 12:24	33-43.4N	142-00.4E	Test002	*460m	0
	96110015	96/11/21 12:34	33-43.6N	142-00.7E	Test002	OK	0
	96110016	96/11/21 12:57	33-44.0N	142-01.0E	Test002	OK	0
	*wire break						
<Experiment 2>							
	96120027	97/01/13 06:37	09-30.0S	105-00.0E	X-1	OK	10
	96120028	97/01/13 13:48	10-30.0S	105-00.0E	X-2	OK	10
	96120029	97/01/15 08:59	12-30.0S	104-59.7E	X-3	OK	10
	96120030	97/01/15 16:29	13-30.0S	105-00.0E	X-4	OK	10
	96120001	97/01/15 23:43	14-30.0S	105-00.0E	X-5	OK	10
	96120002	97/01/16 07:17	15-30.0S	105-00.0E	X-6	OK	10
	96120003	97/01/16 15:03	16-30.0S	105-00.0E	X-7	OK	10
	96120004	97/01/16 22:28	17-30.0S	105-00.0E	X-8	OK	10
	96120005	97/01/17 06:16	18-30.1S	105-00.0E	X-9	OK	10
	96120006	97/01/17 13:42	19-30.0S	105-00.0E	X-10	OK	10
	96120007	97/01/17 21:12	20-30.3S	105-00.0E	X-11	OK	10
	96120008	97/01/18 04:56	21-30.0S	105-00.0E	X-12	OK(op.miss)	10
	96120009	97/01/18 05:13	21-32.9S	105-00.0E	X-12	OK	10
	96120010	97/01/18 15:46	21-00.0S	105-42.9E	X-13	OK	10
	96120011	97/01/18 21:10	20-00.0S	106-25.3E	X-14	OK	10
	96120012	97/01/19 02:38	19-00.0S	107-08.7E	X-15	OK	10
	96120013	97/01/19 07:46	18-00.0S	107-50.0E	X-16	OK	10
I1	96120014	97/01/19 13:38	17-00.0S	108-32.1E	St12C	OK	0

	96120016	97/01/19 20:45	16-00.0S	109-14.4E	X-18	OK	10
	96120015	97/01/20 02:00	15-00.0S	109-56.0E	X-19	OK	10
	96120017	97/01/20 07:11	14-00.0S	110-37.0E	X-20	OK	10
12	96120018	97/01/20 12:32	12-59.8S	111-18.6E	St12D	OK	0
	96120020	97/01/22 19:04	13-30.0S	115-00.0E	X-22	OK	10
	96120021	97/01/23 01:56	14-30.0S	115-00.0E	X-23	OK	10
13	96120022	97/01/23 11:55	16-00.1S	115-00.0E	St17	OK	0
	96120023	97/01/28 20:14	18-30.0S	115-00.0E	X-27	OK	0
	96120024	97/01/29 02:01	19-30.0S	115-00.0E	X-28	OK	10

Table 3. Falling rate equation

Manufacturer(TSK) provided equation

$$D = 3.380175t - 2.14 \times 10^{-4}t^2$$

Exp. 1	probe #	fall rate (calculated by Hanawa's method)
P1	96110007	$D = 3.425757t - 4.750661 \times 10^{-4}t^2$
P2	96110008	$D = 3.443089t - 5.693357 \times 10^{-4}t^2$
P3	96110013	$D = 3.449637t - 4.904536 \times 10^{-4}t^2$
	Averaged fall rate	$D = 3.439494t - 5.116185 \times 10^{-4}t^2$

Exp. 2	probe #	fall rate(calculated by Hanawa's method)
I1	96120014	$D = 3.421808t - 4.407970 \times 10^{-4}t^2$
I2	96120018	$D = 3.400404t - 4.208729 \times 10^{-4}t^2$
I3	96120022	$D = 3.411898t - 4.250370 \times 10^{-4}t^2$
Averaged fall rate		$D = 3.411370t - 4.289023 \times 10^{-4}t^2$
Total Ave. fall rate		$D = 3.425432t - 4.702604 \times 10^{-4}t^2$

Table 5 CTD/XCTD section comparison of thermal/salinity field along 105E
(*calculated by every 30' grided data)

For 600-1000m

	Temperature		Salinity	
	mean	S.D.	mean	S.D.
XCTD	6.043	0.086	34.659	0.024
CTD	6.035	0.112	34.625	0.028
Diff.	0.008	0.082	0.034	0.017

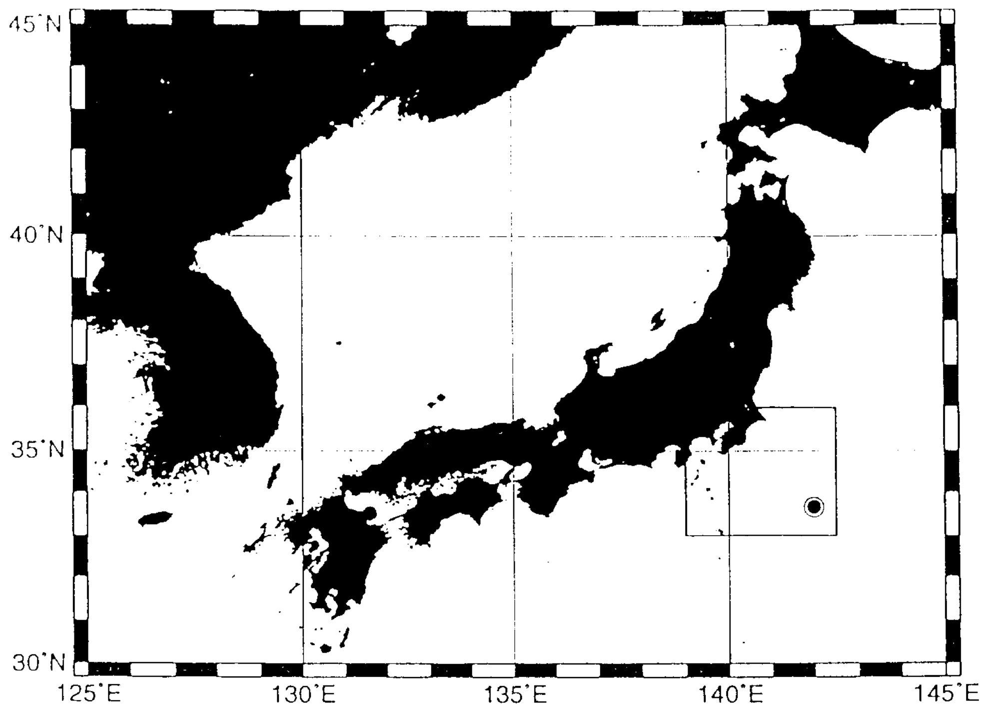
For 900-1000m

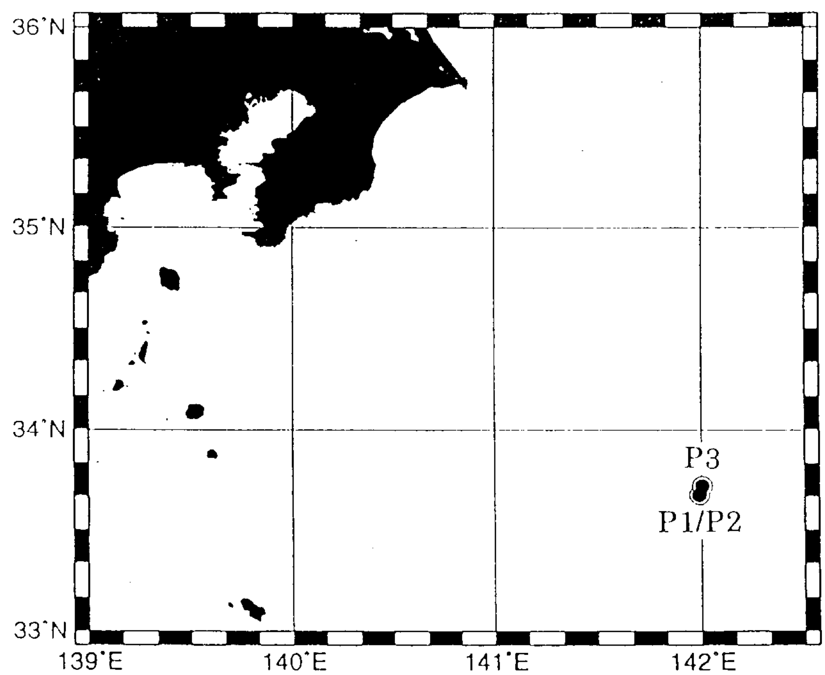
	Temperature		Salinity	
	mean	S.D.	mean	S.D.
XCTD	5.227	0.061	34.663	0.019
CTD	5.188	0.104	34.630	0.017
Diff.	0.039	0.073	0.033	0.018

Table 6 CTD/XCTD comparison of 900-1000m averaged data along 105E

	Temperature		Salinity		Cond.	
	mean	S.D.	mean	S.D.	mean	S.D.
XCTD	5.270	0.075	34.664	0.022	33.817	0.078
CTD	5.244	0.100	34.635	0.017	33.783	0.107
Diff.	0.026		0.029		0.034	

XCTD — CTD Comparison test Pacific Ocean P1 ~ P3





● XCTD ○ CTD

Figure 1

XCTD -- CTD Comparison test Indian Ocean I1 ~ I3

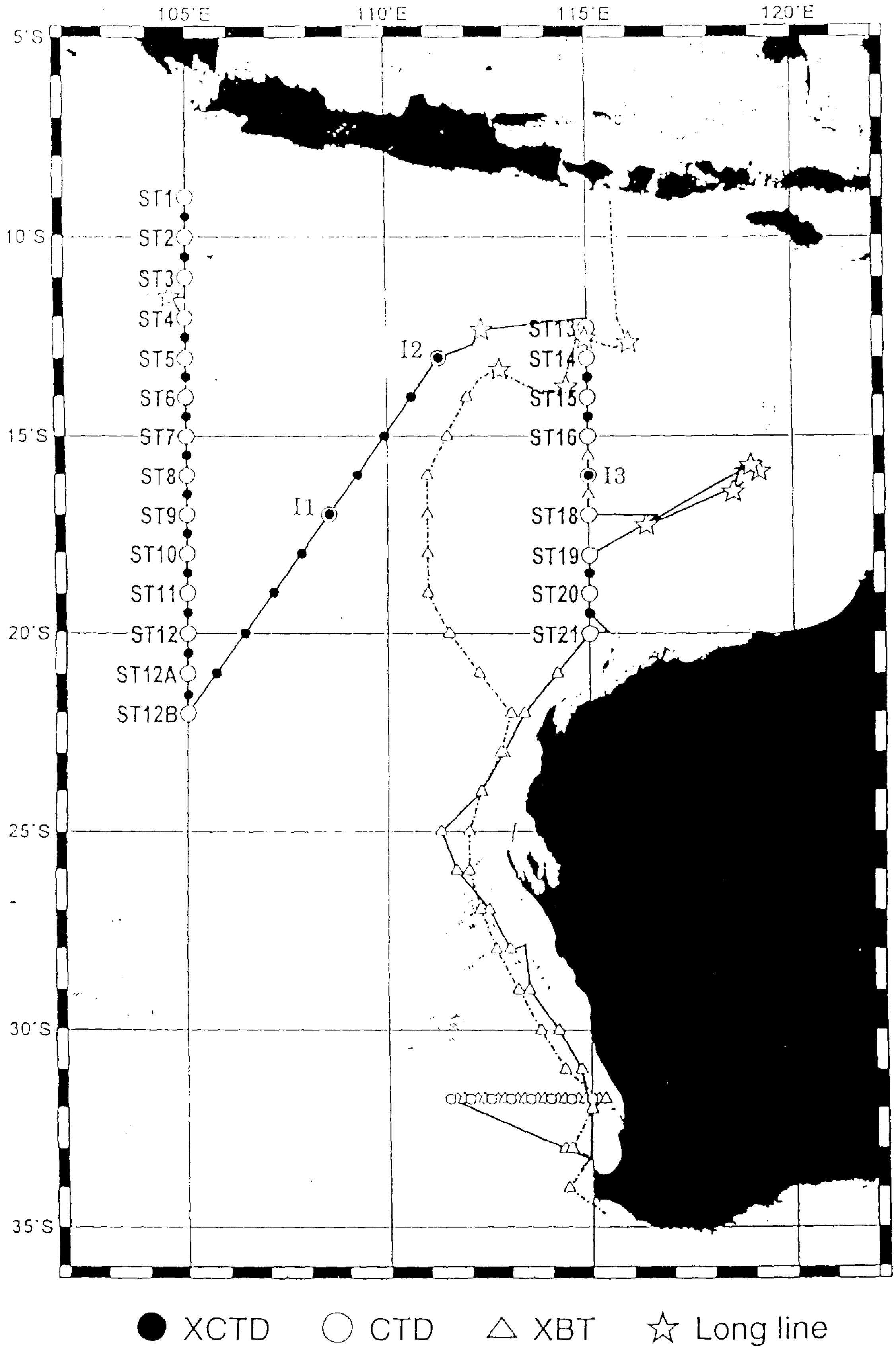


Figure 2

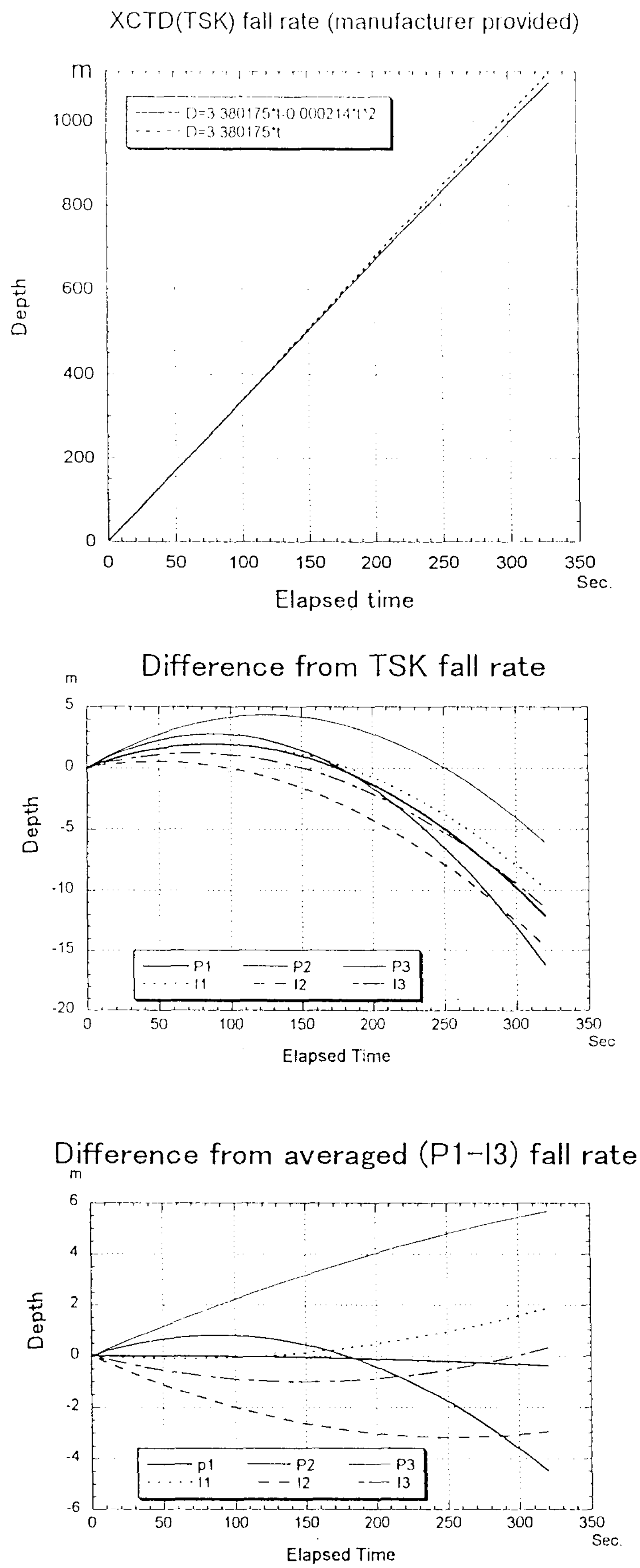

XCTD(TSK) fall rate (manufacturer provided)
m
D=3 380175*t-0 000214*t^2
D=3 380175*t
Depth
1000
800
600
400
200
0
0 50 100 150 200 250 300 350
Sec.
Elapsed time
Difference from TSK fall rate
m
5
0
-5
-10
-15
-20
Depth
P1 P2 P3
I1 I2 I3
0 50 100 150 200 250 300 350
Sec
Elapsed Time
Difference from averaged (P1–I3) fall rate
m
6
4
2
0
-2
-4
-6
Depth
p1 P2 P3
I1 I2 I3
0 50 100 150 200 250 300 350
Sec.
Elapsed Time

Figure 3

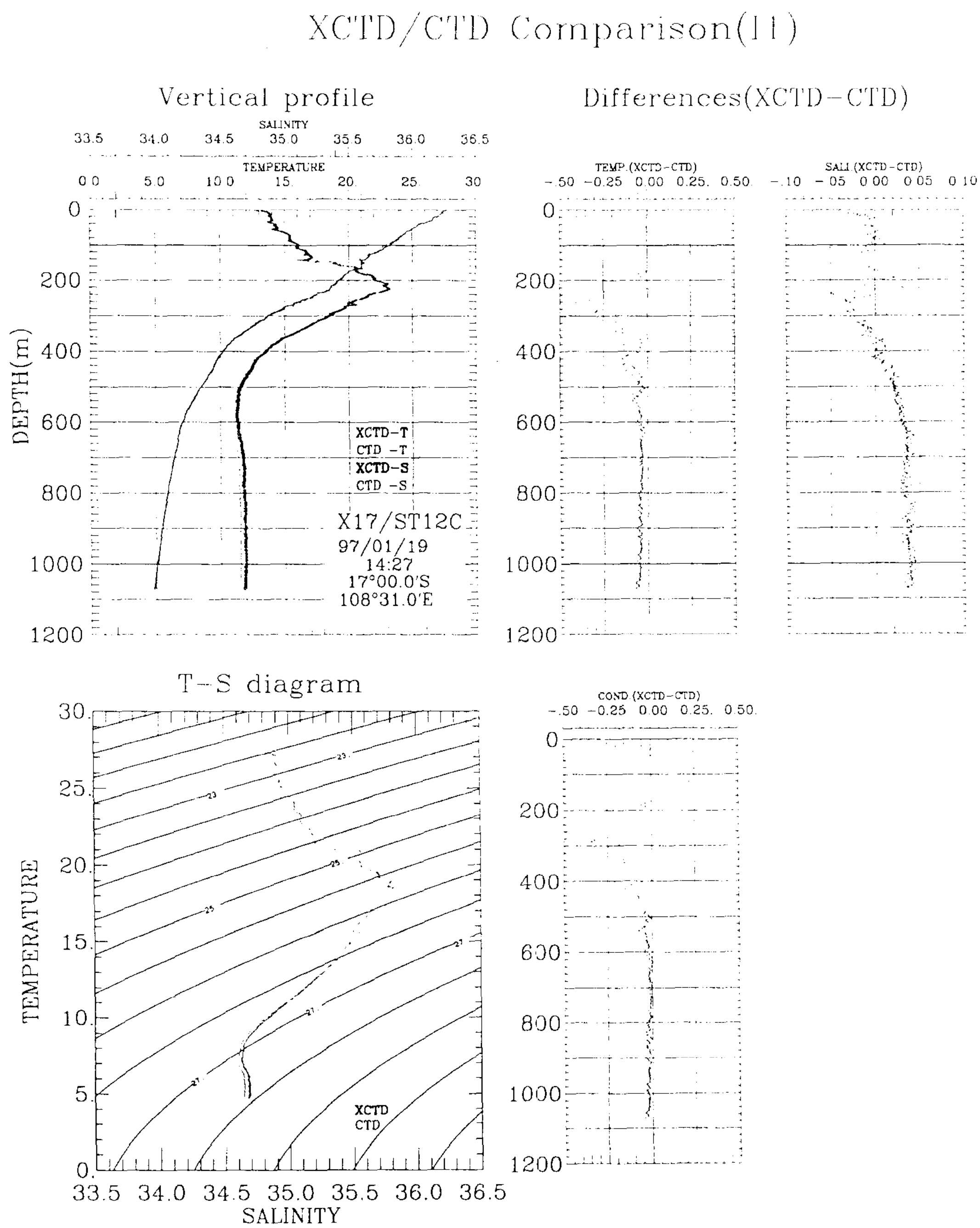

XCTD/CTD Comparison(11)
Vertical profile
Differences(XCTD-CTD)
SALINITY
TEMPERATURE
DEPTH(m)
XCTD-T
CTD -T
XCTD-S
CTD -S
X17/ST12C
97/01/19
14:27
17°00.0'S
108°31.0'E
TEMP.(XCTD-CTD)
SALI (XCTD-CTD)
T-S diagram
TEMPERATURE
SALINITY
XCTD
CTD
COND (XCTD-CTD)

Figure 4a

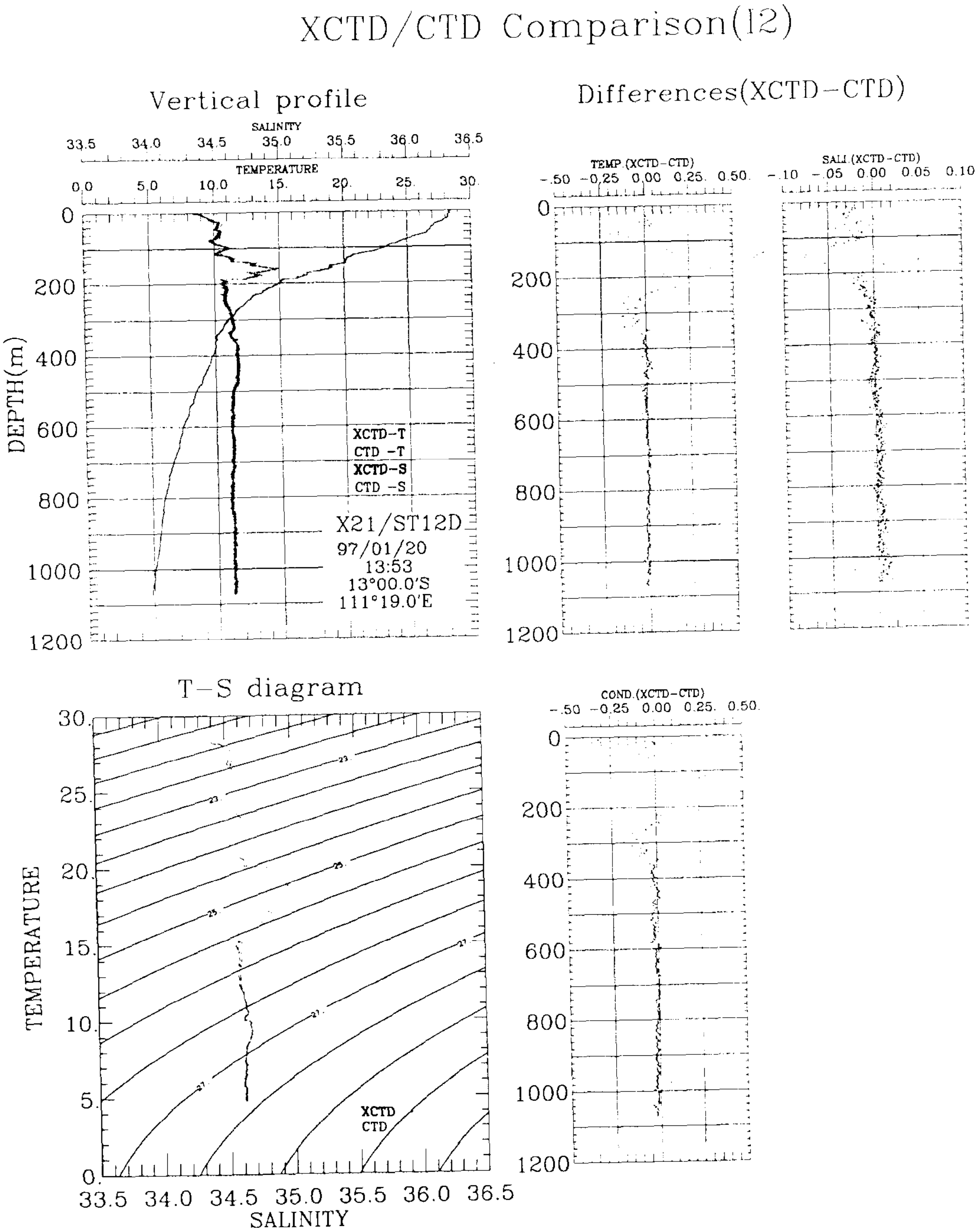

XCTD/CTD Comparison(12)
Vertical profile
SALINITY
33.5 34.0 34.5 35.0 35.5 36.0 36.5
TEMPERATURE
0.0 5.0 10.0 15. 20. 25. 30.
DEPTH(m)
0 200 400 600 800 1000 1200
XCTD-T
CTD -T
XCTD-S
CTD -S
X21/ST12D
97/01/20
13:53
13°00.0'S
111°19.0'E
Differences(XCTD-CTD)
TEMP (XCTD-CTD)
-.50 -0.25 0.00 0.25 0.50
SALI (XCTD-CTD)
-.10 -.05 0.00 0.05 0.10
COND (XCTD-CTD)
-.50 -0.25 0.00 0.25 0.50
T-S diagram
TEMPERATURE
0. 5. 10. 15. 20. 25. 30.
33.5 34.0 34.5 35.0 35.5 36.0 36.5
SALINITY
XCTD
CTD

Figure 4b

XCTD/CTD Comparison(13)

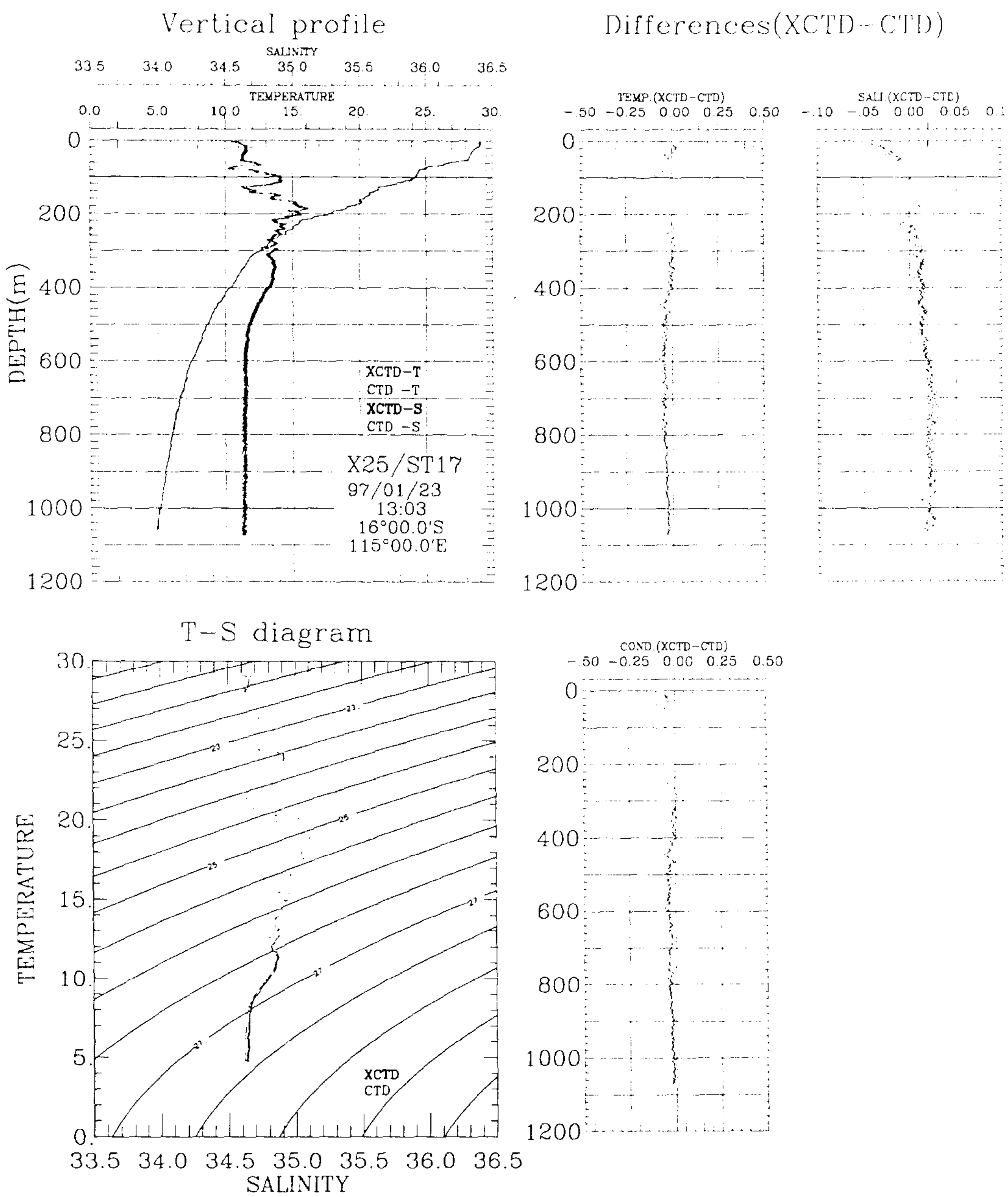


Figure 4c

Temperature Section along 105°E
(CTD only)

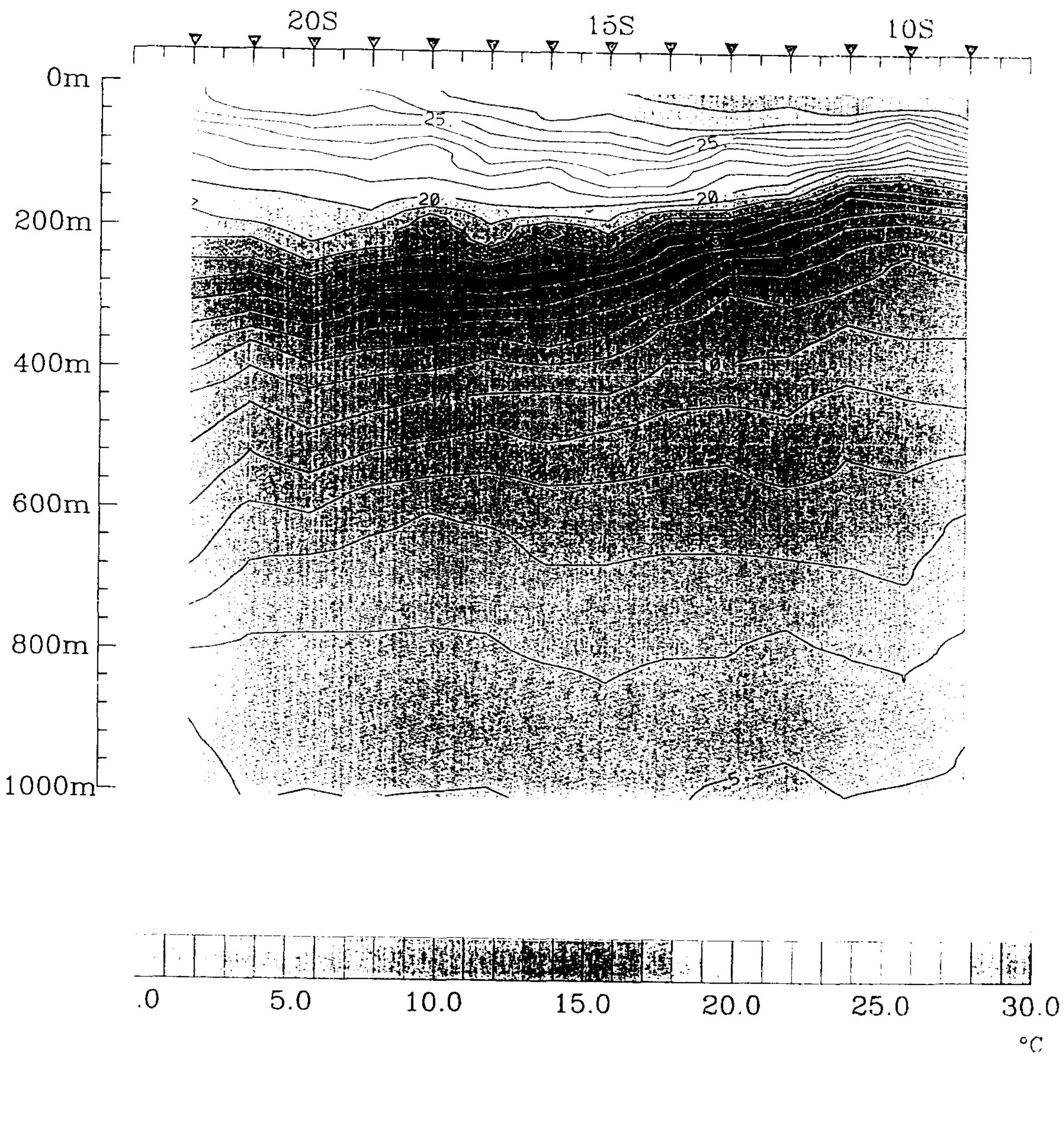


Figure 5a

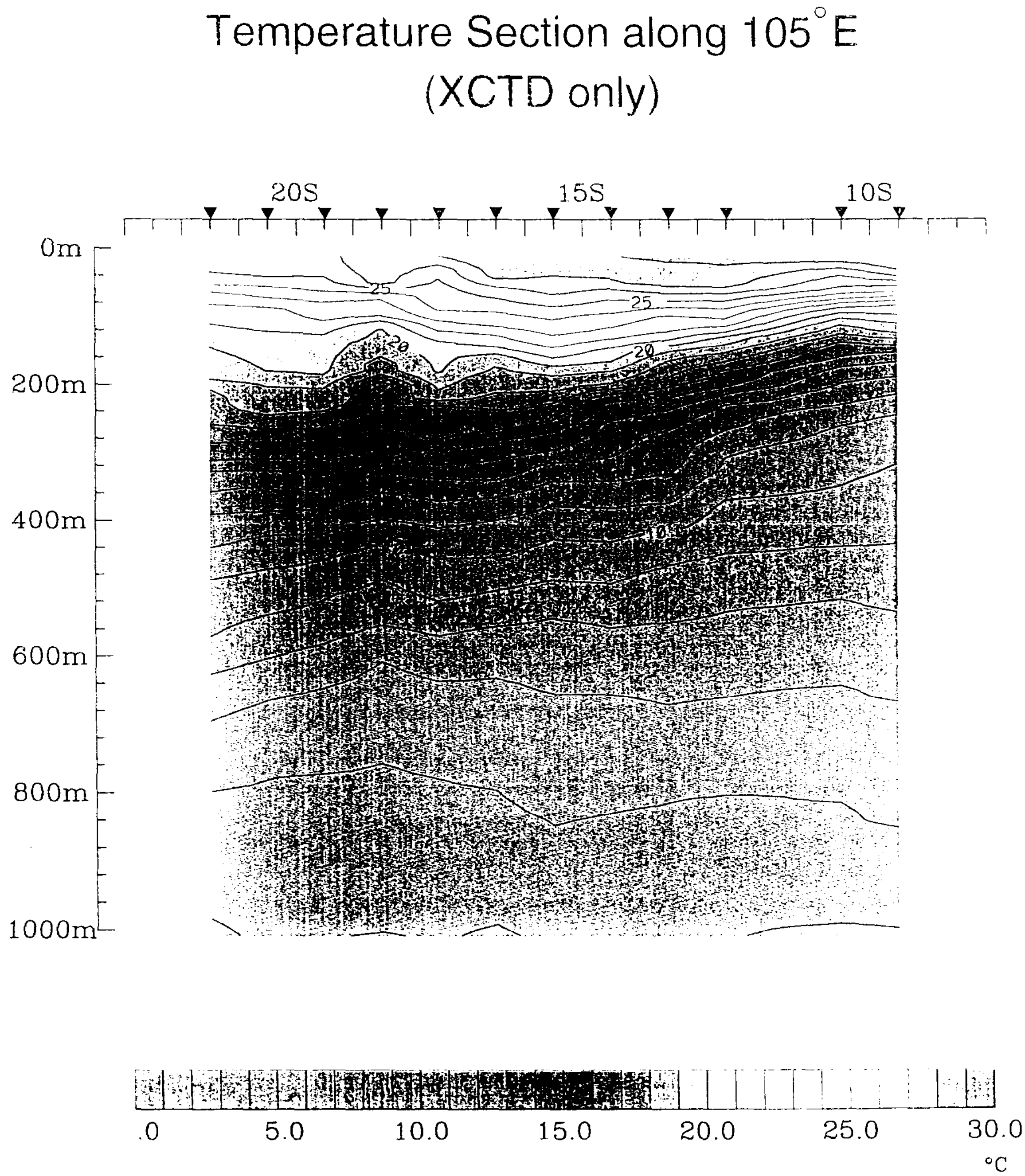

Temperature Section along 105°E
(XCTD only)
20S
15S
10S
0m
200m
400m
600m
800m
1000m
25
25
20
20
10
.0
5.0
10.0
15.0
20.0
25.0
30.0
°C

Figure 5b

Salinity Section along 105° E
(CTD only)

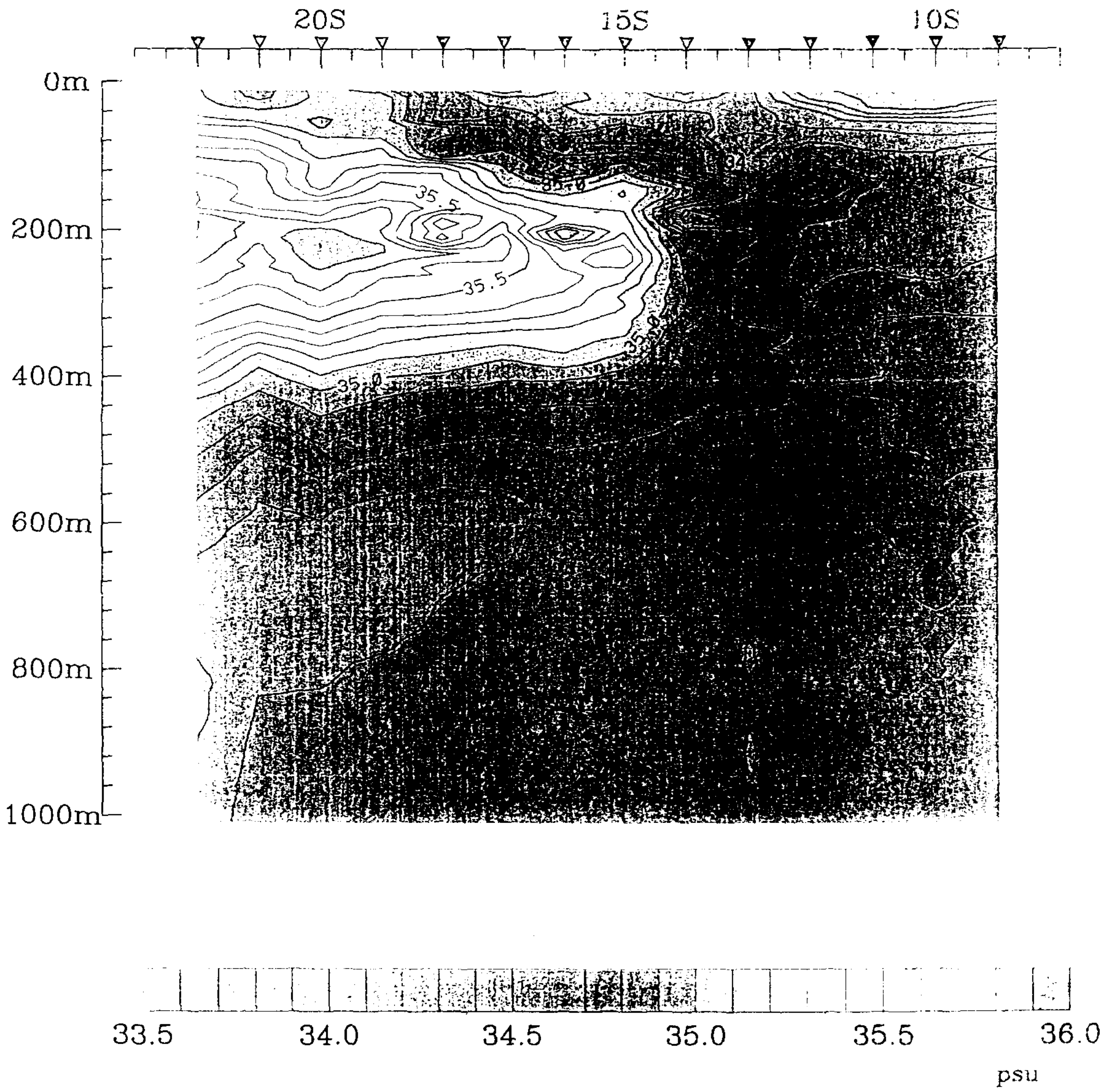


Figure 5c

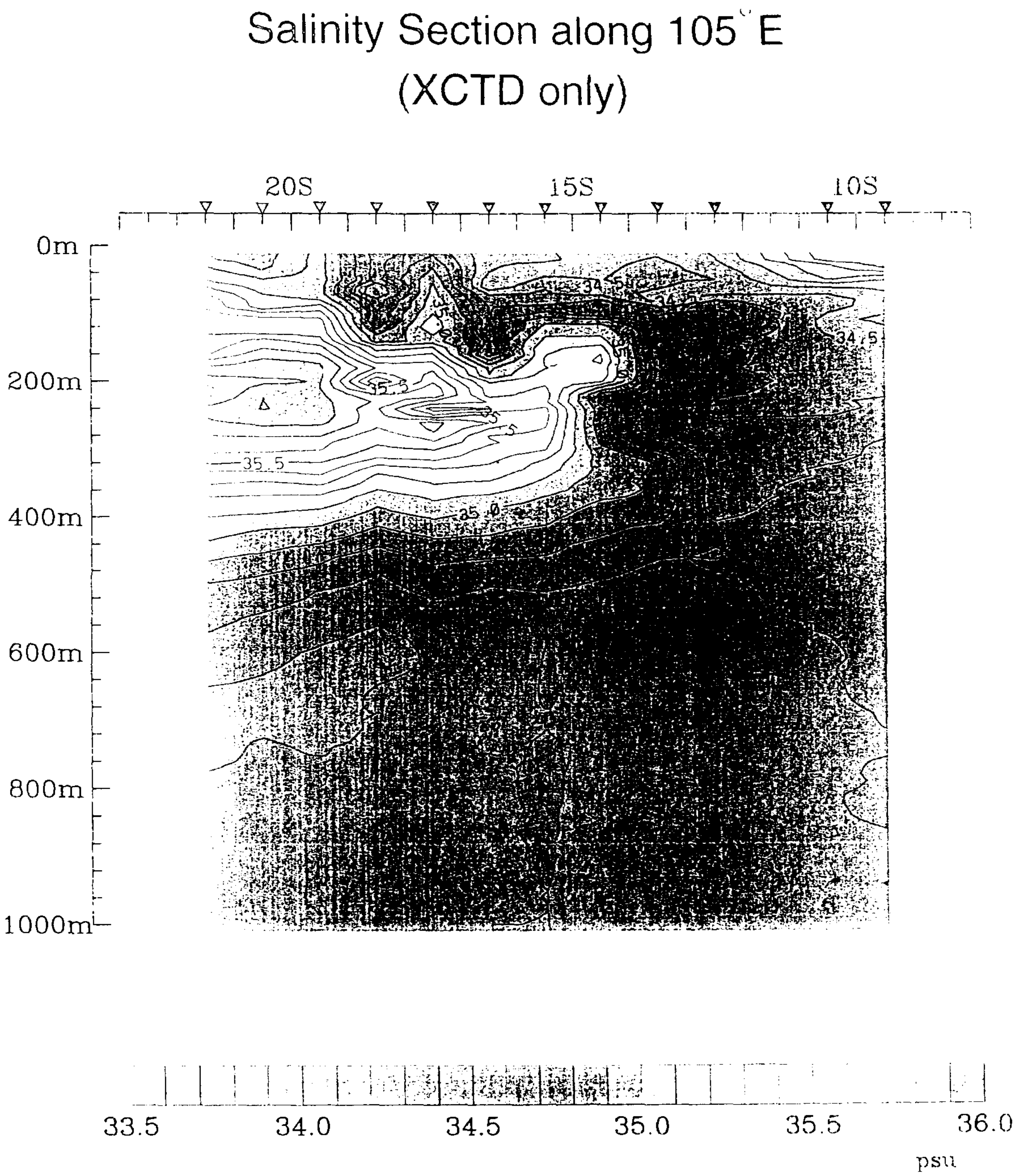

Salinity Section along 105°E
(XCTD only)
20S
15S
10S
0m
200m
400m
600m
800m
1000m
34.5
35.5
35.0
33.5
34.0
34.5
35.0
35.5
36.0
psu

Figure 5d

Differences of temperature
(XCTD−CTD)

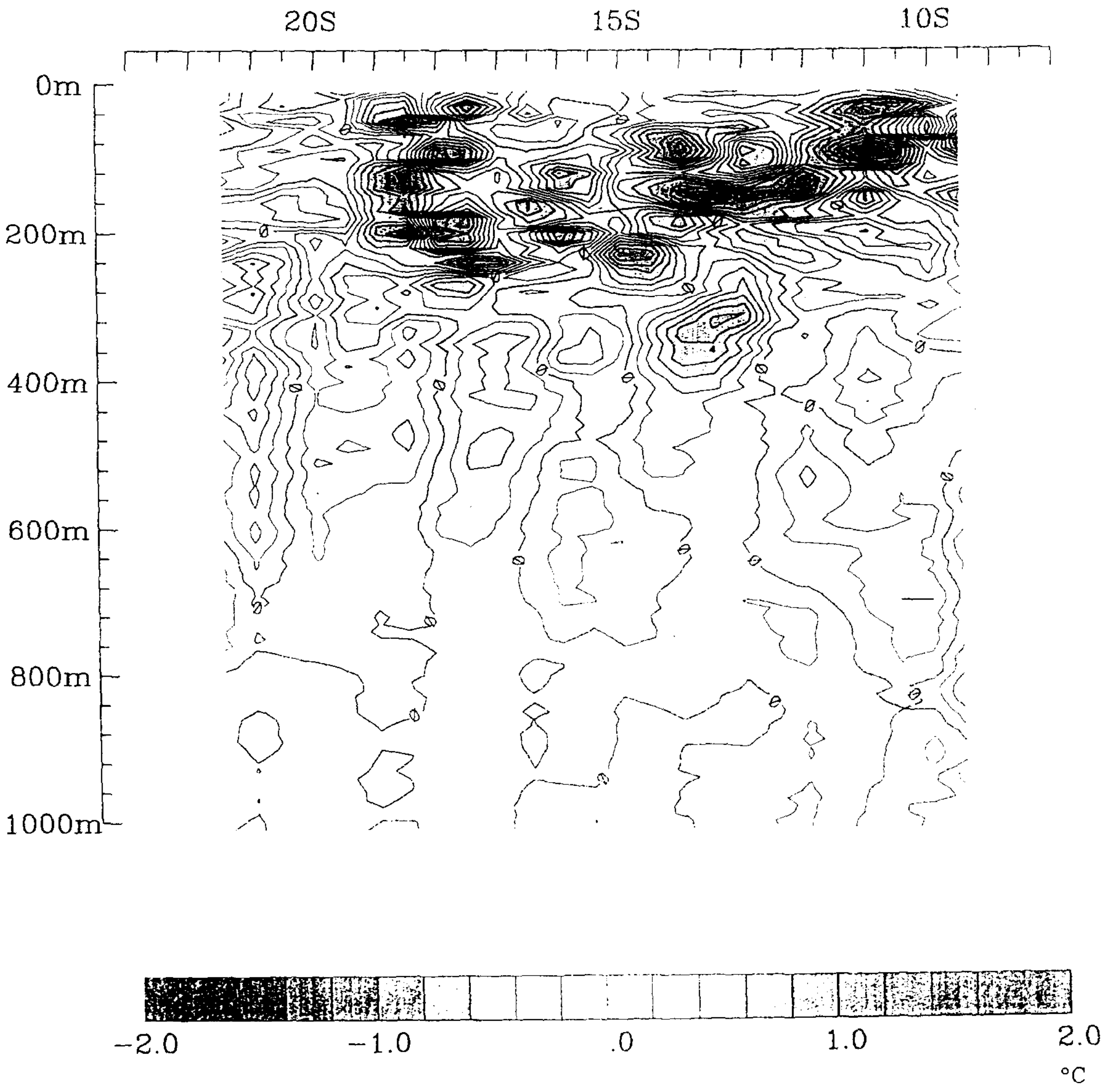


Figure 6a

Differences of salinity
(XCTD—CTD)

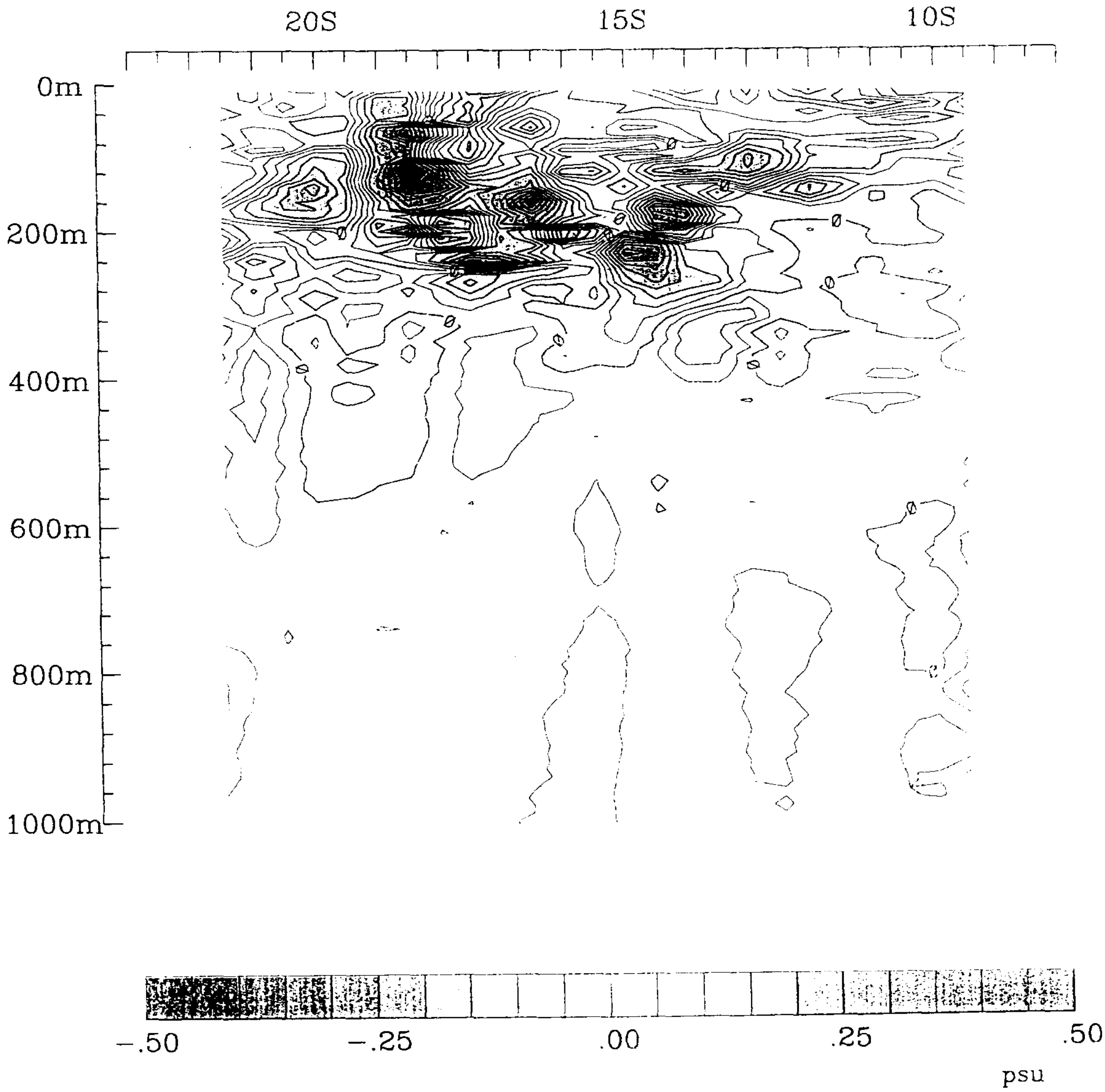


Figure 6b

XCTD／CTD composit profiles and mean differences along 105°E

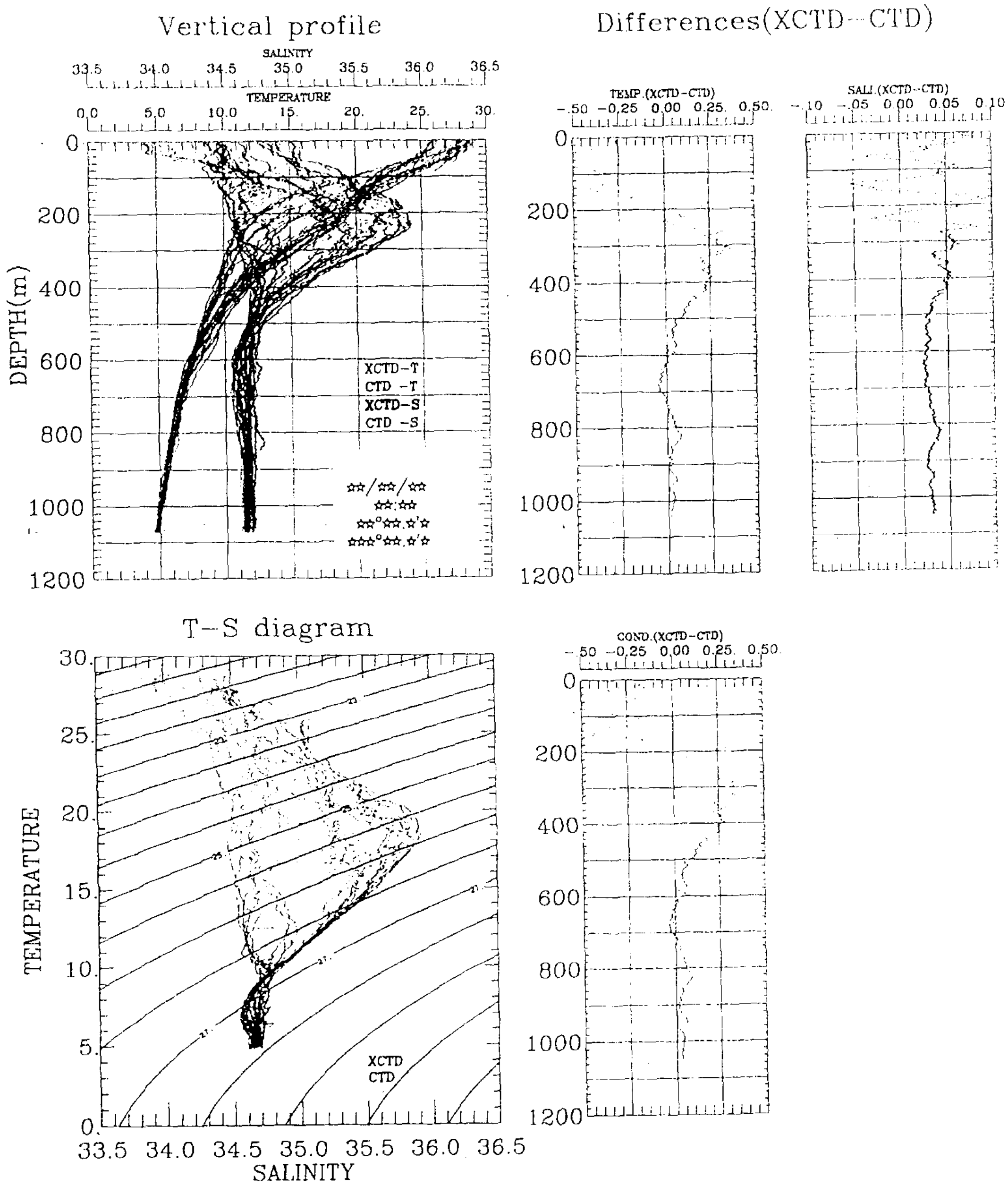


Figure 7

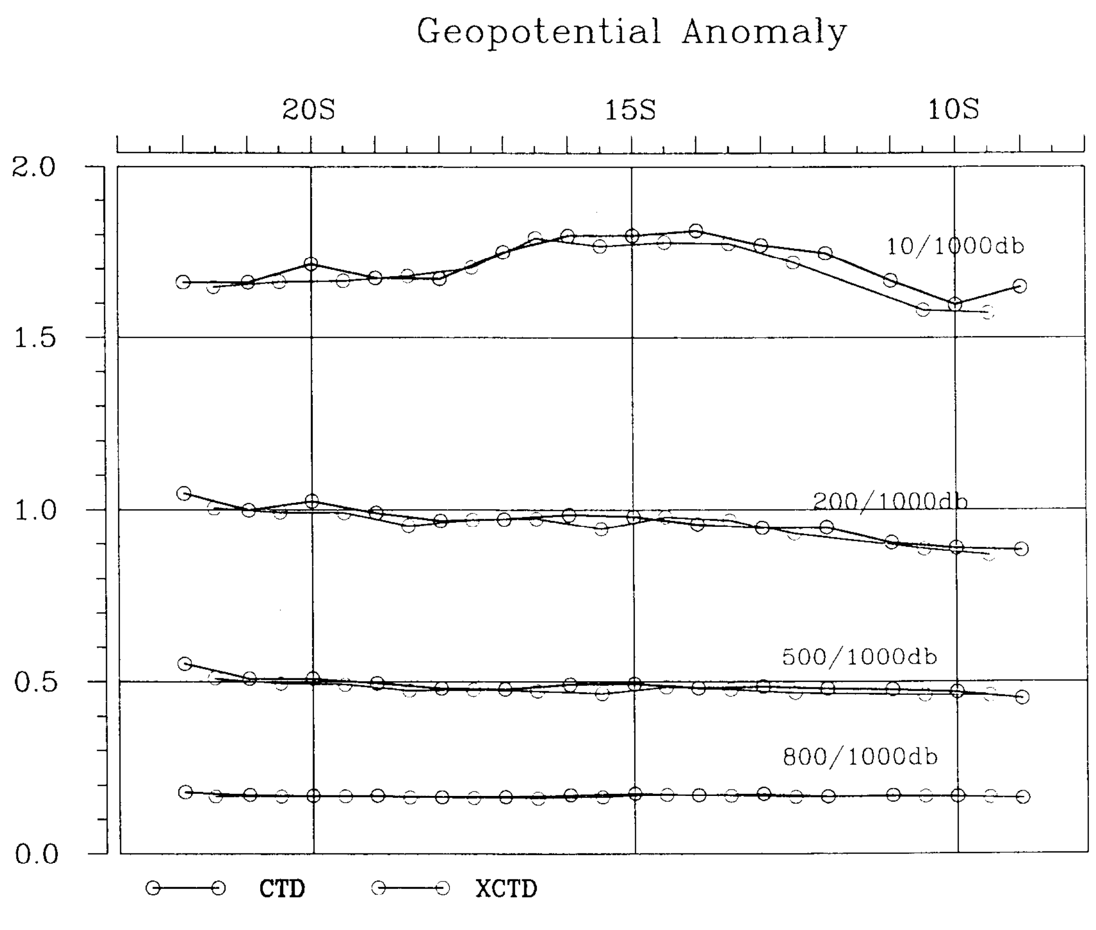

Geopotential Anomaly
20S
15S
10S
2.0
1.5
1.0
0.5
0.0
10/1000db
200/1000db
500/1000db
800/1000db
CTD
XCTD

Figure 8

D. SIPPICAN

XCTD Status

The configuration of Sippican's XCTD probe and deck gear has been stable since January 1994. Probe production levels have been approximately 1500 units per year, including all variations, i.e. surface, submarine, deep and air launch (development) platforms. Percent reliability of probe performance for the surface and submarine versions has consistently been in the nineties. Sources of unreliability include the data acquisition software, system setup and ship environment. Improvements in reliability will focus on these areas.

XCTD Drop Rate

Sippican confirmed the original drop rate has an approximately 30 m offset, too deep, at 1000 m. In investigating this, Sippican determined there was a bi-modal distribution of the drop rate. Weight and dimensional tolerances of the probe are held very tight, so interest was focused on the snap fit of the afterbody to the midbody, which allowed the afterbody to rotate relative to the midbody after the snap fit was made. This rotation was eliminated by gluing the snap joint (started in September 1996). In a test of 24 probes, this gluing operation eliminated the bi-modal distribution of fall rates. These 24 probes were also instrumented with five calibrated pressure points (see item 3 below) which were used to calculate new drop rate coefficients, which Sippican presently recommends be used instead of the original drop rate. The revised drop rate equation is

$$\text{depth} = 3.333t - 0.000468t^2$$

Ongoing Developments

1) The DOS version 4.1 software with GPS input capability and inclusion of the IGOSS drop rate coefficients for T4, T6 and T7 was released in February 1997.

2) The MK14, a remotely controlled version (via RS-232) that handles all data acquisition and processing, and transmits it to a host computer, is available.

3) Detection of a single pressure point via perturbation of the temperature and conductivity data, that corrects the depth data to within +/- 1.5 m at the calibrated point has been demonstrated and is expected to be commercially available, with post processing software to calculate the corrected drop rate, soon.

4) The Windows version of the MK12 software is currently undergoing beta testing and expected to be released soon.

ANNEX IX

EVALUATION AND OPERATIONAL USE OF THERMOSALINOGRAPHS ON SHIPS OF OPPORTUNITY BY ORSTOM

The need for better knowledge of sea surface salinity distribution was brought to light during the TOGA decade (1985-1994) for tropical areas. Unfortunately very few systematic observations were made in the past. Only ORSTOM centers in Noumea (New Caledonia), Tahiti (French Polybnesia) and Le Havre (France) were the quasi only laboratories which developped a network of bucket sampling by merchant ships on the three tropical oceans.

Due to the dramatic decrease of the number of observations and the bad accuracy of measurements, ORSTOM has inpoved the original "meteorological bucket" method of sampling by developping a thermosalinograph automatic technique on several ships of opportunity.

The system consists mainly in a SEABIRD-21 thermosalinometer (TSG), installed as close as possible to the engine water intake, a GPS positioning unit and a PC running the program of sampling and storing the data.

A specific software was developed to allow the storage every 5 minutes of the median value of sea surface salinity over 20 measurements, along the route of the ship. The accuracy of these high density observations (every 5 mitutes instead of every 6 hours) was also proven to be better than the old bucket sampling technique by an order of magnitude (0.02 instead of 0.2/ 0.3 psu). The observed drift of the conductivity cell was quite small (between 0.004 and 0.026 for two years for 4 different systems). However regular calibration every year to the manufactured is highly reccommended. The careful use of an antfouling protection and checking the system at every voyage (every two to three months) is a guarantee for good measurements.

The SSS observations by TSG became operational since few years. Today, ORSTOM is operating 7 TSG systems (2 Atlantic, 2 in western Pacific, 2 on a round the world route, 1 in a regional line around NewCaledonia) and has installed TSG sytems on three Research Vessels.

The TSG is quite useful for monitoring of SSS variability. It allowed recently the fine description of salinity surface fronts between water masses in the western equatorial Pacific and the study of oceanic surface advection during ENSO events in the Pacific ocean . Sea surface salinity being also quite dependant of rainfall and evaporation, the TSG data are useful for the studies of air-sea interactions.

The next step will be an accurate measurement of the sea surface temperature (SST) by additional thermometer and the transmission in real or near real time of the SSS observation to the GTS.

References:

Henin C. and J. Grelet, 1996 : A merchantship thermosalinograph network in the Pacific Ocean. *Deep Sea Research* Vol 43, 11-12, pp 1833-1855.

ANNEX X

LIST OF ACTION ITEMS BY TT/QCAS-IV

1. All TT members to arrange for the implementation of the full JJYY code for data from their countries, in particular their respective national navies.

2. Sippican to provide a copy of their XBT storage and deployment procedures to the Chair and the IGOSS Operations Co-ordinator. Deadline: June 1997.

3. All manufacturers requested to provide information on the effects of storage temperatures, and temperature differentials at deployment, on probe performance, and eventually to specify storage temperature ranges. A. Sy agreed to review this information for the TT. Deadline: end 1997.

4. D. Wright to refine the standard test procedures document, on the basis of comments received. The document should also include temperature testing procedures, and be circulated to TT members for review. Deadline: June 1997.

5. D. Wright and R. Bailey to prepare a draft outline for a Manual on XBT/XCTD Observing Practices, to identify material already available (including in Manuals and Guides No. 3), and to propose actions for its completion. The manual should cover issues such as storage, testing, calibration, deployment, processing, QC, coding, etc. Deadline: August 1997.

6. R. Keeley to investigate possible translation into English, in Canada, of the French TSG Manual. Deadline: May 1997.

7. R. Keeley and R. Bailey to prepare draft modifications to MG No. 3 to incorporate the new BATHY code and procedures for onboard QC agreed at the last session. Deadline: August 1997.

8. T. Ando to provide WMO with information on the new Japanese recorder and probe types for inclusion in code tables. Deadline: May 1997.

9. A. Sy to investigate Sparton probes for testing. R. Keeley to investigate testing and evaluation in Canada. Deadline: May 1997.

10. Sippican requested to consider expanding the new Windows 95 software to include software (e.g. from SEAS) for compilation of BATHY messages with the new IGOSS fall rate equation and pre-GTS QC procedures recommended by the TT.

11. R. Keeley to co-ordinate updates to tables 1170 and 4770 relevant to XCTD and PALACE data in TESAC. R. Keeley and A. Sy to co-ordinate modifications to k2, relevant to CTD QC information in TESAC. All proposals eventually to be submitted to CBS for adoption. Deadline: end 1997.

12. R. Keeley and A. Sy to review TRACKOB and develop proposed modifications relating in particular to surface salinity observations and in consultation with C. Henin, for review by the TT and transferral to CBS for adoption. Deadline: end 1997.

13. Sippican to investigate possible causes of identified Mk 12 recorder problem and propose and/or implement corrective measures. Deadline: end June 1997.

14. K. Mizuno to investigate preparation and availability of generally applicable software for fall rate evaluations, especially for XCTDs, to be eventually provided to all interested agencies and individuals. Deadline: May 1997.

15. R. Bailey to co-ordinate with K. Mizuno, Sippican, TSK and others to develop a specific XCTD evaluation proposal, oriented in particular towards the future operational use of XCTDs. Deadline: end June 1997.

16. C. Henin to co-ordinate preparation of a **Best Practices Guide** for TSG measurements. Deadline: 1998.

17. Chairman to prepare for discussion a draft action plan for ongoing and new probe evaluations, specifying resources required and a timetable for completion. Deadline: end June 1997.

ANNEX XI

LIST OF RECOMMENDATIONS BY TT/QCAS-IV TO SOOPIP

1. The Task Team should have revised terms of reference as given in Annex III, and its name should be changed to SOOP Task Team on Instrumentation and Quality Control (STT/IQC).

2. IGOSS and GOOS will eventually require a full instrument intercomparison and intercalibration programme, as an integral part of an operational ocean observing system. Such a programme, similar to that now in place for the World Weather Watch, will require additional resources. SOOPIP should therefore make this requirement known to both IGOSS and GOOS, and request that action be taken to identify the resources needed, bearing in mind that the task team is the appropriate body to organize and implement intercomparison tests, provided the necessary resources are available.