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WORLD METEOROLOGICAL ORGANIZATION

INTEGRATED GLOBAL OCEAN SERVICES SYSTEM (IGOSS)

SUMMARY OF SHIP-OF-OPPORTUNITY PROGRAMMES AND TECHNICAL REPORTS

This document contains in a consolidated form the national and technical reports on ship-of-opportunity programmes as presented at the Sixth Session of the Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes (Ottawa, Canada, 16-20 October 1995). It is intended to complement the Summary Report of the Meeting or to be used separately, as the case may be.

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AUSTRALIA

R. Bailey, A. Gronell, P. Jackson (CSIRO)

1. Introduction

Australia's economic well-being is intimately linked to climate fluctuations, with periods of severe drought or extensive flooding having a negative effect on economic activity. The occurrence of such fluctuations is largely controlled by the temperature of ocean waters north of Australia. For example, the severe drought of 1982-83 was linked to sea surface temperature changes in the western equatorial Pacific Ocean (the 1982-83 El Nino). Australia's rainfall is also strongly affected by the sea surface temperature in the eastern Indian Ocean.

The geography of the "heat pool" to the north of Australia is characterised by changes in location of its temperature maximum over thousands of kilometres on seasonal and inter-annual time scales. Details of the geography are known to have statistical relationships to the occurrence of the abovementioned climate anomalies, but the physics underlying these relationships is not well understood.

Because of thermal inertia, temperature in the heat pool varies relatively slowly, and acts as a memory in the coupled ocean-atmosphere system. Consequently, ocean temperature can be used as a predictor of rainfall anomalies, either as direct input into statistical models or in the initialisation of numerical/dynamical coupled general circulation models. In either prediction scenario, model development must be preceded by process studies to identify the physics of ocean temperature change. An increase in the accuracy of climate predictions on seasonal to inter-annual time scales will have a significant impact on the ability of society and the economy to adjust to climate variation. Of particular importance will be the ability of primary industry to plan for anomalous conditions in coming seasons. In the longer term, improved information on regional climate change over decades is required by both government and industry. Accurate ocean models can also be applied usefully in shipping, fishing, air-sea rescue, and defence related activities.

1.1 Objectives

The main objective of the CSIRO Ship-of-Opportunity Program (SOOP) is to provide large-scale spatial and temporal data coverage of the relevant oceans basins in support of two of the Division of Oceanography's major Research Programs; Climate and Ocean Processes, and Regional Seas and the Economic Exclusive Zone (EEZ). The specific research goals are:

a) Document ocean temperature in the heat pool north of Australia, and to evaluate the relative importance of surface fluxes, advection, and mixing processes to the thermodynamics of the region. As part of this goal it is necessary to document the variability of the major geostrophic currents in the tropical Indian Ocean on seasonal and inter-annual time scales, and to evaluate their role in changing sea surface temperature.

b) Understand sea level's response to El Nino Southern Oscillation (ENSO) events by examining combined sea level and subsurface ocean temperature data in the eastern Indian Ocean and south west Pacific Ocean.

c) Measure the transport of mass, heat and salt in the surface layers by the major geostrophic currents in the eastern tropical Indian Ocean, south west Pacific Ocean and Southern Ocean, and to determine the role of these currents in climate change.

d) Help initialise and validate data assimilation models for the Indian Ocean and EEZ Region which are being developed by the Division.

e) Form a basis for the design and development of an operational National Ocean Observing System as part of the proposed Global Ocean Observing System (GOOS).

1.2 Connection to National and International Activities

The CSIRO activity is closely coordinated with major international research programs. In particular, the CSIRO program has contributed significantly to the Tropical Ocean Global Atmosphere (TOGA) project and the World Ocean Circulation Experiment (WOCE) of the World Climate Research Program (WCRP). A corner-stone for both of these international projects has been the implementation of an international ocean observing network which can provide the observational data needed for process studies, and for model development and initialisation. Global coverage of the oceans is a key requirement for both projects, and a coordinated international effort has helped achieve this goal. The CSIRO activity is a reasonably large and integral part of the global coverage required.

Nationally, the CSIRO SOOP provides valuable large-scale, long-term coverage of the waters of economic and environmental importance to Australia. These waters include the EEZ region, the Indian and Southern Oceans, and the south west Pacific Ocean. The data is used in real-time by the National Climate Centre (NMC) of the Bureau of Meteorology (BOM), and other climate centres around the world, for climate predictions. It has been shown that the data enhances climate prediction skills. The CSIRO program also actively supports the Royal Australian Navy's (RAN) data collection and regional analysis activities. In general, the data is made available through the national and international archives for general use by government organisations, the civilian community, and industry.

The WCRP officially launched the 10-year TOGA project in 1985, as damage estimates from the 1982-83 El Nino topped several billion dollars. The project aimed to describe how oceans and atmosphere interact, creating short-term climate changes, and to determine whether those changes were predictable. Much has since been learned. Advances in theory, observations, and computer modelling now enable climatologists to predict the onset of El Nino up to 1-1/2 years in advance with reasonable accuracy. With the TOGA project officially finishing at the end of 1994, scientists are now advancing a 15-year follow-up program to build on the enormous success of TOGA. The new WCRP-coordinated effort scheduled to begin in January 1995, will be called CLIVAR (for Climate Variability).

As more and more results are derived from ongoing research, the need for permanent observational systems is being recognised. Indeed, the concept of a Global Ocean Observing System (GOOS), an internationally coordinated, scientifically based program for systematic data collection and exchange, is taking shape and gaining momentum at the national and international level. Already the CSIRO activity contributes significantly to the Integrated Global Ocean Services System (IGOSS), jointly established by the International Oceanographic Commission (IOC) and the World Meteorological Organisation (WMO).

2. CSIRO Expendable Bathythermograph (XBT) Network

In order to measure the transport of mass, heat, and salt in the surface layer of the ocean and the storage capacity of the surface layer for heat and salt, it is necessary to carry-out repeated measurements of global upper ocean variability. These must be taken at both intra- and inter-annual time scales, and the only feasible way to carry out this program is to use volunteer merchant ships that are frequent carriers on particular routes.

The practical objective of the CSIRO SOOP is to collect the full suite of in situ measurements of ocean temperature, salinity, and absolute velocity from volunteer ships on a routine basis. This can be done in two ways, either as broadscale sampling through volunteer observers launching XBTs and XCTDs (expendable conductivity, temperature, and depth instruments) to determine general circulation and upper ocean heat and salt content, or by high-density (high-resolution) sampling along exactly-repeated sections with scientists or oceanographic technicians on board to make the extra measurements required to determine large-scale velocity and geostrophic current and eddy transport variations in the ocean.

The CSIRO broadscale XBT program, using voluntary observers, began operation in 1983. The high-density sampling program began in the Tasman Sea and Coral Sea region at the beginning of 1991, across the throughflow region between Fremantle and Singapore in 1995, and in the Southern Ocean in the austral summer of 1992-93. Since 1983, a total of approximately 30,000 XBTs have been successfully deployed.

The network is operated from a centre in Hobart under the management of research oceanographers. It is deemed vitally important to the success of the program to keep the operations closely linked to the research efforts. Once the data is received in Hobart, it undergoes extensive scientific quality control and analysis by research oceanographers using purposefully developed in-house software and procedures which are being adopted internationally. The recording equipment is installed and serviced by technicians from the CSIRO Division of Oceanography, with general supply and ship-greeting support being provided in the major ports around the nation by the CSIRO Division of Fisheries, Bureau of Meteorology and the Australian Oceanographic Data Centre (AODC).

2.1 Coverage

Figure 1 shows the lines presently in operation. Due to a change in general merchant ship routing on line IX-9, this line continues generally to be only sampled north of the latitude of Sri Lanka, as no regular shipping exists between Fremantle and Sri Lanka. Only occasionally have the ships returned to the previous route due to cargo requirements temporarily changing. The lines in the Southern Ocean (IX-23, IX-28, IX-29, IX-30) are operated by Antarctic supply and research vessels, and operate only during the austral summer months. The operation of these lines provides a very significant and invaluable contribution to the otherwise sparsely sampled Southern Ocean. Lines PX-30/31, PX-34, IX-1, and IX-28 are high-density XBT lines. Oceanographic observers are placed onboard the participating merchant vessels to sample the temperature of the upper 800m of the ocean every 25-50 km. Lines PX-34 and PX-30/31 are run in collaboration with the Scripps Institution of Oceanography (SIO), whilst line IX-28 is run in collaboration with SIO, ORSTOM, and the French Polar Institute (FPI).

Figure 2 shows the location of all XBT stations which have been processed, edited, and accepted at CSIRO from the start of the program in 1983 to the end of 1994. The total does not include XBTs that have failed (approx.7%). Figure 3 shows those XBTs accepted for 1993 and 1994 only, whilst Tables 1 and 2 give the total number of XBTs (including failures), good XBTs, sections, and number of bathy reports sent over the Global Telecommunications System (GTS) in real-time for 1993 and 1994. Wherever possible, lines are sampled at the sampling frequencies and spacings as determined by extensive optimal sampling studies [1,2,3], as adapted and recommended by the TOGA Implementation Plan (Feb, 1990). Figure 4 shows examples of temperature sections from each XBT line.

Surface salinities are being collected with surface sample buckets along the high-density line PX-34, IX-1 and IX-28. A Sea-Bird SBE-21 thermosalinograph has been installed in collaboration with ORSTOM and the FPI on the polar supply vessel, *L'Astrolabe*, operating between Hobart and Dumont d'Urville in Antarctica (IX-28). Figure 5 shows sea surface temperature (SST) and sea surface salinity (SSS) results along one section.

2.2 *Support and Cooperation*

The field program has been a very large undertaking. Although viewed by the Division as necessary in the national interest, it has been too large for the Division to accomplish with its own resources. The strategy for funding from the outset has been to gain resources from several national and international agencies, while maintaining scientific direction and management of the program under the control of research oceanographers. The strategy has proven to be extremely successful, to the point that nearly 4000 ocean soundings are made each year. Significant funding is also received through the CSIRO Climate Change Research Program. CSIRO provides 500 XBTs each year, whilst the RAN (2000), Scripps Institution of Oceanography (500 in 1993; 700 in 1994), and the National Ocean Services Branch (NOS) of the National Oceanographic and Atmospheric Administration (NOAA) in the United States (600), also help in the provision of XBTs. The Japan Meteorological Agency (JMA) provided 200 XBTs in 1993 to help run line IX-22/PX-11. The BOM, as a major user of the real-time data, also assists by paying for the cost of transmitting the bathy reports via satellite for insertion onto the GTS as a contribution to the Integrated Global Ocean Services System (IGOSS). Numerous shipping companies kindly support our research by allowing us to install our recording equipment on board their vessels. BHP Transport, Pacific Forum Line, P&OCL, and the French Polar Institute kindly allow oceanographic observers on board their vessels to undertake the high-density XBT sampling which cannot easily be undertaken by the officer-of-the-watch.

2.3 *Equipment Design and Development*

CSIRO operates Sippican MK-9/Lap-Top configured XBT systems on its merchant ships. The software was extensively re-written by CSIRO for the voluntary observer environment. The XBT systems are also interfaced to CLS ARGOS "add-on" satellite transmitters (co-developed with CSIRO) to enable the relay of bathy data in near real-time. The data undergoes filtering and general quality control checks, as designed for the ARGOS XBT system, before it is sent via satellite for insertion onto the GTS for distribution to scientists and climate prediction centres around the world. A number of small problems continue to plague the GTS and ARGOS relay stations.

The prototype SIO XBT automatic-launcher has been installed on merchant ships utilised in the high-density program. This is a device which can automatically deploy up to six XBTs at predetermined times, making it possible for the deployment of only one oceanographic observer on board a merchant vessel to maintain around the clock high density XBT sampling. CSIRO has extensively modified the hardware of the unit. The trapdoor mechanisms have been redesigned to provide increased mechanical advantage for the solenoid firing pins, and the deck-electronics and launching units have now been mounted in the one unit to facilitate installation. Field evaluations of the modifications are continuing.

Deployment of a thermosalinograph on the M.V *New Zealand Star* is progressing, with intake and outflow valves installed on the vessel in dry-dock during 1993. Depending on availability of funds, a recorder will be installed at a later date.

2.4 *Equipment Evaluations*

CSIRO continues to test and evaluate equipment deployed for the research program to ensure its accuracy and integrity. All such tests and evaluations are coordinated with and submitted to the IGOSS Task Team for Quality Control of Automated Systems (TT/QCAS).

Work continues on evaluating the accuracy of XBTs and XBT data acquisition systems, including an evaluation of the fall rate equation of the XBT. This work has contributed to the work of the XBT Fall Rate Study Subgroup of the TT/QCAS, and a joint paper on the findings has submitted to, and accepted by, the *Journal of Deep Sea Research*. The manufacturer's depth-time equation for the XBT was found to be in error; maximum depth error at 760m was found to be approximately 26m (manufacturer's accuracy specifications give 15m at 760m). A new depth-time equation has been proposed for T-7, T-6, and T-4 types of Sippican XBT's, which is to be adopted internationally in the near future.

CSIRO has also participated in the evaluation of the Sippican eXpendable Conductivity Temperature and Depth (XCTD) probe, including field trials on the PSV Aurora *Australis* and RV. *Franklin* . Unfortunately the results from the *Aurora Australis* early in 1993 were far from promising, with numerous design, software and grounding problems significantly affecting the performance and reliability of the instrument (severe spiking off-scale, fall rate error, inconsistent temperature and salinity offsets- sometimes well outside specifications). Limited trials on the *Franklin* and subsequent more extensive trials on the *Aurora Australis* and from merchant vessels, with modified software and hardware, proved much more promising (fall rate error still present, however, spiking removed, temperature and salinity accuracies more consistent and approximating specifications). There appears to be a consistent problem with the accuracy of the salinity measurement in the upper 50-100m, which may be the result of an air bubble temporarily being trapped around the conductivity cell which is later squeezed out by pressure at depth. The data collected on these voyages will be later fully analysed with data collected by other institutions as part of the TT/QCAS activities.

2.5 *Volunteer Observers*

The success of the program relies heavily on the support given by the voluntary observers on board the merchant vessels. Indeed, during 1993 the M.V. *Anro Australia* celebrated 10 years of XBT sampling for the CSIRO - a truly remarkable accomplishment, and a measure of their generous support of our research. It is considered essential that considerable effort is put into maintaining good public relations with the voluntary observers and their shipping companies. Each ship is visited on every return to an home Australian port so that new supplies can be forwarded, data collected, instrumentation checked, and most importantly, so that good public relations through feedback and attention to observer requirements are maintained. Each ship is also visited by a scientist involved in the research program at least once per year, although generally more often than this.

We are truly indebted to the generous and high level of quality support from the voluntary observers, shipping companies and their agents.

2.6 *Data Management and Quality Control*

Quality Control (QC) of XBT data at the delayed mode stage is closely supervised by research oceanographers participating in the program (see[4]). A flow chart of the QC procedures is shown in figure 6. The vertical profiles are checked on a voyage basis for common malfunctions, regional oceanographic features, drop to drop consistency along the ship track, and repeat drops of unusual features (which we encourage our observers to take). The data are also checked against a climatology based on the data collected by ships participating in the CSIRO Ship-of-Opportunity Program. An archive of profiles with unusual features observed along the different lines is used in the QC process. The features are checked with CTD data as opportunities arise. Quality control of the data is considered to start by providing the voluntary observers with continual feedback on why they are collecting the data as well as the results obtained. The two-way communication between observers and researchers inevitably leads to a more carefully collected and generally higher quality data set.

An interactive editing routine has been set up on the in-house mainframe (UNIX System) computer to edit the data. QC decisions on common malfunctions and real oceanographic features are flagged on the data set (see table 3). The data is further classed (0-4) by depth according to the type of flag associated with the data (see table 4). Class 0 data has had no QC. Class 1 data is good data. Class 2 data has unusual features, but which are considered to be probably real. Class 3 data has features considered to to be most likely the result of instrument malfunctions and not real features. Class 4 data is obviously erroneous data. An extensive "cookbook" has been produced to assist in the QC [4].

The data is stored in three archives. The first archive contains the unedited, full resolution, raw data as collected from the merchant ships. The second archive consists of the edited, full resolution data (Class 4 removed). The third data archive has the data condensed to a 2 metre format (Class 3 removed). This third data archive is the archive used in scientific analysis, and for the transfer of data to other organisations and the global data centres. Each year the quality controlled data are sent to the US NODC (WDCA) and the TOGA Subsurface Thermal Data Centre in France. Periodically the data are sent to the Australian Oceanographic Data Centre (AODC).

CSIRO is also a major contributor to the WOCE Indian Ocean Upper Ocean Thermal Data Assembly Centre (UOT/DAC). Other participants include BOM/BMRC and AODC. Although the BOM and the AODC already jointly operate the Specialised Oceanographic Centre for the Indian Ocean and South Pacific region, the idea of the WOCE UOT/DAC is to involve research scientists in the quality control of XBT data to produce a "scientifically" quality controlled data set for WOCE. The Division's quality control procedures for processing XBT data have therefore been combined with the optimal analysis procedures co-developed with the BMRC in an interactive screen-editing system. This system, called QUEST (Quality Evaluation of Sub-surface Temperature; see[5]), has been used for the scientific quality control of the data set supplied by the World Data Centre A (WDCA) containing all available upper ocean temperature data collected in the Indian Ocean in 1990. AODC staff assisted CSIRO staff in the quality control of the data in Hobart. The Quest system has been used from 1994 onwards to undertake quality control of all CSIRO XBT data on a regular basis. The principle quality control procedures developed by CSIRO are being implemented by the WOCE UOT/DAC's for the Atlantic and Pacific Oceans.

3. FUTURE OF THE CSIRO SOOP

With TOGA completed, the field component of WOCE nearing completion, and the value of such measurements for climate prediction clearly identified by the Knox report and the findings of the Ocean Observing System Development Panel (OOSDP), it is time to develop a strategy to transfer the CSIRO SOOP from a research activity predominantly supported by research funds to an operational program. The CSIRO SOOP is ideally set-up to form one of the components of an effective Regional Ocean Observing Network (ROONET) as a starting point for Australian GOOS. To-date the CSIRO SOOP has received most of its funding support from CSIRO appropriation and CSIRO Climate Research Program (CCRP) funds, with significant in-kind contributions from the Royal Australian Navy (RAN), Australian Bureau of Meteorology (BOM), National Ocean Services (NOS) Section of the US National Oceanic and Atmospheric Administration (NOAA), and the Scripps Institution of Oceanography. It is time now to determine how available resources can best be utilised and reallocated to maintain the CSIRO SOOP as an ongoing, operational activity, thus alleviating research resources so that these can be used in the ongoing research of the collected data and in the development of enhanced technologies for the observing system. It is important to maintain a strong link between the research and operational activities, as this has proven to be one of the main reasons for the acknowledged high success of the present CSIRO SOOP.

4. ACKNOWLEDGEMENTS

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TABLE 1

1993 CSIRO VOS Line Summary

Line	CallSigns	#Sections	#Drops	#Good	#Xmitted*
PX-2	9VUU VJBQ	16	359	343	296
PX-3	VJDP VJDI	10	323	305	297
PX-30**	A3CA	2 (HD)	152	152	0
PX-54	GYSA	5	62	60	59
PX-34	VNGZ	4 (HD)	265	253	0
IX-1	S6FK	26	703	672	657
IX-9	9VBZ 9VWM	12	260	242	230
IX-12	GYSA GYSE GYRW	15	743	693	602
IX-22/ PX-11	VJDI VJDP	9	380	346	342
IX-23	VNAA	1	106	62	0
IX-28***	FHZI	5 (HD)	292	152	20
IX-29	DBIP	1	24	20	0
IX-30	DPIB VNAA	3	62	54	0
Macquarie Is to Heard Is	VNAA	1	41	19	0
Heard Is to Hobart	VNAA	1	24	12	0
TOTALS:			3796	3385	2503

NOTES:
* In some cases numbers transmitted are approximates only.
** This line is run in conjunction with SIO - only CSIRO cruises are reported.
*** This line is run in conjunction with SIO, ORSTOM, and FPI
HD = High-density XBT section.

CALL SIGNS:
9VUU = ANRO ASIA
VJDP = IRON PACIFIC
VJDI = IRON NEWCASTLE
VNAA = AURORA AUSTRALIS
A3CA = FUA KAVENGA
GYSE = NEDLLOYD TASMAN
GYRW = ENCOUNTER BAY
9VWM = NEW ZEALAND STAR (EX MANDAMA)
VJBQ = ANRO AUSTRALIA
VNGL = IRON FLINDERS
VNGZ = IRON DAMPIER
FHZI = L'ASTROLABE
S6FK = SWAN REEFER
GYSA = FLINDERS BAY
9VBZ - AUSTRALIA STAR (EX MAHSURI)
DPIB= ICEBIRD

TABLE 2

1994 CSIRO VOS Line Summary

Line	CallSigns	#Sections	#Drops	#Good*	#Xmitted**
PX-2	9VUU	9	152	146	133
	VJBQ	9	234	212	188
		18	386	358	321
PX-3	VJDP	5	175	168	158
PX-30/31 ***	A3CA	2	195	185	0
PX-32	GYSE	2	26	25	25
PX-34	VNGL	1	61	54	0
	VNGZ	2	144	134	0
		3	205	188	0
IX-1	S6FK	26	661	626	614
IX-9 (P)	9VBZ	1	13	13	13
	9VWM	6	100	92	79
		7	113	106	92
IX-12	GYSA	4	147	122	111
	GYSE	3	150	132	112
	GYRW	5	250	221	201
		12	547	475	424
IX-22/ PX-11	VJDI	1	36	36	30
	VJDP	6	276	262	244
		7	312	298	274
IX-28	FHZI	11	685	484	380
TOTALS:			3305	2913	2288

NOTES:
* A good profile is a succesful profile of > 100 m depth
** In some cases numbers transmitted are approximates only. Some high density XBT runs have not been able to transmit due to a lack of a transmitter and appropriate software. When high density lines have transmitted it is not guaranteed that all messages will reach the satellite, and hence GTS, as a result of the number of samples compared to the number of satellite overpasses.
*** This line is run in conjunction with Scripps - only CSIRO cruises are reported.
(P) = partial coverage of line

CALL SIGNS:

9VUU = ANRO ASIA
VJBQ = ANRO AUSTRALIA
VJDP = IRON PACIFIC
VNGL = IRON FLINDERS
VJDI = IRON NEWCASTLE
VNGZ = IRON DAMPIER
VNAA = AURORA AUSTRALIS
FHZI = L'ASTROLABE
A3CA = FUA KAVENGA
S6FK = SWAN REEFER
GYSA = FLINDERS BAY
GYSE = BOTANY BAY (EX NEDLLOYD TASMAN)
GYRW = ENCOUNTER BAY
9VBZ - AUSTRALIA STAR (EX MAHSURI)
9VWM = NEW ZEALAND STAR (EX MANDAMA)

TABLE 3 Summary of CSIRO Quality Control Codes

Ref. No.	Category	Accept Code	Action	Quality Class	Reject Code	Action	Quality Class
1. Header Information Flags							
1.1	Position Error	PEA	Manually correct.	Class 1 from the surface.	PER	Reject data from working archive.	Class 3 from the surface.
1.2	Time Error	TEA	Manually correct.	Class 1 from the surface.	TER	Reject data from working archive.	Class 3 from the surface.
1.3	Other / Probe Error	OPA	Manually correct.	Class 1 from the surface.	OPR	Reject data from working archive.	Class 3 from the surface.
1.4	Repeat Drop	DUA	Keep more reliable repeat or duplicate.	Class 1 from the surface.	DUR	Reject less reliable repeat or duplicate from working archive.	Class 3 from the surface.
2. Recorder Flags							
2.1	Surface Spikes (Start-up Transient)	CSA	Remove all surface data to 3.9m depth.	Class 1 from the surface.	CSR	Reject data from working archive.	Class 3 from the surface.
2.2	Test Probe	N/A	—	—	TPR	Reject test data on all occasions from working archive.	Class 4 from the surface.
2.3	Bathy Systems Software Error (Modulo 10 Spikes)	MOA	Replace Spikes with linearly interpolated values.	Class 1 from the surface.	MOR	Reject data from working archive.	Class 3 from the surface.
2.4	PROTECNO Systems Leakage (PET Fault)	PFA	Downgrade data from depth of anomaly.	Class 2 from depth of suspected PET fault.	PFR	Delete data from depth of anomaly from working archive.	Class 4 from depth of PET fault.
2.5	Bathy Systems Leakage (Cusping)	CUA	Downgrade data from depth of anomaly.	Class 2 from depth of cusping.	CUR	Reject data from depth of anomaly from working archive.	Class 3 from depth of cusping.
2.6	Bathy Systems Bowing Problem (Bowed Mixed Layer)	BOA	Downgrade data from the surface.	Class 2 from the surface.	BOR	Reject data from working archive.	Class 3 from the surface.
2.7	Sippican MK-9 Processor Malfunction (Sticking Bit Problem)	SBA	Apply a 19 point filter with coefficients of 0.0562 and downgrade.	Class 2 from the surface.	SBR	Apply a 19 point filter with coefficients of 0.0562 and reject data.	Class 3 from the surface.
2.8	Sippican MK-9 Timing Delay Problem (Driver Error)	DRA	Downgrade data from the surface.	Class 2 from the surface.	DRR	Reject data from working archive.	Class 3 from the surface.

Table 3. Summary of CSIRO Quality Control Codes (cont.)

Ref. No.	Category	Accept Code	Action	Quality Class	Reject Code	Action	Quality Class
3. General Profile Flags							
3.1	Hit Bottom	HBA	Reject data from depth of anomaly from working archive.	Class 2 from depth of possible isothermal boundary layer.	HBR	Delete data from depth of anomaly from working archive.	Class 3 from depth of hit bottom event.
3.2	Wire Break	N/A	—	—	WBR	Delete data from depth of anomaly from working archive.	Class 4 from depth of wire break.
3.3	Spike	SPA	Remove erroneous data and linearly interpolate. Downgraded from depth of anomaly.	Class 2 from depth of spike.	SPR	Reject data from depth of anomaly from working archive.	Class 3 from depth of spike.
3.4	High Frequency Interference	HFA	Filter noisy data. Downgrade from depth of anomaly.	Class 2 from depth of high frequency interference.	HFR	Reject data from start depth of anomaly and reject from working archive.	Class 3 from start depth of interference.
3.5	Insulation Penetration	IPA	Replace spike with linearly interpolated data. Downgrade from depth of anomaly	Class 2 from depth of spike.	IPR	Reject data from depth of anomaly from working archive.	Class 3 from depth of spike.
3.6	Constant Temperature Profile	CTA	Keep profile to 10 metres depth and flag CTR below.	Class 1 to 10 metres, Class 3 below.	CTR	Reject data from the surface or below 10m of CTA from working archive.	Class 3 from the surface.
3.7	No Trace	—	—	—	NTR	Delete data from the surface from working archive.	Class 4 from the surface.
3.8	NO Good Profile	—	—	—	NGR	Delete data from depth of anomaly from working archive.	Class 4 from depth of anomaly.

Table 3. Summary of CSIRO Quality Control Codes (cont.)

Ref. No.	Category	Accept Code	Action	Quality Class	Reject Code	Action	Quality Class
4. Inversion / Wire Stretch Flags							
4.1	Inversion (Confirmed)	IVA	Verify inversion in repeat or neighbouring drops.	Class 1 from the surface.	—	—	—
4.2	Inversion in mixed layer (Nub Confirmed)	NUA	Verify nub in repeat or neighbouring drops.	Class 1 from the surface	—	—	—
4.3	Inversion (Probable)	PIA	Check for similar features in neighbouring drops.	Class 2 from depth of probable inversion.	—	—	—
4.4	Wire Stretch (Possible)	WSA	Check if similar features are observed in neighbouring drops. Downgrade data.	Class 2 from depth of possible wire stretch.	—	—	—
4.5	Wire Stretch	—	—	—	WSR	Reject data from depth of anomaly from working archive.	Class 3 below depth of wire stretch.
5. Structure / Signal Leakage Flags							
5.1	Fine Structure Step-like (Confirmed)	STA	Verify fine structure in repeat or neighbouring drops.	Class 1 from the surface.	—	—	—
5.2	Surface anomaly (Fine Structure Special Case)	SAA	Check for evidence of surface anomalies in the region.	Class 1 from the surface	—	—	—
5.3	Fine Structure (Probable)	FSA	Check for fine structure in neighbouring drops. Downgrade data from the surface.	Class 2 from the surface.	—	—	—
5.4	Leakage (Possible)	LEA	Check if similar anomalies are observed in neighbouring drops. Downgrade data.	Class 2 from depth of possible leakage.	—	—	—
5.5	Leakage	—	—	—	LER	Reject data from depth of anomaly from working archive.	Class 3 below depth of leakage.

Table 3. Summary of CSIRO Quality Control Codes (cont.)

Ref. No.	Category	Accept Code	Action	Quality Class	Reject Code	Action	Quality Class
6. Eddy-Front / Temperature Offset Flags							
6.1	Eddy / Front	EFA	Verify eddy / front in repeat or neighbouring drops.	Class 1 from the surface.	—	—	—
6.2	Meso-Scale Structure	MEA	Check for meso-scale structure in neighbouring drops.	Class 1 from the surface.	—	—	—
6.3	Temperature Offset	—	—		TOR	Check neighbouring profiles for temperature differences. Reject data from working archive.	Class 3 from the surface.

TABLE 4

Data Quality Class

Class	Quality	Description
Class 0	No QC Done	Class 0 data is the level at which all data enters the working archive, and has not yet been quality controlled.
Class 1	Good Data	Class 1 data is top quality data in which no malfunctions are identified and all real features have been verified during the quality control process.
Class 2	"Probably" Good Data	Class 2 data is good data in which some unusual but probably real features, and/or malfunction errors which can be corrected or are small enough to be ignored without seriously effecting the overall quality of the data, are observed. Data is downgraded to Class 2 from the depth of anomalous (probably real) features.
Class 3	"Probably" Bad Data	Class 3 data is possibly good data in which some unusual, but probably erroneous features are observed. Data is downgraded to Class 3 and rejected (may be retrieved) from the working archive from the depth of anomalous (probably erroneous) features.
Class 4	Bad Data	Class 4 data is bad data in which obviously erroneous values are observed. Data is downgraded to Class 4 and deleted from the working archive from the depth of erroneous features.

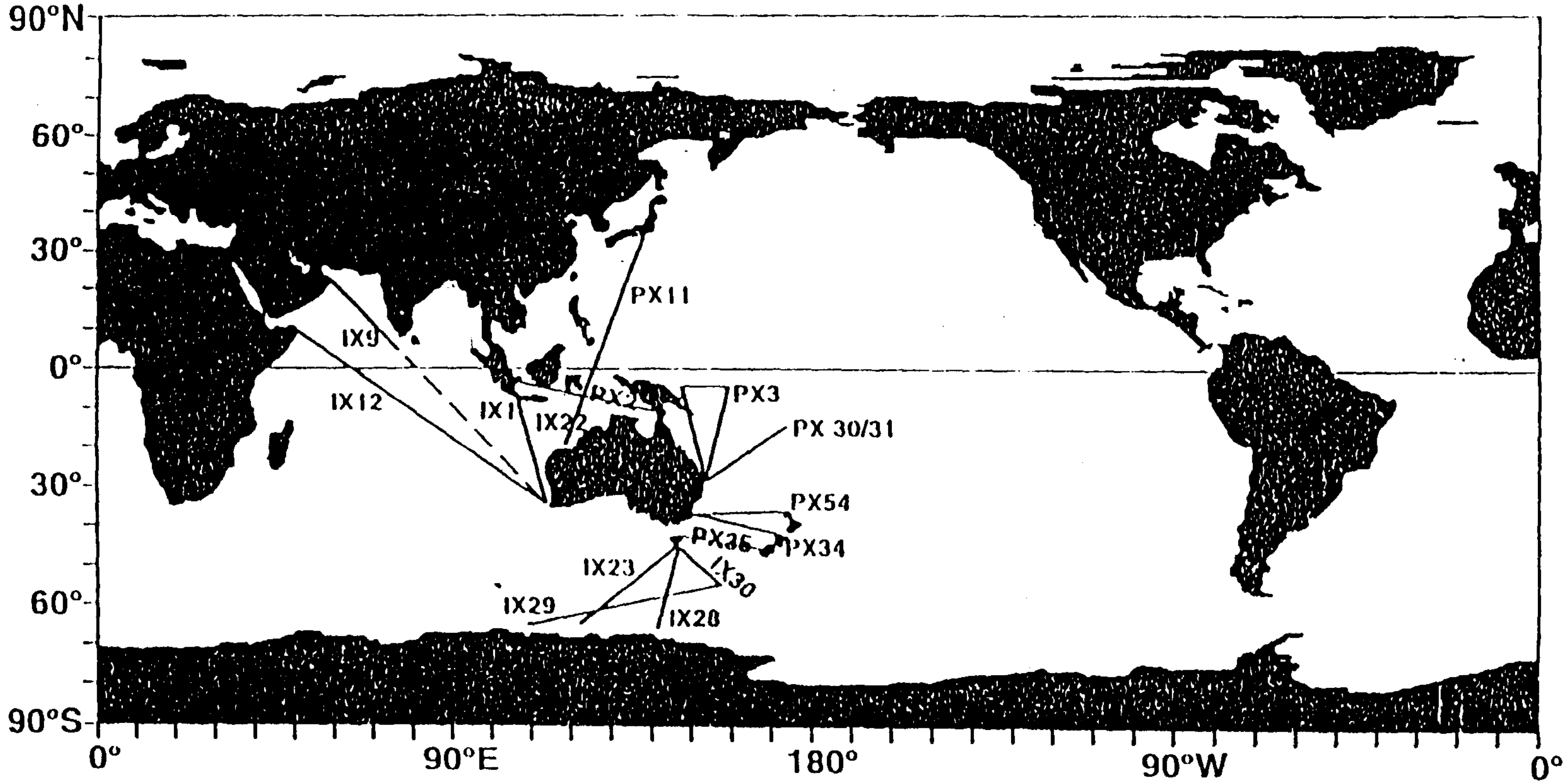


Figure 1. 1993 CSIRO Voluntary Observing Ship Routes

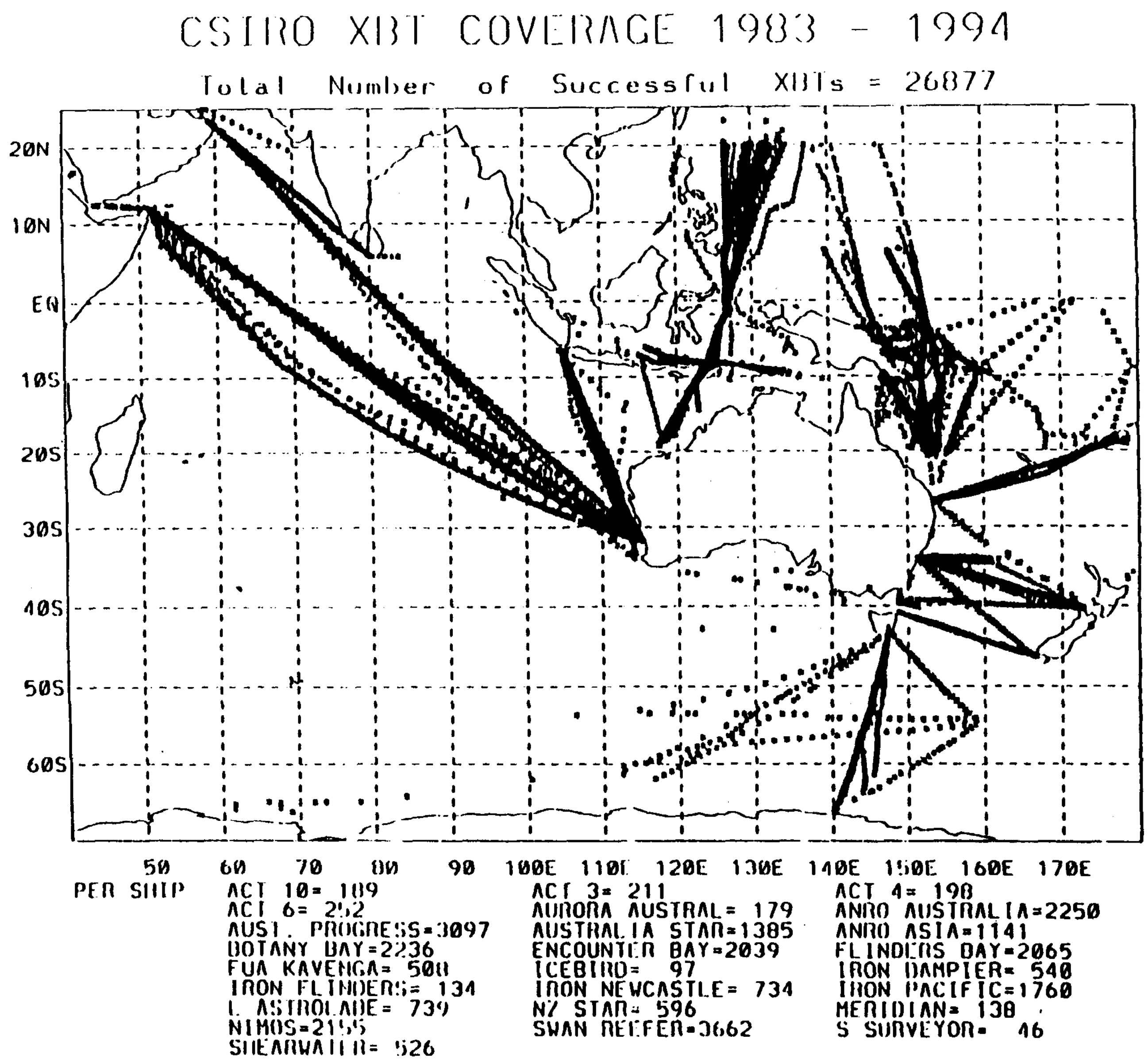
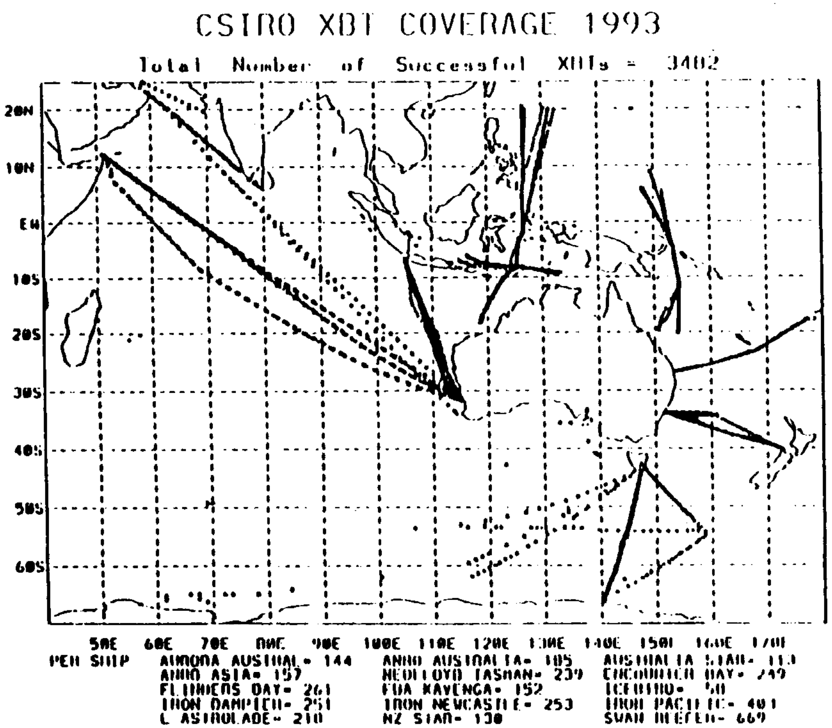

CSIRO XBT COVERAGE 1983 - 1994
Total Number of Successful XBTs = 26877
20N
10N
EQ
10S
20S
30S
40S
50S
60S
50 60 70 80 90 100E 110E 120E 130E 140E 150E 160E 170E
PER SHIP
ACT 10= 189
ACT 6= 252
AUST. PROGRESS=3097
BOTANY BAY=2236
FUA KAVENGA= 508
IRON FLINDERS= 134
L ASTROLABE= 739
NIMOS=2155
SHEARWATER= 526
ACT 3= 211
AURORA AUSTRAL= 179
AUSTRALIA STAR=1385
ENCOUNTER BAY=2039
ICEBIRD= 97
IRON NEWCASTLE= 734
NZ STAR= 596
SWAN REEFER=3662
ACT 4= 198
ANRO AUSTRALIA=2250
ANRO ASIA=1141
FLINDERS BAY=2065
IRON DAMPIER= 540
IRON PACIFIC=1760
MERIDIAN= 138
S SURVEYOR= 46

Figure 2.


CSIRO XBT COVERAGE 1993
Total Number of Successful XBTs = 3402
20N
10N
EQ
10S
20S
30S
40S
50S
60S
50E 60E 70E 80E 90E 100E 110E 120E 130E 140E 150E 160E 170E
PER SHIP
AURORA AUSTRAL= 144
ANRO ASIA= 157
FLINDERS BAY= 261
IRON DAMPIER= 251
L ASTROLABE= 210
ANRO AUSTRALIA= 105
HEDLEY LOYD TASMAN= 239
FUA KAVENGA= 152
IRON NEWCASTLE= 253
NZ STAR= 130
AUSTRALIA STAR= 113
ENCOUNTER BAY= 249
ICEBIRD= 50
IRON PACIFIC= 401
SWAN REEFER= 669

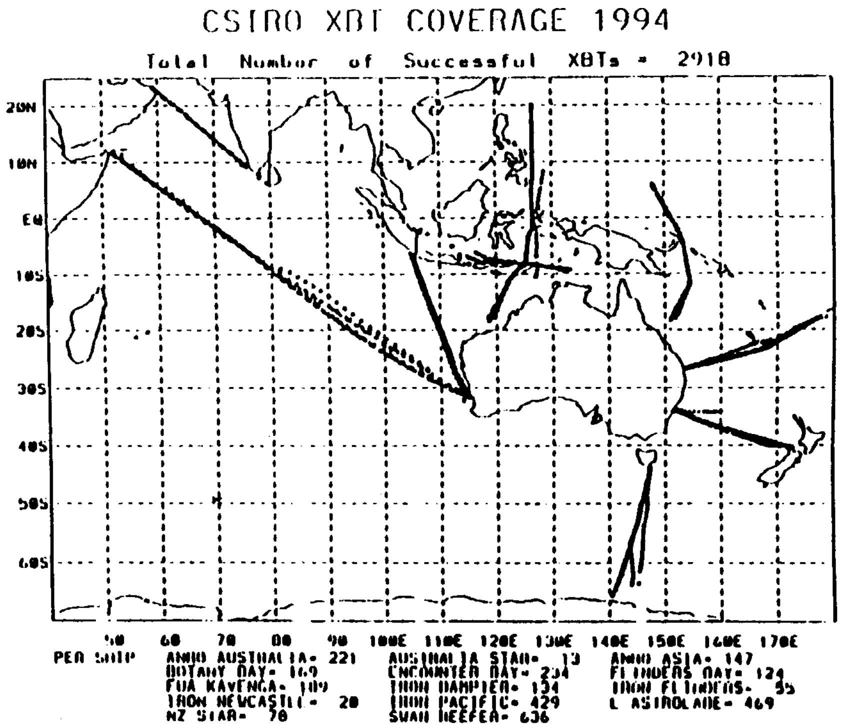
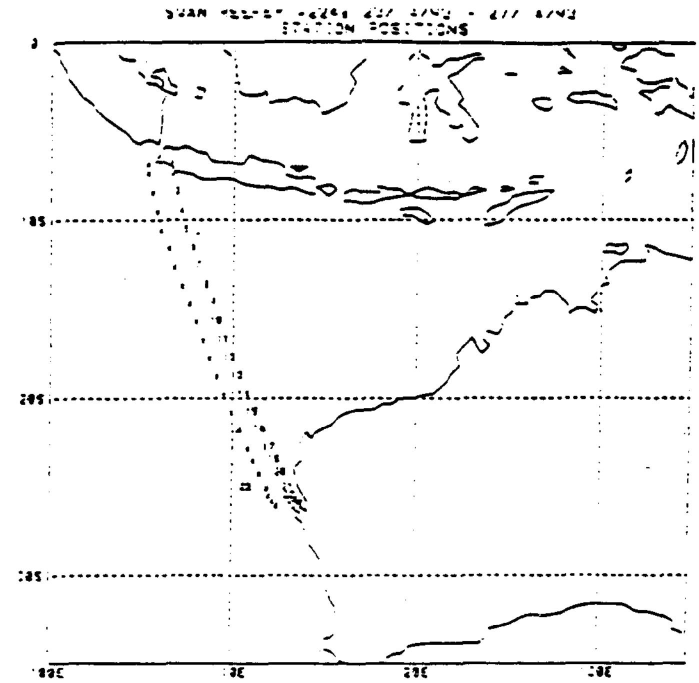

CSIRO XBT COVERAGE 1994
Total Number of Successful XBTs = 2918
20N
10N
EQ
10S
20S
30S
40S
50S
60S
50 60 70 80 90 100E 110E 120E 130E 140E 150E 160E 170E
PER SHIP
ANRO AUSTRALIA= 221
BOTANY BAY= 169
FUA KAVENGA= 109
IRON NEWCASTLE= 20
NZ STAR= 78
AUSTRALIA STAR= 13
ENCOUNTER BAY= 234
IRON DAMPIER= 134
IRON PACIFIC= 429
SWAN REEFER= 636
ANRO ASIA= 147
FLINDERS BAY= 124
IRON FLINDERS= 55
L ASTROLABE= 469

Figure 3.



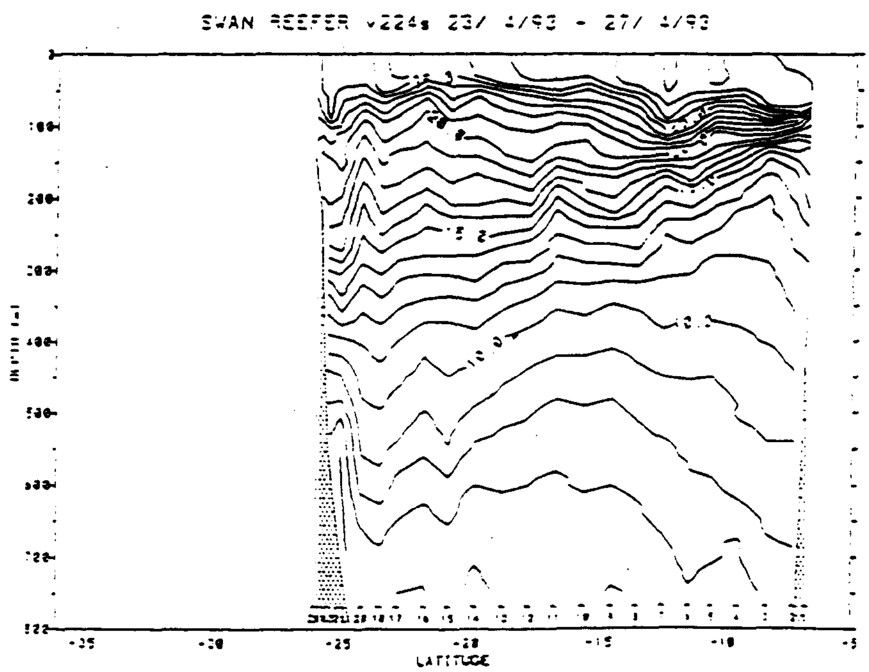


Figure 4a. Temperature section (line IX-1)

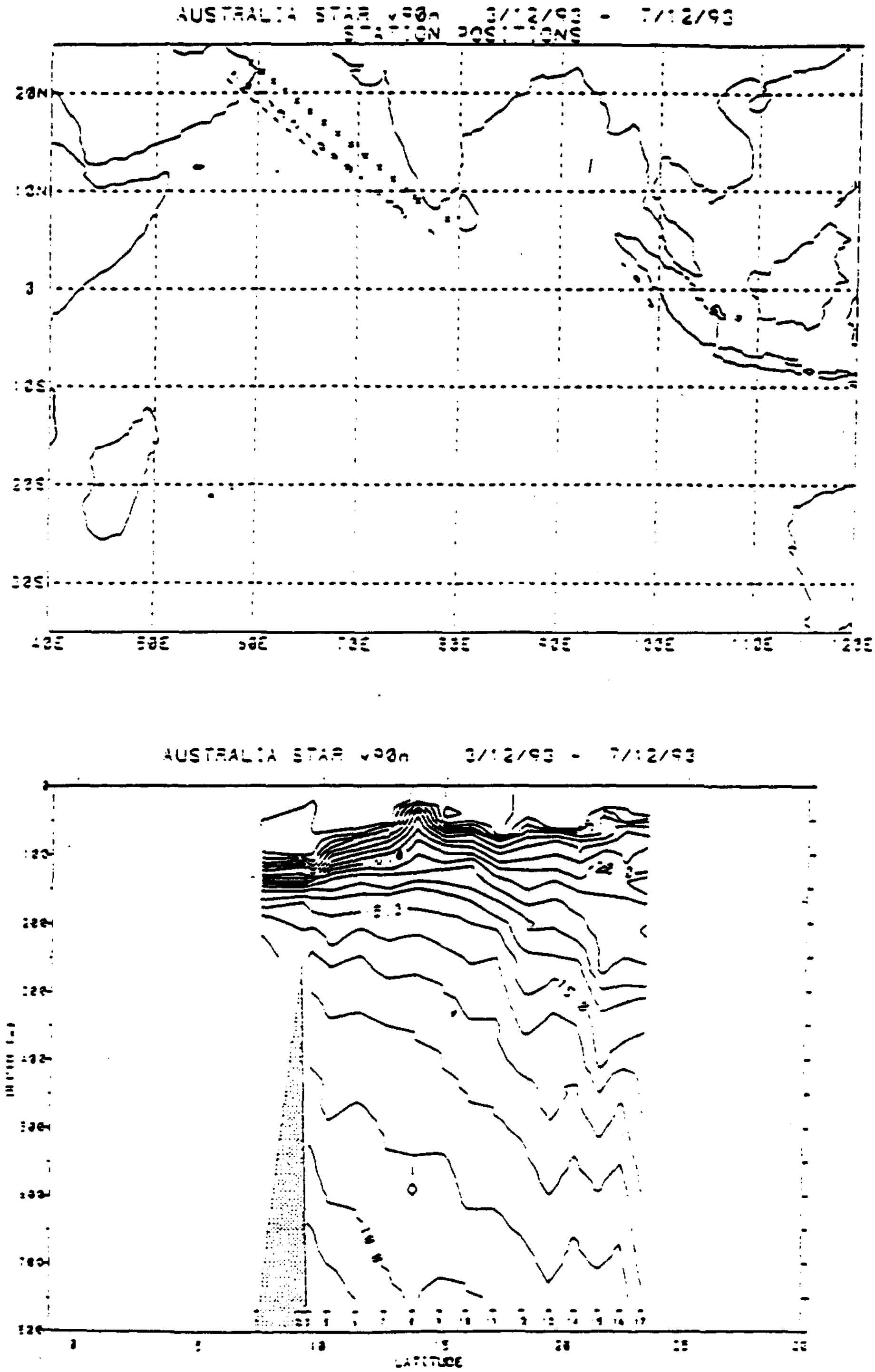


Figure 4b. Temperature section (line IX-9)

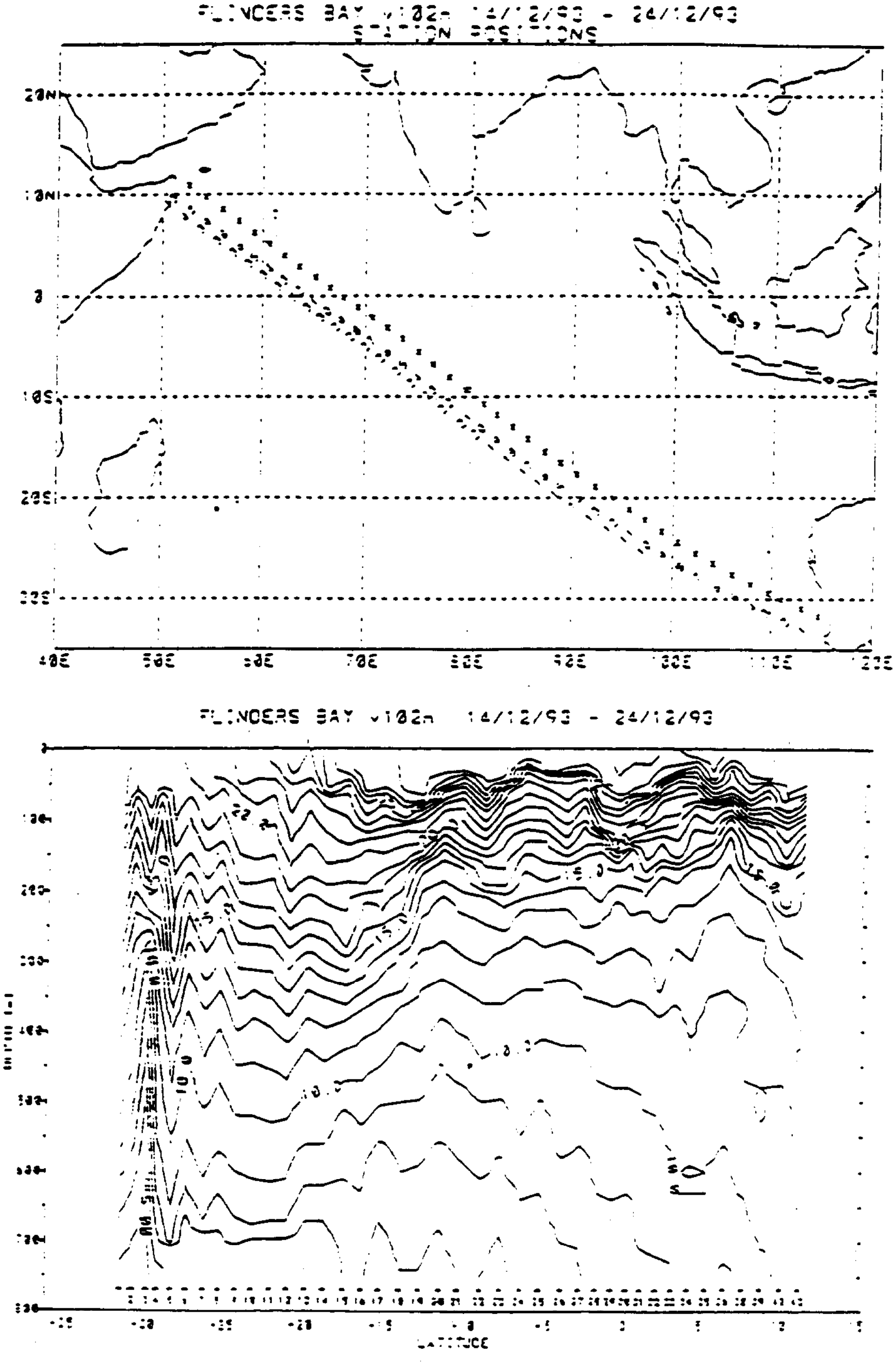
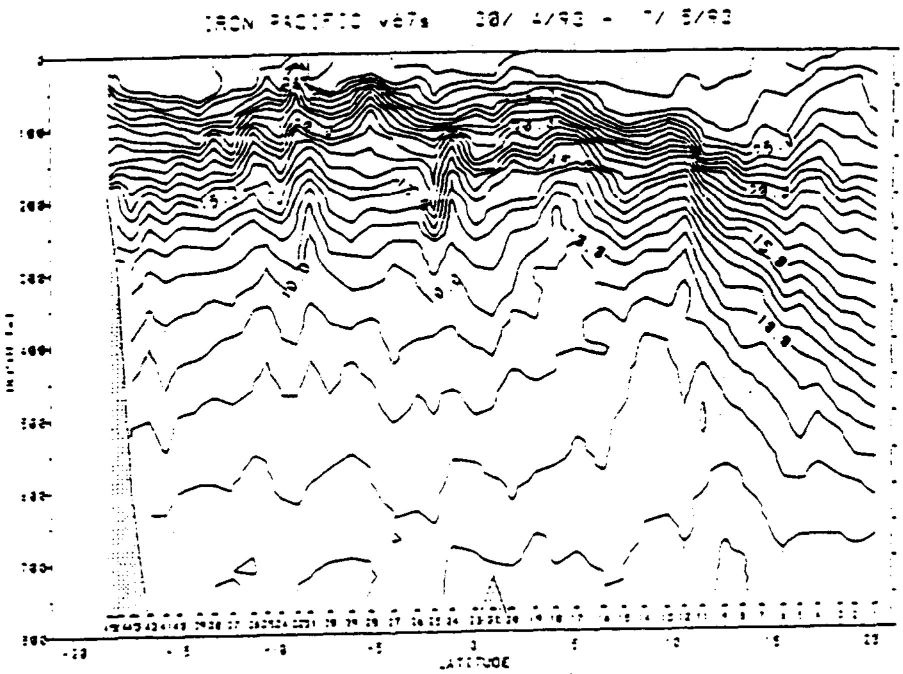


Figure 4c. Temperature section (line IX-12)



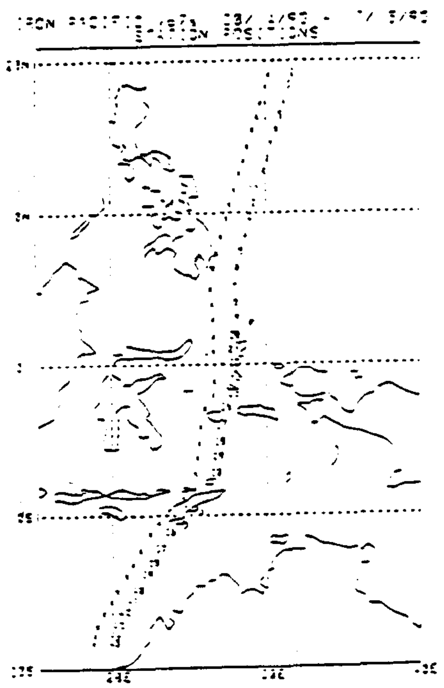


Figure 4d. Temperature section (line IX-22/PX-11)

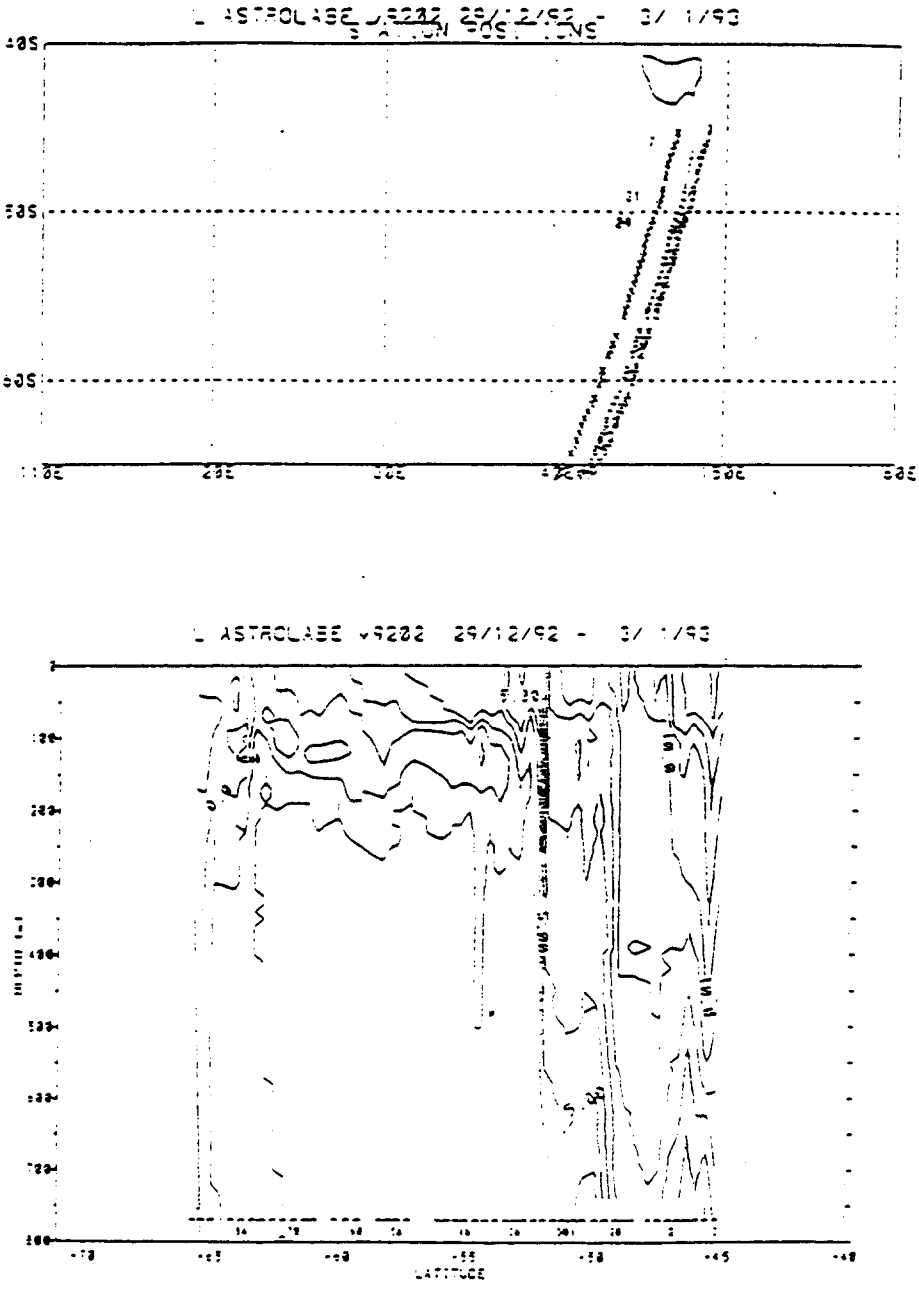


Figure 4e. Temperature section (line IX-28)

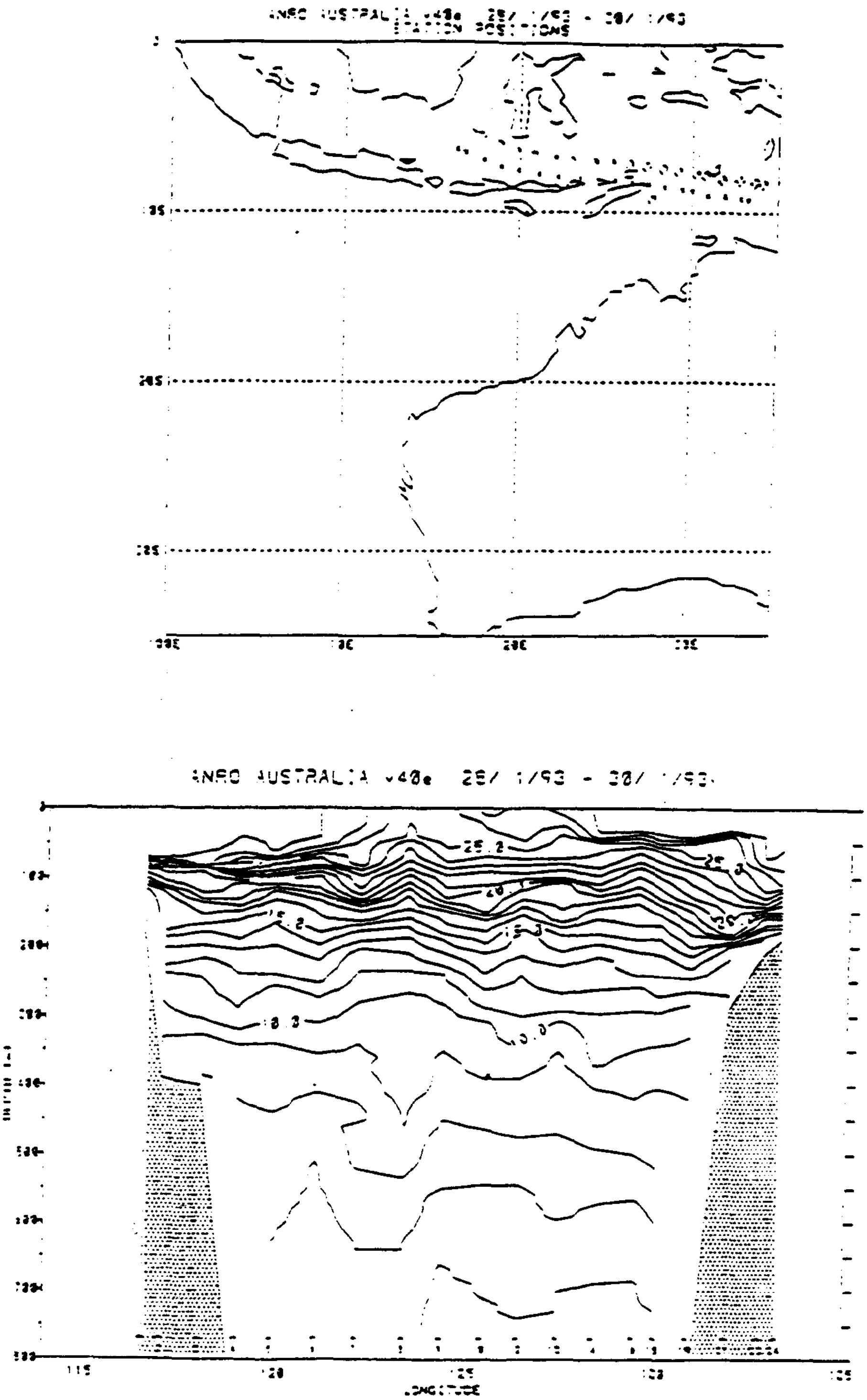
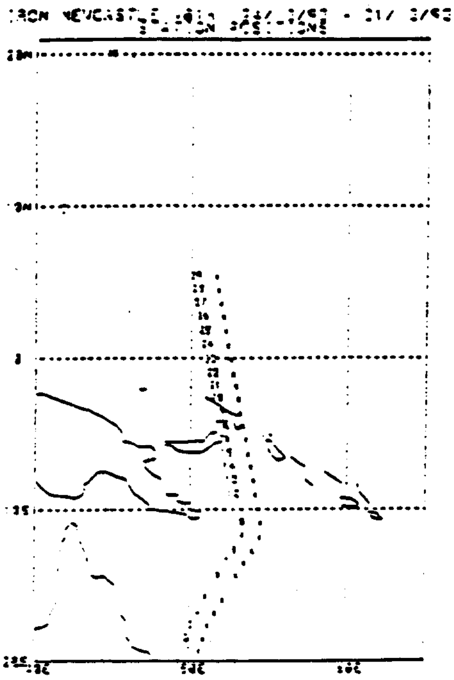


Figure 4f. Temperature section (line PX-2)



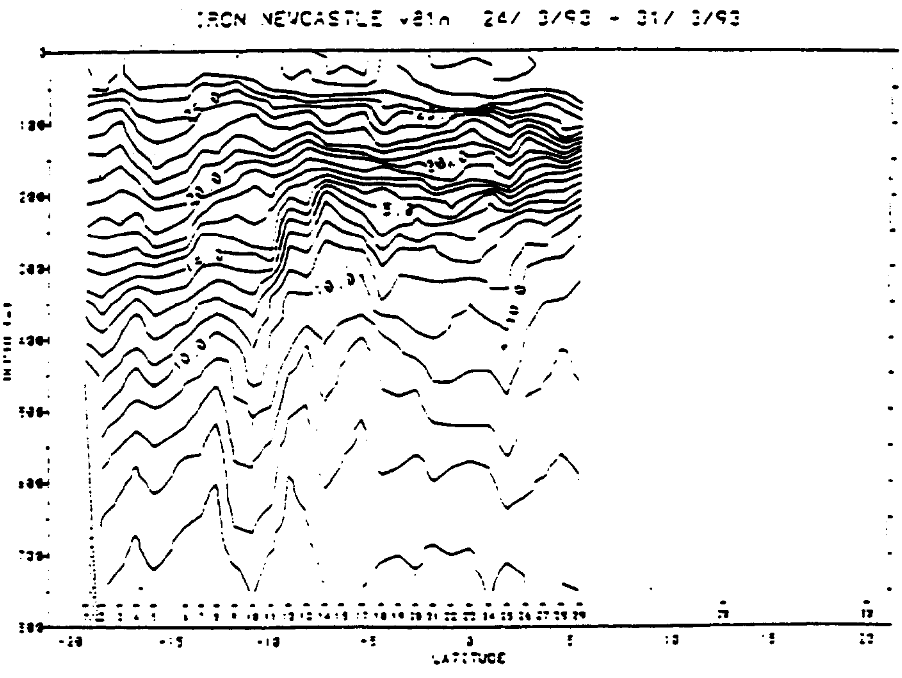


Figure 4g. Temperature section (line PX-3)

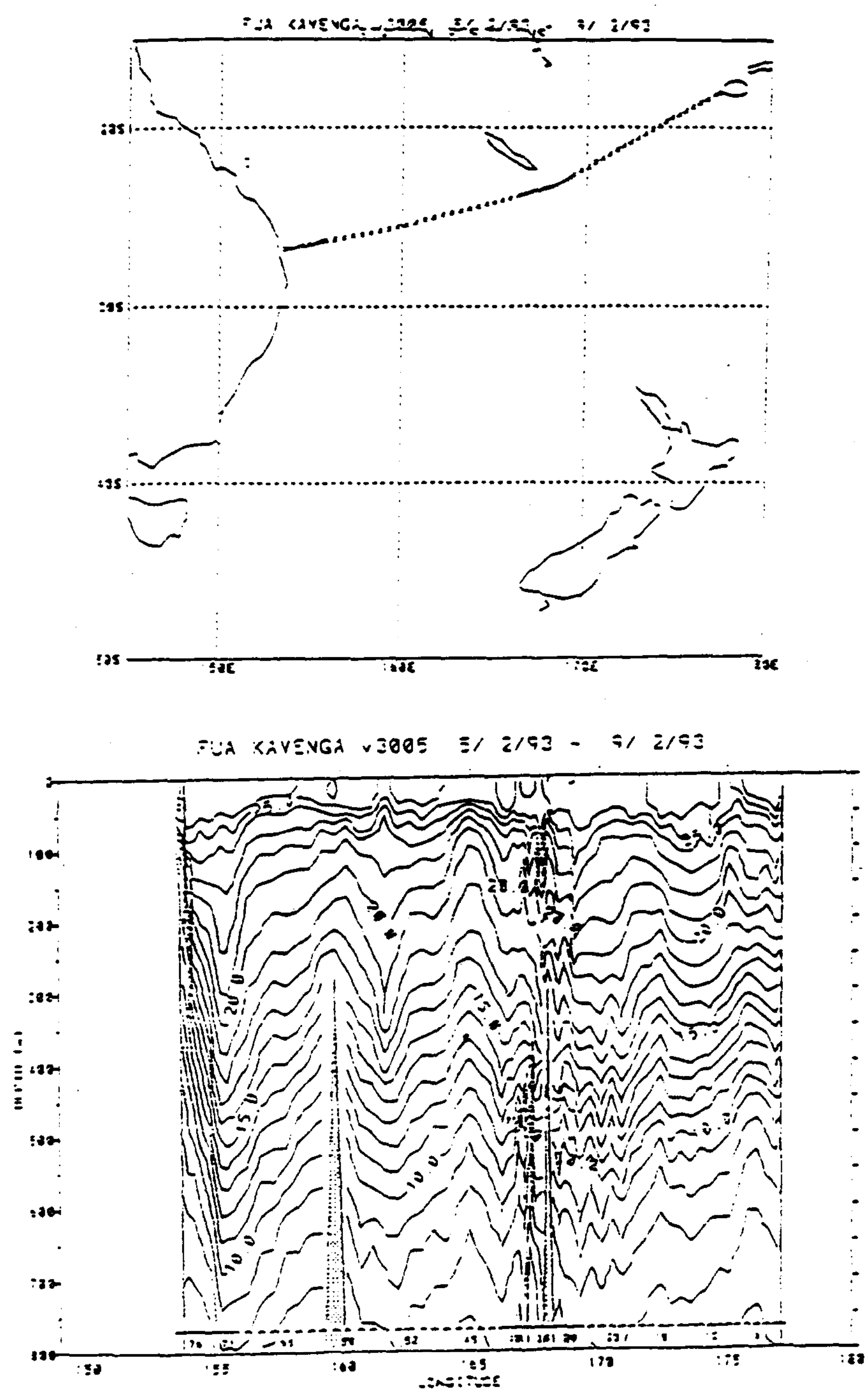
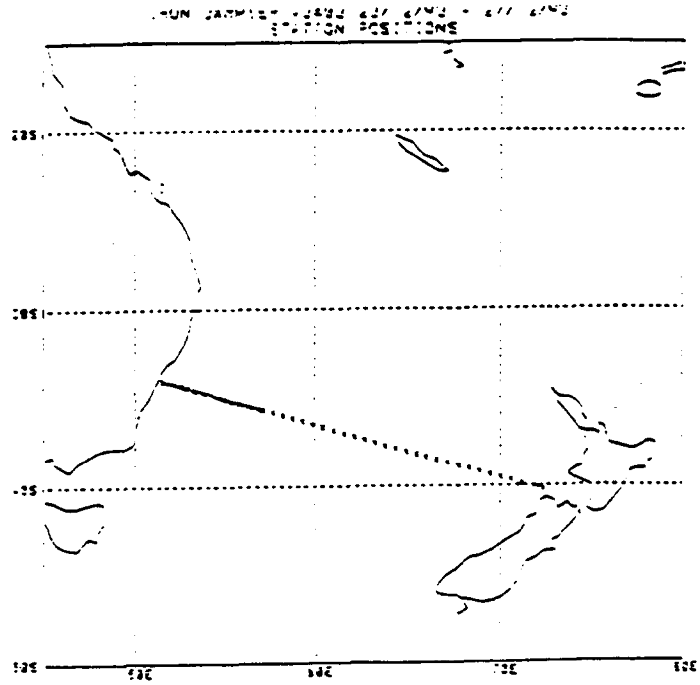


Figure 4h. Temperature section (line PX-30/31)



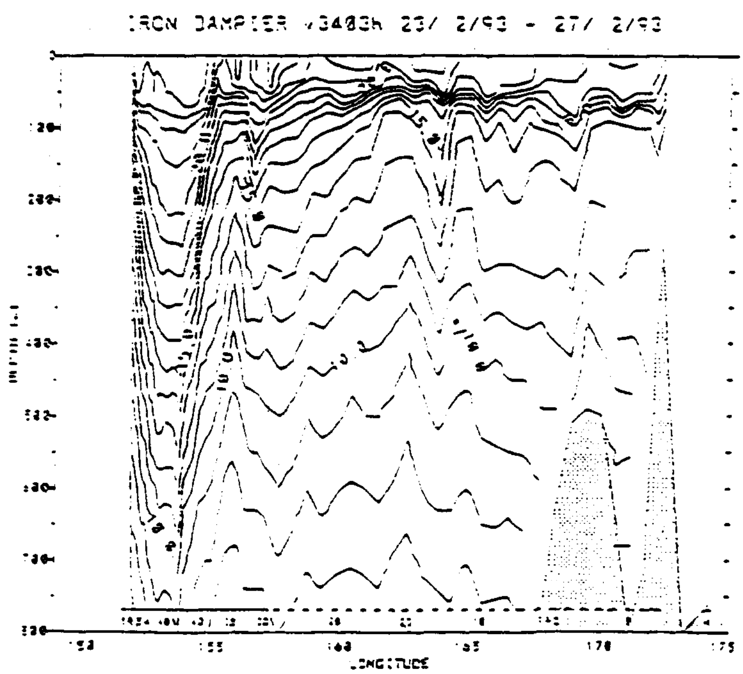
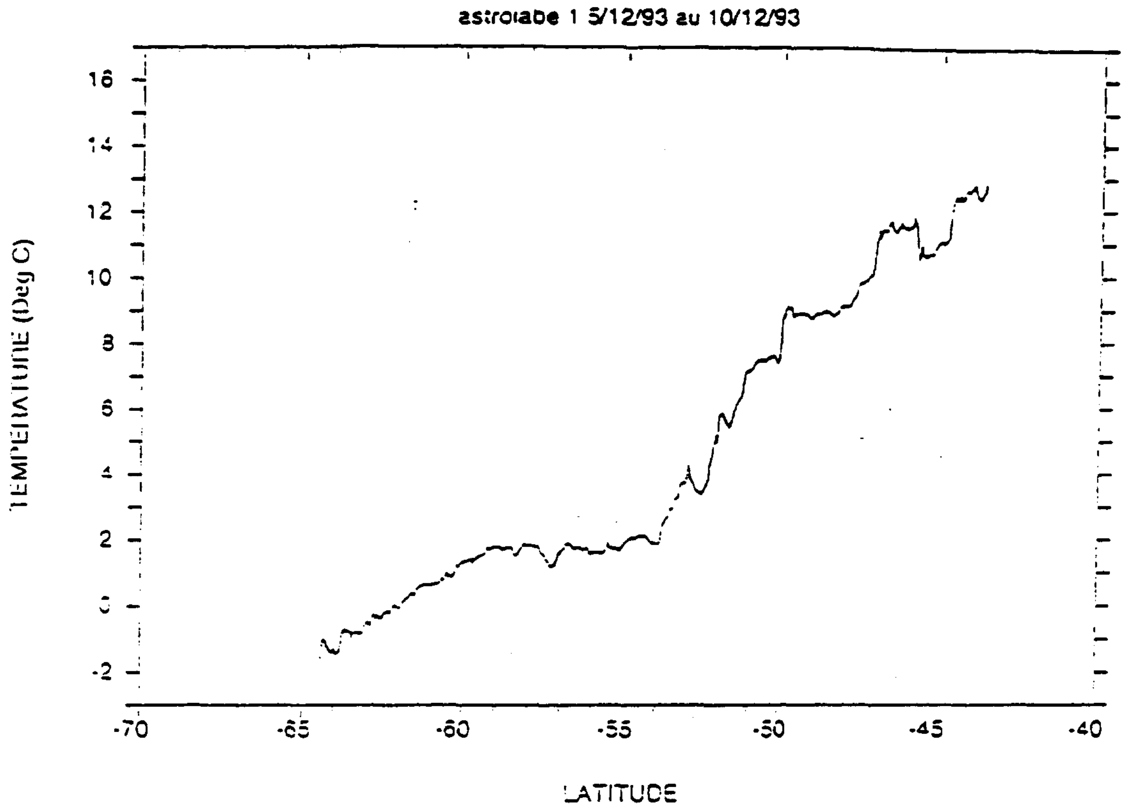


Figure 4i. Temperature section (line PX-34)



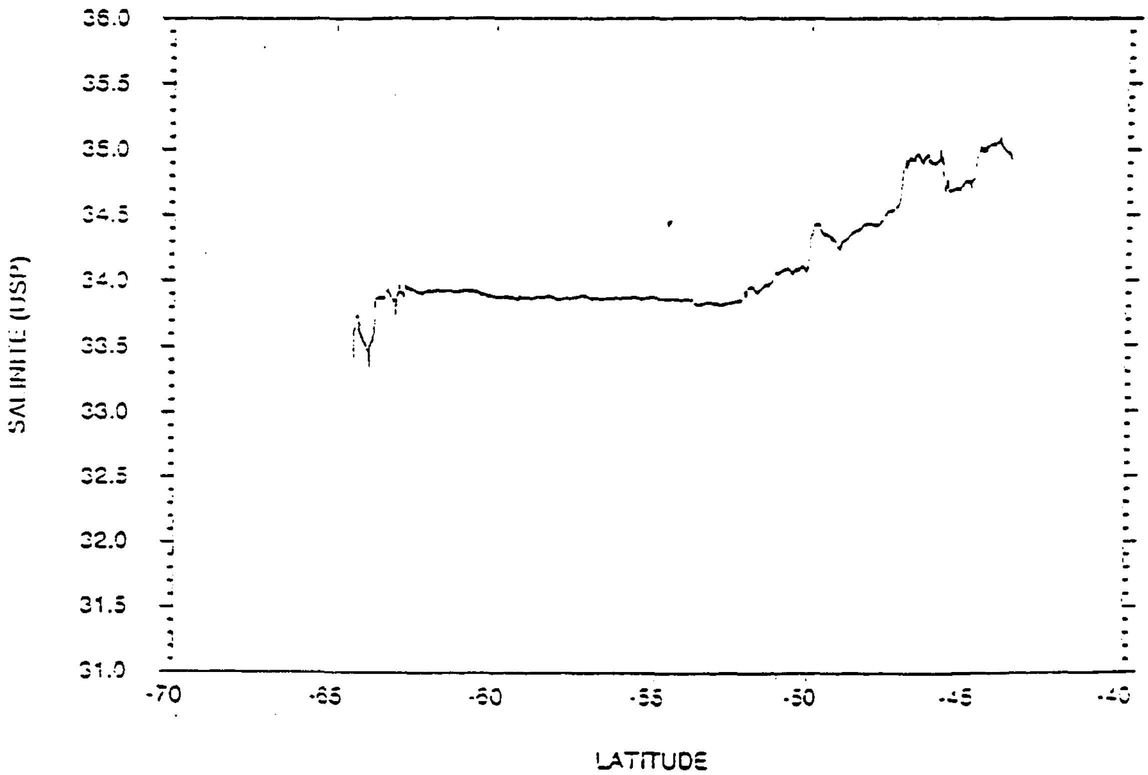


Figure 5. **SST and SSS between Hobart and Dumont d'Urville (IX-28).**

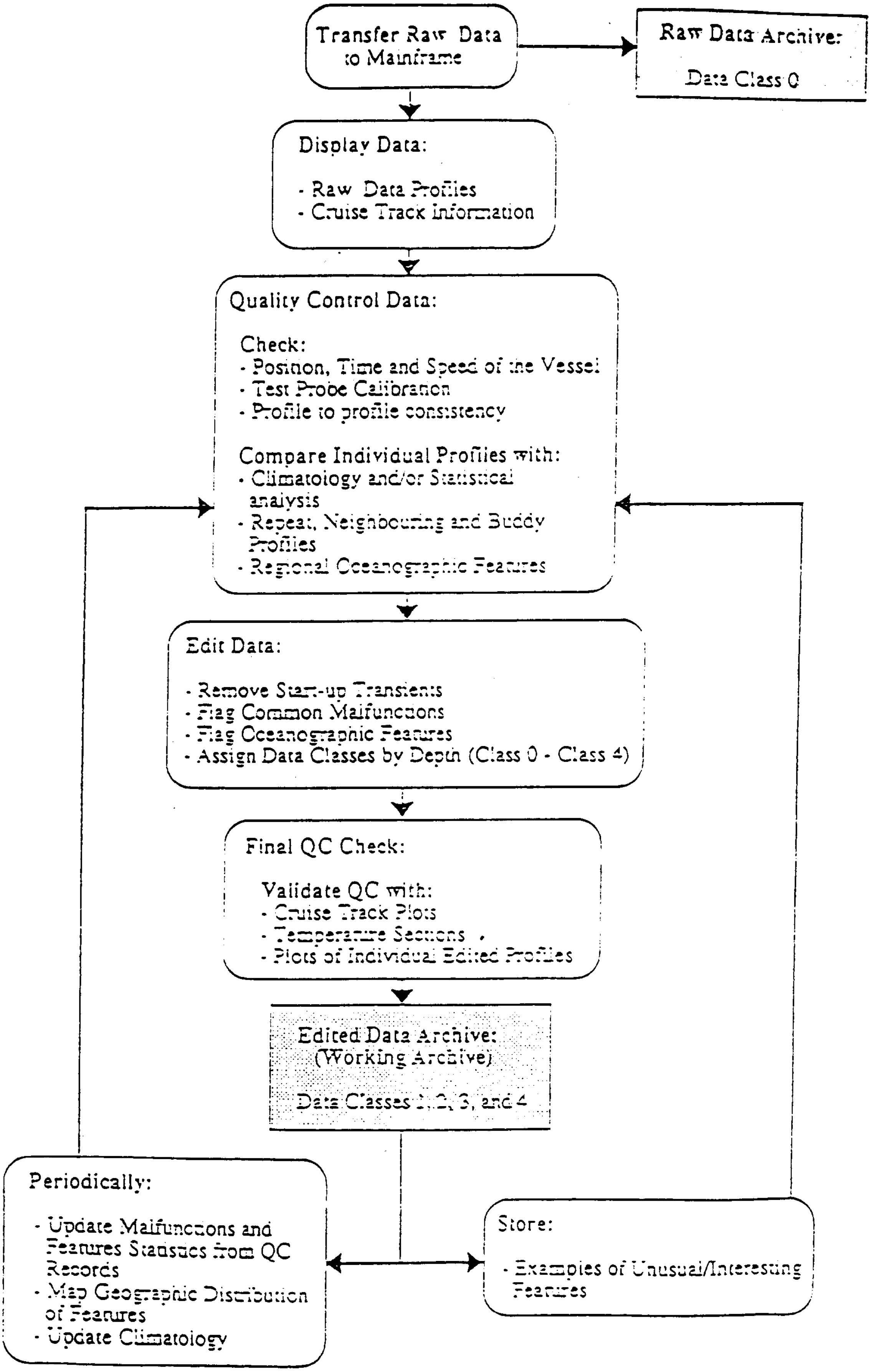


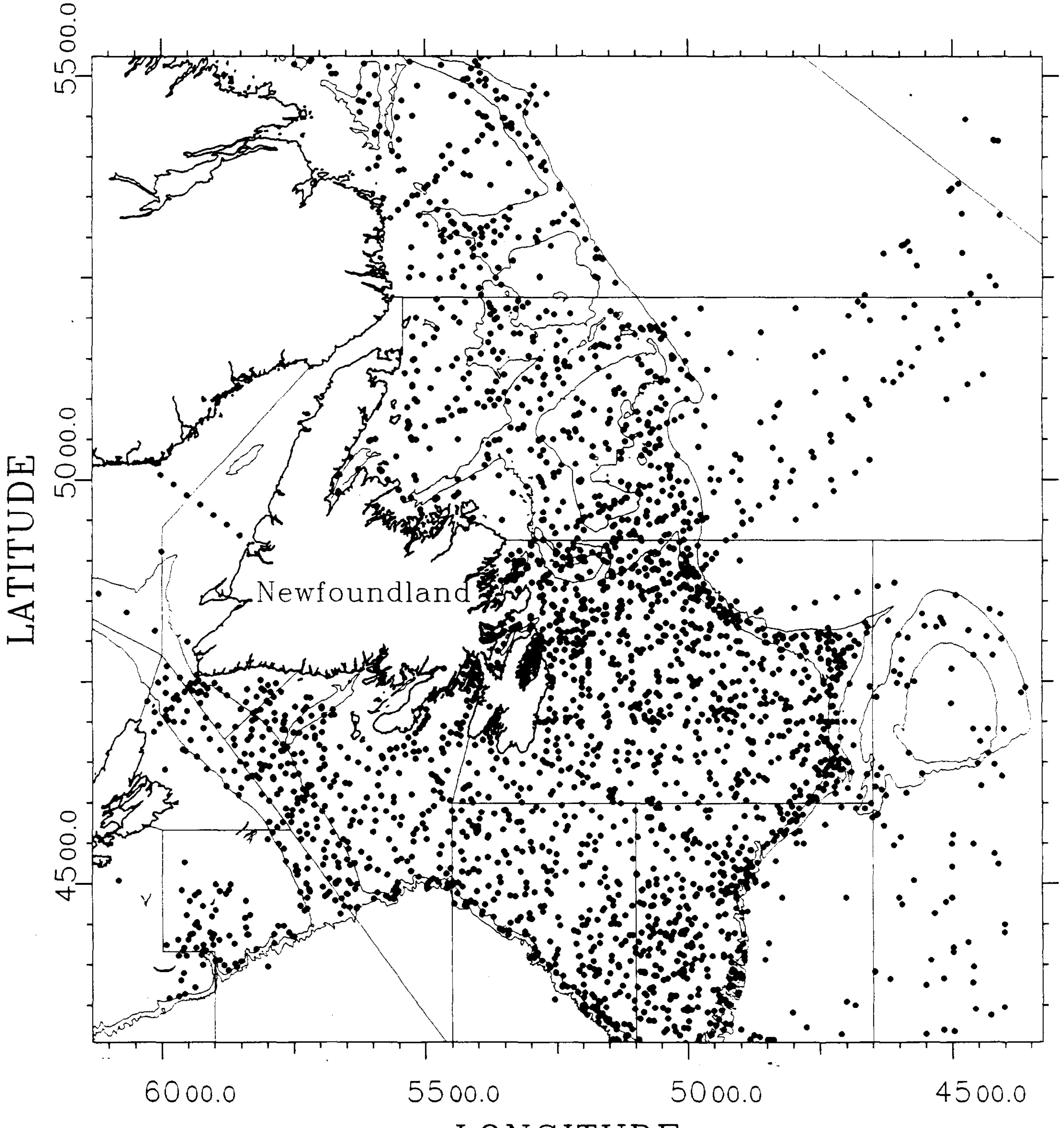
Figure 6. CSIRO XBT data processing flow chart.

CANADA

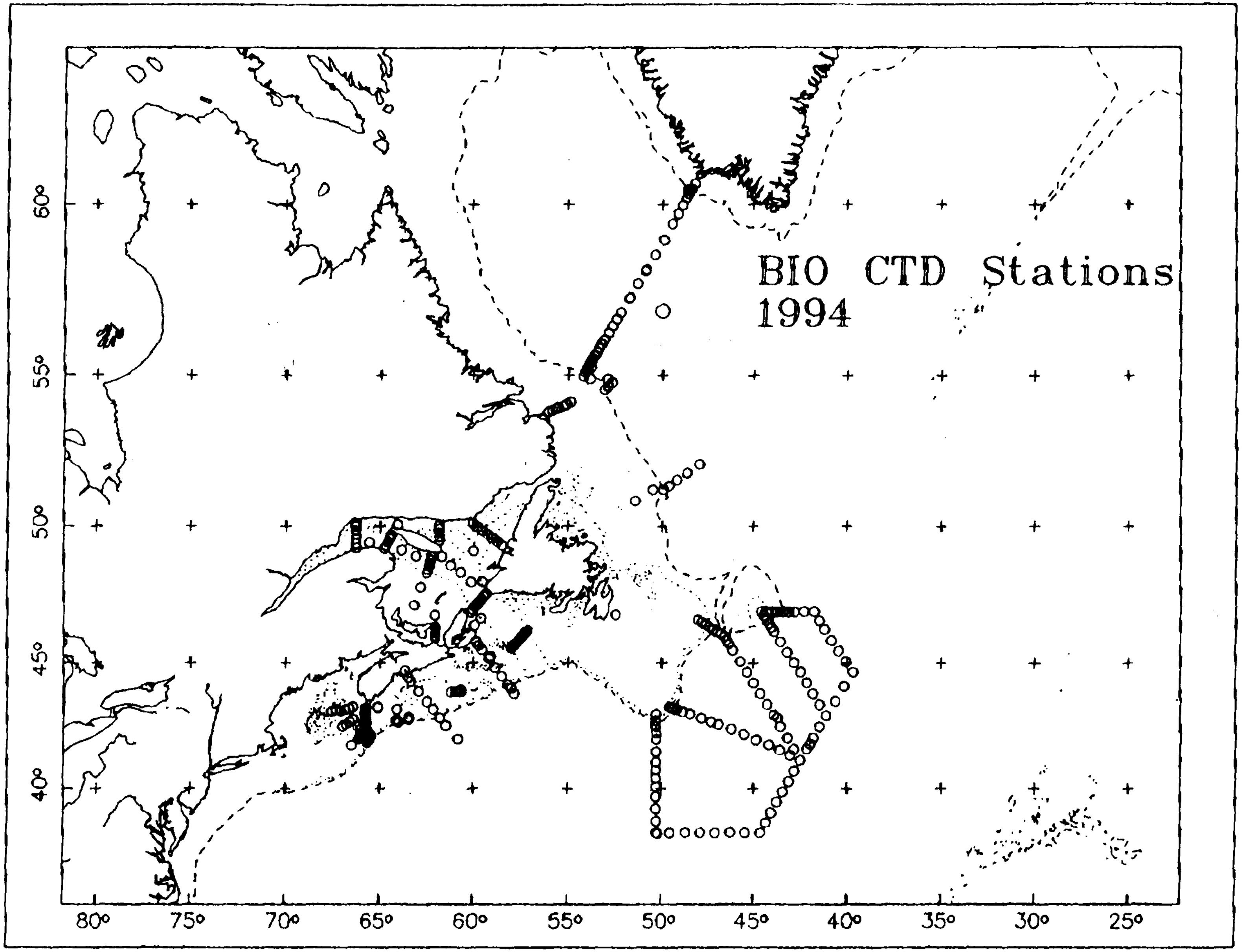
Almost all oceanographic data collected by Canadian Scientists are from research vessels. The only ship-of-opportunity line (as IGOSS defines it) is the XBT line from Cape Race to Reykjavik on MV "Skogafoss" (AX2 is its WOCE designation), managed by Dr. Fred Dobson from Bedford Institute of Oceanography. In 1994, this line was occupied about once a month, each data set consisting of 16-18 drops of T-7 XBTs, spaced 50 nm from Cape Race to 45W, 100 nm from 45W to Reykjavik. Most transects were actually Reykjavik to Cape Race, since the ship tows a CPR in the other direction and it snags the wire. Two of the transects - Feb and June, 1994 - dropped twice as often from Cape Race to 45W; they were done by Gilles Reverdin of Lamont-Doherty. He also made about 20 drops on the Halifax-Boston part of Skogafoss's runs, which are included in the datasets. All have been quality controlled up to April; the rest await a new MEDS algorithm. The success rate of the XBT drops is about 80% in summer and 50% in winter. In addition, Gilles Reverdin and the NOAA SAIL Lab (Miami: Warren Krug) are running a Thermosalinograph on this line on a trial basis.

Dr. C.S Wong at the Institute of Ocean Sciences has a trans-Pacific program in cooperation with Japanese scientists to measure a suite of surface parameters such as temperature and salinity, CO_2, methane, nutrients, and chlorophyll. The sampling is done from the vessel Skaugran which travels from Vancouver to Tokyo about 6-8 trips per year. The XBT component of this program is supported by VOS in US.

In addition to these commercial vessel-based programs, the Dept. of Fisheries and oceans has several research-vessel based ship-of-opportunity programs. The temperature/salinity data set generated from these programs are quality controlled and archived at MEDS. Recently, many of the research vessels are equipped with acoustic current profilers to collect velocity profiles along the cruise track. The data collected from the east coast are now compiled and processed, and put in an archive using the CODAS software developed by University of Hawaii. Once the system is set up we hope to input all ADCP data in Canada into this archive. These archives have been proven to be a valuable resource for climate-related programs.

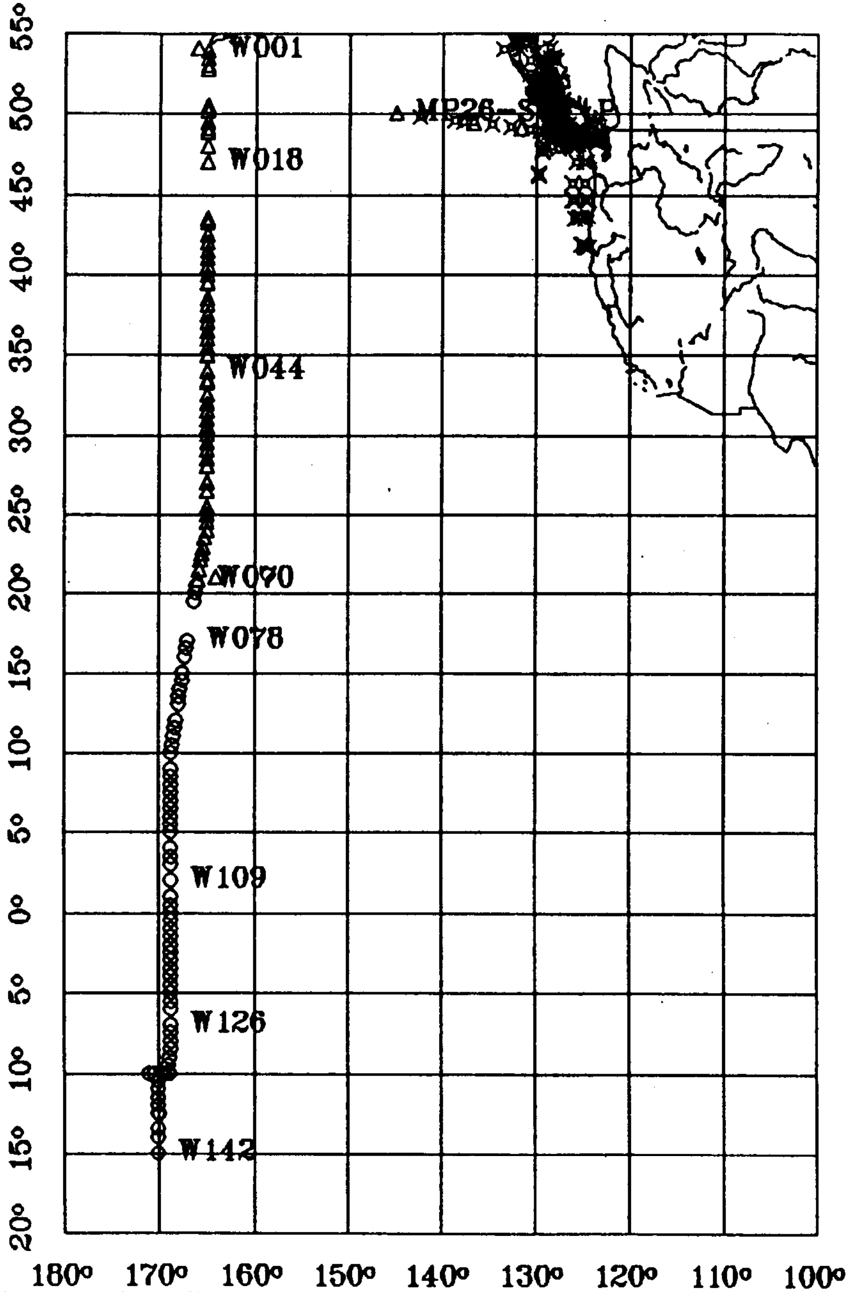


Locations of CTD/XBT profiles collected in 1994 by the Newfoundland Region

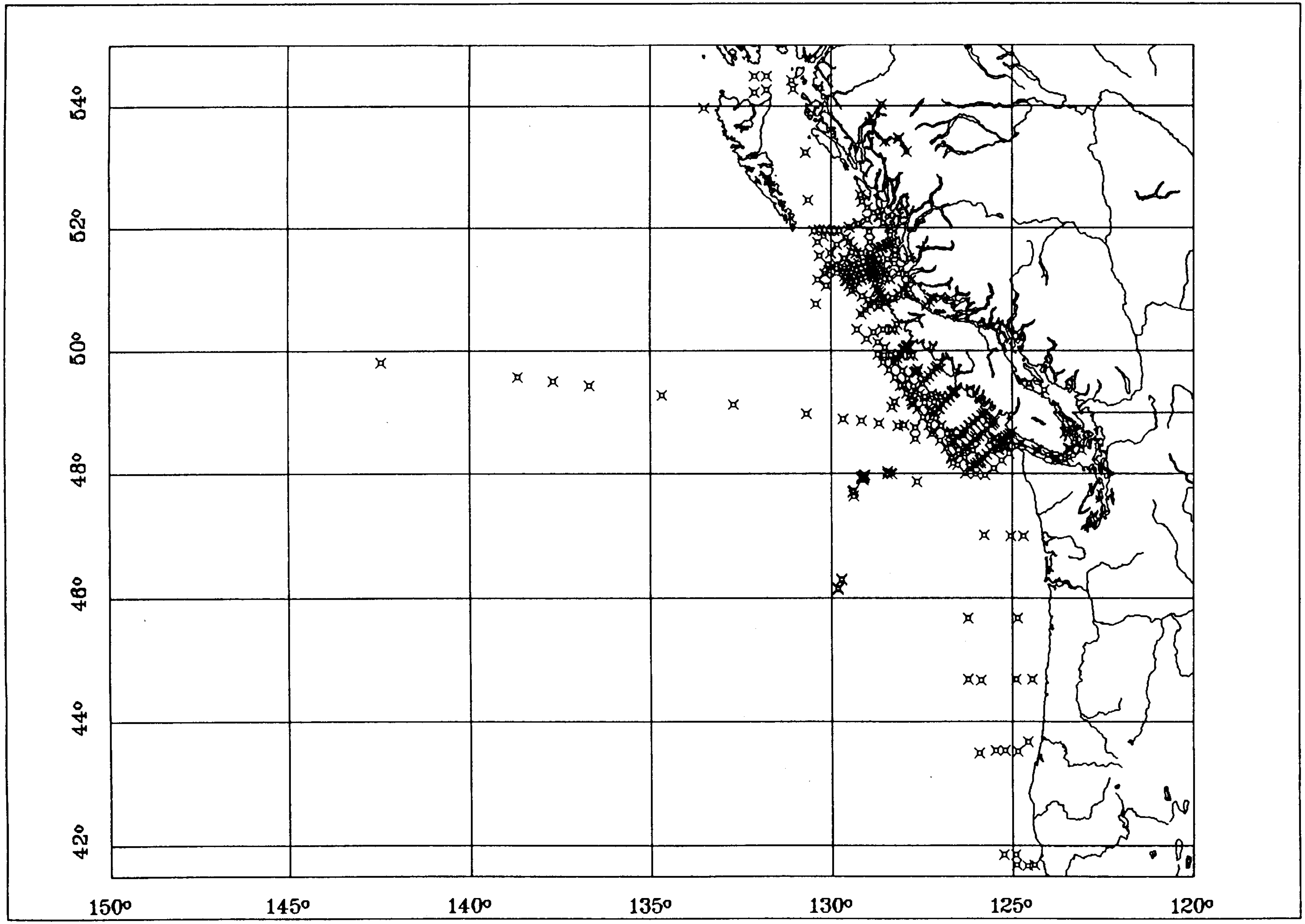


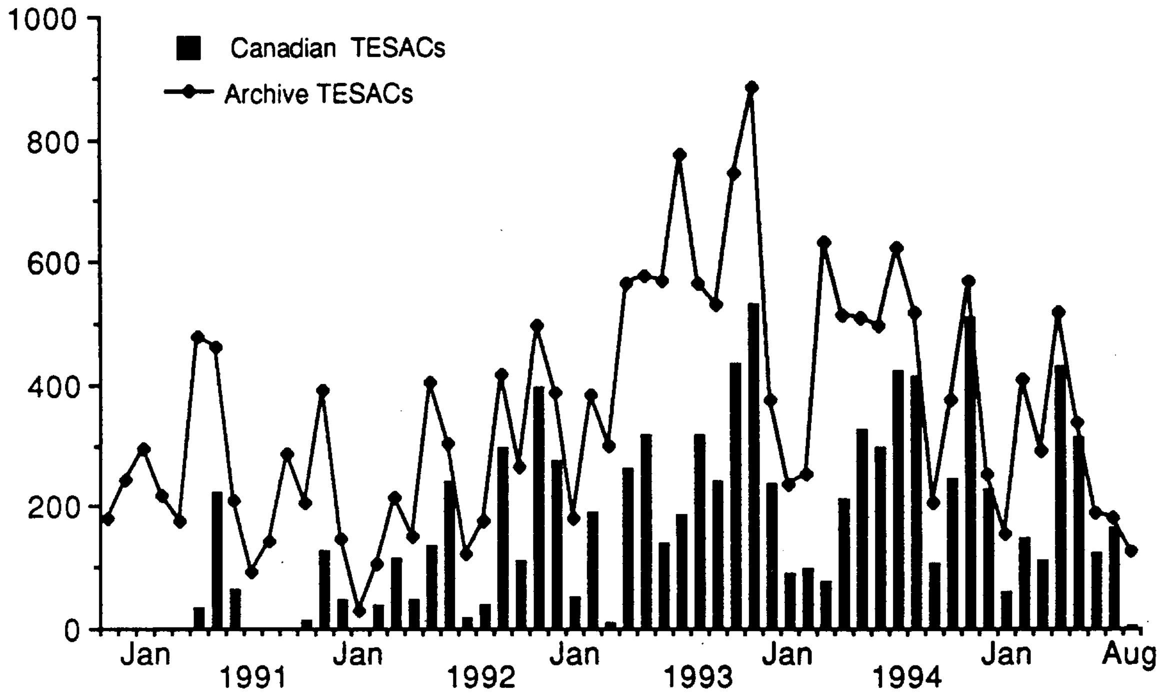
Locations of CTD/XBT profiles collected by Bedford Institute of Oceanography

Locations of CTD/XBT profiles collected by Institute of Oceanography



Locations of CTD/XBT profiles collected by Institute of Oceanography





TESACs collected by Canada compared to the total number available

FRANCE

A. DESSIER[1], P. RUAL[2], C. PEIGNON[3], T. LUDJET[4], H. ROQUET[5]

La France a participé au programme de manière régulière principalement sur financement TOGA. Cette participation se traduit par la prise de responsabilité des divers centres ORSTOM pour couvrir la zone tropicale des Océans Atlantique, Indien et Pacifique.

De ce fait, la contribution apportée sur chacun des océans sera présentée.

1 : Centre TOGA Brest (ORSTOM) e-mail : dessier@orstom.orstom.fr

2 : Responsable des lâchers XBT Pacifique (ORSTOM) e-mail : rual@noumea.orstom.nc

3 : Centre Nouméa (ORSTOM) e-mail : peignon@noumea.orstom.nc

4 : Responsable français IGOSS-OTA (Météo-France) e-mail : Thierry.Ludjet@meteo.fr

5 : Responsable des activités R&D de la Prévision Marine (Météo-France) e-mail : Herve.Roquet@meteo.fr

Océan Pacifique

Les tableaux 1 à 3, ainsi que les figures I à III ont été préparés et transmis par Pierre RUAL et Christophe PEIGNON, du centre ORSTOM de Nouméa :

- Tableau 1: récapitulatif par navire et par voyage des lâchers XBT effectués en 1994 et au premier semestre 1995 dans l'Océan Pacifique, sous la responsabilité de l'ORSTOM.

- Tableau 2 : récapitulatif par navire des lâchers XBT effectués en 1994 et au premier semestre 1995 dans l'Océan Pacifique, sous la responsabilité de l'ORSTOM.

- Tableau 3 : récapitulatif par ligne et par navire des mesures de thermosalinographe effectuées en 1994 dans l'Océan Pacifique, Atlantique et Indien sous la responsabilité de l'ORSTOM.

- Figure I : localisation géographique des lâchers XBT effectüés en 1994 dans l'Océan Pacifique, sous la responsabilité de l'ORSTOM.

- Figure II : localisation géographique des mesures de thermosalinographe effectuées en 1994 dans l'Océan Pacifique, Atlantique et Indien sous la responsabilité de l'ORSTOM

- Figure III : localisation géographique des mesures au seau de température et salinité de surface effectuées en 1994 dans l'Océan Pacifique, sous la responsabilité de l'ORSTOM

Océan Atlantique et Indien

Le tableau 4, ainsi que la figure IV ont été préparés et transmis par Alain DESSIER, du centre TOGA de Brest :

- Tableau 4 : récapitulatif par navire et par ligne des lâchers XBT effectués en 1994 dans l'Océan Atlantique et Indien, sous la responsabilité de l'ORSTOM.

- Figure IV : localisation géographique des lâchers XBT effectués en 1994 dans l'Océan Atlantique et Indien, sous la responsabilité de l'ORSTOM.

Seules les observations effectuées entre 30°N et 30°S sont ici prises en compte.

SMT - Centre Océanographique Spécialisé

Les figure V et VI ont été préparées par Thierry LUDJET, du Centre Océanographique Spécialisé français (Météo-France, SCEM/PREVI/MAR, Toulouse) :

- Figure V : localisation géographique des messages BATHY et TESAC reçus en 1994 sur le SMT, au Centre Océanographique Spécialisé français.

- Figure VI : localisation géographique des messages BATHY français reçus en 1994 sur le SMT, au Centre Océanographique Spécialisé français.

RELEVE DES TIRS EFFECTUES
ANNEE 1994 - 1er SEMESTRE 1995.

Navire	*Voyage*	*tirs lancés*	*bons tirs*	*%bons tirs*	*période*
Coral Islander	1	84	80	95,2	août-octobre 94
	2	67	58	86,6	octobre-novembre 94
	Ss Total	*151*	*138*	*91,4*	
CGM Rimbaud	22	90	88	97,8	décembre 93-mars 94
	23	71	63	88,7	avril-août 94
	24	62	56	90,3	août-septembre 94
	Ss Total	*223*	*207*	*92,8*	
CGM Ronsard	6	67	60	89,6	novembre 93-février 94
	7	67	61	91,0	février-mai 94
	8	70	63	90,0	mai-août 94
	9	50	48	96,0	septembre-décembre 94
	Ss Total	*254*	*232*	*91,3*	
CGM Racine	21	67	53	79,1	octobre 93-janvier 94
	22	30	22	73,3	janvier-avril 94
	23	59	57	96,6	avril-août 94
	24	55	54	98,2	août-novembre 94
	Ss Total	*211*	*186*	*88,2*	
CGM Renoir	1	40	37	92,5	février-mars 94
	2	82	58	70,7	juillet-octobre 94
	Ss Total	*122*	*95*	*77,9*	
FORTHBANK	11	70	68	97,1	janvier-mai 94
	12	95	90	94,7	mai-octobre 94
	Ss Total	*165*	*158*	*95,8*	
EXPLORER	14	74	65	87,8	octobre 93-janvier 94
	15	67	64	95,5	janvier-mars 94
	16	73	69	94,5	mars-mai 94
	17	73	67	91,8	mai-juillet 94
	18	76	69	90,8	juillet-septembre 94
	19	65	65	100,0	septembre-novembre 94
	Ss Total	*428*	*399*	*93,2*	
CRUSADER	1	74	72	97,3	janvier-mars 94
	2	87	82	94,3	mars-juillet 94
	3	50	47	94,0	juillet-août 94
	4	61	59	96,7	août-octobre 94
	5	57	51	89,5	octobre-décembre 94
	Ss Total	*329*	*311*	*94,5*	
CHALLENGER	2	54	52	96,3	décembre 93-février 94
	3	56	53	94,6	février-juin 94
	4	78	72	92,3	juin-octobre 94
	Ss Total	*188*	*177*	*94,1*	
CLYDEBANK	1	68	66	97,1	mars-juillet 94
	2	72	71	98,6	juillet-décembre 94
	Ss Total	*140*	*137*	*97,9*	
Pacific Islander	79	112	105	93,8	janvier-mars 94
	80	82	78	95,1	mars-mai 94
	81	127	120	94,5	mai-juillet 94
	82	108	98	90,7	juillet-septembre 94
	83	108	103	95,4	septembre-octobre 94
	Ss Total	*537*	*504*	*93,9*	
ATALANTE	2	82	78	95,1	octobre 93-juillet 94
	3	51	51	100,0	aout 94
	4	18	16	88,9	septembre-octobre 94
	Ss Total	*151*	*145*	*96,0*	
KOCHNEV	2	72	69	95,8	décembre 93-janvier 94
	Ss Total	*72*	*69*	*95,8*	
TOTAUX		*2971*	*2758*	*92,8*	

<u>Tableau 1</u> (page précédente) : récapitulatif par navire et par voyage des lâchers XBT effectués en 1994 et au premier semestre 1995 dans l'Océan Pacifique, sous la responsabilité de l'ORSTOM.

BILAN XBT 94-début 95										
NAVIRE	SIGLE	Nb de voyages	Voyages	94	95	tirs enreg. (1994 - 1995)	bons tirs	% bons tirs	dernier passage	premier voyage
Coral Islander	CORA	6	CORA01 à 06	3	3	527	467	88.6	03/08/1995	16/08/1994
CGM Rimbaud	RIMB	6	RIMB22 à 27	4	2	377	333	88.3	12/08/1995	09/08/1988
CGM Ronsard	RONS	6	RONS06 à 11	5	1	374	324	86.6	14/07/1995	08/10/1988
CGM Racine	RACI	6	RACI21 à 26	5	1	334	298	89.2	22/05/1995	06/09/1988
CGM Renoir	RENO	5	RENO01 à 05	4	1	237	203	85.7	05/04/1995	fev 94
FORTHBANK	FORT	4	FORT12 à 15	4	0	270	259	95.9	11/03/1995	18/08/1989
EXPLORER	EXPL	10	EXPL14 à 23	7	3	664	624	94.0	12/07/1995	04/07/1991
CRUSADER	CRUS	9	CRUS01 à 09	6	3	525	496	94.5	12/08/1995	19/01/1994
CHALLENGER	CHAL	7	CHAL01 à 07	4	3	387	367	94.8	15/07/1995	22/12/1993
CLYDEBANK	CLYD	3	CLYD01 à 03	3	0	236	218	92.4	28/04/1995	17/03/1994
Pacific Islander	PAIS	9	PAIS79 à 87	6	3	881	832	94.4	07/07/1995	avt 86
ATALANTE	ATAL	3	ATAL02 à 04	3	0	151	145	96.0	30/10/1994	27/07/1993
KOCHNEV	KOCH	1	KOCH02	1	0	72	69	95.8	05/02/1994	01/10/1993
TOTAUX		75		55	20	5035	4635	92.1		

<u>Tableau 2</u> : récapitulatif par navire des lâchers XBT effectués en et au premier semestre 1995 dans l'Océan Pacifique, sous la responsabilité de l'ORSTOM.

BILAN THERMO PAR LIGNE POUR 1994.

LIGNE	NAVIRE	FICHIERS EN BASE	DONNEES PAR FICHIER	TRANSECTS
PX 4	pacific islander	pais9401	10259	1
		pais9402	10166	1
		pais9403	10905	1
		pais9404	11007	1
		pais9405	10459	1
		pais9406	9981	1
	s.total	**6 fichiers**	**62777**	**6**
PX 5	explorer	expl9401	10511	1
		expl9402	7711	1
		expl9403	7567	1
		expl9404	6787	1
		expl9405	5634	1
		expl9406	7106	1
	s.total	**6 fichiers**	**45316**	**6**
PX 9	explorer	5 idem	5 idem	5
	s.total	**5 fichiers**		**5**
PX 12	pacific islander	6 idem	6 idem	6
	ronsard	rons9401	17416	1
		rons9402	1396	1
		rons9403	16209	1
		rons9404	6962	1
	s.total	**10 fichiers**	**41983**	**10**
PX 17	ronsard	4 idem	4 idem	4
	s.total	**4 fichiers**		**4**
PX 31	ronsard	4 idem	4 idem	4
	s.total	**4 fichiers**		**4**
PX 51	explorer	6 idem	6 idem	6
	atalante	atal9401	4156	1
	s.total	**7 fichiers**	**4156**	**7**
PX 53	pacific islander	6 idem	6 idem	6
	s.total	**6 fichiers**		**6**
ZONECO NC	atalante	atal9402	5692	
		atal9403	10276	
	alis	alis9401	1783	
		alis9402	1826	
		alis9403	3844	
		alis9404	3143	
		alis9405	1786	
		alis9406	4889	
		alis9408	2680	
	s.total	**9 fichiers**	**35919**	
IX 1	ronsard	4 idem		4
	s.total	**4 fichiers**		**4**
IX 10	ronsard	4 idem		4
	s.total	**4 fichiers**		**4**
AX 3	ronsard	4 idem		4
	s.total	**4 fichiers**		**4**
TOTAUX		**26 fichiers**	**190151**	**60**
		differents.	**données.**	**transects.**

Tableau 3 (page précédente) : récapitulatif par ligne et par navire des mesures de thermosalinographe effectuées en 1994 dans l'Océan Pacifique, Atlantique et Indien sous la responsabilité de l'ORSTOM.

			Nb.Lachers	Transmis
FNZP	RACINE		14	0
C6KF8	DELMAS SURCOUF	AX05	30	2
C6ML7	ILE DE LA REUNION	AX05	61	20
J8JA4	CARRYMAR	AX05	98	34
FNDH	LA PEROUSE	AX11	246	91
3EET4	EIFFEL	AX15	36	25
C6MJ4	RENEE DELMAS	AX15	51	35
C6ML7	ILE DE LA REUNION	AX15	22	8
FNDK	PATRICIA DELMAS	AX15	43	28
FNQM	SUZANNE DELMAS	AX15	23	13
FNWC	NATHALIE DELMAS	AX15	61	36
DIDA	ARIANA	AX20	286	126
J8JA4	CARRYMAR	AX20	122	59
P3LK3	SAINT GEORGES	AX20	47	23
3EET4	EIFFEL	AX26	14	11
FNXN	SAINT ROMAIN	AX26	72	52
FNXW	SAINT ROCH	AX26	34	24
J8JA4	CARRYMAR	AX29	52	34
FNOM	RENOIR	IX01	14	18
FNZQ	RIMBAUD	IX01	15	7
3EET4	EIFFEL	IX03	71	53
C6MJ4	RENEE DELMAS	IX03	186	63
FNDK	PATRICIA DELMAS	IX03	180	111
FNQM	SUZANNE DELMAS	IX03	139	73
FNWC	NATHALIE DELMAS	IX03	130	99
DIDA	ARIANA	IX10	31	14
FNJT	KORRIGAN	IX10	163	39
FNOM	RENOIR	IX10	47	30
FNPA	RONSARD	IX10	58	16
FNZP	RACINE	IX10	45	14
FNZQ	RIMBAUD	IX10	24	7
total			2415	1165
Rapport Transmis/Lachers				48,24%

Tableau 4 : récapitulatif par navire et par ligne des lâchers XBT effectués en 1994 dans l'Océan Atlantique et Indien, sous la responsabilité de l'ORSTOM.

FIGURE I

2931 bons tirs XBT - Annee 1994 -

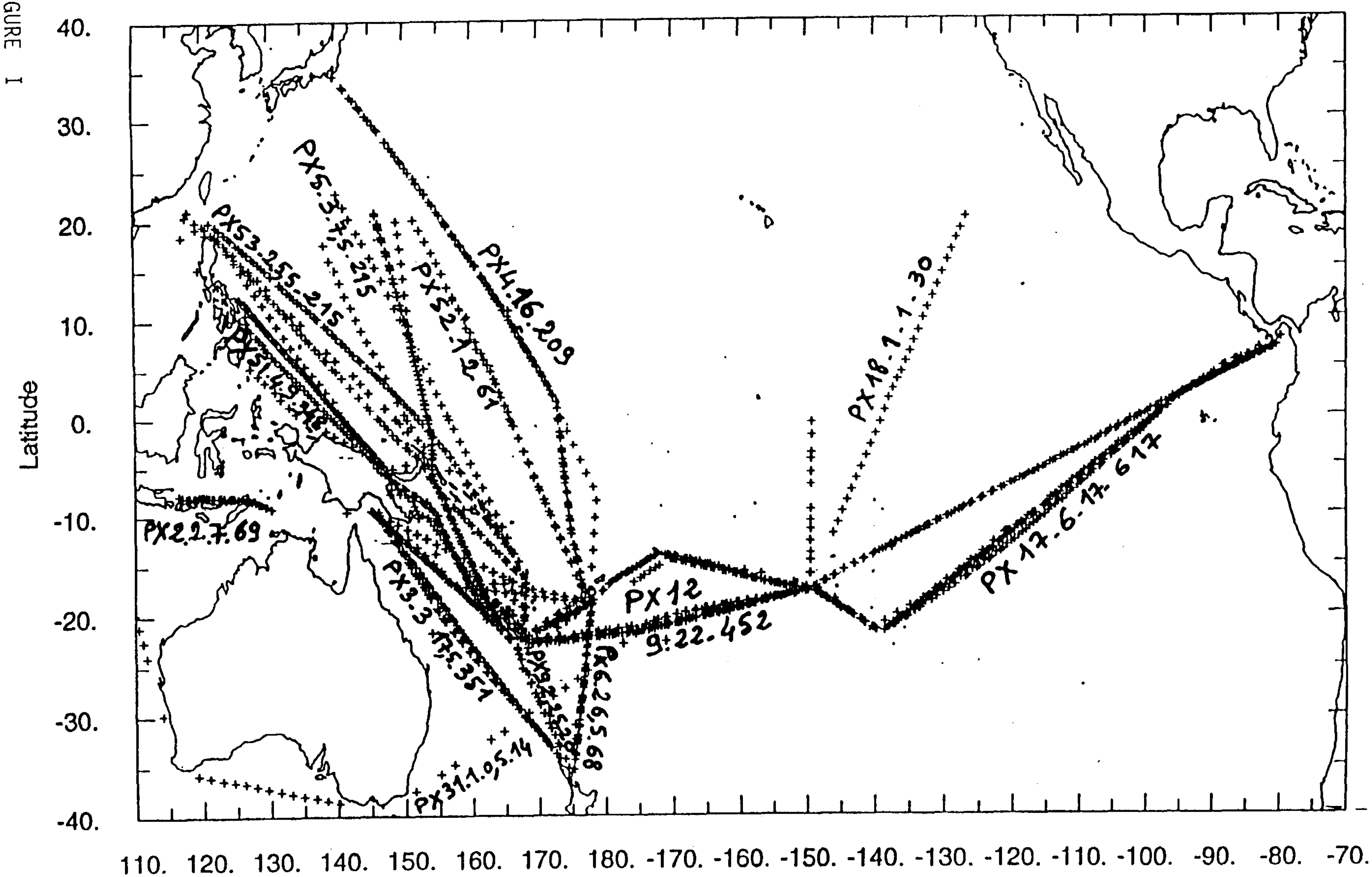


FIGURE II

Thermosalinographe - Annee 1994 -

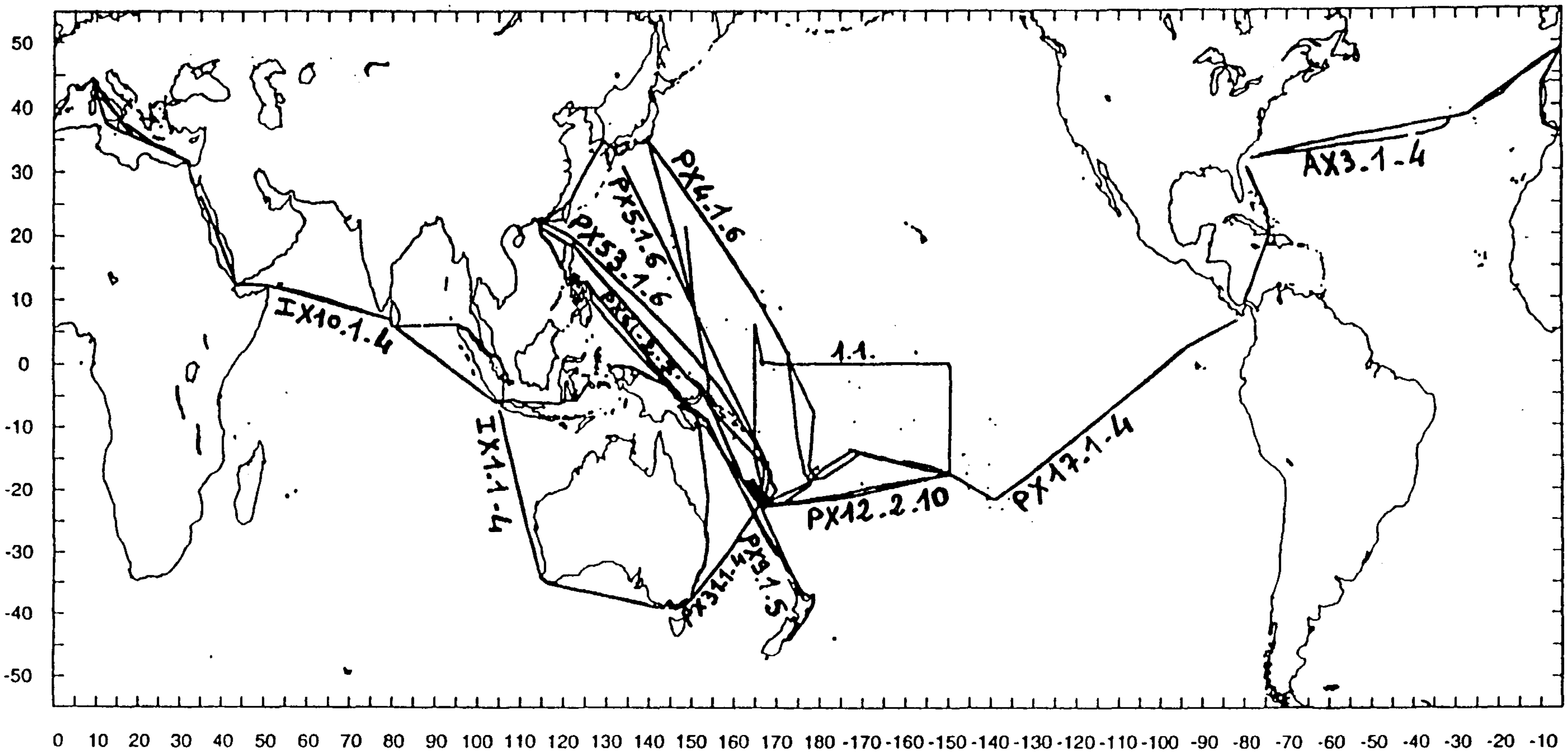


FIGURE III

SST/SSS NM : 1/94 à12/94 LONG 110./ 290. LAT -40./ 40. 1648 OBS

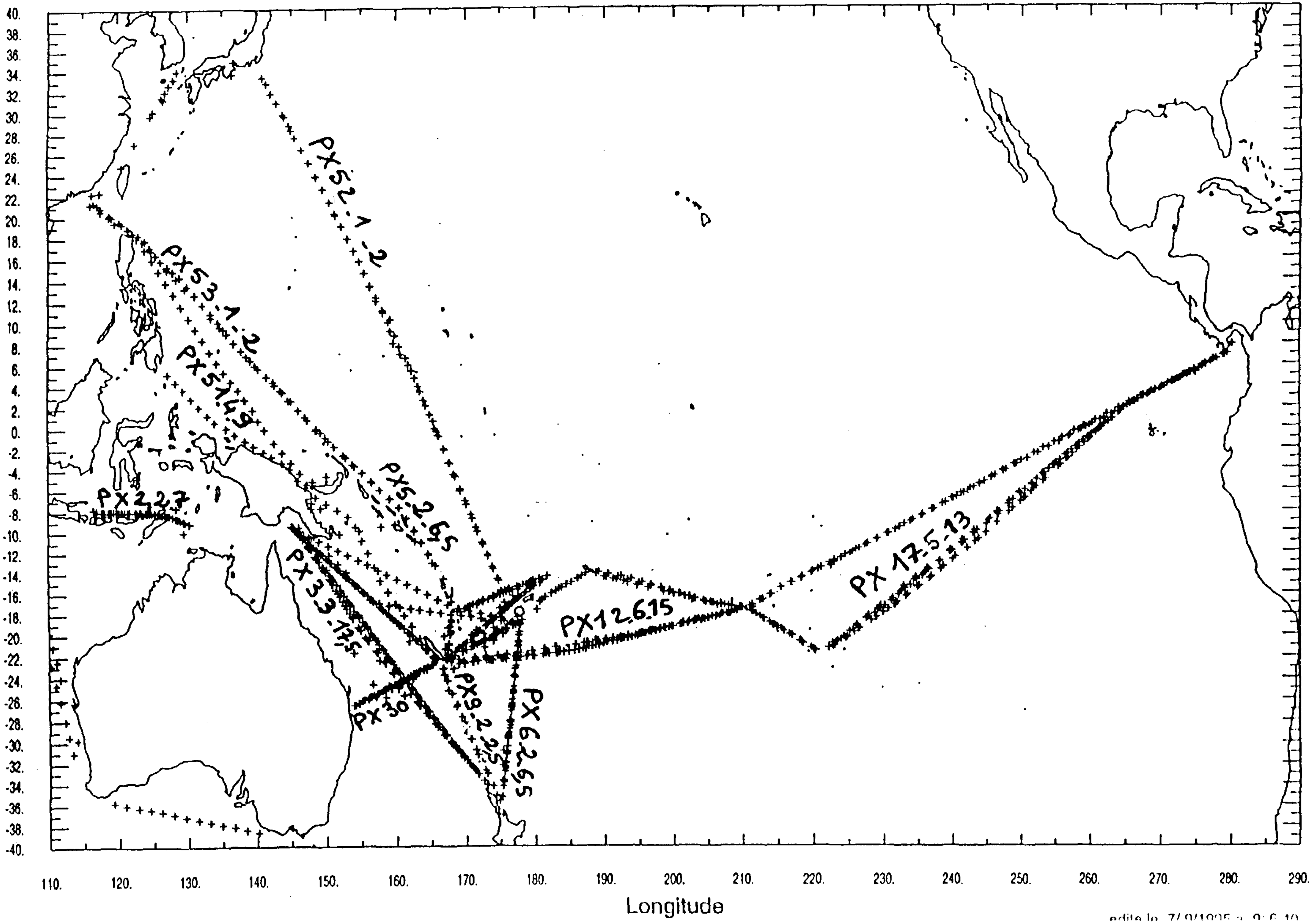
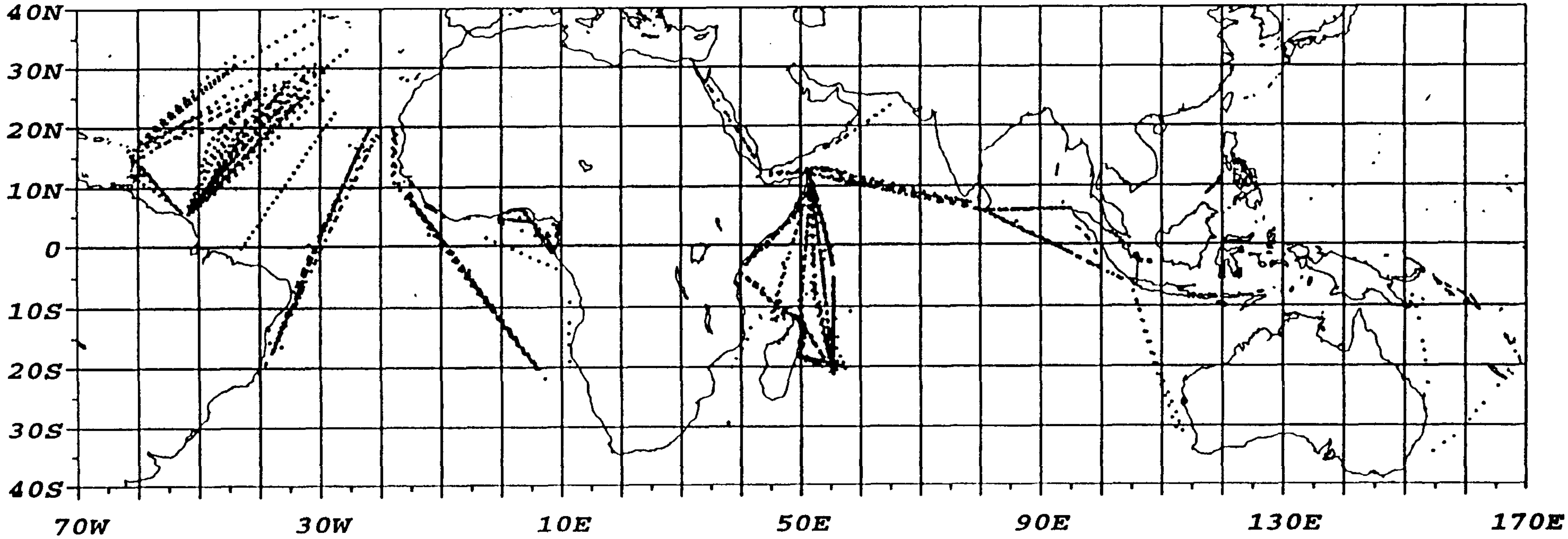


FIGURE IV



2415 observations

FIGURE V

METEO FRANCE

METEO-FRANCE/SMISO

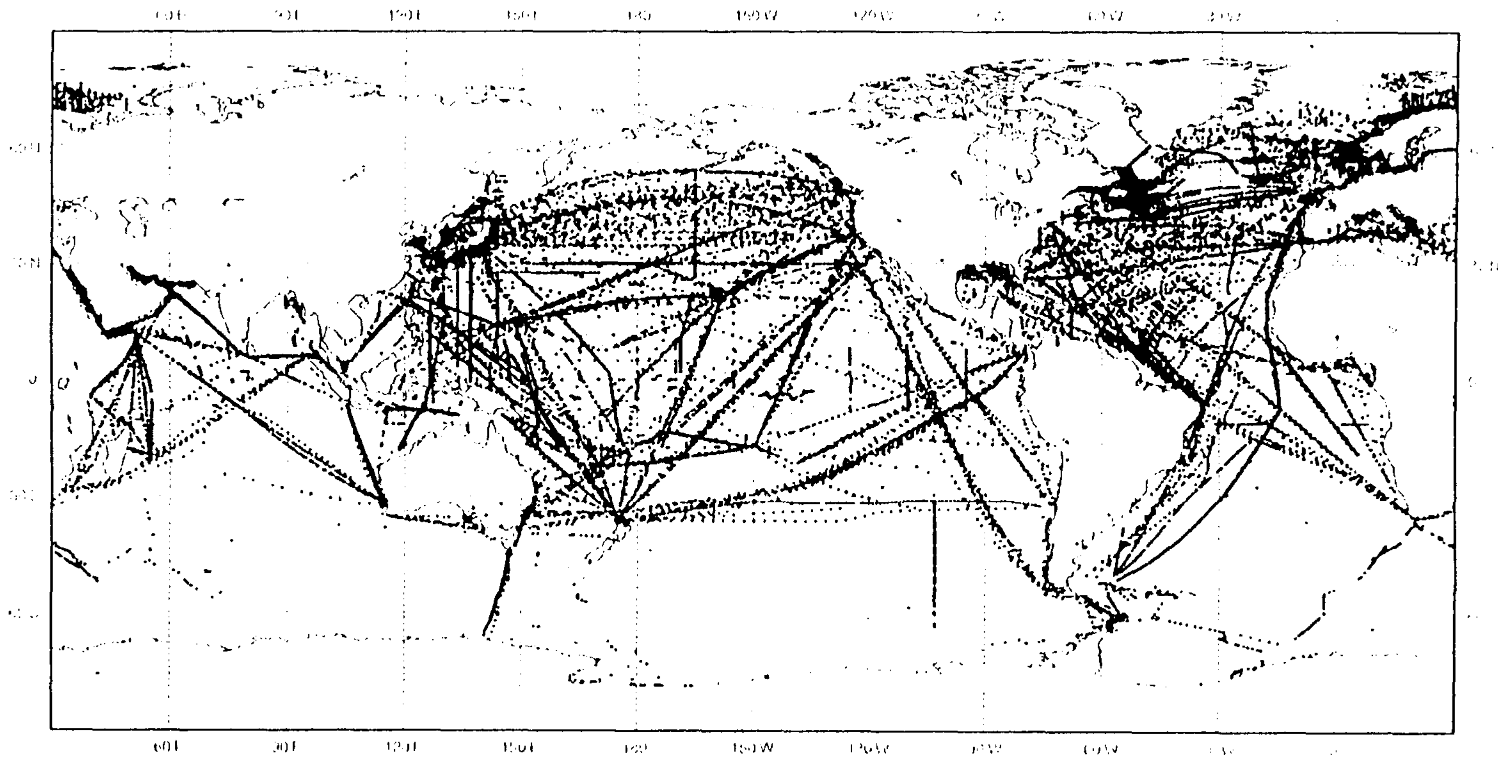
FRENCH MET OFFICE/IGOSS

Carte de pointage des observations recues en 1994

Mapping position plot chart of data received during 1994

Messages : BATHY+TESAC

Total : 58633



MAGICS 4.2 Solaris - ludjet - 13 September 1995 17:56:16

FIGURE VI

METEO FRANCE

METEO-FRANCE/SMISO

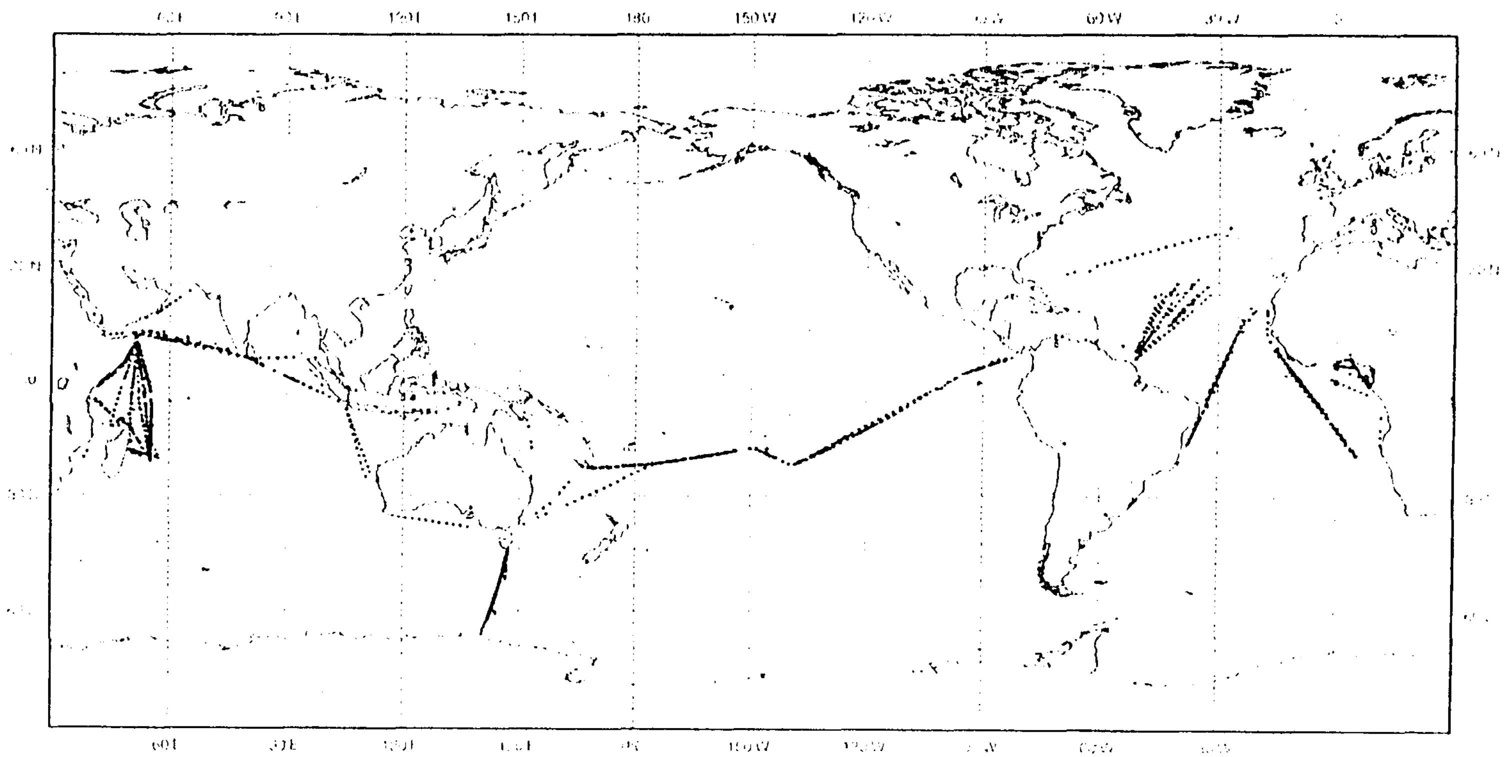
FRENCH MET OFFICE/IGOSS

Carte de pointage des observations francaises recues en 1994

Mapping position plot chart of french data received during 1994

Messages : BATHY

Total : 1517



MAGICS 4.2 Solaris - Iudjet - 13 September 1995 18:28:10

ATLANTIC AND INDIAN OCEANS*

During 1994, eight shipping lines have been sampled more or less regurlarly: six in the Atlantic and two in the Indian Ocean. There is a slight decrease relative to the previous years. Due to the scarcity of the probes and logistic difficulties, it was necessary to optimize, in time and space, the sampling along the shipping lines.

Consequently, we decided a decrease of the launches on the over-sampled lines (as IX03 and AX20) but the number of ships remained the same. Due to the uncertainties of the probe supply, the launching along AX20 and AX26 was even temporary interrupted for three months at the beginning of the year, but is again working now.

Sampling along AX15 is in progress relative to 1993. However, sampling along IX06 has been stopped due to the lack of shipping.

The success rate is 86%, in spite of frequent crew changes. This good results is due to a constant motivation from the manager. The data transmitted in real time continue to decrease, although most of the ships are equiped with an Argos system. It could be due to the inexperience of the crew or to a lack of reliability of the transmissions.

---

*Report prepared by A. Dessier, Brest TOGA Centre (ORSTOM)

XBT sampling planned in 1995/96
4 launchs/day

<u>Indian Ocean</u>

IX03 only direct line La Reunion-Red Sea
Two tracks/month
432 probes/year
four ships

IX10 no XBT, only SSS

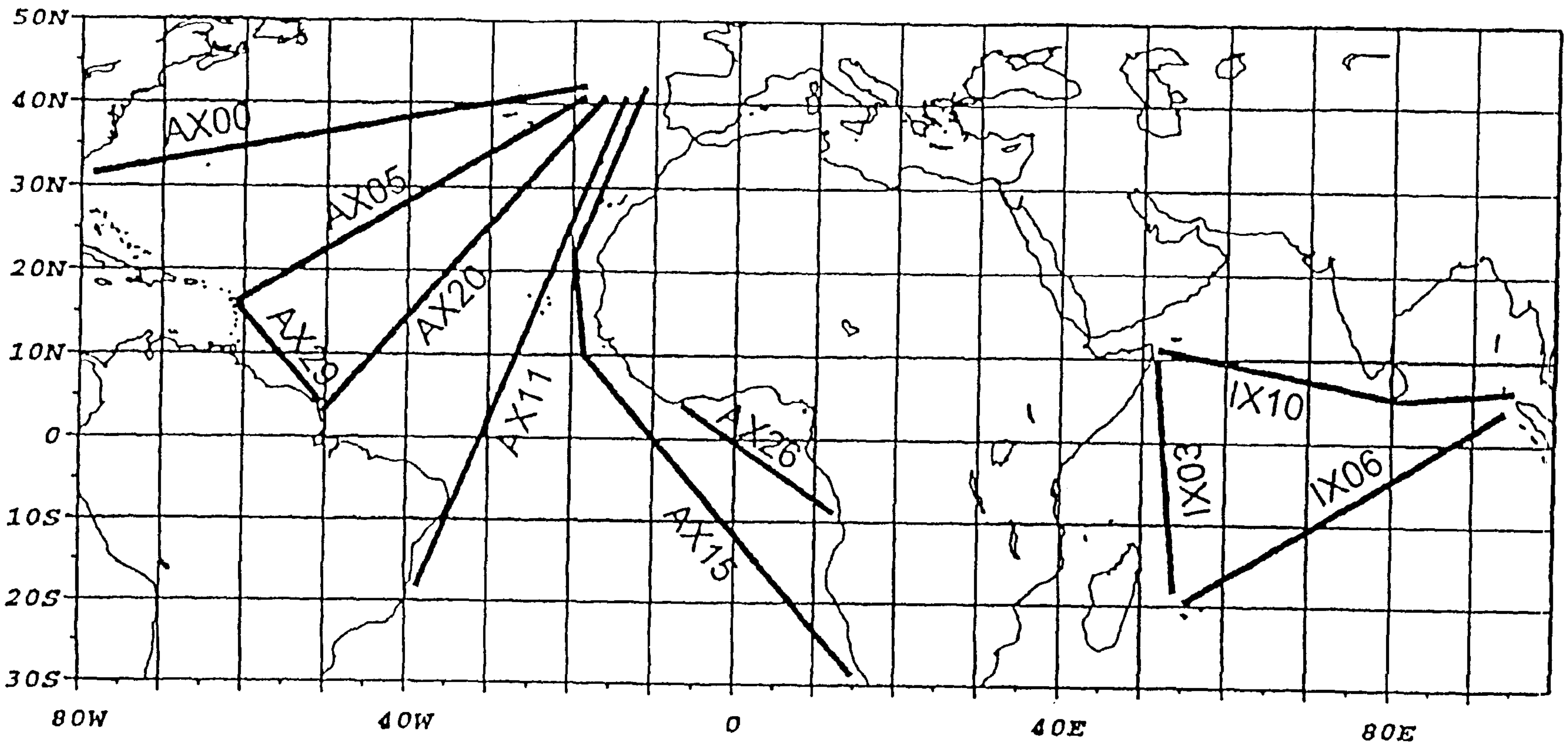
IX06 nothing

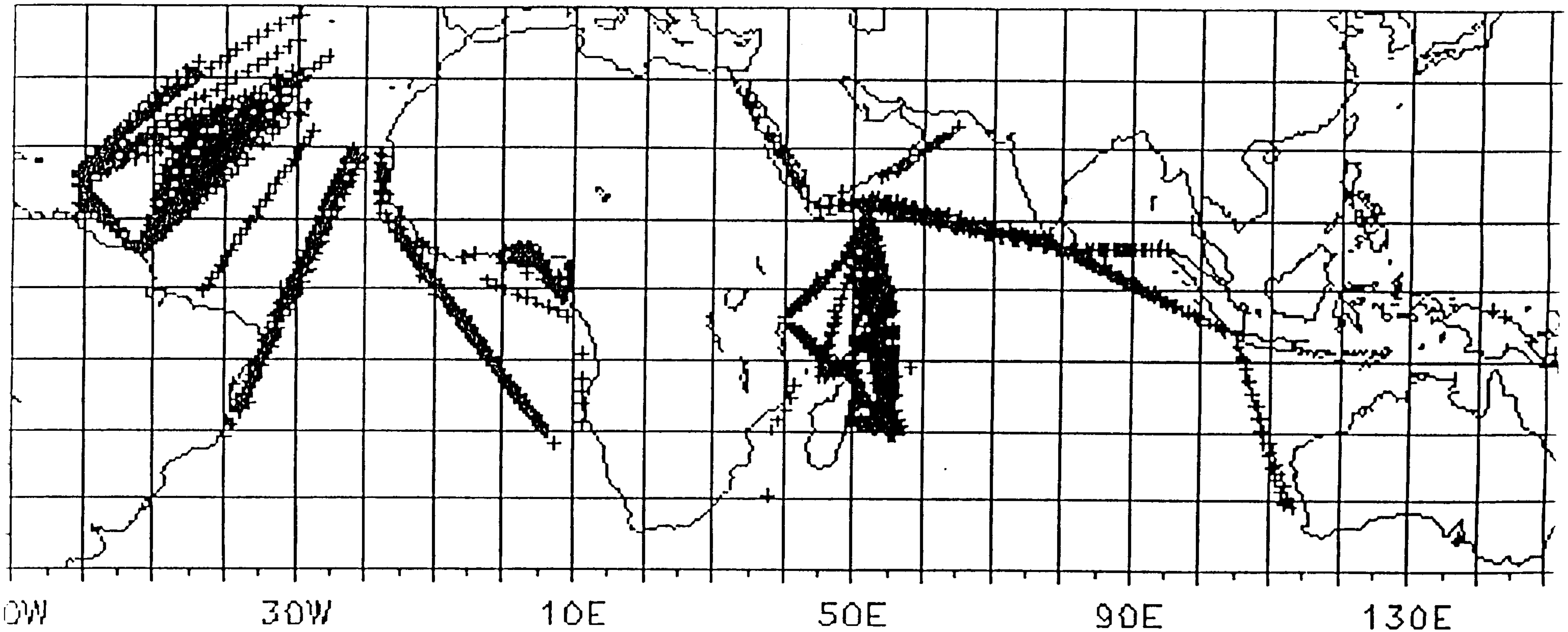
<u>Atlantic Ocean</u>

AX05 40°N - West Indies
one track/month
312 probes/year
one ship

AX20 40°N - French Guyana
Two tracks/month
936 probes/year
two ships

AX11 Europe-Brasil (20°N-20°S)
one track/month
288 probes/year
one ship


50N
40N
30N
20N
10N
0
10S
20S
30S
80W
40W
0
40E
80E
AX00
AX05
AX20
AX11
AX15
AX26
IX10
IX03
IX06



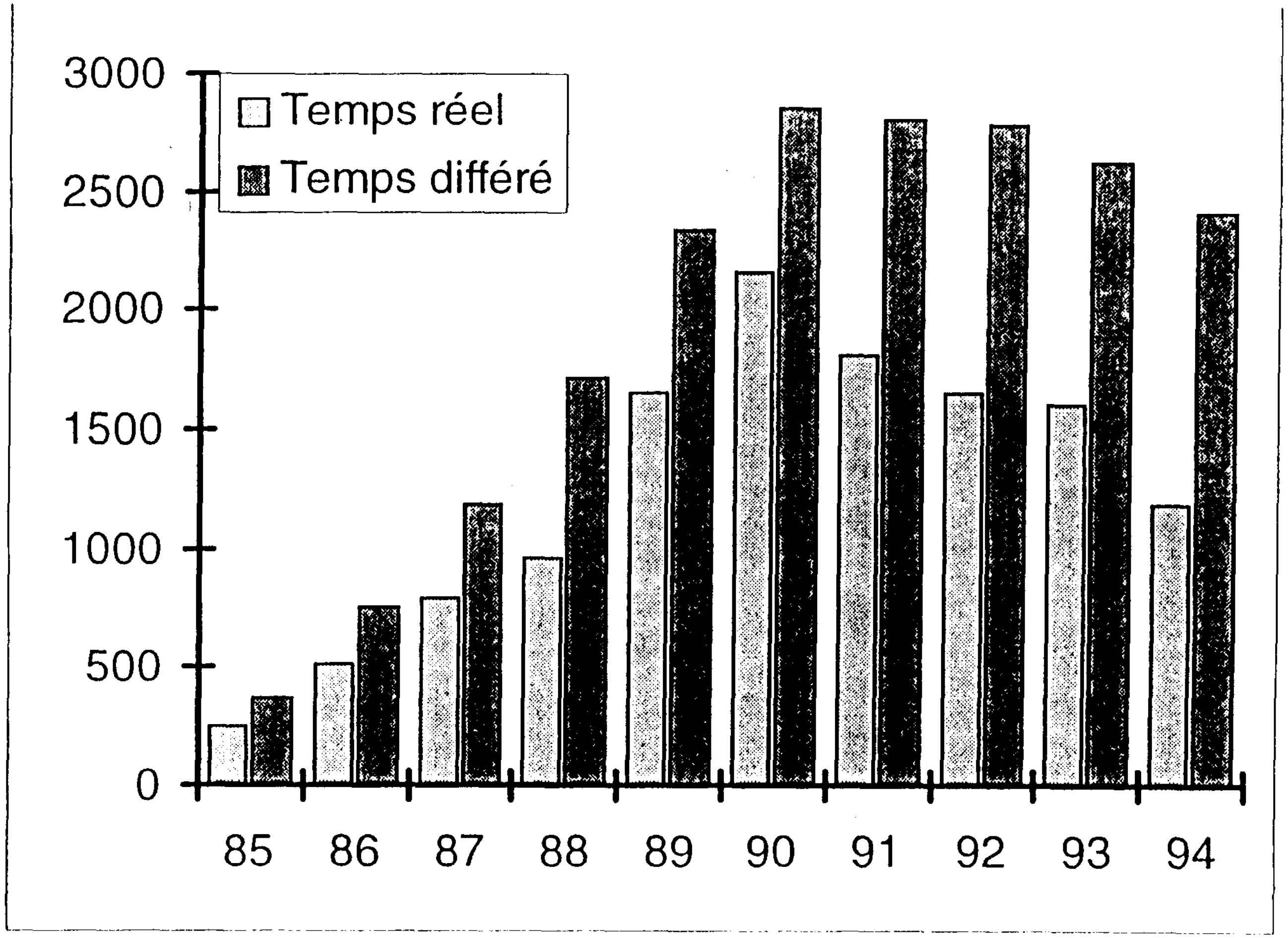
Répartition géographique des lancers XBT en 1994

Ligne TOGA	Total 1991	Total 1992	Total 1993	Total 1994
IX03	394	564	877	706
IX10	246	222	240	365
IX06	102	71	201	
AX11	660	671	270	246
AX20	239	301	539	450
AX15	480	320	100	236
AX26	233	273	191	120
AX05	339	279	372	189
AX29				57
AX00			12	

Récapitulatif par ligne TOGA des lancers XBT en 1994

Code radio	Navire	Total
3EET4	Eiffel	121
C6MJ4 (FNQC)	Renée Delmas	237
C6ML7	Ile de La Réunion	83
DIDA	Ariana	317
FNCZ (C6KF8)	Delmas Surcouf	30
FNDH	La Pérouse	246
FNDK	Patricia Delmas	223
FNJT	Korrigan	163
FNOM	Renoir	61
FNPA	Ronsard	58
FNQM	Suzanne Delmas	162
FNWC	Nathalie Delmas	191
FNXN	Saint Romain	72
FNXW	Saint Roch	34
FNZP	Racine	59
FNZQ	Rimbaud	39
J8JA4	Carrymar	272
P3LK3	Saint Georges	47

Récapitulatif par navire



Evolution du nombre totale d'observations sur les réseaux ORSTOM Atlantique et Océan Indien.

LIGNES94.XLS

	BILAN DES TIRS XBT PAR LIGNE POUR 1994.			
LIGNE	NAVIRE	BONS TIRS	BATHYS	TRANSECTS
PX 2	challenger	8	8	1
	challenger	8	8	1
	challenger	7	7	1
	challenger	5	5	1
	rimbaud	8	8	0.5
	challenger	2	2	0.5
	challenger	7	7	0.5
	challenger	17	17	1
	challenger	7	7	0.5
	Totaux	**69**	**69**	**7**
PX 3	challenger	14	14	1
	challenger	11	11	1
	crusader	26	26	1
	crusader	25	24	1
	challenger	9	9	1
	challenger	11	11	1
	crusader	21	22	1
	challenger	12	12	1
	crusader	12	12	0.5
	racine	3	3	1
	crusader	7	7	0.5
	challenger	14	14	0.5
	crusader	8	8	0.5
	challenger	16	16	0.5
	crusader	31	31	1.5
	challenger	15	15	0.5
	crusader	25	25	0.5
	crusader	16	16	0.5
	crusader	21	20	0.5
	challenger	19	19	1
	crusader	14	14	0.5
	challenger	21	21	1
	Totaux	**351**	**350**	**17.5**
PX 4	pacific islander	23	25	1
	pacific islander	26	26	1
	pacific islander	45	45	1
	pacific islander	43	45	1
	pacific islander	7	7	0.5
	pacific islander	35	35	0.5
	pacific islander	30	30	1
	Totaux	**209**	**213**	**6**
PX 5	explorer	32	32	1
	explorer	30	31	1
	clydebank	5	5	0.5
	explorer	32	33	1
	explorer	31	32	1
	explorer	30	30	1
	explorer	25	25	1
	pacific islander	30	30	1
	Totaux	**215**	**218**	**7.5**

LIGNES94.XLS

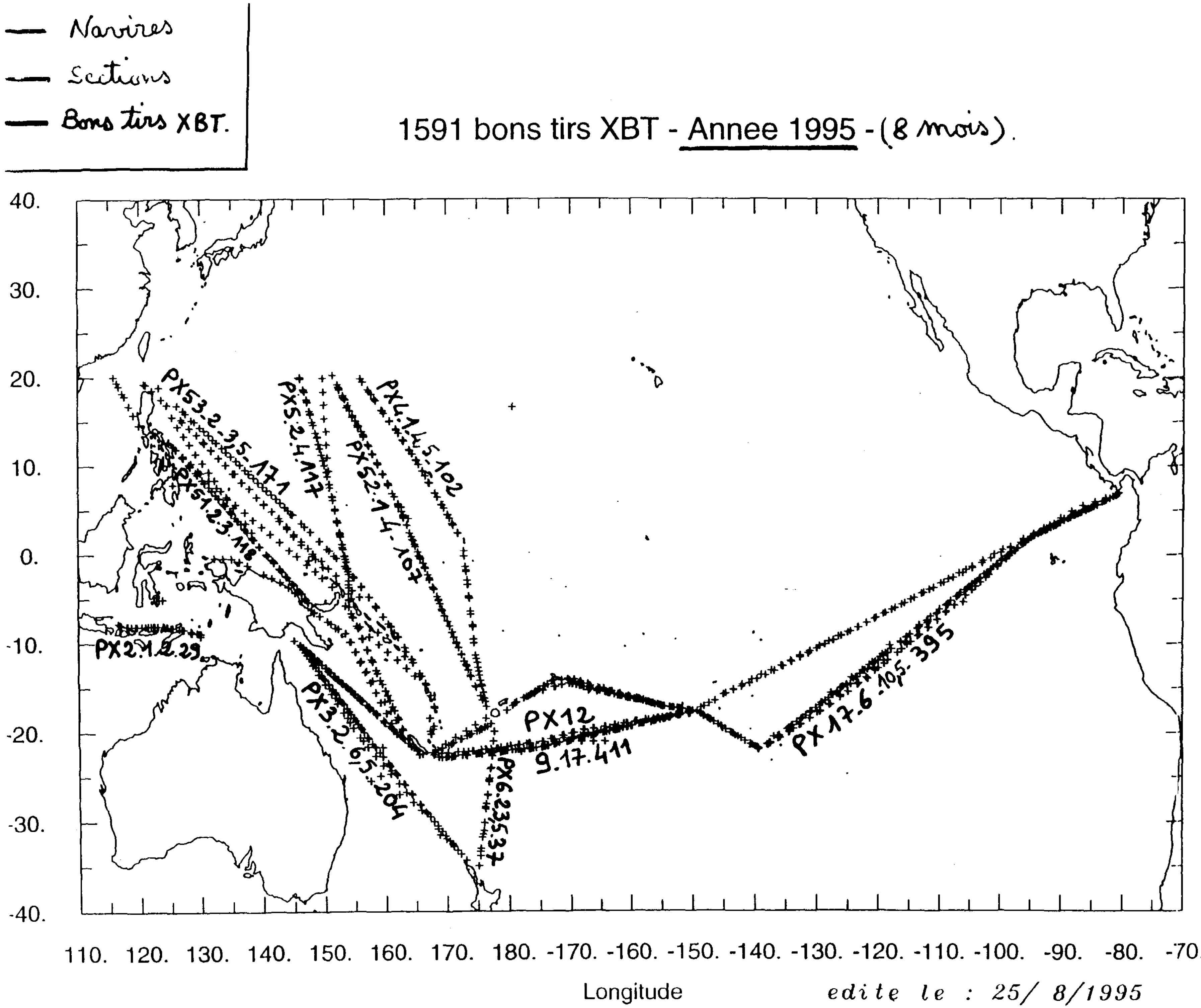
PX 6	crusader	12	12	1
	challenger	4	4	0.5
	crusader	10	11	1
	challenger	11	11	1
	crusader	11	11	1
	crusader	10	9	1
	challenger	10	10	1
	Totaux	**68**	**68**	**6.5**
PX 9	crusader	10	10	1
	explorer	2	2	0.5
	crusader	8	8	1
	Totaux	**20**	**20**	**2.5**
PX 12	racine	15	16	1
	ronsard	7	7	0.5
	ronsard	11	11	0.5
	pacific islander	36	37	1.5
	challenger	3	3	0.5
	pacific islander	5	5	0.5
	renoir	7	7	0.5
	rimbaud	17	17	1
	clydebank	6	6	0.5
	pacific islander	13	13	0.5
	ronsard	24	22	1
	forthbank	23	23	1
	pacific islander	37	38	1.5
	pacific islander	2	2	0.5
	rimbaud	16	16	1
	racine	30	30	1
	ronsard	14	14	0.5
	crusader	7	7	0.5
	forthbank	12	12	0.5
	forthbank	7	8	0.5
	coral islander	9	9	0.5
	renoir	11	11	0.5
	pacific islander	26	26	0.5
	rimbaud	20	20	1
	crusader	6	5	0.5
	racine	19	19	1
	coral islander	26	26	1
	clydebank	17	17	0.5
	clydebank	6	6	0.5
	ronsard	20	20	1
	Totaux	**452**	**453**	**22**
PX 13	pacific islander	**21**	**21**	**1.5**
PX 17	racine	13	12	0.5
	ronsard	42	41	1
	renoir	30	30	1
	rimbaud	38	38	1
	racine	22	22	1
	ronsard	32	30	0.5
	forthbank	8	8	0.5
	ronsard	6	6	0.5

LIGNES94.XLS

	forthbank	37	37 0.5	
	clydebank	17	17 0.5	
	clydebank	18	19 0.5	
	rimbaud	38	38	1
	racine	15	16 0.5	
	ronsard	41	42	1
	forthbank	48	48	1
	renoir	33	33	1
	rimbaud	36	36	1
	racine	5	5 0.5	
	racine	30	29 0.5	
	clydebank	48	48	1
	ronsard	24	24 0.5	
	ronsard	5	5 0.5	
	renoir	31	31	1
	Totaux	**617**	**615**	**17**
PX 18	kochnev	**30**	**30**	**1**
PX 30	crusader	5	5 0.5	
	crusader	4	4 0.5	
	Totaux	**9**	**9**	**1**
PX 31	renoir	**14**	**14 0.5**	
PX 51	explorer	34	34	1
	explorer	37	37	1
	clydebank	20	20	1
	explorer	34	34	1
	atalante	78	78	1
	coral islander	39	39	1
	explorer	39	39	1
	explorer	34	34	1
	explorer	33	33	1
	Totaux	**348**	**348**	**9**
PX 52	coral islander	32	32	1
	coral islander	29	29	1
	Totaux	**61**	**61**	**2**
PX 53	pacific islander	41	41	1
	pacific islander	39	40	1
	pacific islander	36	36	1
	pacific islander	34	35	1
	pacific islander	35	35 0.5	
	coral islander	30	30	1
	Totaux	**215**	**217 5.5**	
IX 1	rimbaud	**14**	**14**	**1**
IX10	racine	8	7	1
	forthbank	30	30	1
	Totaux	**38**	**37**	**2**
IX 31	rimbaud	**13**	**13**	**1**
ZONECO NC	atalante	**51**	**43**	**1**

	BILAN DES TIRS XBT PAR LIGNE POUR 1995.			
LIGNE	**NAVIRE**	**BONS TIRS**	**BATHYS**	**TRANSECTS**
PX 2	challenger	9	9	1
	challenger	10	10	0.5
	challenger	10	10	0.5
	Totaux	**29**	**29**	**2**
PX 3	challenger	13	13	1
	crusader	22	22	0.5
	crusader	14	14	0.5
	challenger	16	16	0.5
	challenger	12	12	0.5
	crusader	36	36	0.5
	crusader	11	11	0.5
	crusader	15	15	0.5
	challenger	10	10	0.5
	challenger	16	16	0.5
	crusader	21	21	0.5
	crusader	17	17	0.5
	Totaux	**204**	**203**	**6.5**
PX 4	pacific islander	3	3	0.5
	pacific islander	24	24	1
	pacific islander	26	26	1
	pacific islander	23	23	1
	pacific islander	26	26	1
	Totaux	**102**	**102**	**4.5**
PX 5	explorer	34	34	1
	explorer	32	32	1
	pacific islander	10	10	0.5
	explorer	19	19	0.5
	explorer	4	4	0.5
	explorer	18	18	0.5
	Totaux	**117**	**117**	**4**
PX 6	crusader	10	10	1
	challenger	9	9	1
	crusader	11	11	1
	crusader	7	7	0.5
	Totaux	**37**	**37**	**3.5**
PX 12	renoir	18	18	1
	pacific islander	27	27	1
	coral islander	32	32	1
	rimbaud	9	9	0.5
	racine	18	18	1
	pacific islander	18	18	0.5
	forthbank	20	20	0.5
	pacific islander	20	20	0.5
	forthbank	6	6	0.5
	ronsard	20	20	1
	coral islander	41	41	1
	renoir	11	11	0.5
	renoir	8	8	0.5

	clydebank	15	15	0.5	
	pacific islander	15	15	0.5	
	rimbaud	4	4	0.5	
	rimbaud	8	8	0.5	
	racine	19	19		1
	challenger	6	6	0.5	
	ronsard	5	5	0.5	
	pacific islander	16	16	0.5	
	pacific islander	3	3	0.5	
	coral islander	25	25	0.5	
	rimbaud	9	9	0.5	
	racine	12	12		1
	pacific islander	26	26	0.5	
	Totaux	**411**	**411**		**17**
PX 17	rimbaud	20	20	0.5	
	racine	37	37		1
	forthbank	44	44		1
	ronsard	24	24	0.5	
	ronsard	15	15	0.5	
	renoir	35	34		1
	clydebank	24	24	0.5	
	clydebank	22	22	0.5	
	rimbaud	41	41		1
	ronsard	19	19		1
	racine	41	41		1
	ronsard	9	9	0.5	
	rimbaud	35	35	0.5	
	racine	29	29		1
	Totaux	**395**	**394**	**10.5**	
PX 30	crusader	7	7	0.5	
	renoir	5	3	0.5	
	Totaux	**12**	**10**		**1**
PX 31	crusader	8	8	0.5	
	crusader	7	7	0.5	
	Totaux	**15**	**15**		**1**
PX 51	explorer	38	38		1
	explorer	25	25	0.5	
	explorer	21	21	0.5	
	coral islander	34	34		1
	Totaux	**118**	**118**		**3**
PX 52	coral islander	23	23		1
	coral islander	25	25		1
	coral islander	28	28		1
	coral islander	31	31		1
	Totaux	**107**	**107**		**4**
PX 53	pacific islander	34	34	0.5	
	coral islander	34	25		1
	pacific islander	21	21	0.5	
	coral islander	31	31	0.5	
	pacific islander	26	26	0.5	
	pacific islander	25	25	0.5	
	Totaux	**171**	**162**	**3.5**	


Navires
Sections
Bons tirs XBT.
1591 bons tirs XBT - Annee 1995 - (8 mois).
40.
30.
20.
10.
0.
-10.
-20.
-30.
-40.
PX53.2.35.171
PX5.2.4.117
PX52.7.4.107
PX4.14.5.102
PX51.2.3.118
PX2.1.2.29
PX3.2.65.204
PX12
9.17.411
PX6.2.35.37
PX17.6.105.395
110. 120. 130. 140. 150. 160. 170. 180. -170. -160. -150. -140. -130. -120. -110. -100. -90. -80. -70.
Longitude
edite le : 25/ 8/1995

GERMANY

A. Sy (BSH)

Overview

German ship-of-opportunity programme (SOOP) activities are virtually unchanged from those reported at SOOP-V meeting held in Hobart, Australia (IOC, 1993). They are focussed on the Atlantic Ocean, with several German institutions involved. The "Institut für Meereskunde", Kiel (IfM Kiel), and the "Bundesamt für Seeschiffahrt und Hydrographie", Hamburg (BSH), each operate two lines as the German contribution to WOCE (AX-3, 11, 17, 18). They should be operational at least until the end of 1996. In addition, several research vessels, e.g. "Meteor", "Gauss", "Polarstern", and "Walther Herwig III", carry out XBT measurements while en route. Most of these SOOP activities are PI-driven, and thus motivations and mechanisms for the observatons are research-based rather than being an application-based official German contribution to IGOSS. Technical and organizational information about these lines is summarized in the attached Table. Almost all real-time SOOP data are inserted into GTS by the BSH with a delay of about 3 days to 1 week. Finally, and in addition to these data acquisition activities, real-time data from various oceans have been contributed to IGOSS by the German Navy since 1993.

Ship-of-opportunity network

In the framework of her fishstock surveys for the North Atlantic Fisheries Organisation (NAFO), measurements along line AX-1/2 are carried out by R.V. "Walter Herwig III" operated by "Bundesforschungsanstalt für Fischerei", Hamburg (BFAFI). This line was not set up officially by BFAFI, but the suggestion to drop occasionally XBTs along the vessel's route to and from Greenland once or twice a year was accepted. R.V. "Walter Herwig III" is equipped with a MK-12 SEAS III unit for data acquisition and transmission. Real-time and delayed mode data are processed by BSH. These measurements probably will be continued for the next years (M. Stein, pers. comm.).

Line AX-3 has been operated by BSH as a high density line without serious problems since 1988. The sampling strategy for this line is designed to meet both WOCE requirements and the PI's own scientific objectives. The programme is funded by the German Ministry of Education, Science, Research and Technology (BMBF) until 1997. The scientific rationale is described in IOC (1993).

From the start of the programme in 1988, measurements have been carried out regularly by the German container vessel "Köln Express" and have been supplemented irregularly by the research vessels "Professor Multanovsky", "Gauss" and "Meteor". A MK-12 SEAS-III unit and NOAA's software is used for data acquisition and transmission. So far, the line has been kept operational almost without interruption. As of September 1995, 86 sections have been collected, most of which have a resolution of better than 40 nautical miles (Fig. 1). For this line, "Fast Deep" probes are now used as a standard. These modified T-5 probes are capable of covering the upper 1200 m at a ship's speed of 20 knots. An example of a section is shown in Fig. 2.

While temperature measurements with adequate temporal and spatial resolution can give an idea about space and time scales, XBTs alone do not satisfactorily meet the requirements for the investigation of heat flux or other important processes. XCTD probes were therefore used as soon as they became available. Up to now 4 sections with XCTD measurements have been carried out along line AX-3. Whereas first XCTD versus CTD comparisons showed that XCTD probes needed further design developments by the manufacturer (Sy, 1993), the last field test in the North Atlantic in December 1994 showed promising results (for details see Annex: Sy, 1995).

As the first German SOOP contribution to IGOSS, line AX-11 was established in 1981 by DHI (now BSH). It has been kept operational until today without major interruptions. At present no problems are recognizable which could jeopardize continuation of this programme. Both data acquisition system and data management are the same as for line AX-3. For this programme, "Deep Blue" (T-7) probes are used as a standard. The measurements were carried out by the German container vessel "Monte Rosa" on her way due north without any serious problems. An example of a section is given in Fig. 3.

Lines AX-17/18 were set up by "Institut für Meereskunde", Kiel (IfM Kiel), as part of WOCE in 1989. The scientific objective is to investigate the heat storage variability in the upper ocean and the eddy activity of the Subtropical Gyre. Funding by the German Ministry of Education, Science, Research and Technology (BMBF) will not be continued in 1996.

The operation of these lines proved difficult due to long service distances between Germany and South Africa and due to the lack of regular and long-term shipping services between South Africa and South America (R. Onken, pers. comm.). After two years of successful operation, the programme was interrupted for the first time at the end of 1991. It was taken up again a year later, but only for one additional year. Finally, IfM Kiel was able to reactivate their programme at the beginning of 1995. Since then, on a more or less regular basis, measurements have been carried out by two Taiwanese vessels, "Excellence Container" and "Prosperity Container". As in the past, "Fast Deep" (T-5) probes are used. Both vessels are equipped with a Nautilus Marine Service data acquisition system designed for real-time data transmission via METEOSAT. An example of an AX-18 section is given in Fig. 4.

Efforts have been continued to collect data from the Southern Ocean. R.V. "Polarstern" from "Alfred-Wegener-Institut", Bremerhaven (AWI), is equipped with a Nautilus Marine Service system for routine XBT measurements and real-time data transmission and has used Sparton probes. During the 1994/1995 Antarctic research season, she transmitted BATHY messages along her way to and from Antarctica (AX-12 and AX-22/25). However, because of financial shortages in their budget and a not very convincing scientific rationale for XBT drops outside the Antarctic region, "Polarstern" will not continue her measurements along line AX-12. Similar arguments and low accuracy and reliability of XBT measurements in cold waters will also lead to a drastic reduction of XBT drops during her field work in the Southern Ocean. From areas south of the Polar Front, AWI scientists report a high failure rate of XBT drops (occasionally up to 50 %) and data quality problems (non-systematic temperature shifts towards higher temperatures) occurring randomly at low temperatures (E. Fahrbach, pers. comm.).

Further activities

Remarkable additional XBT real-time data contributions in 1994 came from the South Atlantic and the North Atlantic from R.V. "Meteor", R.V. "Poseidon" and R.V. "Walter Herwig III" and from various ocean areas from the German Navy. After the Navy's decision to declassify their data 14 days after having been collected, the number of German BATHY reports doubled. A regional overview of all BATHY messages submitted to GTS by BSH in 1994 is given in Fig. 5.

To comply with the IGOSS request for more TESAC messages, we have continued to convert the CTD bottle readings into TESAC code for transmittion from ship to BSH by e-mail. However, this procedure is used only for WOCE cruises because of the higher data quality standards of WOCE CTDs.

The SST programme of BSH, which was established in 1987, has been continued. Data are collected by both governmental and merchant vessels. The latter are equipped with Pt100 contact thermometers (Sy and Ulrich, 1990). All SST data received at BSH are inserted into GTS as TRACKOB reports (Fig. 6). Finally, temperature data from selected stations of the BSH's stationary automatic network in German coastal waters in the North Sea and Baltic Sea are inserted into GTS as BATHY coded messages.

GTS data exchange and non-operational XBT data processing

For more than 20 years, BSH has participated actively in IGOSS and acts as the German input and output GTS hub for real-time oceanographic bulletins. Fig. 7 shows that the contribution to the IGOSS real-time data flow has been relatively continuous during this period of time. We hope to contribute in the same way in the future. Trackplots of the output for BATHY and TESAC messages in 1994 are given in Fig. 8 and Fig. 9 respectively.

Quality control (QC) of real-time data prior to insertion into the GTS is carried out manually at BSH for most SOOP data but not for Navy data. The QC consists of checks of the position of the vessel by means of track plots and by visual inspection of profiles on the computer screen. If necessary, erroneous data are corrected or rejected by interactive screen editing.

Our main focus is delayed mode XBT data from BSH research programmes or SOOP in the North Atlantic. Processing and careful quality control are closely supervised by the PI of the programme. The routines are similar to those used for CTD/XCTD data processing. A flow diagram of non-operational XBT data processing is shown in Fig. 10 which is representative of the bulk of the data. For some single profiles of particularly poor quality, the processing may differ under certain circumstances. However, QC also consists of regular ship visits to check the equipment carefully and to provide captains and mates with continual feedback. Intensive communication between researcher and observer pays in terms of improved data quality.

References

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Sy, A. und J. Ulrich (1990): North Atlantic Ship of Opportunity XBT Programme, 1989 - Data Report. Wiss.-Techn. Berichte aus dem Deutschen Hydrographischen Institut, 1990-2, 89 pp.

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

Sy, A. (1995): Modified MK-12/XCTD System finally passes the Field Test in the North Atlantic. In: Sixth Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes, Ottawa, Canada, 16-20 October 1995. IOC Meeting Report.

Table 1: Status of existing SOOP lines operated by German institutions

	Europe-Greenland	Europe-Halif./N.Y.	Europe-Brazil	Europe-Antarc.	S.America-Cape Town		Cape Town-Antarctica
TWI #	AX-1/2	AX-3	AX-11	AX-12	AX-17	AX-18	AX-22/25
Ship	"Walther Herwig"	"Köln Express"	"Monte Rosa"	"Polar-stern"	"Prosperity Container" "Excellence Container"		"Polar-stern"
Callsign	DBFR	DAKE	DGLM	DBLK	BMAD BMAE	BMAD BMAE	DBLK
Start	11/1989	5/1988	1981	1991	5/1989	9/1989	
Finish	open	1997 ?	open	terminated	1996	1996	1997 ?
Frequency	2/yr	8/yr	7/yr	1/yr	6/yr	6/yr	2/yr
Density	6/d	12/d	6/d	6/d	6/d	6/d	6/d
Probes	T-7	T-5(FastDeep) XCTD (1/yr)	T-7	XBT-7	T-5(F.D.)	T-5(F.D.)	XBT-7
Equipment	SEAS III MK-12	SEAS III MK-12	SEAS III MK-12	Nautilus PC, DCP	Nautilus PC, DCP	Nautilus PC, DCP	Nautilus PC, DCP
Real-time	METEOSAT	METEOSAT	METEOSAT	METEOSAT	METEOSAT	METEOSAT	METEOSAT
Agency	BFAFI Hamburg	BSH Hamburg	BSH Hamburg	AWI Bremerhaven	IfM Kiel	IfM Kiel	AWI Bremerh.
Programme	Fisheries	WOCE	IGOSS/WOCE	WOCE/AWI	WOCE	WOCE	AWI
PI	M.Stein	A.Sy	A.Sy	E.Fahrbach	G.Siedler	G.Siedler	E.Fahrb.
1-12/1994:							
Sections	3	8	7	1	-	-	3
Profiles	71	384	350	?	-	-	?
GTS	55	359	339	68			143
1-06/1995:							
Sections	-	4	4	-	1	3	1
Profiles	-	225	205	-	35	136	?
GTS	-	188	205	-	-	79	76
Problems:	-	-	-	Funding, Scientific Rationale	Shipping Lines, Funding, Logistics		Data Qual Costs vs. Benefit

In addition, several research vessels will carry out XBT/XCTD measurements irregularly while en route, e.g.

R.V. "Meteor"	DBBH
R.V. "Walther Herwig III	DBFR
R.V. "Gauss"	DBBX
R.V. "Valdivia"	DESI
R.V. "Poseidon"	DBKV
R.V. "Polarstern"	DBKL

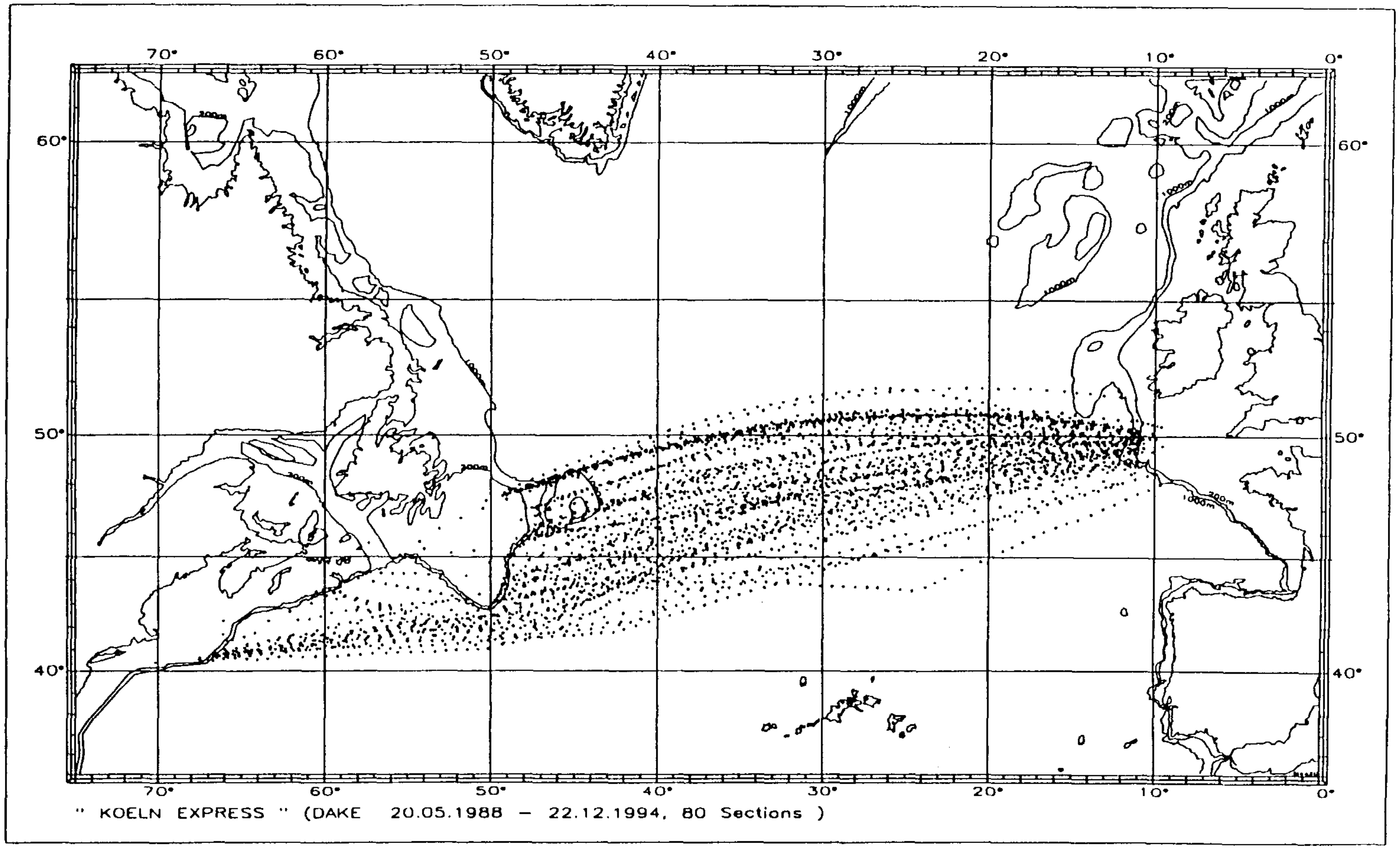
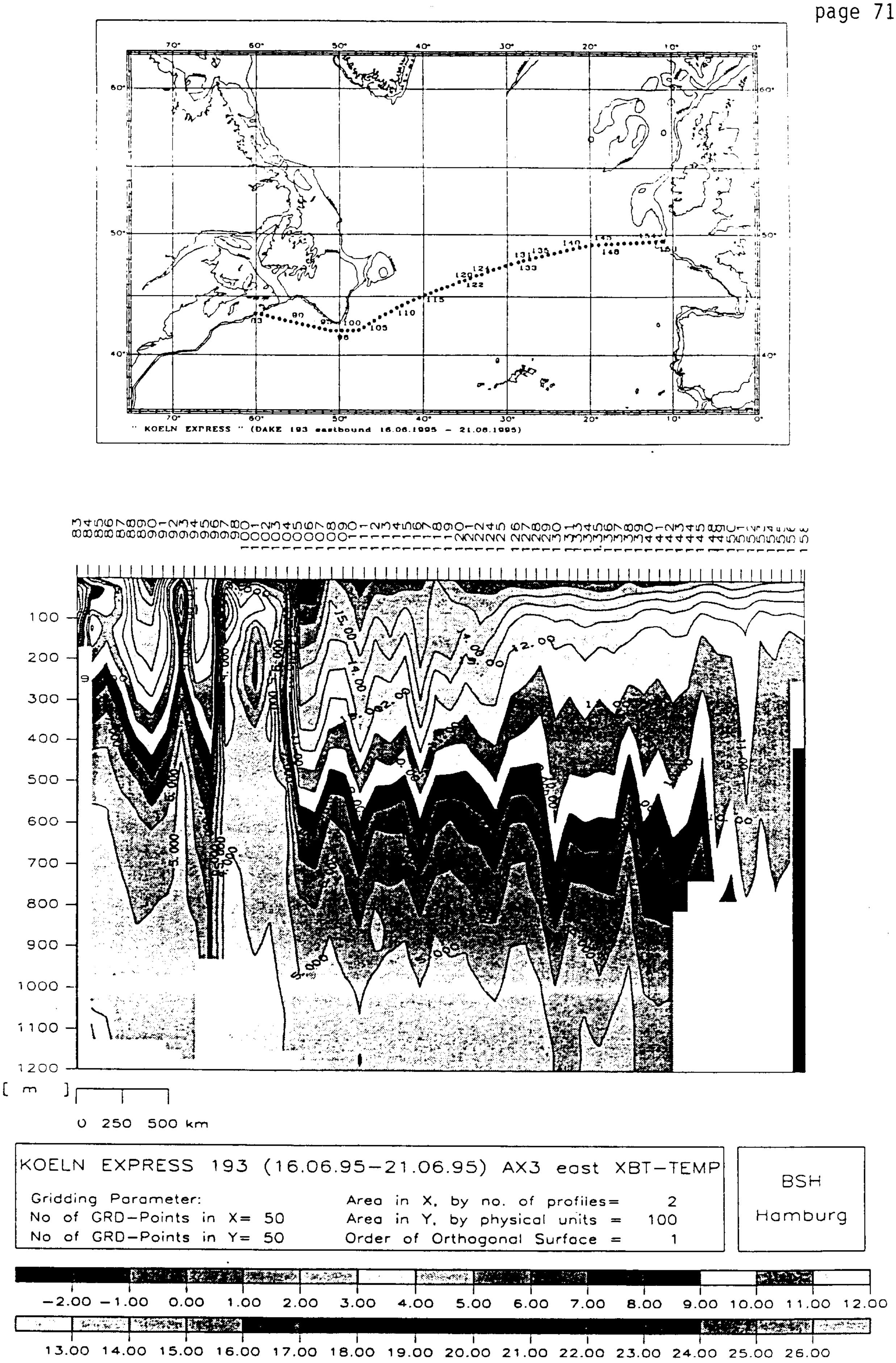
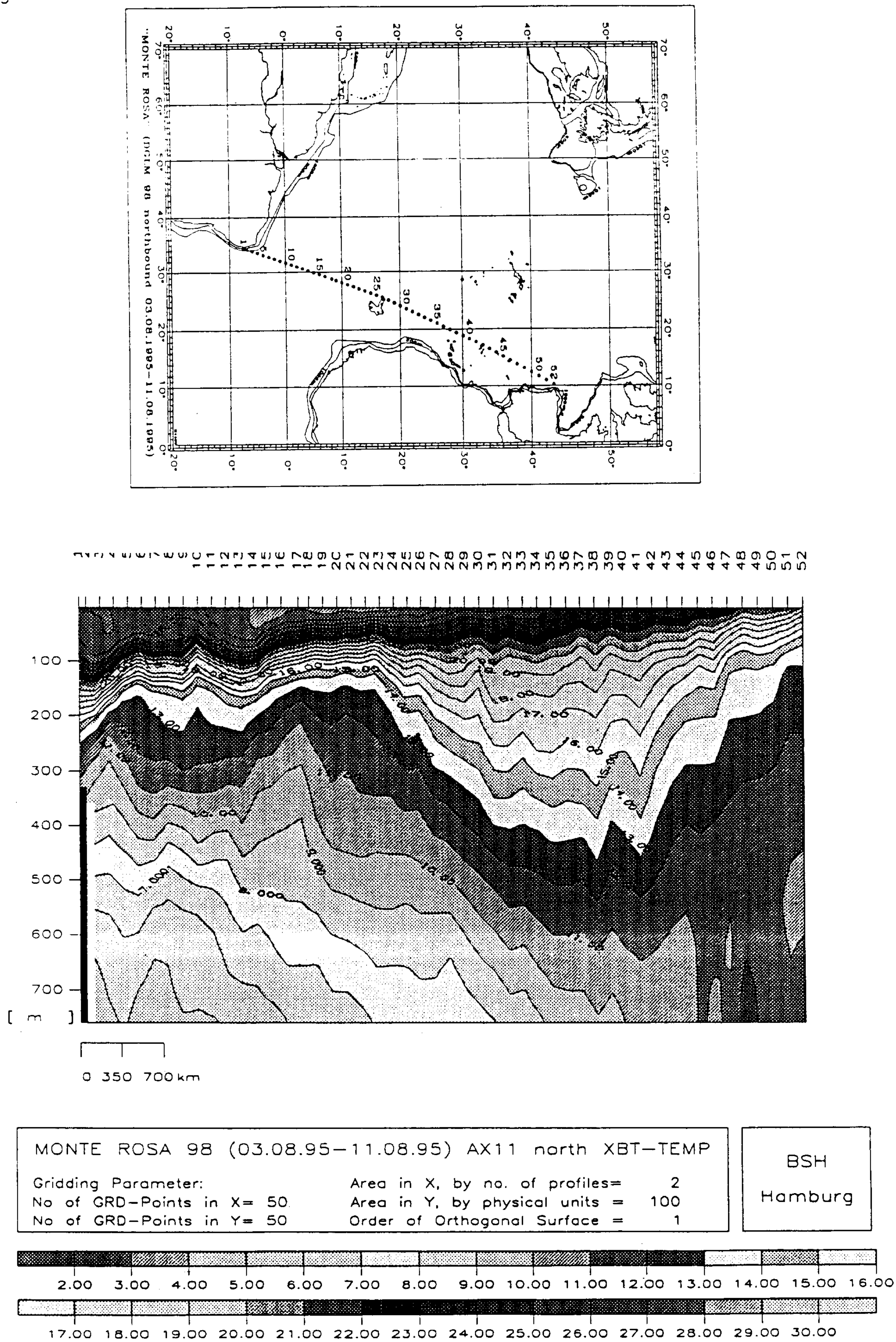


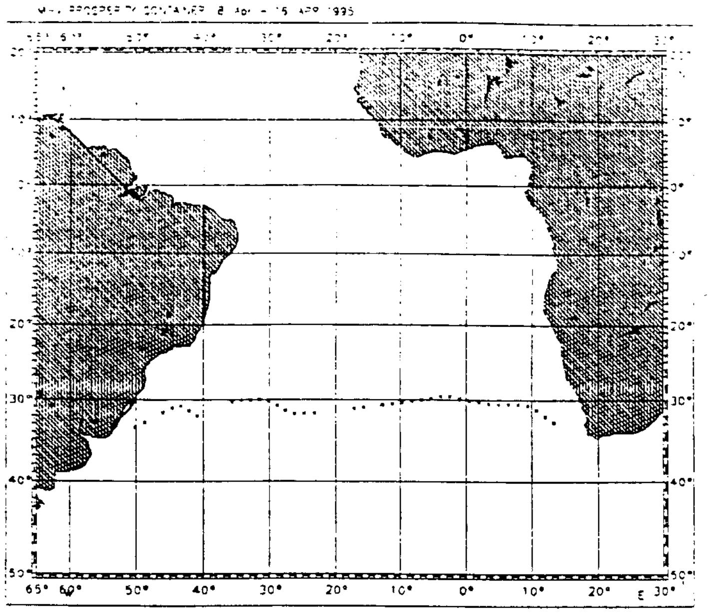
Fig. 1: XBT data distribution of BSH high density line AX-3 from May 1988 to December 1994



<u>Fig. 2:</u> Example of a "Fast Deep" (T-5) XBT section across the North Atlantic along AX-3 carried out by CMS "Köln Express" in June 1995



<u>Fig. 3:</u> Example of an AX-11 XBT section carried out by CMS "Monte Rosa" in August 1995



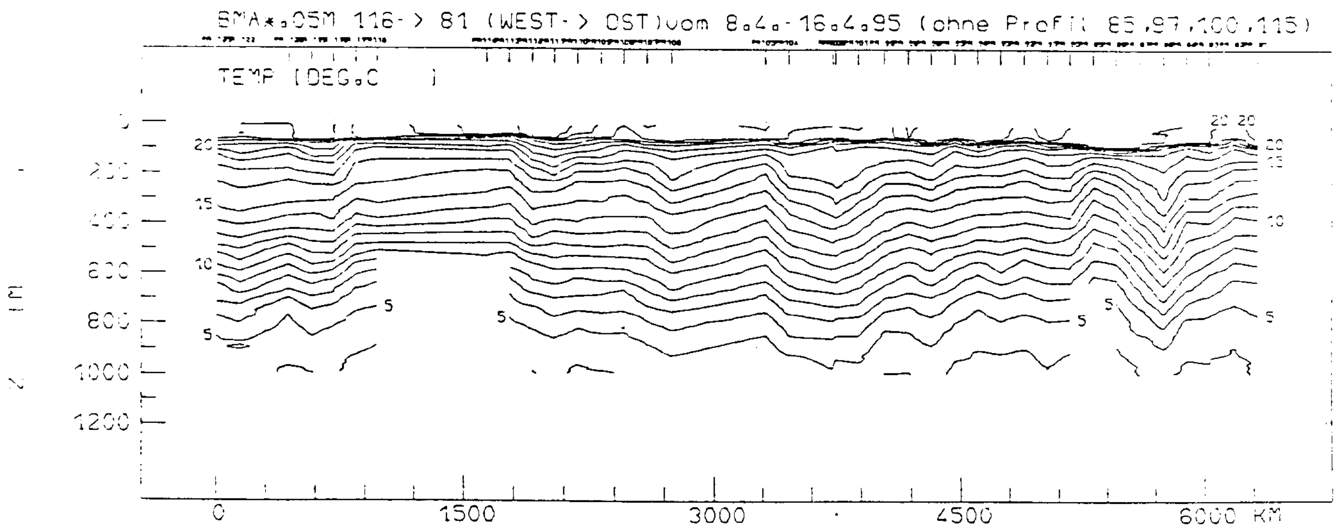


Fig. 4: Example of a XBT section of line AX-18 from Cape Town to Buenos Aires carried out by CMS "Prosperity Container" in April 1995

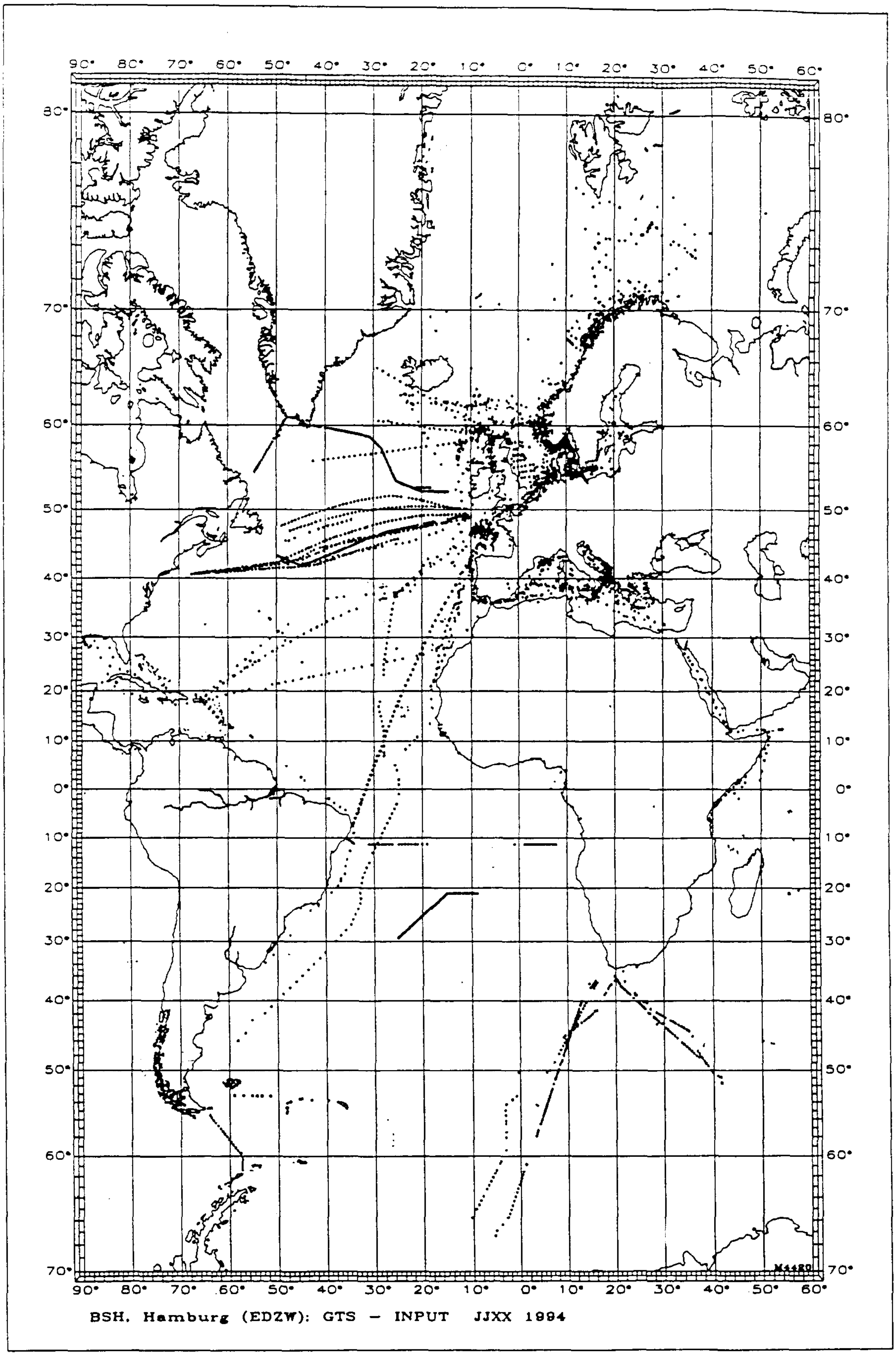


Fig. 5: Trackplot of BATHY messages submitted to GTS by BSH in 1994

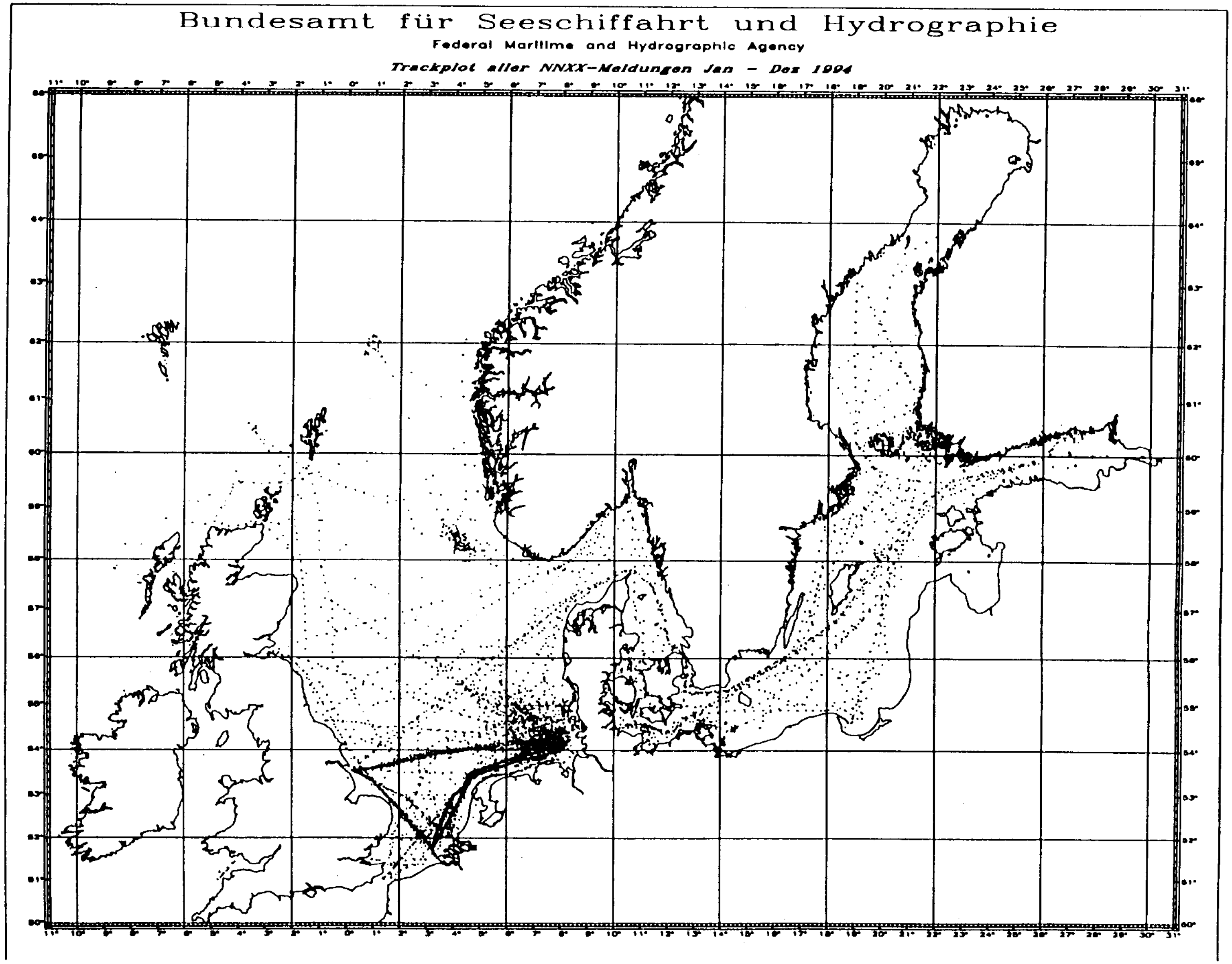


Fig. 6: Trackplot of TRACKOB messages of the BSH SST programme in 1994

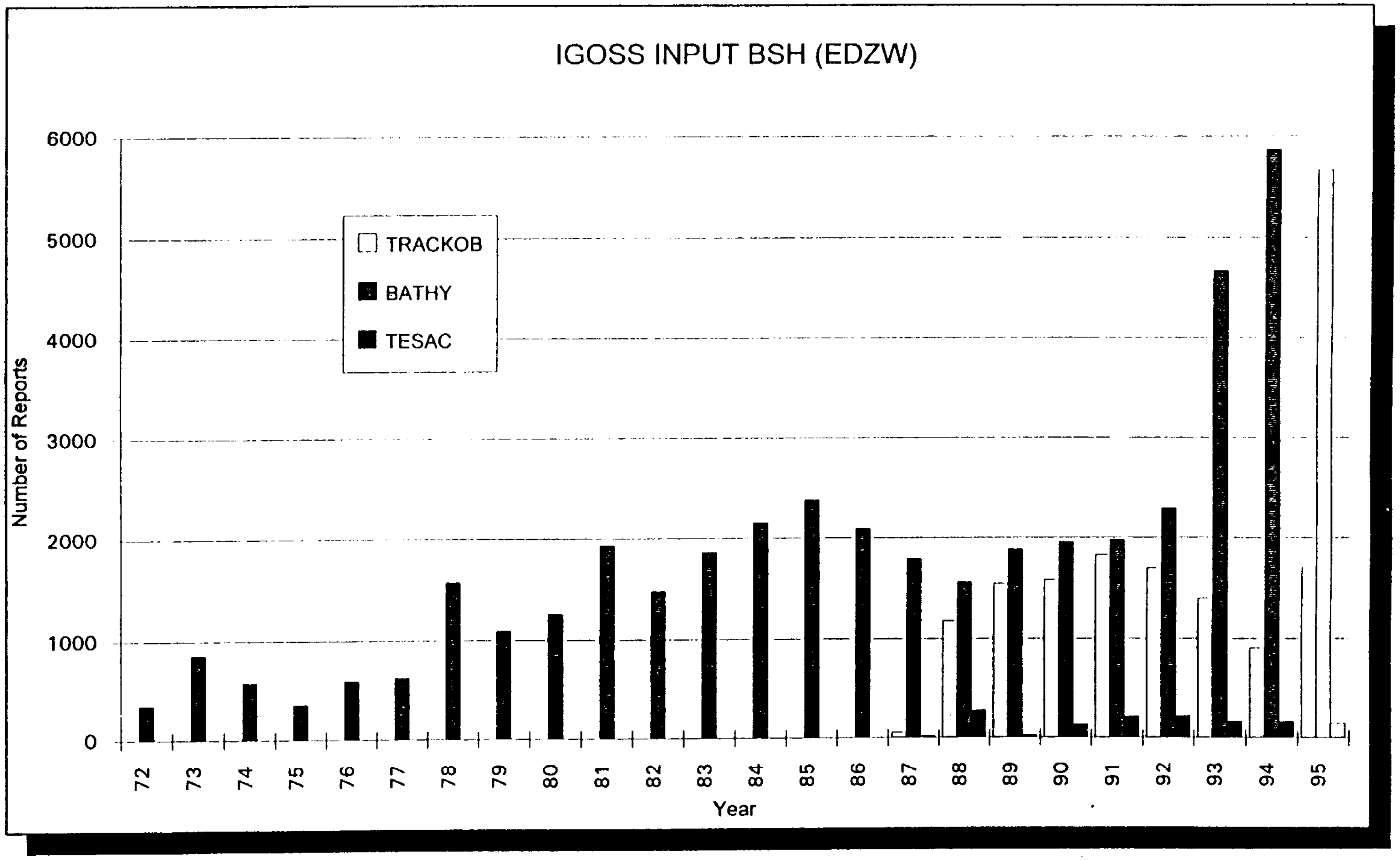


Fig. 7: Column chart of yearly BATHY, TESAC and TRACKOB input by BSH (1995: estimated)

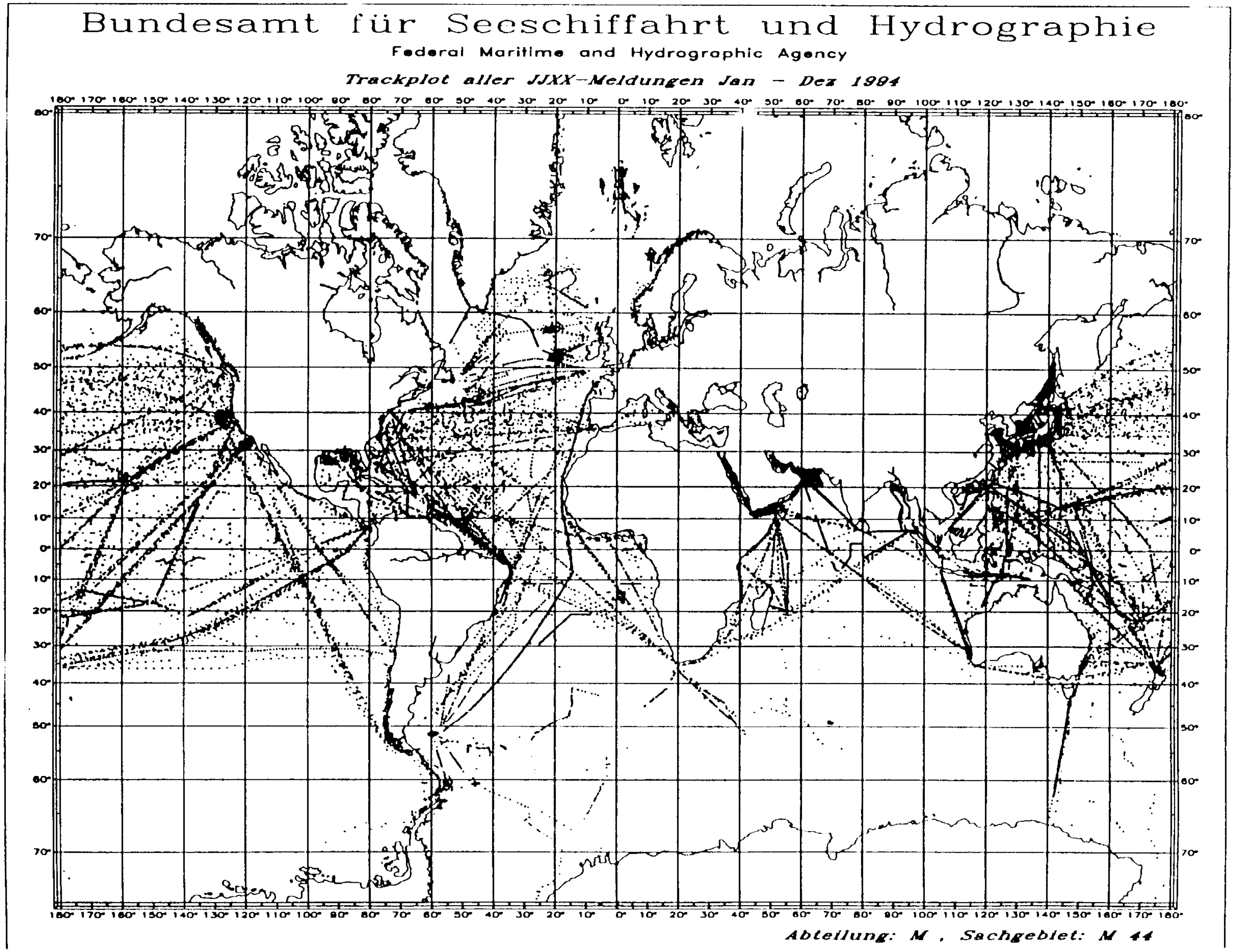


Fig. 8: Trackplot of BATHY messages received at BSH in 1994 (output + input)

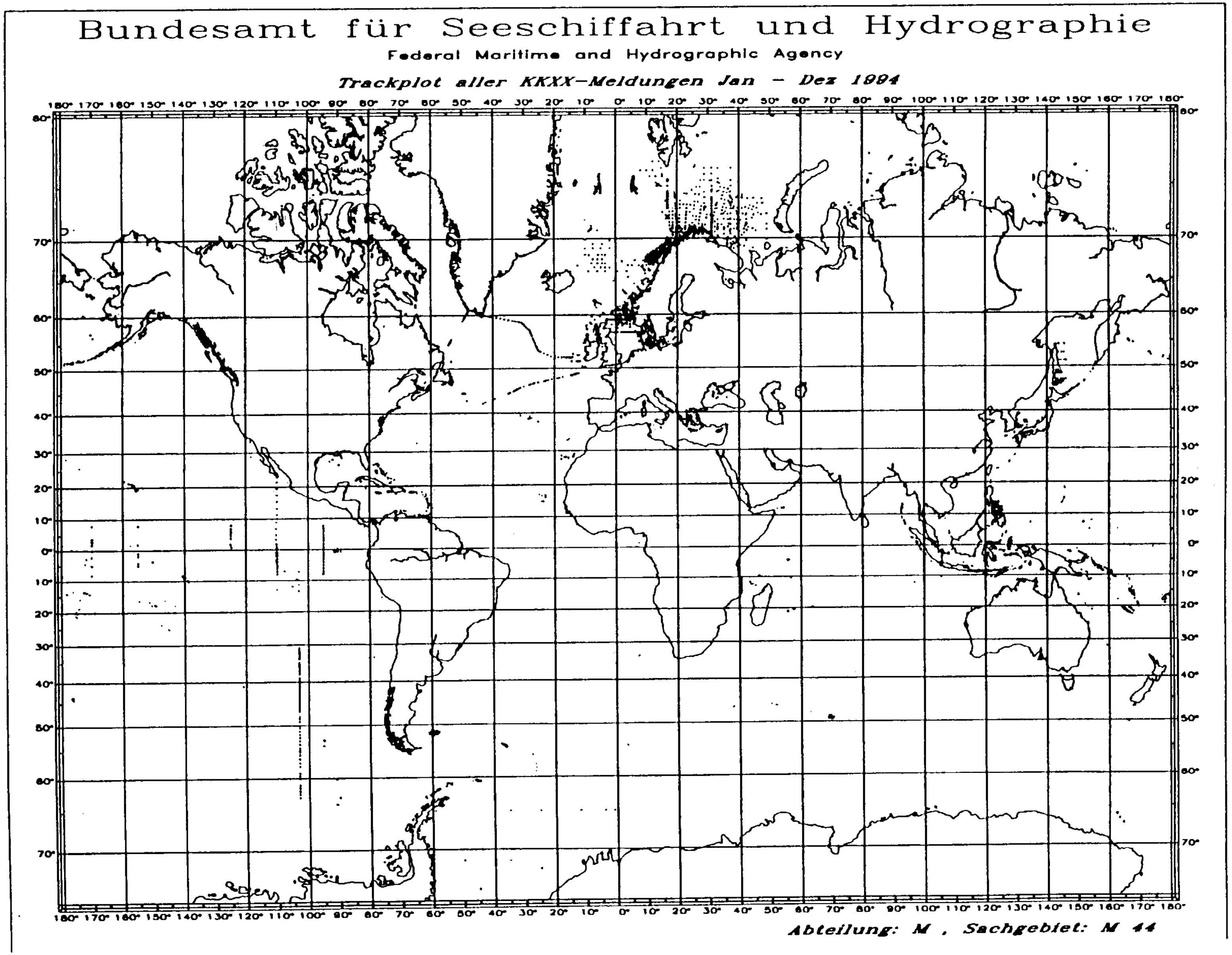


Fig. 9: Trackplot of TESAC messages received at BSH in 1994 (output + input)

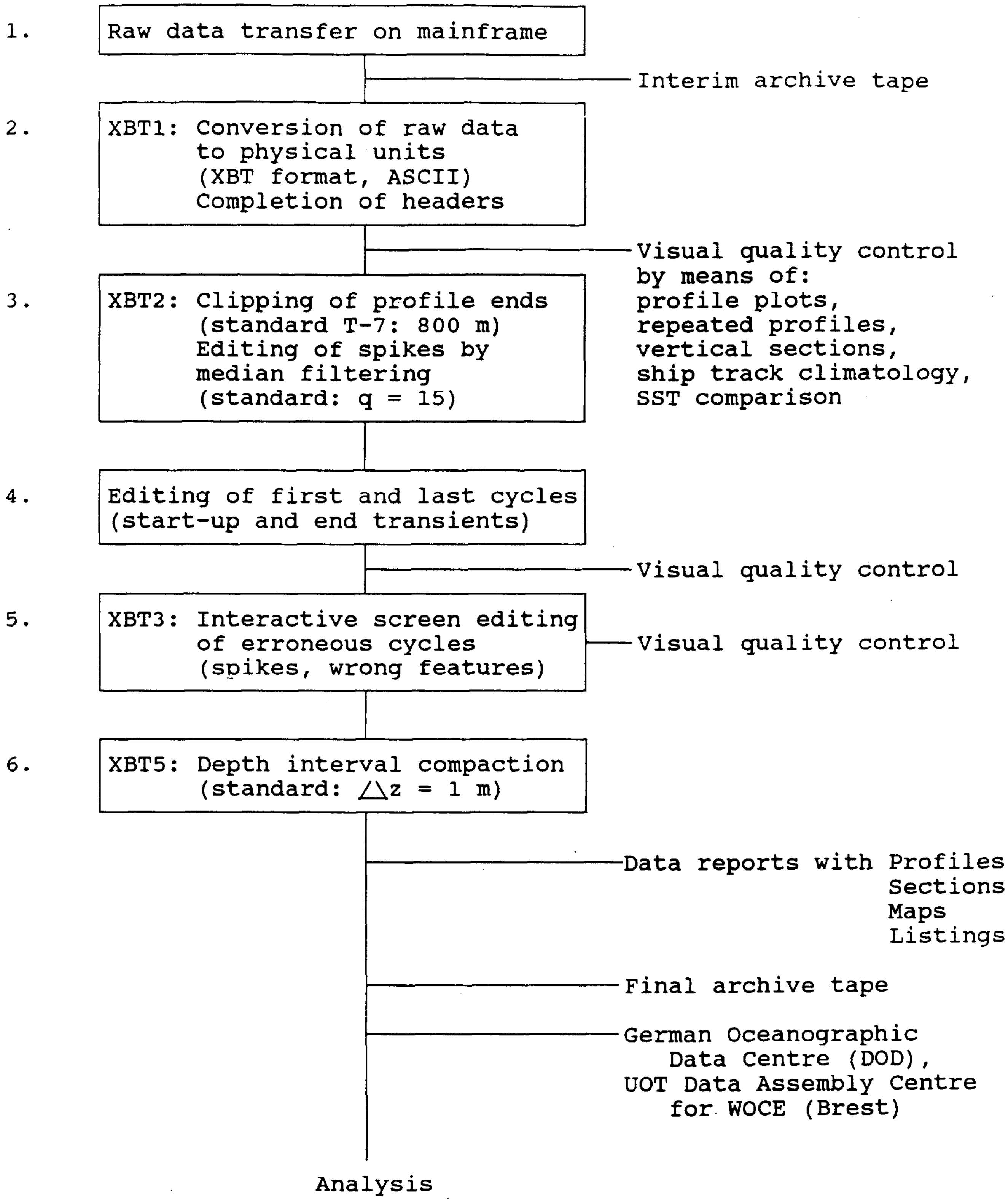


Fig. 10: Flow diagram for non-operational XBT data processing

JAPAN

Item 4.1 Status of Existing SOOP Lines

In 1994, the Japan Meteorological Agency (JMA) has been conducting three ships of opportunity, namely WELLINGTON MARU (JITV), KASHIMASAN MARU (JFPQ) and GEORGE WASHINGTON BRIDGE (JKCF) as to XBT observations. A total of 1,123 BATHY messages were transmitted from these ships. Details are shown in *Table 1*. These XBT observations were funded by the Science and Technology Agency (STA).

The XBT sampling on PX26 (TRANSPAC) by GEORGE W. BRIDGE has been suspended since March 1995 due to completion of the supporting project of STA.

Besides them, a number of research vessels of national organizations also reported XBT/CTD sampling in the form of BATHY messages in 1994 as shown in *Table 2*.

Item 4.2 Planned and Proposed SOOP Lines

Japan's planned SOOP lines in 1995-1997 are provided in *Table 3*.

JMA will use T7s in the place of T6s on PX5 by WELLINGTON MARU from the end of 1995 with the same sampling density as before.

High density XBT sampling on IX10 (east) by KASHIMASAN MARU is planned to be conducted once in 1995 and twice in 1996. The high density sampling will be made only on the way from Japan to the Persian Gulf. The station spacing is 3 hours a drop (about 45 miles a drop).

JMA is making efforts to resume the XBT sampling on PX26 under a new project which is now under consideration in STA.

Item 5.2 Equipment - New Developments

The National Research Institute off Far Seas Fisheries is making a comparison test of salinity profiles between XCTD (TSK: The Turumi-Seiki CO., LTD) and CTD. At present, XCTD has not yet achieved adequate salinity accuracy.

TABLE 1. JAPAN's SOOP LINES SUMMARY FOR 1994

LINE	FROM	TO		
PX5	**NEW ZEALAND**	**JAPAN**		
SHIP (CALL SIGN)		SECTIONS	DENSITY	BATHY
WELLINGTON MARU (JITV)		**6/YR**	**4/DAY**	**228**

LINE	FROM	TO		
PX26	**(TRANSPAC)**			
SHIP (CALL SIGN)		SECTIONS	DENSITY	BATHY
GEORGE W. BRIDGE (JKCF)		**12/YR**	**4/DAY**	**224**

LINE	FROM	TO		
PX49	**TAIWAN**	**MALACCA STR.**		
SHIP (CALL SIGN)		SECTIONS	DENSITY	BATHY
KASHIMASAN MARU (JFPQ)		**14/YR**	**4/DAY**	**119**

LINE	FROM	TO		
IX9	**OFF SRI LANKA**	**PERSIAN GULF** (north)		
SHIP (CALL SIGN)		SECTIONS	DENSITY	BATHY
KASHIMASAN MARU (JFPQ)		**14/YR**	**4/DAY**	**165**

LINE	FROM	TO		
IX10	**MALACCA STR.**	**OFF SRI LANKA** (east)		
SHIP (CALL SIGN)		SECTIONS	DENSITY	BATHY
KASHIMASAN MARU (JFPQ)		**14/YR**	**4/DAY**	**134**

LINE	FROM	TO		
—	**HONG KONG**	**NEW ZEALAND**		
SHIP (CALL SIGN)		SECTIONS	DENSITY	BATHY
WELLINGTON MARU (JITV)		**8/YR**	**4/DAY**	**253**

TOTAL 1,123

TABLE 2. NUMBER OF DATA INSERTED ONTO GTS IN THE FORM OF BATHY MESSAGES DURING 1994 IN JAPAN

LEGEND
JMA = JAPAN METEOROLOGICAL AGENCY
JFA = JAPAN FISHERIES AGENCY
MSA = MARITIME SAFETY AGENCY
DA = DEFENSE AGENCY
JAMSTEC = JAPAN MARINE SCIENCE AND TECHNOLOGY CENTER
TOHOKU U. = TOHOKU UNIVERSITY

SHIP	CALL SIGN	AGENCY	BATHY	LINES
RYOFU MARU	JGZK*	JMA	312	
KEIFU MARU	JBOA	JMA	214	
KOFU MARU	JDWX	JMA	291	
SHUMPU MARU	JFDG	JMA	258	
CHOFU MARU	JCCX	JMA	295	
SEIFU MARU	JIVB	JMA	310	
WELLINGTON MARU	JITV	JMA	481	PX5
KASHIMASAN MARU	JFPQ	JMA	418	PX49,IX9,IX10
GEORGE W. BRIDGE	JKCF	JMA	224	PX26
KAIYO MARU	JNZL	JFA	201	
YOKO MARU	7KDD	JFA	21	
SHOYO	JCOD	MSA	25	
TAKUYO	7JWN	MSA	40	
SHIRASE	JSVY	DA	4	
KAIYO	JRPG	JAMSTEC	82	
OGASAWARA MARU**	JRBM	TOHOKU U.	133	
		TOTAL	**3,309**	

*: Call sign for the new RYOFU MARU has been JGQH since July 1995.

**: A domestic ferry (SOO) which regularly shuttles between Tokyo and Bonin Islands (27-20N, 142E)

TABLE 3. JAPAN's SOOP PLANS FOR 1995-1997

LINE	CALL SIGN	SECTIONS 1995	1996	1997	PROBE TYPE	DENSITY
PX5	JITV	8(5*)	8	8?	T6(1995),T7	4/DAY
PX26	JKCF	2(2*)	0	?	T7	4/DAY
PX49	JFPQ	14(9*)	14	14?	T6	4/DAY
IX9 north	JFPQ	13(9*)	12	14?	T6	4/DAY
		1(0*)	2	0?	T6	8/DAY
IX10 east	JFPQ	13(9*)	12	14?	T6	4/DAY
		1(0*)	2	0?	T6	8/DAY
HONG KONG - NEW ZEALAND:	JITV	8(6*)	8	8?	T6(1995),T7	4/DAY

*: completed as of September 1 in 1995.

UNITED KINGDOM

The following ships reported to IGOSS during 1994:

OWS CUMULUS - operated by J MARR and funded by the Met. Office; IT carries an XBT launcher, SMART CTD probe and "O" wire meter supplied by the MOD. Probes provided by MOD.

RJ BJARNI SAEMUNDSSON and RV ARNI FRIDRIKSSON - operated and funded by the Marine Institute in Reykjavik. The ships operate within the Iceland EEZ and use XBT launchers, DOP's and probes supplied by MOD.

MV BRUAFOSS - operated by EIMSKIP between Reykjavik-Immingham-Rotterdam. Equipment and expendables supplied by MOD.

RRS DISCOVERY - operated by RVS as part of NERC, and will be heavily involved in Shelf Edge Seas Studies for which MOD has contributed some XBTs. Launcher and DCP owned by MOD.

ARKTIS VISION - owned by Elite Shipping, recently taken over UK/FIPZ route from Westmore. NOAA owns the equipment and MOD provides XBTs.

The total number of reports made to IGOSS in 1994 are as follows:

CUMULUS	**560**
DISCOVERY	**31**
BJARNI SAEMUNDSSON	**87**
ARNI FRIDRIKSSON	**87**
BRUAFOSS	**70**

UNITED STATES OF AMERICA

National Ocean Service - Observing Network Branch

The U.S. VOS XBT program collects XBT data along internationally agreed upon routes (see Table 1.) in support of scientific activities of the World Climate Research Program including WOCE, CLIVAR, GCOS the GOOS and emerging short-term climate forecasting. We anticipate level or reduced funding over the next couple of years, but will continue to monitor our assigned routes as best we can. Development and implementation of a new version of SEAS software and the use of Standard C transmissions will proceed.

Since the last IGOSS Ship-of-Opportunity Meeting in Hobart, Tasmania in March of 1993, the U.S. VOS XBT program operated by the National Oceanic and Atmospheric Administration - National Ocean Service has concentrated on improving the overall quality of our monitoring efforts. We have accomplished this by four methods.

1- By identifying, recruiting, and supporting back up vessels to guarantee the required monthly coverage on XBT lines for which we are responsible.

2- By increasing the number of ship visits and maintaining a supply of "hot spares" equipment to facilitate the change out of equipment that has failed.

3- By increasing our international co-ordination by establishing centers of support in Singapore, Durban and Kuwait.

4- By a more effective use of our real time data base and the implementation of Internet FTP data transfers.

We have had to terminate sampling on lines PX-20, 21, 22 and 43, consolidate lines PX-7, 9, and 13 in the Pacific Ocean due to inadequate probe supplies, logistics, nor no available ships. By next year we anticipate a severe reduction on line PX-26. However, some of these terminations were balanced by expansion into the Indian and south Atlantic and Pacific Oceans. Table 2 summarizes the U.S. participation in the IGOSS XBT Ship-of-Opportunity Program since 1990 by showing the number of ships and routes supported, the number of XBT's collected and the commensurate percentage of the total global data suite collected for those years.

The location of XBT observations collected and transmitted via SEAS for 1993 and 1994 are provided in Figures 1 and 2. All observations received in real time were made available to the international community via the Global Telecommunications System.

Additionally, available through this office is a catalogue of monthly plots summarizing the global transmission of all real time XBT data from participating IGOSS members.

TABLE 1. Existing United States/NOAA/NOS XBT Lines

PACIFIC OCEAN:

Routes/Requirements	Ships - Call Sign
PX-1 (Calif.- Indonesia): Req.: 860 obs/yr., 72/mo. 12 trans./yr., 4/day.	Boga. Lima - YDLR Golden. Indah - 9VVB
PX-7/9 (New Zealand-Hawaii-Seattle): Req.: 1080 obs/yr., 90/mo. 12 trans./yr., 4/day.	Col. Canada - ELQN3 Col. California - DHCM
PX-8 (Panama-New Zealand): Req.: 700 obs/yr., 59/mo. 12 trans./yr., 4/day.	America Star - C6JZ2 Melbour. Star - C6JY6 Queens. Star - C6JZ3
PX-10 (Hawaii - Guam/Saipan): Req.: 316 obs/yr., 27/mo. 12 trans./yr., 4/day.	S/L Enterprise - KRGB S/L Navigator - WPGK S/L Pacific - WSRL S/L Trader - KIRH
PX-13 (Calif.-New Zealand): Req.: 770 obs/yr, 65/mo. 12 trans./yr., 4/day.	Col. Canada - ELQN3 Col. California - DHCM
PX-14 (Alaska - Cape Horn): Req.: 1080 obs/yr., 90/mo. 18 trans./yr., 4/day.	Northern Lion - A8IE Western Lion - A8BN Eastern Lion - 6ZFB Southern Lion - A8SF St. Lucia - D5ND Mt. Cabrite - D5NE
PX-18 (California - Tahiti): Req.: 900 obs/yr., 75/mo. 18 trans./yr., 4/day.	Polynesia - D5NZ Moana Pacific - OWUO6
PX-26 (TRANSPAC REGION): Req.: 2000 obs/yr., 167/mo. 36 trans./yr., 4/day.	S/L Defender - KGJB S/L. Enterprise - KRGB S/L Navigator - WPGK S/L Pacific - WSRL S/L Trader - KIRH Tai He - BOAB Skaubryn - LAJV4 Skaugran - LADB2
PX-50 (Valparaiso-New Zealand): Req.: 700 obs/year, 59/mo. 12 trans./yr., 4/day.	Calif. Current - ELMG2 Gulf Current - ELMF9 Pacific Maru - JJGC Joana Bonita - 3EFY6

ATLANTIC OCEAN:

Routes/Requirements	Ships - Call Sign
AX-2 (Newfoundland-Iceland): Req.: 200 obs/yr., 17/mo. 12 trans./yr., 4/day.	Skogafoss - V2QT Strong Ice. - WBD9290
AX-4 (N.Y. - Gibraltar): Req.: 440 obs/yr., 37/mo. 12 trans./yr., 4/day.	Ned. Raleigh Bay - PHKG Sea Premier - ELBD7 Crist. Columbo - ICYS
AX-7 (Gulf of Mex.- Gibraltar): Req.: 520 obs/yr., 44/mo. 12 trans./yr., 4/day. High Density Req.: 800 obs/year	Colima - DZST Mitla - XCNX
AX-8 (N.Y. - Cape of Good Hope): Req.: 960 obs/yr., 80/mo. 12 trans./yr., 4/day.	Nomzi - MTQU3 Charles Lykes - 3EJT9 Olivebank - 3ETQ5
AX-10 (N.Y. - Caracas/Trinidad): Req.: 200 obs/yr., 17/mo. 12 trans./yr., 4/day.	Shining Star - WVFZ Sea Lion - KJLV Sea Wolf - KNFG
AX-12 (Europe to Antarc./Falklands): Req.: 800 obs/yr, 67/mo. 12/trans./yr., 4/day. Supported by the U.K.	Arktis Vision - OXWJ2
AX-14 (Rio to Nigeria): Req.: 480 obs/yr., 40/mo. 12/trans./yr., 4/day.	Sao Louis - 9HVO3
AX-16 (Rio to Walvis Bay): Req.: 480 obs/yr., 40/mo. 12/trans./yr., 4/day.	Sao Louis - 9HVO3
AX-29 (New York - Brazil): Req.: 360 obs/yr., 30/mo. 12 trans./yr., 4/day.	Sea Wolf - KNFG Sea Lion - KJLV

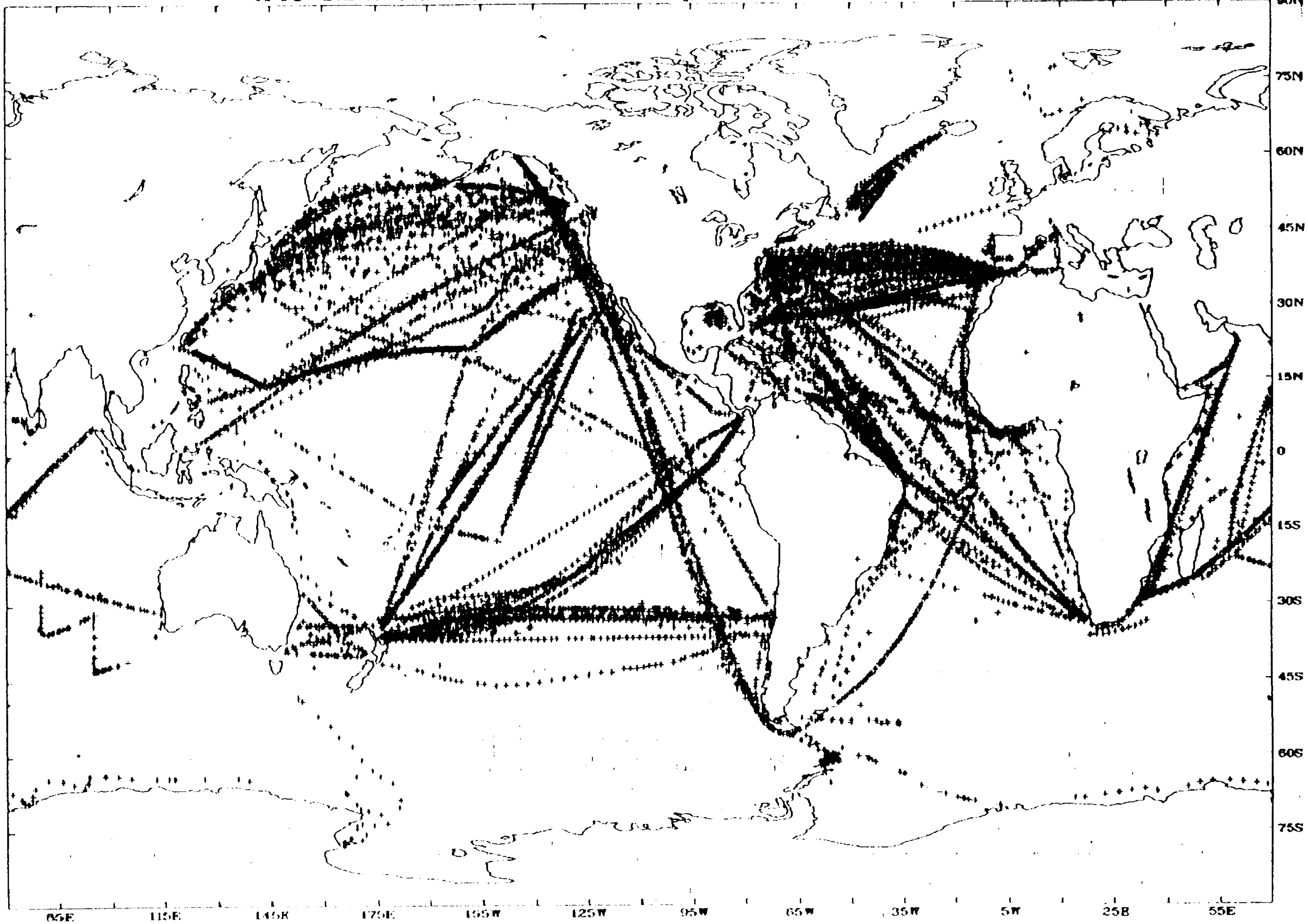
INDIAN OCEAN:

Routes/Requirements		Ships - Call Sign
IX-6 (Mauritius - Malacca Strait): Req.: 340 obs/yr., 29/mo. 12 trans./yr., 4/day.		Oranje - J8FG9 Vaal - J8IU N.V. Neck - PGEB
IX-7 (C. of Good Hope - Arabian Gulf): Req.: 520 obs/yr., 44/mo. 12 trans./yr., 4/day	(Pend.)	Afris Pion. - P3FY5 CMBT Emerald - C6HQ8 Afris Wave - P3FJ5
IX-15 (Mauritius-Fremantle): Req.: 380 obs/yr, 32/mo. 12 trans./yr., 4/day.		Pacific Maru - JJGC Joana Bonita - 3EFY6
IX-21 (C. of Good Hope - Mauritius): Req.: 400 obs/yr., 34/mo. 12 trans./yr., 4/day.		Pacific Maru - JJGC N.V. Neck - PGEB Joana Bonita - 3EFY6 Oranje - J8FG9 Vaal - J8IU
IX-8 (Bombay - Mauritius): Req.: 360 obs/yr., 30/mo. 12 trans./yr., 4/day	(Pend)	Afris Pion. - P3FY5 Afris Wave - P3FJ5

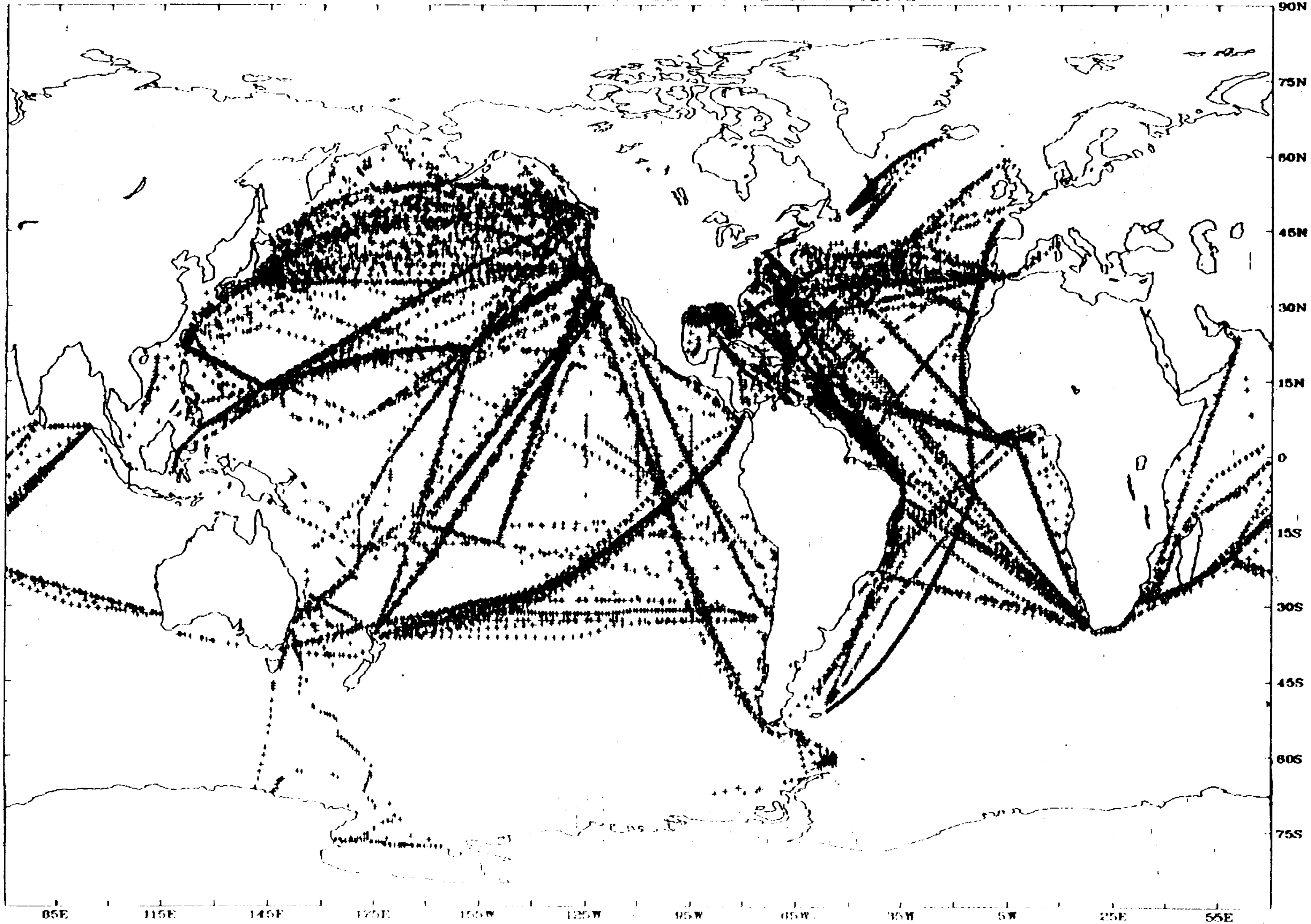
TABLE 2.

United States VOS/XBT Summary						
	1990	**1991**	**1992**	**1993**	**1994**	**1995 est.**
No. of Ships	79	80	76	71	78	70
No. of Routes	27	26	29	28	24	24
No. of XBT's	10.9K	19.3K	15.6K	15.0K	16.3K	15.0K
% R-T Global	34%	58%	42%	44%	41%	?

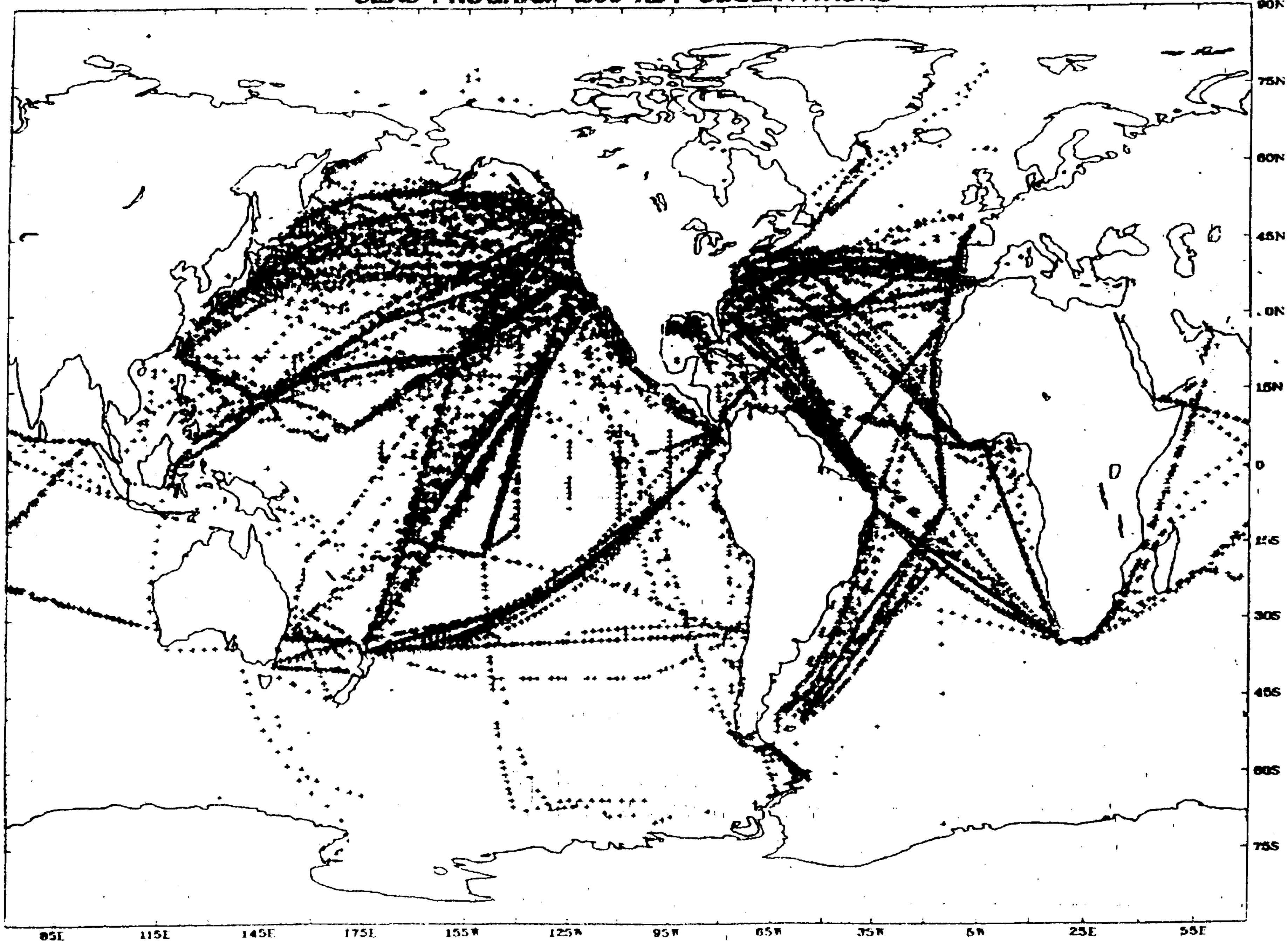
1995 SEAS XBT OBSERVATIONS (JANUARY-OCTOBER 12TH)



SEAS PROGRAM 1994 XBT OBSERVATIONS



SEAS PROGRAM 1993 XBT OBSERVATIONS



TECHNICAL REPORTS

ECONOMIC BENEFITS OF IGOSS DATA: A DRAFT REPORT

R. Stoddart, MEDS, Canada

Introduction

The oceans cover the greater part of the planet's surface and, like the atmosphere, are three dimensional. For years human intervention into this domain was restricted to transportation across its surface and harvesting its abundant fishery resources. Today the situation has changed. Technology and human interventions have increased but our knowledge is lagging behind.

Today we exploit the living resources of the ocean, using modern technology capable of targeting and collecting huge quantities of fish. However, the complex environmental factors dictating abundance and recruitment of those resources are poorly understood.

Our increasing population prefers to live on the attractive coastal environments, imposing developmental and waste impacts that have already adversely affected the quality of the sensitive fringes of the ocean. Important marine habitats, such as coral reefs and mangrove swamps, have suffered, possibly irreversibly threatening the biodiversity of the sea in ways we do not fully understand. These same coastal communities are themselves at risk from the ravages of storms, tides and waves whose timing and location is still an inexact science.

It is known that the oceans contribute to the world weather and climate through the exchange and distribution of heat and carbon dioxide, but we don't know enough to say how much and how changes in the atmosphere will interact with changes in the ocean and vice versa. We don't know how stable or unstable the present situation is on global or regional scales.

The mineral resources of the coastal and deep ocean seabed are in the preliminary stages of exploitation. Information (ice, waves, bottom currents, etc.) on operational surface and sub-surface conditions is critical. The same surface information is needed for a safe and efficient marine transportation sector, with routing around storms and adverse conditions, as well as utilizing ocean current information for fuel economy.

The biggest drawback to the progress of a well understood and predictable ocean environment has been the lack of data to address the scientific uncertainties and to input into the predictive models. IGOSS is the only global system dealing with the operational collection and exchange of this much needed information. The need for, and the benefits of, this system are discussed below.

Weather and Climate

Benefits of weather data are indisputable. There are many users, from the general public who want to know how to dress on a day-to-day basis, to specific clients who want to operate safely and efficiently, like the aviation industry. The main questions facing the atmospheric specialists go beyond justifying exchanging data in real time - they deal with issues such as how much data is enough, and how best can remote and in situ data be incorporated into forecast models.

Economic studies have been undertaken for some atmospheric parameters. For instance, airplanes routinely collect atmospheric data during trans-oceanic flights so that rerouting of subsequent aircraft can avoid areas of turbulence and ensure fuel efficiency. The Federal Aviation Administration (FAA) of the USA has estimated that 80% of the air traffic delays greater than 15 minutes are caused by weather resulting in an economic loss of $1 billion per year. This economic loss is expected to be about $1.7 billion by year 2001 of which $423 million could be avoidable through exploitation of improved aviation weather services (C.H. Sprinkle -NWS/USA, in WMO 1994, pp. 83-86). A thorough review of the economic and social benefits of meteorological and hydrological services has been undertaken through two conferences (WMO, 1990 and 1994). Similar possibilities for economic savings exist in the ocean environment.

Devastation from events such as El Niño are easily illustrated by their cost. It has been estimated (TOGA, 1985) that the physical damages caused during the 1982-83 El Niño in Peru were of the order of $649M (agribusiness), $106M (fishing), $479M (industry), $16M (electrical energy), $310M (mining), $303M (transportation, communications), $70M (housing), $57M (health, water, sewage systems), and $6M (education). Significant damage estimates from the same event were also made for Ecuador and Bolivia. Teleconnections of El Niño events to other parts of the globe, Africa, North America, etc. are real but imperfectly understood. Models are being developed and improved through TOGA to address the problem of El Niño prediction; IGOSS data is fundamental to these predictions. Countries will benefit from TOGA results through improved warnings of climate variability in time to take alternative actions where appropriate. An example (NOAA/Oregon State University, 1995) of a study on the benefits of forecasting can be found in the USA agriculture sector where economists estimate that $235M per year on average would be saved if data (which would include IGOSS data) were available to permit a high skilled forecast (.8 accuracy) of ENSO events 9 to 12 months in advance. For a modest skill forecast (.6 accuracy) of ENSO events the saving would be $211M while a perfect forecast (1.0 accuracy) would yield $284M in savings. The present value of a high skilled forecast ability (using a conservative 10 year 6% discount rate) is $1.8 billion.

In the atmospheric community very complex numerical models are on a continuous path of improvement. The accuracy of forecasts emanating out of these models is very highly dependent upon the quality and quantity of supporting observed data and particularly dependent upon the global exchange of data. Generally, human intervention in the making of forecasts is gradually providing a smaller and decreasing gain in value beyond that which is obtainable through the direct use of numerical guidance. Nevertheless, all applications show the potential for considerable further growth in forecast value with continued increases in forecast skill. Many national meteorological and hydrological services have undertaken studies to come up with cost/benefit ratios as a means of justifying their programs. These ratios have been estimated to be from 1:7 for the UK (S. Teske and P. Robinson, 1994) to 1:10+ for Canada (The DPA Group, 1985) and to 1:20 for Germany (The German Meteological Service, 1995) and even higher in some other jurisdictions.

The ocean community lags the atmospheric community by decades in exchanging real time data. The reasons are simple: (i) there is no in situ population on the ocean to collect data, as compared to weather data over land areas, (ii) atmospheric sounders, such as aircraft and satellite sensors, are more prevalent than ocean subsurface data sounders, (iii) the majority of users of weather forecasts are terrestrially based, but recognize that large-scale or global data sets are required for weather forecasts - the ocean users do not tend to think that large-scale data sets are required to understand/forecast local conditions, and (iv) in general, the cost per unit of data is much higher for oceans data than atmospheric data. That being said, with the paucity of oceans data, it only makes economic sense that as much data as is possible be exchanged in a timely fashion to serve all potential users. With global commerce continuing to escalate, and environmental concerns such as climate change and variability becoming more apparent, specification of the oceans heat storage and movement, and the air/sea exchanges of heat, moisture and momentum through coupled ocean/atmosphere models, are becoming more essential to the improvement of short and longer range forecasts.

Fisheries

Fish have temperature and salinity preferences. Pelagic living species such as salmon, albacore, tuna, etc. prefer a relatively narrow range of ocean temperatures, and IGOSS data together with remotely sensed data can help define these areas in time and space. Other features (such as the position of the thermocline, fronts and convergence zones) decernable with the aid of IGOSS data, are important to fisheries distributions. It is well known that some commercial species, such as swordfish, are temperature dependant since fishermen use hull mounted temperature sensors in real time to actually set their hooks and lines. Tidal and other oceanographic real time data have been utilized in support of commercial aquaculture activities. Unfortunately, little if any analysis has been done to quantify the value of real time data to fisheries. In order to share experiences and opportunities, Canada co-hosted, with the IOC and others, an International Symposium on Operational Fisheries Oceanography (ISOFO) in October 1989. Two hundred and thirty (230) scientists, managers, fishermen, and consultants from thirty (30) nations participated and exchanged valuable experiences on ocean environment and fisheries interactions.

During and subsequent to ISOFO, Canada undertook pilot projects to test the economic practicality of operational oceanography for fisheries purposes. One such program was the development of a "Temperature Directed Fisheries System" to provide Fisheries Products International (FPI) with real-time oceanographic information to aid the search for commercial fish off the coast of Newfoundland, specifically cod, American plaice and yellowtail flounder. The pilot system provided biweekly real-time sea bottom temperature maps to the offshore trawlers using the real-time data from temperature sensors on the trawl nets in concert with a computer network between vessels and a shore facility. While proving useful, the system has not been subsequently implemented because of cost considerations. Another project along the same lines, in support of northern cod fisheries research, is the examination of different types of oceanographic data products based on temperature, salinity and currents, that could be useful to scientists and fishermen that would relate environmental factors to fish abundance and distribution, and to stock assessment requirements. The data products thus selected, are intended to be generated on a routine basis.

Some work has been undertaken to examine novel approaches to collecting IGOSS type data in support of fisheries. For instance, Seakem (1987) demonstrated the feasibility of using aircraft to obtain timely and inexpensive, compared to using research vessels, oceanographic data for fisheries management using fisheries surveillance aircraft and air expendable bathythermographs (AXBT).

Marine Transportation

In early days ships plied the seas using the brute force approach in getting from Point A to Point B by taking the most direct route while utilizing historical knowledge of the local ocean currents and winds to ensure as safe and efficient passage as possible. Cost was not usually an over-riding factor; but, with modern capabilities to look at basin scale oceans in real time, it makes sense to utilize real time weather and ocean conditions to route vessels. Dooley (1985) has clearly demonstrated the fuel cost-savings and time benefits of ship ocean routing by comparing actual vessel transits in the North Pacific. In fact, there are private companies with this as their main objective (Oceanroutes, Kendall, 1990). Ship routing represents an application area with a benefit of $150M annually to the world economy. A ship routing service, which costs about $800-$900, saves 3-4 hours per Atlantic crossing and in excess of 7 hours in crossing the Pacific compared to un-routed ships (J.C. Thomson et al, 1994).

A critical area for real time oceanography in support of marine transportation relates to search and rescue, and marine spills. The major concern is knowing the currents, either measured or predicted through models. In addition, real time reporting of sea level (tidal) data has many benefits for marine transportation, ranging from predicting the oceanic component of storm surges, to safety information for ships manouvering in ports, to ship draft/cargo loads in areas subject to water level fluctuations from river regulation, sedimentation, and tidal effects.

Defence

Naval requirements for oceanographic data in real time have some similarities to fisheries needs except that the concerns relate to the location of other vessels and equipment instead of fish. In addition to normal transportation and special oceanographic requirements, the naval requirements are to understand the physical structure of the 3-D ocean since acoustic properties in the ocean are temperature, salinity, depth and range dependent.

The U.S. Navy/NOAA Oceanographic Data Distribution System (NOAA NODDS) undertook a review of the benefits of its system as a method of providing private sector and government agency access to the U.S. Navy's Fleet Numerical Meteorology and Oceanography Center (FNMOC) operational and oceanographic analyses and forecast charts. Duernberger (1986) determined that the non-profit system should be an efficient method to access unclassified numerical products to users at a fair price, assuming adequate communication systems.

In a changing world, navies world-wide are beginning to provide data through IGOSS that they collect through their normal operational activities. This should result in increased economic spin-off to many other sectors such as fisheries, etc. It is hoped, and likely, that exchange of this type of data will increase in the future.

Ocean Research

In situ IGOSS data from vessels of opportunity, drifters, etc., together with remote sensing data to gain a synoptic picture of the surface of the ocean, can help direct research vessels areas of direct concern and help in future sampling strategies as the vessel moves from one water mass to another. IGOSS data can help direct research efforts to allow for modifications of experiments as they unfold. Fuel savings, and savings in research scientist and support staff time, will also be accomplished.

Russian researchers have long utilized IGOSS data sets for constructing descriptions of water temperature, salinity, density and other related characteristics on the surface of the North Atlantic (once every 5 days) and the North Pacific (once every 10 days), and below the surface of the North Atlantic (once a month). Also, they have utilized SHIP, drifting buoy, BATHY and TESAC data, in operational time frames, to correct water temperature data collected via satellites.

Data Management

Workshops have been held to review the range, complexity and performance of a number of real time ocean data collection and transmission systems (IEEE-WHOI, 1983). Troubles (malfunctioning, bias) with deployed sensors on ships-of-opportunity, autonomous platforms, research vessels, etc. can be detected through real time reporting. Efficiencies can be made through early detection and correction of these problem areas. It does not make any scientific or economic sense to await the visit of a technician to a sensor, just to determine that the data being collected is in error - further delay and lost data would likely result if the vessel has to depart port without the sensor being fixed or replaced. Nowadays one cannot afford to waste data collection opportunities.

Summary

Benefits associated with improvements in forecasting marine conditions will be spread over a large sector of ocean users. The Marine Board, USA National Research Council (1989) listed the following primary benefits related to the ocean of improved forecasts: shipping - reduced passage time/fuel consumption; offshore oil and gas - improved deepwater drilling efficiency; fisheries/recreation - enhanced safety of life, reduced equipment and vessel damage, increased fisheries harvest, improved economic efficiency of fishing; coastal and EEZ development and management - optimized waste disposal, reduced costs of beach nourishment, improved oil spill cleanup, more effective search and rescue. A similar list of secondary benefits is also contained in the report.

A range of oceanographic services for clients is desirable and possible, from real time exchange of data for operation purposes, to provision of information, expertise and analyses based on the results of research programs. Comprehensive surveys of needs and opportunities have been undertaken in a number of countries (DFO/MEDS, 1988). In many instances the data available is too sparse in time and space to create data products by simple averaging and display tools. Meteorology has developed sophisticated data assimilation schemes within their forecast models to deal with their predictive efforts; similar efforts will have to be done for ocean products. Success has been evident in some areas; these are summarized in the IOC/WMO IGOSS Products Bulletin (1994). Some agencies, such as the Japan Meteorological Agency (1993) prepare comprehensive brochures outlining real time oceanographic data and products available in their country.

It costs resources and time to exchange oceanographic data in real time. The largest single benefit from this investment of resources is to understand the ocean so as best to deploy vessels, probes and personnel in areas of direct interest. For instance, it makes no economic sense to send fisheries vessels to areas where the desired species cannot exist because of environmental conditions - the same logic applies for ocean research efforts, deployment of defence vessels, etc.

Much of the above discussion goes beyond what is normally thought of as IGOSS data (subsurface temperature, salinity and currents). This report has been prepared in the spirit of viewing IGOSS as an operational oceanography program that looks at any parameter (sea level, etc.) and sensors (remote sensing, etc.) that can be utilized for the common good of all those working in the marine environment.

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QUESTIONNAIRE ON THE ECONOMIC BENEFITS OF IGOSS DATA

Please complete and forward to: Mr. R.B.L. Stoddart, Physical and Chemical Sciences Directorate, Department of Fisheries and Oceans, 200 Kent Street, Ottawa, Ontario, K1A 0E6, Canada, (or send by facsimile to +(613) 990-5510; E-mail: Oceanscience.ottawa).

1. Does your country/agency/company provide ocean services (products or data) in operational time frames that are driven by economic considerations? If yes please describe briefly in a sentence or two per initiative, including an indication of the actual time frame for each service. Also, identify the economic sector being served, e.g. fisheries, transportation, offshore energy, etc.

2. (i) What are the costs to your agency, for each product, of providing the services;

   (ii) what are the financial benefits achieved, either directly or indirectly? Be as specific as possible, even where only narrative justification is given rather than a cost/benefit analysis.

3. Do users pay for the provision of these services? If so, do the funds recovered meet the incremental costs of the provision of the service? Exceed it?

4. Are there documented spin-off benefits from operational data used for additional purposes, such as engineering design criteria for ships, rigs, etc.?

5. Are there specific operational oceanographic services, that are technically and scientifically feasible, that you currently do not provide but that you have been approached to undertake? If so, what are they? Also, have the proponents indicated a willingness to pay for such services, even partially?

6. Are the economic benefits of providing operational oceanographic (IGOSS) data and products documented in available literature? If so please provide a full reference, and if possible the actual document along with this completed questionnaire.

7. Can you provide any additional rationale or examples on the economic benefits of IGOSS data that would help to expand or strengthen the attached draft paper prepared by the rapporteur from Canada. If so, please provide a paragraph or two that could be included in the paper, or a page or two that could be appended to the paper as a specific example of the economic benefits of the IGOSS programme.

8. Other considerations that you feel could prove useful.

   Name, affiliation, address, fax and E-mail of the individual completing this questionnaire.

IGOSS DATA FLOW MONITORING

-Exchange of BATHY/TESAC/TRACKOB Bulletins on the GTS-

P. Kerherve, WMO

1. Procedures for the exchange of BATH/TESAC/TRACKOB bulletins on the GTS

1.1 The BATHY/TESAC/TRACKOB reports are compiled into GTS bulletins before their insertion into the GTS. A GTS bulletin is defined by an abbreviated heading.

1.2 The format of the abbreviated headings shall be in conformity with the standard practices given in Publication WMO-No. 9 (Manual on the GTS - Volume I - Part II - paragraph 2.3.2); the part $T_1T_2A_1A_2ii$ of the abbreviated headings of BATHY/TESAC/TRACKOB bulletins shall have the following format:

T_1T_2 =	SO	
A_1 =		W (for ocean weather stations) and V (for mobile ships or other marine stations)
A_2 =		A, B, C, D, E, F, J or X depending on the area from which the reports contained in the bulletin originate,
ii =		01-19 inclusive for global distribution,
ii =		20-39 inclusive for regional and interregional distribution,
ii =		40-89 inclusive for national and bilaterally agreed distribution.

More details can be found in the above-mentioned paragraph 2.3.2 of the Manual on the GTS.

1.3 Volume C of WMO Publication No. 9 contains the Catalogue of Meteorological Bulletins which gives for each compiling or editing centre of the GTS the list of meteorological bulletins being transmitted for global, interregional and regional exchange. The Catalogue of Meteorological Bulletins is updated by the WMO Secretariat on the basis of the information provided by WMO Members; centres are kept informed by the WMO Secretariat of any change in the Catalogue of Meteorological Bulletins through METNO messages inserted into the GTS, the monthly letter of the operation of the WWW and Marine meteorological Services and/or the new editions of the Catalogue of Meteorological Bulletins.

1.4 The BATHY/TESAC/TRACKOB bulletins, like any other GTS bulletins, are exchanged on the GTS according to predetermined transmission schedules based on the abbreviated headings identifying the bulletins. At the automated GTS centres, the information required to implement these transmission schedules is contained in tables, called the switching directory of the GTS centre. The end-users (such as the oceanographical centres) should define the transmission schedules with the GTS centres from which they receive the GTS bulletins; information related to any difficulties met in the reception of the required data should be sent to this GTS centre. It is suggested that oceanographical centres and GTS centres review regularly matters related to the exchange of BATHY/TESAC/TRACKOB bulletins, and develop arrangements to ensure that efficient remedial action be undertaken in case of difficulties, like the designation of focal points for the exchange of BATHY/TESAC/TRACKOB bulletins at the oceanographical centres and the GTS centres

1.5 In the accordance with the Manual on the GTS, all available BATHY/TESAC/TRACKOB reports (up to 30 days after the time of observation) should be exchanged at the global level (on the part of the GTS called the main telecommunication network). This means that all these reports should be compiled at least in one GTS bulletin with the part ii of its abbreviated heading being included in the sequence 01-19.

1.6 The same BATHY/TESAC/TRACKOB report may be compiled into several bulletins by GTS centres. There are two main reasons:

(a) The GTS may be used to transmit reports compiled within a first bulletin from a collecting centre (e.g. an operator of meteorological satellites) to the centre responsible for the insertion of the report into the GTS for its global distribution. In this respect, the responsible centre will compile the report within a second bulletin. With a view to ensuring its global distribution, the part ii of the abbreviated heading of the second bulletin should be included in the sequence 01-19 (see above paragraph 1.5).

(b) With a view to facilitating the regional or national distribution of reports, a GTS centre may wish to compile or recompile reports within different bulletins.

2. Monitoring of the exchange of BATHY/TESAC/TRACKOB bulletins on the GTS

1994 annual global monitoring

2.1 Within the framework of the plan for monitoring the operation of the World Weather Watch (WWW), an annual global monitoring exercise on the availability at WWW centres of data exchanged on the GTS is carried out from 1 to 15 October. This annual global monitoring of the operation of the WWW includes the monitoring of the availability of BATHY/TESAC/TRACKOB bulletins.

2.2 With a view to ensuring that the monitoring centres monitor the same set of data, a reference monitoring data set is defined as the list of bulletins to be globally exchanged on the GTS. This list is comprised by the bulletins having an abbreviated heading with ii included in the sequence 01-19. The list prepared for the 1994 annual global monitoring is given in Appendix A.

2.3 The analysis of the monitoring results provided by Tokyo, Toulouse and Washington is given in Appendix A. Table 1 shows the number of bulletins received at the centres within the five and 15 minutes following the earliest time of reception for each bulletin as well as the total number of bulletins received. Table 2 shows the availability in terms of percentage of the number of bulletins received by each centre in comparison with the total number of bulletins received by the three centres. Table 3 shows for each bulletin received by at least one of the three centres the differences in the times of reception and in the number of reports received by each centre.

2.4 The summary of the results given in Appendix A shows that:

(a) Tokyo, Toulouse and Washington received 87.5 per cent, 98.1 per cent and 98.5 per cent of the bulletins;

(b) Nearly all the bulletins were received within 10 minutes.

2.5 Table 3 of Appendix A shows that the three centres did not receive systematically bulletins having the same parts of the abbreviated headings (CCCC or $T_1T_2A_1A_2$ii CCCC). Tokyo reported not to have received the 34 bulletins compiled by Oslo (ENMI) and ESWI (Norköpping) and the 19 bulletins SOVX11 RJTD (from Tokyo). Toulouse reported not to have received the three bulletins compiled by Buenos Aires (SABM). Washington reported not to have received the two bulletins compiled by ESWI (Norköpping). The systematic non-reception of bulletins constitutes the main deficiency since the number of other missing reports is five or six for each centre (about one per cent of the total number of bulletins received). This deficiency may be due to problems in the implementation of the monitoring (some bulletins were not monitored) or in the updating of switching directories at GTS centres.

Further monitoring activities

2.6 Within the framework of the WWW Programme, a pilot monitoring of the main telecommunication network (MTN) of the GTS is being carried out. The objective of this monitoring is to complement the annual global monitoring; GTS (MTN) centres will share the workload of monitoring on a quasi-continuous basis the data set exchanged on the GTS. More detailed information on the pilot MTN monitoring is given in Appendix B.

2.7 The meeting may wish to consider arrangements for a more efficient use of the analysis of the monitoring results. A proposal would be that the analysis of the results of the annual global monitoring of the WWW operation related to the BATHY/TESAC/TRACKOB bulletins be distributed to the oceanographical centres. Thus the oceanographical centres could compare the bulletins available at GTS centres with the bulletins that they received during the same period; this comparison could form a basis for discussion with the GTS centres from which they received the bulletins. In this respect, the oceanographical centres should carry out the WWW monitoring activities in accordance with the relevant procedures included in the Manual on the GTS. The oceanographical centres should participate at least in the annual global monitoring; a few could participate in the next phases of the pilot MTN monitoring.

Appendix A

Summary of the results of 1994 annual global monitoring of the operation of the WWW related to BATHY/TESAC/TRACKOB bulletins

1. Reference monitoring data set

The reference monitoring data set is defined as the list of the bulletins to be globally exchanged on the GTS. This list is comprised by the bulletins having an abbreviated heading with ii included in the sequence 01-19. The 1994 list, based on the edition of May 1994 of the Volume C (Catalogue of meteorological bulletins) of WMO Publication No. 9, is the following:

SOVA01 EGRR	SOVA02 EGRR	SOVA10 RUMS	SOVB01 EGRR	SOVB01 VTBB	SOVB02 EGRR
SOVB10 RUHB	SOVB10 RUMS	SOVC01 EGRR	SOVC01 SABM	SOVC01 SBBR	SOVC01 SKBO
SOVC02 EGRR	SOVC10 RUHB	SOVC10 RUMS	SOVD01 BIRK	SOVD01 CWHF	SOVD01 CWPF
SOVD01 EGRR	SOVD01 KWBC	SOVD02 BIRK	SOVD02 CWOW	SOVD02 EGRR	SOVD02 KWBC
SOVD03 KWBC	SOVD04 KWBC	SOVD05 KWBC	SOVD06 KWBC	SOVD07 KWBC	SOVD08 KWBC
SOVD09 KWBC	SOVD10 RUHB	SOVD10 RUMS	SOVD11 KWBC	SOVD12 KWBC	SOVD13 KWBC
SOVE01 AMMC	SOVE01 EGRR	SOVE01 NTAA	SOVE02 AMMC	SOVE02 EGRR	SOVE10 RUHB
SOVF01 BIRK	SOVF01 EDZW	SOVF01 EGRR	SOVF01 ENMI	SOVF01 ESWI	SOVF01 LFPW
SOVF02 BIRK	SOVF02 EGRR	SOVF02 ESWI	SOVF10 RUMS	SOVJ01 EGRR	SOVJ02 EGRR
SOVJ10 RUML	SOVX01 DEMS	SOVX01 RJTD	SOVX02 DEMS	SOVX02 RJTD	SOVX10 RUHB
SOVX10 RUMS	SOVX11 RJTD	SOVX12 RJTD	SOWB01 RJTD	SOWF01 ENMI	

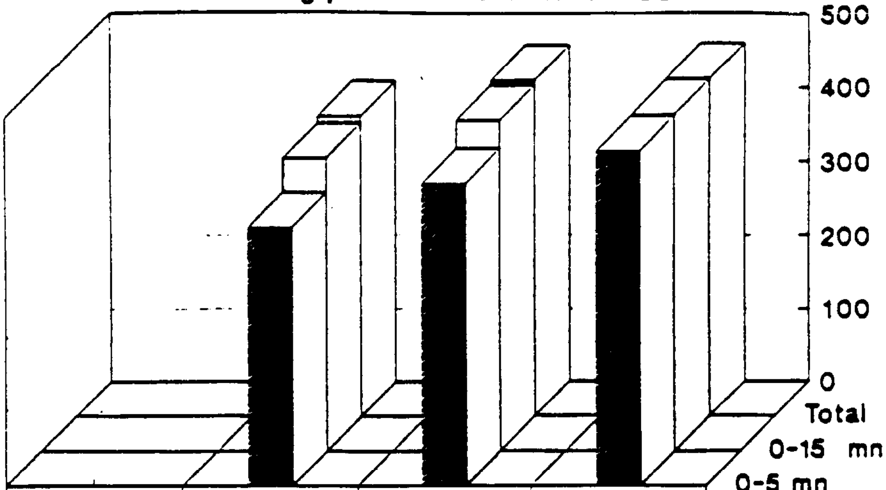
2. Summary of the analysis of the monitoring results provided by Tokyo, Toulouse and Washington

The summary of the analysis of the monitoring results provided by Tokyo, Toulouse and Washington is given in the following Tables 1 to 3.

Appendix A, p. 2

Table 1

Number of BATHY/TESAC/TRACKOB bulletins received at Tokyo, Toulouse and Washington
Monitoring period: 1-15 October 1994

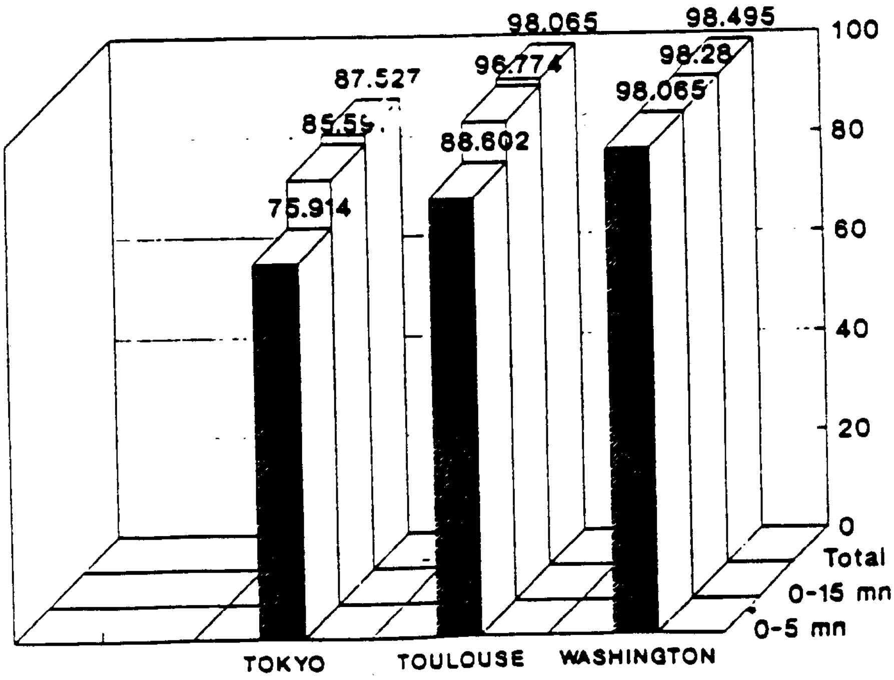


	TOKYO	TOULOUSE	WASHINGTON
Total	407	456	458
0-15 mn	398	450	457
0-5 mn	353	412	456

Table 2

Percentage of the number of BATHY/TESAC/TRACKOB bulletins received at Tokyo, Toulouse and Washington in comparison with the total number of bulletins received by the three centres

Monitoring period: 1-15 October 1994



Appendix A, p. 3

Table 3

Comparison of the times of reception of the bulletins and of the numbers of reports received within the bulletins

Description of the contents of the columns

Column	Abbreviation	Description
1	Bulletin	Abbreviated heading of the bulletin (see note 1)
2	TR	Earliest time of reception
3	TTOK	Difference (in minutes) between the time of reception at Tokyo and the earliest time of reception (see note 2)
4	TTOU	Difference (in minutes) between the time of reception at Toulouse and the earliest time of reception (see note 2)
5	TWAS	Difference (in minutes) between the time of reception at Washington and the earliest time of reception (see note 2)
6	NR	Maximum number of reports received by the three centres
7	RTOK	Difference between the maximum number of reports received by the three centres and the number of reports received at Tokyo
8	RTOU	Difference between the maximum number of reports received by the three centres and the number of reports received at Toulouse
9	RWAS	Difference between the maximum number of reports received by the three centres and the number of reports received at Washington

Note 1: The complete abbreviated heading includes the following groups:

$T_1T_2A_1A_2ii$ CCCC YYGGgg (BBB)

with:

$T_1T_2A_1A_2ii$: As detailed in paragraph 1.2

CCCC: Location indicator of the compiling centre

YYGGgg: Group date/time of the compilation (day of the month: YY; hour: GG; minutes: gg)

BBB: Optional group (e.g. sequencing retard bulletins: RRA, RRB, etc.)

Note 2: A blank in the columns TTOK, TTOU or TWAS means that the relevant centre did not report to have received the relevant bulletin

Appendix A, Table 3, P. 1

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
AMMC								
SOVE01 AMMC 031200	031200	0	1	0	4	1	0	1
SOVE01 AMMC 040000	040000	0	2	0	2	0	0	0
SOVE01 AMMC 041200	041200	0	3	0	5	2	0	2
SOVE01 AMMC 050000	050000	0	3	0	3	0	0	0
SOVE01 AMMC 051200	051200	0	3	0	18	3	0	3
SOVE01 AMMC 060000	060000	0	2	0	6	0	0	0
SOVE01 AMMC 061200	061200	0	2	0	8	0	0	0
SOVE01 AMMC 070000	070000	0	3	0	3	1	0	1
SOVE01 AMMC 071200	071200	0	3	0	4	0	0	0
SOVE01 AMMC 080000	080000	0	2	0	4	0	0	0
SOVE01 AMMC 091200	091200	0	2	0	4	0	0	0
SOVE01 AMMC 101200	101200	0	3	0	6	0	0	0
SOVE01 AMMC 111200	111200	0	3	0	4	0	0	0
SOVE01 AMMC 131200	131200	0	3	0	3	0	0	0
Total number of reports for AMMC					74	7	0	7
CWOW								
SOVD02 CWOW 031750	031845	3	3	0	4	0	0	0
Total number of reports for CWOW					4	0	0	0
EDZW								
SOVF01 EDZW 050729	050732	4	0	1	34	5	0	10
SOVF01 EDZW 050937	050936	4	0	1	10	0	0	0
SOVF01 EDZW 050938	050938	2	0	0	10	0	0	0
SOVF01 EDZW 051006	051006	3	0	0	3	3	0	0
SOVF01 EDZW 051027	051027	5	0	0	3	3	0	0
SOVF01 EDZW 051038	051038	2	0	1	3	3	0	0
SOVF01 EDZW 051055	051057	2	0	0	19	0	0	4
SOVF01 EDZW 061046	061046	1	0	0	4	4	0	0
SOVF01 EDZW 061108	061108	3	0	0	2	2	0	0
SOVF01 EDZW 061410	061411	4	0	0	5	5	0	0
SOVF01 EDZW 101327	101327	3	0	0	18	0	0	0
SOVF01 EDZW 101331	101331	3	0	0	18	0	0	0
SOVF01 EDZW 101354	101355	3	0	0	5	5	0	0
SOVF01 EDZW 101404	101405	4	0	0	25	0	0	0
SOVF01 EDZW 101418	101419	1	0	0	25	0	0	0
SOVF01 EDZW 101426	101427	3	0	0	25	0	0	0
SOVF01 EDZW 110702	110703	3	0	0	25	0	0	0
SOVF01 EDZW 110712	110713	4	0	0	25	0	0	0
SOVF01 EDZW 110726	110727	3	0	0	25	0	0	0
SOVF01 EDZW 110738	110739	3	0	0	25	0	0	0
SOVF01 EDZW 110838	110839	1	0	0	21	0	0	0
SOVF01 EDZW 110908	110907	4	0	0	4	4	0	0
SOVF01 EDZW 110925	110925	3	0	0	4	4	0	0
SOVF01 EDZW 110940	110940	4	0	0	4	4	0	0
Total number of reports for EDZW					342	42	0	14

Appendix A, Table 3, P. 2

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
BGRR								
SOVF01 BGRR 010021	010045	0	0	0	1	0	0	0
SOVF01 BGRR 020021	020024	0	0	0	1	0	0	0
SOVF01 BGRR 021221	021224	20	1	0	1	0	0	0
SOVF01 BGRR 021228	021232	22	5	0	1	0	0	0
SOVF01 BGRR 021828	021837	3	1	0	1	0	0	0
SOVF01 BGRR 030021	030026	0	0	0	1	0	0	0
SOVF01 BGRR 031221	031232	3	0	0	1	0	0	0
SOVF01 BGRR 031828	031833	2	8	0	1	0	0	0
SOVF01 BGRR 040021	040025	1	1	0	1	0	0	0
SOVF01 BGRR 040028	040032	1	0	0	1	0	0	0
SOVF01 BGRR 040628	040632	0	0	0	1	0	0	0
SOVF01 BGRR 041228	041245	0	0	0	1	0	0	0
SOVF01 BGRR 051221	051308	1	3	0	1	0	0	0
SOVF01 BGRR 060021	060027	0	0	0	1	0	0	0
SOVF01 BGRR 061221	061301	0	0	0	1	0	0	0
SOVF01 BGRR 071221	071226	0	0	0	1	0	0	0
SOVF01 BGRR 080021	080047	0	0	0	1	0	0	0
SOVF01 BGRR 081221	081222	0	0	0	1	0	0	0
SOVF01 BGRR 090021	090028	0	0	0	1	0	0	0
SOVF01 BGRR 090628	090632	0	0	0	1	0	0	0
SOVF01 BGRR 091221	091223	0	0	0	1	0	0	0
SOVF01 BGRR 100021	100027	0	1	0	1	0	0	0
SOVF01 BGRR 100028	100030	0	1	0	1	0	0	0
SOVF01 BGRR 100628	100632	1	1	0	1	0	0	0
SOVF01 BGRR 101221	101228	0	0	0	1	0	0	0
SOVF01 BGRR 101828	101832	1	0	0	1	1	0	0
SOVF01 BGRR 110021	110026	0	0	0	1	0	0	0
SOVF01 BGRR 110028	110029	0	0	0	1	1	0	0
SOVF01 BGRR 110628	110631	0	0	0	1	0	0	0
SOVF01 BGRR 111221	111225	2	0	0	1	0	0	0
SOVF01 BGRR 111228	111234	0	0	0	1	0	0	0
SOVF01 BGRR 111828	111833	2	0	0	1	0	0	0
SOVF01 BGRR 120021	120034	0	0	0	1	0	0	0
SOVF01 BGRR 120628	120634	0	0	0	1	0	0	0
SOVF01 BGRR 121221	121239	5	0	1	1	0	0	0
SOVF01 BGRR 121228	121241	4	0	1	1	0	0	0
SOVF01 BGRR 122300 RTD	130349	3	3	0	1	0	0	0
SOVF01 BGRR 130000	130550	1	13	0	1	0	0	0
SOVF01 BGRR 130028	130030	0	0	0	1	0	0	0
SOVF01 BGRR 130628	130634	0	0	0	1	1	0	0
SOVF01 BGRR 131221	131236	1	0	1	1	0	0	0
SOVF01 BGRR 140021	140023	0	0	0	1	0	0	0
SOVF01 BGRR 141221	141238	0	0	0	1	0	0	0
SOVF01 BGRR 150021	150026	3	0	1	1	0	0	0
SOVF01 BGRR 150621	150628	0	0	0	1	0	0	0
SOVF01 BGRR 151221	151225	0	0	0	1	0	0	0
SOVF01 BGRR 151821	151822	43	0	0	1	0	0	0
SOVF01 BGRR 151822	151828	38	0	0	1	0	0	0
SOVF01 BGRR 302300 COR	010240	0			1	0	1	1
Total number of reports for BGRR					49	3	1	1

Appendix A, Table 3, P. 3

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
ENMI								
SOVF01 ENMI 071200	071305		0	0	1	1	0	0
SOVF01 ENMI 071300	071429		0	4	1	1	0	0
SOVF01 ENMI 080000	080053		0	0	1	1	0	0
SOVF01 ENMI 081600	081706		0	0	1	1	0	0
SOVF01 ENMI 090000	090053		0	0	1	1	0	0
SOVF01 ENMI 090300	090355		0	0	1	1	0	0
SOVF01 ENMI 090400	090506		0	2	1	1	0	0
SOVF01 ENMI 090500	090608		0	0	1	1	0	0
SOVF01 ENMI 090800	090906		0	0	1	1	0	0
SOVF01 ENMI 091000	091108		0	0	1	1	0	0
SOVF01 ENMI 091200	091306		0	0	1	1	0	0
SOVF01 ENMI 091400	091506		0	0	1	1	0	0
SOVF01 ENMI 091900	092006		0	0	1	1	0	0
SOVF01 ENMI 092200	092252		0	0	1	1	0	0
SOVF01 ENMI 100000	100053		0	0	1	1	0	0
SOVF01 ENMI 100200	100253		0	1	1	1	0	0
SOVF01 ENMI 100800	100909		0	0	1	1	0	0
SOVF01 ENMI 101600	101706		0	1	1	1	0	0
SOVF01 ENMI 110300	110353		0	0	1	1	0	0
SOVF01 ENMI 110600	110653		0	0	1	1	0	0
SOVF01 ENMI 110900	111006		0	0	1	1	0	0
SOVF01 ENMI 111200	111307		0	0	1	1	0	0
SOVF01 ENMI 111600	111706		0	3	1	1	0	0
SOVF01 ENMI 112100	112153		0	0	1	1	0	0
SOVF01 ENMI 120000	120053		0	0	1	1	0	0
SOVF01 ENMI 121000	121106		0	0	1	1	0	0
SOVF01 ENMI 122000	122053		0	0	1	1	0	0
SOVF01 ENMI 130200	130254		0	0	1	1	0	0
SOVF01 ENMI 131200	131307		0	1	1	1	0	0
SOVF01 ENMI 131500	131607		0	0	1	1	0	0
SOVF01 ENMI 140200	140255		0	0	1	1	0	0
SOVF01 ENMI 140900	141007		0	0	1	1	0	0
SOVF01 ENMI 141200	141308		0	0	1	1	0	0
SOVF01 ENMI 141800	141856		0	0	1	1	0	0
Total number of reports for ENMI					34	34	0	0
ESWI								
SOVF01 ESWI 101000	100954		0		2	2	0	2
SOVF01 ESWI 121000	121005	0	0		1	0	0	1
Total number of reports for ESWI					3	2	0	3
KWBC								
SOVD01 KWBC 031723	031723	5	3	0	17	0	0	0
SOVD01 KWBC 031723 RRA	031723	6	3	0	16	0	0	0
SOVD01 KWBC 031723 RRB	031723	6	3	0	16	0	0	0
SOVD01 KWBC 031723 RRC	031723	6	3	0	18	0	0	0
SOVD01 KWBC 031723 RRD	031723	6	3	0	26	0	0	0
SOVD01 KWBC 031723 RRE	031723	6	3	0	26	0	0	0

Appendix A, Table 3, P. 4

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
SOVD01 KWBC 031723 RRF	031723	7	3	0	26	0	0	0
SOVD01 KWBC 031723 RRG	031723	7	3	0	26	0	0	0
SOVD01 KWBC 031723 RRH	031723	7	3	0	27	0	0	0
SOVD01 KWBC 031723 RRI	031723	7	3	0	25	0	0	0
SOVD01 KWBC 041723	041723	8	9	0	16	0	0	0
SOVD01 KWBC 041723 RRA	041723	8	9	0	19	0	0	0
SOVD01 KWBC 041723 RRB	041723	8	9	0	26	0	0	0
SOVD01 KWBC 041723 RRC	041723	8	9	0	22	0	0	0
SOVD01 KWBC 051522	051523	2	2	0	16	0	0	0
SOVD01 KWBC 051522 RRA	051523	2	2	0	17	0	0	0
SOVD01 KWBC 051522 RRB	051523	2	2	0	26	0	0	0
SOVD01 KWBC 051522 RRC	051523	2	2	0	25	0	0	0
SOVD01 KWBC 061719	061718	3	3	0	14	0	0	0
SOVD01 KWBC 061719 RRA	061718	3	3	0	16	0	0	0
SOVD01 KWBC 061719 RRB	061718	3	3	0	19	0	0	0
SOVD01 KWBC 061719 RRC	061718	3	3	0	26	0	0	0
SOVD01 KWBC 061719 RRD	061718	4	3	0	23	0	0	0
SOVD01 KWBC 071558	071558	2	2	0	15	0	0	0
SOVD01 KWBC 071558 RRA	071558	2	2	0	16	0	0	0
SOVD01 KWBC 071558 RRB	071558	3	2	0	21	0	0	0
SOVD01 KWBC 071558 RRC	071558	3	2	0	26	0	0	0
SOVD01 KWBC 071558 RRD	071558	3	2	0	16	0	0	0
SOVD01 KWBC 111757	111758	5	5	0	15	0	0	0
SOVD01 KWBC 111757 RRA	111758	5	5	0	14	0	0	0
SOVD01 KWBC 111757 RRB	111758	5	5	0	16	0	0	0
SOVD01 KWBC 111757 RRC	111758	6	5	0	15	0	0	0
SOVD01 KWBC 111757 RRD	111758	6	5	0	15	0	0	0
SOVD01 KWBC 111757 RRE	111758	6	6	0	15	0	0	0
SOVD01 KWBC 111757 RRF	111758	6	6	0	15	0	0	0
SOVD01 KWBC 111757 RRG	111758	6	6	0	19	0	0	0
SOVD01 KWBC 111757 RRH	111758	6	6	0	18	0	0	0
SOVD01 KWBC 111757 RRI	111758	6	6	0	16	0	0	0
SOVD01 KWBC 111757 RRJ	111758	7	6	0	14	0	0	0
SOVD01 KWBC 111757 RRK	111758	7	6	0	20	0	0	0
SOVD01 KWBC 111757 RRL	111758	7	6	0	26	0	0	0
SOVD01 KWBC 111757 RRM	111758	7	6	0	25	0	0	0
SOVD01 KWBC 111757 RRN	111758	7	6	0	26	0	0	0
SOVD01 KWBC 111757 RRO	111758	7	7	0	25	0	0	0
SOVD01 KWBC 111757 RRP	111758	8	7	0	26	0	0	0
SOVD01 KWBC 111757 RRQ	111758	8	7	0	26	0	0	0
SOVD01 KWBC 111757 RRR	111758	8	7	0	26	0	0	0
SOVD01 KWBC 111757 RRS	111758	8	7	0	25	0	0	0
SOVD01 KWBC 111757 RRT	111758	8	7	0	9	0	0	0
SOVD01 KWBC 121736	121732	7	3	0	16	0	0	0
SOVD01 KWBC 121736 RRA	121732	8	3	0	14	0	0	0
SOVD01 KWBC 121736 RRB	121732	8	3	0	19	0	0	0
SOVD01 KWBC 121736 RRC	121732	8	3	0	26	0	0	0
SOVD01 KWBC 121736 RRD	121732	8	3	0	18	0	0	0
SOVD01 KWBC 131531	131531	3	3	0	15	0	0	0
SOVD01 KWBC 131531 RRA	131531	3	4	0	15	0	0	0
SOVD01 KWBC 131531 RRB	131531	3	4	0	20	0	0	0
SOVD01 KWBC 131531 RRC	131531	3	4	0	26	0	0	0
SOVD01 KWBC 131531 RRD	131531	3	4	0	20	0	0	0
SOVD01 KWBC 141459	141459	2	2	0	16	0	0	0

Appendix A, Table 3, P. 5

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
SOVD01 KWBC 141459 RRA	141459	2	3	0	14	0	0	0
SOVD01 KWBC 141459 RRB	141459	2	3	0	16	0	0	0
SOVD01 KWBC 141459 RRC	141459	3	3	0	23	0	0	0
SOVD01 KWBC 141459 RRD	141459	3	3	0	25	0	0	0
SOVD01 KWBC 141459 RRE	141459	3	3	0	11	0	0	0
SOVD06 KWBC 031723	031723	7	3	0	10	0	0	0
SOVD06 KWBC 041723	041724	7	3	0	1	0	0	0
SOVD06 KWBC 071558	071558	3	2	0	2	0	0	0
SOVD06 KWBC 111757	111759	7	7	0	2	0	0	0
Total number of reports for KWBC					1297	0	0	0
LFPW								
SOVF01 LFPW 031500	031630	1	0	2	13	0	0	0
SOVF01 LFPW 031500 RRA	031632	1	0	2	13	0	0	0
SOVF01 LFPW 031500 RRB	031632	1	0	2	13	0	0	0
SOVF01 LFPW 031500 RRC	031633	0	0	1	13	0	0	0
SOVF01 LFPW 031500 RRD	031633	0	0	1	7	0	0	0
SOVF01 LFPW 041500	041632	0	0	2	13	0	0	0
SOVF01 LFPW 041500 RRA	041632	0	0	2	5	0	0	0
SOVF01 LFPW 051500	051631	0	0	1	13	0	0	0
SOVF01 LFPW 051500 RRA	051631	0	0	1	6	0	0	0
SOVF01 LFPW 061500	061631	0	0	3	11	0	0	0
SOVF01 LFPW 101500	101630	1	0	3	13	0	0	0
SOVF01 LFPW 101500 RRA	101633	5760	5758	0	13	0	0	0
SOVF01 LFPW 101500 RRB	101633	5760	5758	0	13	0	0	0
SOVF01 LFPW 101500 RRC	101633	5761	5758	0	6	0	0	0
SOVF01 LFPW 111500	111631	2	0	6	13	0	0	0
SOVF01 LFPW 121500	121631	0	0	4	5	0	0	0
SOVF01 LFPW 141500 RRC	141634	31		0	6	0	6	0
Total number of reports for LFPW					176	0	6	0
RJTD								
SOVX01 RJTD 011743	011743	0	3	0	1	0	0	0
SOVX01 RJTD 012043	012043	0	2	0	1	0	0	0
SOVX01 RJTD 012313	012313	0	2	0	1	0	0	0
SOVX01 RJTD 020243	020243	0	3	0	1	0	0	0
SOVX01 RJTD 020543	020543	0	7	0	1	0	0	0
SOVX01 RJTD 020843	020843	0	1	0	1	0	0	0
SOVX01 RJTD 021113	021113	0	2	0	1	0	0	0
SOVX01 RJTD 021443	021443	0	3	0	3	0	0	0
SOVX01 RJTD 022043	022043	0	2	0	2	0	0	0
SOVX01 RJTD 022313	022313	0	2	0	1	0	0	0
SOVX01 RJTD 030201	030339		4	0	4	4	0	0
SOVX01 RJTD 030243	030243	0	2	0	2	0	0	0
SOVX01 RJTD 030543	030543	0	2	0	1	0	0	0
SOVX01 RJTD 030843	030843	0	3	0	1	0	0	0
SOVX01 RJTD 031113	031113	0	2	0	1	0	0	0
SOVX01 RJTD 031443	031443	0	3	0	2	0	0	0
SOVX01 RJTD 040243	040243	0	2	0	3	0	0	0
SOVX01 RJTD 040843	040843	0	3	0	1	0	0	0

Appendix A, Table 3, P. 6

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(RR)	(RTOK)	(RTOU)	(RWAS)
SOVX01 RJTD 041443	041443	0	2	1	5	0	0	0
SOVX01 RJTD 041743	041743	0	6	0	4	0	0	0
SOVX01 RJTD 042043	042043	0	2	0	3	0	0	0
SOVX01 RJTD 042313	042313	0	2	0	5	0	0	0
SOVX01 RJTD 050243	050243	0	1	0	6	0	0	0
SOVX01 RJTD 050543	050543	0	6	0	5	0	0	0
SOVX01 RJTD 050843	050843	0	2	0	5	0	0	0
SOVX01 RJTD 051113	051113	0	2	0	4	0	0	0
SOVX01 RJTD 051443	051443	0	5	0	5	0	0	0
SOVX01 RJTD 051743	051743	0	8	0	2	0	0	0
SOVX01 RJTD 052043	052043	0	2	0	3	0	0	0
SOVX01 RJTD 052313	052313	0	3	0	4	0	0	0
SOVX01 RJTD 060243	060243	0	3	0	3	0	0	0
SOVX01 RJTD 060543	060543	0	7	0	2	0	0	0
SOVX01 RJTD 060843	060843	0	2	0	5	0	0	0
SOVX01 RJTD 061113	061113	0	1	0	2	0	0	0
SOVX01 RJTD 061443	061443	0	2	0	5	0	0	0
SOVX01 RJTD 061743	061743	0	7	0	4	0	0	0
SOVX01 RJTD 062043	062043	0	3	0	3	0	0	0
SOVX01 RJTD 062313	062313	0	2	0	4	0	0	0
SOVX01 RJTD 070843	070843	0	2	0	5	0	0	0
SOVX01 RJTD 071113	071113	0	2	0	3	0	0	0
SOVX01 RJTD 071443	071443	0	3	0	2	0	0	0
SOVX01 RJTD 071743	071743	0	20	0	8	0	0	0
SOVX01 RJTD 072043	072043	0	2	0	4	0	0	0
SOVX01 RJTD 072313	072313	0	2	0	3	0	0	0
SOVX01 RJTD 080243	080243	0	2	0	3	0	0	0
SOVX01 RJTD 080543	080543	0	3	0	3	0	0	0
SOVX01 RJTD 080843	080843	0	3	0	5	0	0	0
SOVX01 RJTD 081113	081113	0	2	0	3	0	0	0
SOVX01 RJTD 081443	081443	0	2	0	2	0	0	0
SOVX01 RJTD 081743	081743	0	2	0	3	0	0	0
SOVX01 RJTD 082043	082043	0	2	0	2	0	0	0
SOVX01 RJTD 082313	082313	0	3	0	2	0	0	0
SOVX01 RJTD 090243	090243	0	2	0	3	0	0	0
SOVX01 RJTD 090543	090543	0	3	0	2	0	0	0
SOVX01 RJTD 090843	090843	0	3	0	1	0	0	0
SOVX01 RJTD 091113	091113	0	2	0	1	0	0	0
SOVX01 RJTD 091443	091443	0	3	0	3	0	0	0
SOVX01 RJTD 091743	091743	0	2	0	2	0	0	0
SOVX01 RJTD 092043	092043	0	2	0	2	0	0	0
SOVX01 RJTD 092313	092313	0	3	0	2	0	0	0
SOVX01 RJTD 100243	100243	0	3	0	1	0	0	0
SOVX01 RJTD 100543	100543	0	4	0	2	0	0	0
SOVX01 RJTD 100843	100843	0	1	0	1	0	0	0
SOVX01 RJTD 101113	101113	0	3	0	2	0	0	0
SOVX01 RJTD 101443	101443	0	3	0	1	0	0	0
SOVX01 RJTD 101743	101743	0	2	0	2	0	0	0
SOVX01 RJTD 102043	102043	0	2	0	1	0	0	0
SOVX01 RJTD 102313	102313	0	3	0	2	0	0	0
SOVX01 RJTD 110243	110243	0	4	0	3	0	0	0
SOVX01 RJTD 110543	110543	0	3	0	1	0	0	0
SOVX01 RJTD 110843	110843	0	3	0	2	0	0	0
SOVX01 RJTD 111113	111113	0	1	0	2	0	0	0

Appendix A, Table 3, P. 7

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
SOVX01 RJTD 111443	111443	0	3	0	2	0	0	0
SOVX01 RJTD 111743	111743	0	1	0	1	0	0	0
SOVX01 RJTD 112043	112043	0	2	0	3	0	0	0
SOVX01 RJTD 120843	120843	0	2	0	1	0	0	0
SOVX01 RJTD 121443	121443	0	1	0	1	0	0	0
SOVX01 RJTD 122043	122043	0	3	0	1	0	0	0
SOVX01 RJTD 130543	130543	0	2	0	1	0	0	0
SOVX01 RJTD 130843	130843	0	1	0	2	0	0	0
SOVX01 RJTD 131113	131113	0	3	0	1	0	0	0
SOVX01 RJTD 131443	131443	0	3	0	1	0	0	0
SOVX01 RJTD 131743	131743	0	2	0	1	0	0	0
SOVX01 RJTD 132043	132043	0		0	2	0	2	0
SOVX01 RJTD 132313	132313	0	2	0	1	0	0	0
SOVX01 RJTD 140243	140243	0	3	0	1	0	0	0
SOVX01 RJTD 140543	140543	0	4	0	1	0	0	0
SOVX01 RJTD 140843	140843	0	2	0	1	0	0	0
SOVX01 RJTD 141113	141113	0	5	0	2	0	0	0
SOVX01 RJTD 141443	141443	0	3	0	3	0	0	0
SOVX01 RJTD 141743	141743	0	3	0	1	0	0	0
SOVX01 RJTD 142043	142043	0	2	0	3	0	0	0
SOVX01 RJTD 142313	142313	0	2	0	1	0	0	0
SOVX01 RJTD 150243	150243	0	3	0	2	0	0	0
SOVX01 RJTD 150543	150543	0	3	0	2	0	0	0
SOVX01 RJTD 150843	150843	0	3	0	2	0	0	0
SOVX01 RJTD 151113	151113	0	2	0	2	0	0	0
SOVX01 RJTD 151443	151443	0	4	0	2	0	0	0
SOVX01 RJTD 151743	151743	0	2	0	2	0	0	0
SOVX01 RJTD 152043	152043	0	2	0	1	0	0	0
SOVX11 RJTD 010000	010249		2	0	2	2	0	0
SOVX11 RJTD 011200	011449		2	0	2	2	0	0
SOVX11 RJTD 020000	020249		1	0	3	3	0	0
SOVX11 RJTD 030000	030249		2	0	4	4	0	0
SOVX11 RJTD 040000	040249		3	0	4	4	0	0
SOVX11 RJTD 050000	050249		2	0	4	4	0	0
SOVX11 RJTD 060000	060249		3	0	3	3	0	0
SOVX11 RJTD 070000	070249		2	0	2	2	0	0
SOVX11 RJTD 080000	080249		3	0	2	2	0	0
SOVX11 RJTD 090000	090249		3	0	3	3	0	0
SOVX11 RJTD 100000	100249		4	0	3	3	0	0
SOVX11 RJTD 110000	110249		3	0	3	3	0	0
SOVX11 RJTD 111200	111449		2	0	1	1	0	0
SOVX11 RJTD 120000	120249		1	0	3	3	0	0
SOVX11 RJTD 121200	121449		2	0	1	1	0	0
SOVX11 RJTD 130000	130249		1	0	3	3	0	0
SOVX11 RJTD 140000	140249		2	0	2	2	0	0
SOVX11 RJTD 150000	150249		2	0	1	1	0	0
SOVX11 RJTD 151200	151449		2	0	1	1	0	0
SOWB01 RJTD 010240	010240	0	3	0	3	0	0	0
SOWB01 RJTD 010540	010540	0	3	0	3	0	0	0
SOWB01 RJTD 010840	010839	1	3	0	3	0	0	0
SOWB01 RJTD 011140	011140	0	2	0	3	0	0	0
SOWB01 RJTD 011440	011440	0	1	0	3	0	0	0
SOWB01 RJTD 011740	011740	0	0	0	3	0	0	0
SOWB01 RJTD 012040	012040	0	2	0	3	0	0	0

Appendix A, Table 3, P. 8

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(RR)	(RTOK)	(RTOU)	(RWAS)
SOWB01 RJTD 012340	012339	1	3	0	3	0	0	0
SOWB01 RJTD 020240	020239	1	4	0	3	0	0	0
SOWB01 RJTD 020540	020540	0	1	0	3	0	0	0
SOWB01 RJTD 020840	020840	0	3	0	3	0	0	0
SOWB01 RJTD 021140	021140	0	2	0	3	0	0	0
SOWB01 RJTD 021440	021439	1	4	0	3	0	0	0
SOWB01 RJTD 021740	021740	0	1	0	3	0	0	0
SOWB01 RJTD 022040	022040	0	2	0	3	0	0	0
SOWB01 RJTD 022340	022339	1	4	0	3	0	0	0
SOWB01 RJTD 030240	030240	0	2	0	3	0	0	0
SOWB01 RJTD 030540	030540	0	2	0	3	0	0	0
SOWB01 RJTD 030840	030839	1	1	0	3	0	0	0
SOWB01 RJTD 031140	031140	0	2	0	3	0	0	0
SOWB01 RJTD 031440	031439	1	2	0	3	0	0	0
SOWB01 RJTD 031740	031740	0	1	0	2	0	0	0
SOWB01 RJTD 032040	032040	0	4	0	3	0	0	0
SOWB01 RJTD 032340	032340	0	2	0	3	0	0	0
SOWB01 RJTD 040240	040240	0	3	0	3	0	0	0
SOWB01 RJTD 040540	040540	0	3	0	3	0	0	0
SOWB01 RJTD 040840	040840	0	4	0	3	0	0	0
SOWB01 RJTD 041140	041140	0	1	0	3	0	0	0
SOWB01 RJTD 041440	041440	0	4	3	3	0	0	0
SOWB01 RJTD 041740	041739	1	3	0	3	0	0	0
SOWB01 RJTD 042040	042040	0	2	0	3	0	0	0
SOWB01 RJTD 042340	042340	0	2	0	3	0	0	0
SOWB01 RJTD 050240	050240	0	2	0	3	0	0	0
SOWB01 RJTD 050540	050540	0	2	0	3	0	0	0
SOWB01 RJTD 050840	050840	0	3	0	3	0	0	0
SOWB01 RJTD 051140	051139	1	4	0	3	0	0	0
SOWB01 RJTD 051440	051440	0	5	0	3	0	0	0
SOWB01 RJTD 051740	051739	1	3	0	3	0	0	0
SOWB01 RJTD 052040	052040	0	2	0	3	0	0	0
SOWB01 RJTD 052340	052340	0	1	0	3	0	0	0
SOWB01 RJTD 060240	060239	1	4	0	3	0	0	0
SOWB01 RJTD 060540	060539	1	3	0	3	0	0	0
SOWB01 RJTD 060840	060839	1	3	0	3	0	0	0
SOWB01 RJTD 061140	061140	0	4	0	3	0	0	0
SOWB01 RJTD 061440	061439	1	3	0	3	0	0	0
SOWB01 RJTD 061740	061739	1	3	0	3	0	0	0
SOWB01 RJTD 062040	062040	0	3	0	3	0	0	0
SOWB01 RJTD 062340	062339	1	3	0	3	0	0	0
SOWB01 RJTD 070240	070239	1	2	0	3	0	0	0
SOWB01 RJTD 070540	070540	0	2	0	3	0	0	0
SOWB01 RJTD 070840	070839	1	2	0	3	0	0	0
SOWB01 RJTD 071140	071140	0	3	0	3	0	0	0
SOWB01 RJTD 071440	071440	0	4	0	3	0	0	0
SOWB01 RJTD 071740	071739	1	24	0	3	0	0	0
SOWB01 RJTD 072040	072040	0	3	0	3	0	0	0
SOWB01 RJTD 072340	072340	0	2	0	3	0	0	0
SOWB01 RJTD 080240	080240	0	2	0	3	0	0	0
SOWB01 RJTD 080540	080540	0	1	0	3	0	0	0
SOWB01 RJTD 080840	080839	1	4	0	3	0	0	0
SOWB01 RJTD 081140	081140	0	3	0	3	0	0	0
SOWB01 RJTD 081440	081440	0	1	0	3	0	0	0

Appendix A, Table 3, P. 9

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
SOWB01 RJTD 081740	081739	1	3	0	3	0	0	0
SOWB01 RJTD 082040	082040	0	2	0	3	0	0	0
SOWB01 RJTD 082340	082340	0	1	0	3	0	0	0
SOWB01 RJTD 090240	090239	1	3	0	3	0	0	0
SOWB01 RJTD 090540	090540	0	2	0	3	0	0	0
SOWB01 RJTD 090840	090840	0	3	0	3	0	0	0
SOWB01 RJTD 091140	091139	1	3	0	3	0	0	0
SOWB01 RJTD 091440	091439	1	2	0	3	0	0	0
SOWB01 RJTD 091740	091740	0	3	0	3	0	0	0
SOWB01 RJTD 092040	092040	0	2	0	3	0	0	0
SOWB01 RJTD 092340	092340	0	3	0	3	0	0	0
SOWB01 RJTD 100240	100240	0	3	0	3	0	0	0
SOWB01 RJTD 100540	100540	0	3	0	3	0	0	0
SOWB01 RJTD 100840	100840	0	1	0	3	0	0	0
SOWB01 RJTD 101140	101140	0	1	0	3	0	0	0
SOWB01 RJTD 101440	101440	0	3	0	4	0	0	0
SOWB01 RJTD 101740	101740	0	2	0	3	0	0	0
SOWB01 RJTD 102040	102040	0	1	0	3	0	0	0
SOWB01 RJTD 102340	102340	0	2	0	4	0	0	0
SOWB01 RJTD 110240	110240	0	4	0	3	0	0	0
SOWB01 RJTD 110540	110540	0	2	0	3	0	0	0
SOWB01 RJTD 110840	110839	1	3	0	3	0	0	0
SOWB01 RJTD 111140	111139	1	4	0	3	0	0	0
SOWB01 RJTD 111440	111439	1	2	0	3	0	0	0
SOWB01 RJTD 111740	111739	1	3	0	3	0	0	0
SOWB01 RJTD 112040	112039	1	4	0	3	0	0	0
SOWB01 RJTD 112340	112340	0	2	0	3	0	0	0
SOWB01 RJTD 120240	120240	0	2	0	3	0	0	0
SOWB01 RJTD 120540	120539	1	4	0	3	0	0	0
SOWB01 RJTD 120840	120840	0	2	0	5	0	0	0
SOWB01 RJTD 121140	121140	0	38	0	5	0	0	0
SOWB01 RJTD 121440	121439	1	4	0	3	0	0	0
SOWB01 RJTD 121740	121740	0	2	0	3	0	0	0
SOWB01 RJTD 122040	122039	1	2	0	3	0	0	0
SOWB01 RJTD 122340	122339	1	2	0	3	0	0	0
SOWB01 RJTD 130240	130239	1	3	0	3	0	0	0
SOWB01 RJTD 130540	130539	1	2	0	3	0	0	0
SOWB01 RJTD 130840	130840	0	2	0	3	0	0	0
SOWB01 RJTD 131140	131140	0	4	0	3	0	0	0
SOWB01 RJTD 131440	131440	0	3	0	3	0	0	0
SOWB01 RJTD 131740	131739	1	2	0	3	0	0	0
SOWB01 RJTD 132040	132040	0	3	0	3	0	0	0
SOWB01 RJTD 132340	132340	0	3	0	3	0	0	0
SOWB01 RJTD 140240	140240	0	3	0	3	0	0	0
SOWB01 RJTD 140540	140540	0	1	0	3	0	0	0
SOWB01 RJTD 140840	140840	0	2	0	3	0	0	0
SOWB01 RJTD 141140	141139	1	3	0	3	0	0	0
SOWB01 RJTD 141440	141440	0	1	0	3	0	0	0
SOWB01 RJTD 141740	141740	0	3	0	3	0	0	0
SOWB01 RJTD 142040	142039	1	3	0	3	0	0	0
SOWB01 RJTD 142340	142339	1	3	0	3	0	0	0
SOWB01 RJTD 150240	150239	1	3	0	3	0	0	0
SOWB01 RJTD 150540	150540	0	3	0	3	0	0	0
SOWB01 RJTD 150840	150839	1	4	0	3	0	0	0

Appendix A, Table 3, P.10

Bulletins	(TR)	(TTOK)	(TTOU)	(TWAS)	(NR)	(RTOK)	(RTOU)	(RWAS)
SOWB01 RJTD 151140	151140	0	3	0	3	0	0	0
SOWB01 RJTD 151440	151439	1	2	0	3	0	0	0
SOWB01 RJTD 151740	151739	1	2	0	3	0	0	0
SOWB01 RJTD 152040	152040	0	1	0	3	0	0	0
SOWB01 RJTD 152340	152340	0	3	0	3	0	0	0
Total number of reports for RJTD					647	51	2	0
RUHB								
SOVB10 RUHB 010000	010643	27	0	24	4	0	0	0
SOVB10 RUHB 011200	020944	0	0	0	3	0	0	0
SOVB10 RUHB 021200	040838	0			5	0	5	5
SOVB10 RUHB 040000	050030	0			3	0	3	3
SOVB10 RUHB 071200	080605	0	0	0	2	0	0	0
SOVB10 RUHB 300000	010646	0			4	0	4	4
Total number of reports for RUHB					21	0	12	12
RUMS								
SOVF10 RUMS 010600	010647	2	0	0	1	0	0	0
SOVF10 RUMS 021200	021229	2	0	0	1	0	0	0
SOVF10 RUMS 030930	030939	3	0	0	1	0	0	0
SOVF10 RUMS 040600	040616	3	0	1	1	0	0	0
SOVF10 RUMS 051800	051826	2	0		0	0	0	0
SOVF10 RUMS 061200	061341	4	0	0	1	0	0	0
SOVF10 RUMS 070600	070635	2	0	0	1	0	0	0
Total number of reports for RUMS					6	0	0	0
SABM								
SOVC01 SABM 131525	131527			0	4	4	4	0
SOVC01 SABM 131526	131527			0	3	3	3	0
SOVC01 SABM 131527	131528			0	3	3	3	0
Total number of reports for SABM					10	10	10	0
Total number of reports					2663	149	31	37

Appendix B

Pilot MTN monitoring

A. MTN specialized monitoring centres (MSMCs)

1. The monitoring activities require major resources for the preparation of the monitoring results at monitoring centres as well as for the compilation of the monitoring results and their analysis (i.e. at the Secretariat). It is therefore worth to consider how the best use of resources could be made to improve the assessment of the operation of the WWW. It is proposed to:

(a) maintain the annual global monitoring;

(b) share between MTN centres the additional workload required to alleviate the inherent shortcomings of the annual global monitoring. Specialized MTN monitoring centres (MSMCs) would take the responsibility of monitoring specific set of data, on a quasi-continuous basis.

2. It is proposed that three MSMCs undertake the specific monitoring for each set of data, these three centres being located in three different WMO Regions. The various data sets are given in Table A. One of the MSMCs responsible for monitoring a given set of data should take the responsibility of analysing and comparing the availability of the data at the other MSMCs; for this purpose, the MSMCs should sent to the relevant MSMC a copy of the set of messages received at their centres during a defined period (e.g. 15 days) on a diskette or through other media (internet,...). This exchange of sets of messages instead of (processed) monitoring results will make it possible to prepare consistent comparisons at the level of the bulletins as well as the level of the reports, thus avoiding the discrepancies dues to the differences in the implementation of monitoring procedures.

3. The activities of the minimum of the three MSMCs for each set of data could therefore be summarized as follows:

(a) to monitor the reception of the relevant sets of messages and send a copy of the set of messages to the MSMC(s) in charge of their analysis for example every three months with the format given in Appendix;

(b) to prepare analyses of the set of messages sent by the other MSMCs (in particular with a view to comparing the availability of data at the MSMCs) and to dispatch their analysis for example within the next month; at least one of the MSMCs responsible to monitor a specific set of data should undertake this activity.

4. It is proposed to invite those centres having taken responsibilities in the qualitative monitoring of a certain set of data to consider to take the responsibilities of MSMC for the same type of data.

Pilot project

5. With a view to facilitating the start of this new monitoring activity, a pilot project may be established as follows:

(a) MTN centres (e.g. up to three MTN centres for each of the set of data included in Table A included in Appendix, limited to part A for TEMP) sent every three months to the Secretariat a copy of the relevant set of messages in accordance with the format of presentation given in Appendix;

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(b) The Secretariat will develop tools to analyze the set of messages and will review the presentation of the monitoring results and their dispatch to the members of the SG-OM designated by the countries or to other interested experts, in co-ordination with the chairman of SG-OM;

(c) Additional MTN centres may wish to participate in the analysis of the set of messages and co-ordinate their action with the Secretariat.

B. Procedures for the Pilot MTN monitoring

1. Responsibilities of MTN centres

As regards the monitoring and analysis of the set of messages, the responsibilities of the MTN centres are given in Table A.

2. Periods of monitoring

The monitoring should be carried out in two phases:

(a) at first, the MTN centres should send samples of the set of messages received during one day, preferably on 18 April 1995 to the MTN centres in charge of their analysis as well as to the WMO Secretariat; this would make it possible for the analysis centres and the WMO Secretariat to check the formats of presentation of the set of messages, to consider the best means of exchange of the sets and to prepare their analyses;

(b) then, the MTN centres should send the set of messages recorded during the two periods:

(i) 1-15 July 1995;

(ii) 1-15 October 1995.

3. Format of presentation of the set of messages proposed to be sent on diskette to the WMO Secretariat during the pilot project

3.1 The set of data to be monitored is defined in Table A. The format of the messages should preferably be in conformity with paragraph 2 of Part II of the Manual on the GTS in alphabet international No. 5 and, if this is not possible, the differences between this recommended format and the format used should be detailed. The complete message (including the starting line, the abbreviated heading, the text and the end-of-message signals) should be provided.

3.2 The time of reception of each bulletin and the location indicator CCCC of the centre from which the bulletin was received or which inserts the bulletin (in sequence: YYMMDDHHmmCCCC), should be given before the starting line of each bulletin as follows:

(a) Group date-time of reception:

- YY: two last digits of the year
- MM: month
- DD: day
- HH: hour
- mm: minute

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(b) Location indicator CCCC as given in the WMO Publication No. 9 - Volume C -Catalogue of Meteorological Bulletins.

e.g. 9411281205AMMC for a bulletin received from WMC Melbourne on 28 November 1994 at 1205 UTC.

3.3 The messages should preferably be grouped by types of data. The names of the relevant files CCCCTTYY.ASC should be defined as follows:

(a) CCCC being the location indicator of the monitoring centre

(b) TT representing the type of data as given in Table A;

(c) YY being a sequence number if the whole data file had to be split into several media (e.g. diskettes). YY = 00 if there is one single file.

e.g. RJTDSY02.ASC for SYNOP messages entered into the diskette No.2 by RTH Tokyo.

3.4 The monitoring centres should send as soon as possible, at the same time, all the relevant messages related to the same monitoring period (i.e. all messages for which the date-time group of the abbreviated heading corresponds to days 1-15 of the month). Since such messages can be received just after the monitoring period, the monitoring centres will have to wait until all the bulletins concerned are received before sending the comprehensive set of messages to the Secretariat.

3.5 The media used to sent the messages should preferably be diskettes 3.5 inches. With a view to reducing the number of diskettes, a compression code may be used; in this case the required decryption software should be provided to the Secretariat. The WMO Secretariat is also ready to consider the use of Internet for this pilot project.

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Table A

Set of data (Note 1) For each type of data, the value of TT (see sub-paragraph 3.3.(b)) is given in brackets	Specialized MTN monitoring centres (MSMCs) monitoring set of messages	Specialized MTN monitoring centres (MSMCs) in charge of the analysis of the set of messages
1. SYNOP reports (TT=SY)	- Algiers - Buenos-Aires - Offenbach - Tokyo	- Tokyo
2.Parts A of TEMP (TT=TT) and PILOT reports (TT=PP)	- Brasilia - Nairobi - Sofia - Toulouse	- Sofia
3. CLIMAT (TT= CL) and CLIMAT TEMP (TT=CT) reports	- Buenos-Aires - Cairo - Sofia - Toulouse	- Buenos Aires
4. SHIP (TT=SH), TEMP SHIP (TT=TS), PILOT SHIP (TT=PS), BUOY (TT=BU) and BATHY/TESAC/TRACKOB (TT= BT) reports	- Cairo - Offenbach - Toulouse	- Offenbach
5. AIREP (TT=AI) and AMDAR (TT=AM) reports	-Tokyo -Toulouse	- Toulouse

Note 1: The reference monitoring data sets are determined as the list of abbreviated headings of bulletins containing SYNOP, TEMP, PILOT , CLIMAT , CLIMAT TEMP, SHIP, TEMP SHIP, PILOT SHIP, BUOY, AIREP/AMDAR, and BATHY/TESAC/TRACKOB reports which have to be globally exchange according to the Catalogue of Meteorological Bulletins.

Note 2: The Secretariat will provide on a diskette the reference monitoring data sets to the monitoring centres.

IMPROVED MK-12/XCTD SYSTEM TESTED IN THE FIELD

A. Sy, BSH, Germany

Introduction

An XCTD field evaluation on "Meteor" cruise no. 30/3 in the eastern North Atlantic in December 1994 and measurements under realistic ship-of-opportunity conditions in September/October 1995 have completed a series of field trials started in 1992. The first at-sea tests revealed significant deficiencies in the system's performance (Sy, 1993). The urgent need to improve the reliability and accuracy of XCTD measurements led to the development of various modified devices by the system's manufacturer, Sippican, Inc. The combined modifications result in a new configuration of the MK-12 hardware, firmware and software, and also include changes of the XCTD probe. After several field and laboratory tests carried out by the manufacturer (Elgin, 1994), the results were sufficiently promising to convince the customer of significant improvements of the overall system performance. The purpose of the last field evaluation was to check the manufacturer's specification of the final product independently, i.e. from the customer's point of view. The system's accuracy for XCTD measurements is claimed by the manufacturer to be $\pm$ .03 °C for temperature, $\pm$ .03 mS/cm for conductivity, and $\pm$ 5 m or 2 % for depth (Sippican, 1992; 1994).

Operational details of the field test

12 XCTD probes were calibrated by Sippican, Inc. in September 1994 and made available for this test. The data acquisition system used a Compaq LTE 4/33C laptop computer with extension unit, equipped with a Sippican MK-12 rev. J interface, firmware rev. 2.1 and software rev. 2.2.1. The "Meteor" cruise no. 30/3 was aimed at contributing to the WOCE Hydrographic Programme (WHP section A1). The XCTD test sites are located west of the British Isles (Fig. 1). This ocean area provides favourable conditions due to its well developed hydrographic stratification in both temperature and salinity.

Severe weather conditions forced a premature end of our regular research programme before we had the opportunity to carry out the planned XCTD field trial. Therefore, it was decided to use a combination of T-5 XBT and test XCTD probes en route home as a poor makeshift substitute to complete our hydrographic section in a rough-and-ready way (XCTD test part A). After successful and problem-free launching of 6 XCTDs at a ship's speed of about 6 knots (Table 1), we were surprised by a sudden unpredicted favourable change of the weather situation. We returned to the break-off point of the hydrographic section to resume our field work including the originally planned XCTD versus CTD intercomparisons (XCTD test part B).

Field test part B was carried out with XCTD drops at 2 regular CTD stations (stat. # 542 and # 546) side by side with the down-profiling of a well calibrated NBIS MK-IIIB CTD. The protocol shown in Table 1 should clarify the procedure. The CTD data were processed according to WOCE standards (WHP, 1994). XCTD data processing included the conversion of raw data to physical units, editing of spikes and noise by 5-point-moving-median filtering (q = 5) of temperature and conductivity (Sy, 1985), editing of start-up and profile end transients, and compaction to 2 dbar intervals. The accuracy of the reference CTD data was estimated as $\Delta T < \pm 2$ mK for temperature, $\Delta S < \pm 0.002$ for salinity and $\Delta p < \pm 2$ dbar for pressure. The temporal stability of all parameters was extremely good.

Test results

All 12 probes launched gave traces from the sea surface to below 1000 m depth. In contrast to the previous 6 drops of test part A, which were carried out without any difficulties at all, the remaining 6 drops of test part B encountered problems. One drop failed, although good data were acquired, due to a software breakdown and data loss, for which a user mistake cannot be ruled out. One profile became very noisy below 730 m depth with unusable data, which may have indicated a signal wire problem. During one drop a wire jam was detected, which fortunately could be removed in time to prevent a premature wire break.

No erroneous profile is detectable in the T/S section of test part A (Fig. 2 b,c). The XCTD temperature section corresponds well to the XBT section (Fig. 2 a) as well as to the CTD section 30 nm south, which was carried out 3 days later (Fig. 2 d). The XCTD salinity section shows the usual eddy and stratification structures which correspond also quite well to those of the CTD section (Fig. 2 e). A significant discrepancy is revealed, low salinities, for the upper 50 m of drop # 6 caused by a slow start of the conductivity measurement. In test part B, XCTD drop # 7 showed the same start-up problem in the upper 60 m. Elgin (1994) provides the plausible explanation that air bubbles remaining in the conductivity cell cause too low a conductivity measurement until they eventually collapse by increasing pressure.

A first idea on the quality of all measurements of test part B is provided by Fig. 3. No calibration failures are detectable. The comparison of data from the homogeneous mixed layer provides a better estimate of the accuracy and the start-up problem. The range of temperature differences between XCTD and CTD traces does not exceed the $\pm$ 0.03 °C limit below 10 m depth (Fig. 4).

However, the conductivity differences of two profiles exceed the $\pm$ 0.03 mS/cm limit significantly (Fig. 5). Generally, the XCTD conductivity is low with respect to the reference CTD. This reduced overall accuracy and the start-up problem demonstrate the difficulty of controlling the conductivity parameter and consequently the computed salinity (Fig. 6). Increasing differences of some traces below 60 m are probably caused by temporal variability of the field (Fig. 4a, 5a, 6a).

The temperature data accuracy found in the mixed layer of the upper ocean remains stable also for the deeper ocean (Fig. 7). However, the conductivity difference becomes smaller with increasing probe depth and eventually falls inside the $\pm$ 0.03 mS/cm limit in the lower half of the traces (Fig. 8). This indicates that the data quality is positively influenced by increasing pressure, i.e. the bubble formation in the conductivity cell on launching is probably a more general problem. Ordinary air bubbles seem to be responsible for the slow start effect and micro bubbles for the reduced conductivity accuracy at the profile's upper part. Elgin (1994) reported on different resolution across the range of conductivity, with the poorest resolution at the high end. The measurements at the test sites, however, do not show these high conductivity values. As for conductivity, the salinity difference is also significantly reduced with greater depth (Fig. 9). It should also be noted that the 42.921 value previously used as standard conductivity was changed to the commonly recommended 42.914 value (R.Elgin, pers. comm.).

The hydrographic stratification allows an easy evaluation of the depth formula. As for XBT probes (Hanawa et al., 1994), the XCTDs fall faster than specified. The depth fall rate variability is small. The depth error is estimated to be about -30 m at 900 m depth (or about 3.3 %). That corresponds to previous findings (Sy, 1993) and shows that no change of the hydrodynamically effective underwater body design was carried out. Thus, for a more accurate re-calculation of the depth fall rate formula, all old and new XCTD versus CTD intercomparison data can be used.

With the improved system design, no increasing noise with depth is detectable (Fig. 10). The peak-to-peak noise was found to be in the range of the resolution of the MK-12 ($\pm$ 0.01 °C, $\pm$ 0.01 mS/cm). Also, the system grounding problem and the data offset at 900 m were obviously solved.

Measurements along a transoceanic section

A suitable opportunity to extend the test results by experiences obtained under realalistic ship-of-opportunity conditions was presented by CMS "Köln Express" (gross tonnage: 39,000 tons, length: 240 m, speed: 19 knots) from September 29 to October 2, 1995 when a complete section from the English Channel to the Grand Banks was carried out (Fig. 11). All measurements were carried out by a scientist from the vessel's stern (launch height: 10 m). For data acquisition the same equipment was used as 9 months before, except software rev. 3.03. From 60 probes, calibrated by Sippican, Inc. in August 1995, 4 probes failed due to probe malfunctioning (Fig. 12) and another 4 probes failed due to fatal software problems. Although the data processing is not yet finished a preliminary conductivity start-up failure rate is estimated as about 50 %.

The measurements were carried out under severe weather conditions. The ship's speed of 12 to 19 knots and the strong head wind added up to relative windspeeds of up to 60 knots or Bf. 11 (Fig. 12). Frequency distributions of depth ranges and of prevailing windspeeds are displayed in Fig. 13 and Fig. 14. XCTD probes are designed to cover the upper 1000 m at a maximum ship's speed of 10 knots. The depth range of XCTD profiles was found between 460 m and 764 m with a mean maximum depth of 606 m. For many ship-of-opportunity programmes this reduced depth range will not meet their requirements. No relationship between windspeed and depth range or windspeed and probe malfunctioning can be deduced from Figs. 13 and 14. The probe malfunctions occured at high and at low windspeeds and are thus more likely a manufacturing problem. One should expect to find a strong dependence of the depth range from both ship's speed and windspeed. In this case, however, both effects are superimposed (Figs. 15 and 16). The visible effect of windspeed on the depth range appears in terms of an increasing maximium depth variability, but without a decreasing mean maximum depth.

Conclusion

The results of the field evaluation of December 1994 and of the transoceanic section 9 months later conclusively reveal that modification efforts of the manufacturer during the last years have resulted in a significant MK-12/XCTD system performance improvement. Obviously most performance difficulties encountered at previous sea trials have been successfully solved. The system is at the point of meeting the claimed specification. Unsolved deficiencies are the slow conductivity start problem, the reduced conductivity accuracy at low pressure, and the inaccurate depth formula. Also the MK12 software, although easy to use, needs a careful revision. To review the XCTD depth fall rate should be one of the next actions to be taken by the IGOSS Task Team on Quality Control of Automated Systems (TT/QCAS).

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XCTD TEST Protocol, Cruise "Meteor" 30/3

Drop #	Date	Time (UTC)	Position Lat N	Position Long W	Depth m	SST °C	Wind m/s	Remarks
TEST PART A								
1	9.12.94	18:00	53 00.9	22 47.6	4000	11.1	12.0	s/n 94090122, (XCTD/XBT section), XBT # 114
2	"	21:10	52 49.5	22 00.3	4000	11.1	13.0	s/n 94090119 " XBT # 116
3	10.12.	01:05	52 47.6	21 10.7	3711	10.9	23.0	s/n 94090110, (wrong pos in file), XBT # 120
4	"	03:55	52 50.3	20 21.7	2550	11.0	20.5	s/n 94090116, (XCTD/XBT section), XBT # 122
5	"	06:55	52 48.0	19 31.7	2600	11.1	16.0	s/n 94090121 " XBT # 124
6	"	10:05	52 47.1	18 40.0	3526	11.1	16.0	s/n 94090118, (end XCTD section), XBT # 126 slow conductivity start-up
TEST PART B								
fail	13.12.	12:55	52 20.0	18 52.0	4280	11.6	3.0	s/n 9409112, CTD # 542, run-time error M6101 data loss but good profile up to 1237m
7	"	13:06	"	"	"	"	"	s/n 9409115, CTD # 542 at 700 m slow conductivity start-up
8	"	13:14	"	"	"	"	"	s/n 9409114, CTD # 542 at 1200 m
9	"	13:25	"	"	"	"	"	s/n 9409113, CTD # 542 at 1700 m noisy below 730 m
10	14.12.	11:41	52 20.0	15 47.0	3255	10.9	11.0	s/n 9409117, CTD # 546 at 50 m
11	"	11:52	"	"	"	"	"	s/n 9409120, CTD # 546 at 500 m XCTD wire jam removed

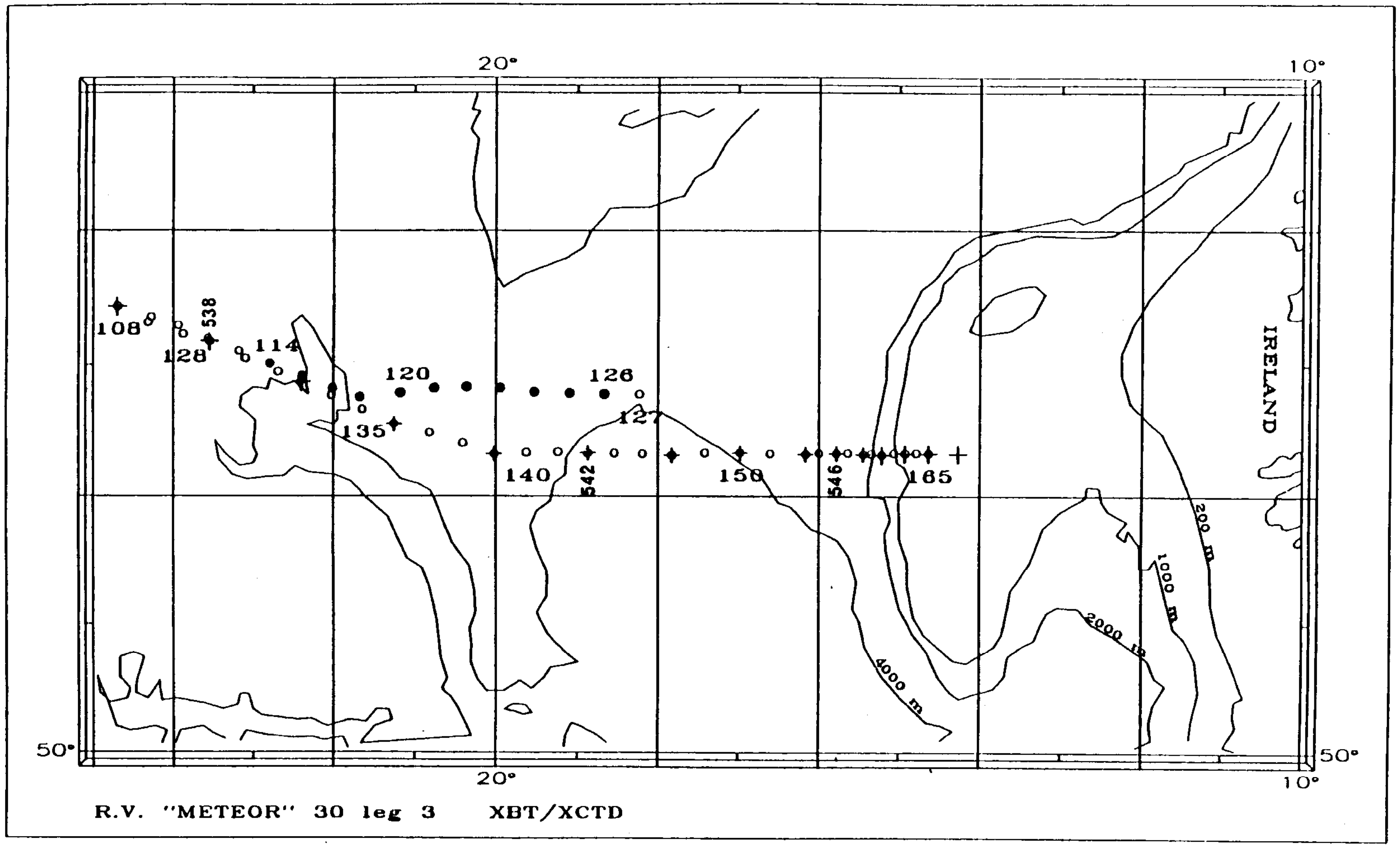
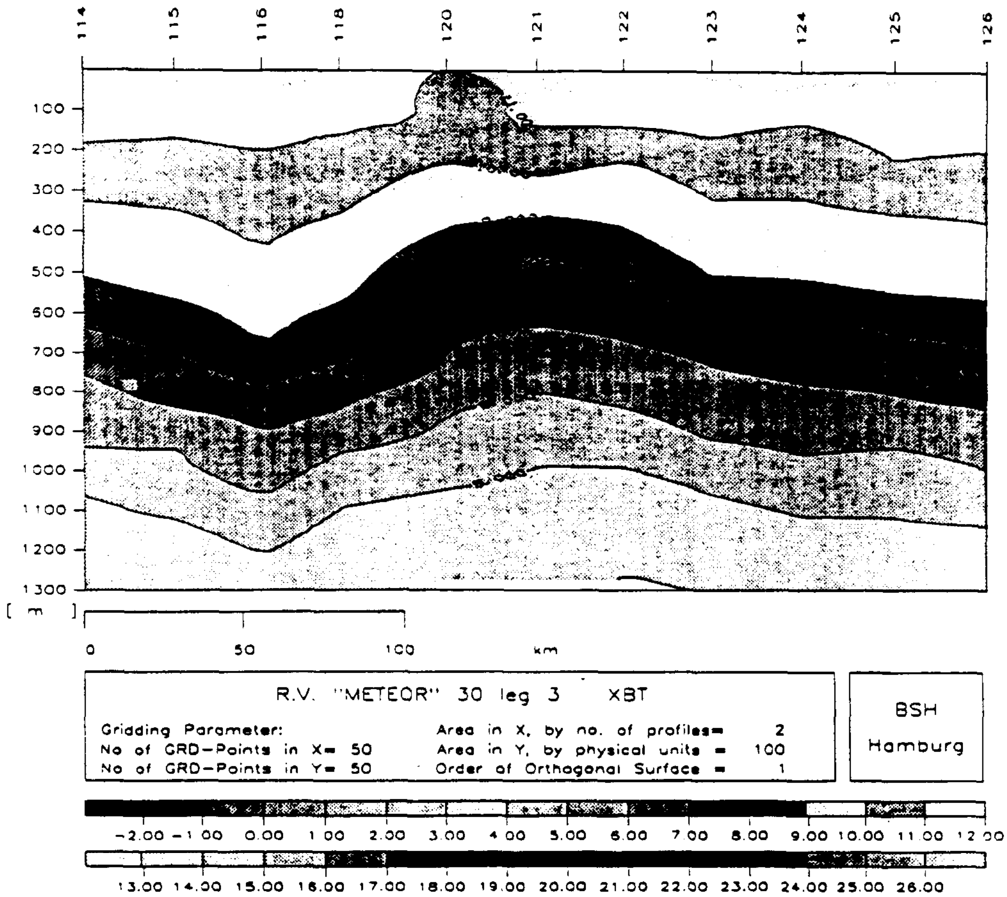


Fig. 1: XCTD test sites of WOCE-Nord cruise "Meteor" 30/3 (December 1994)

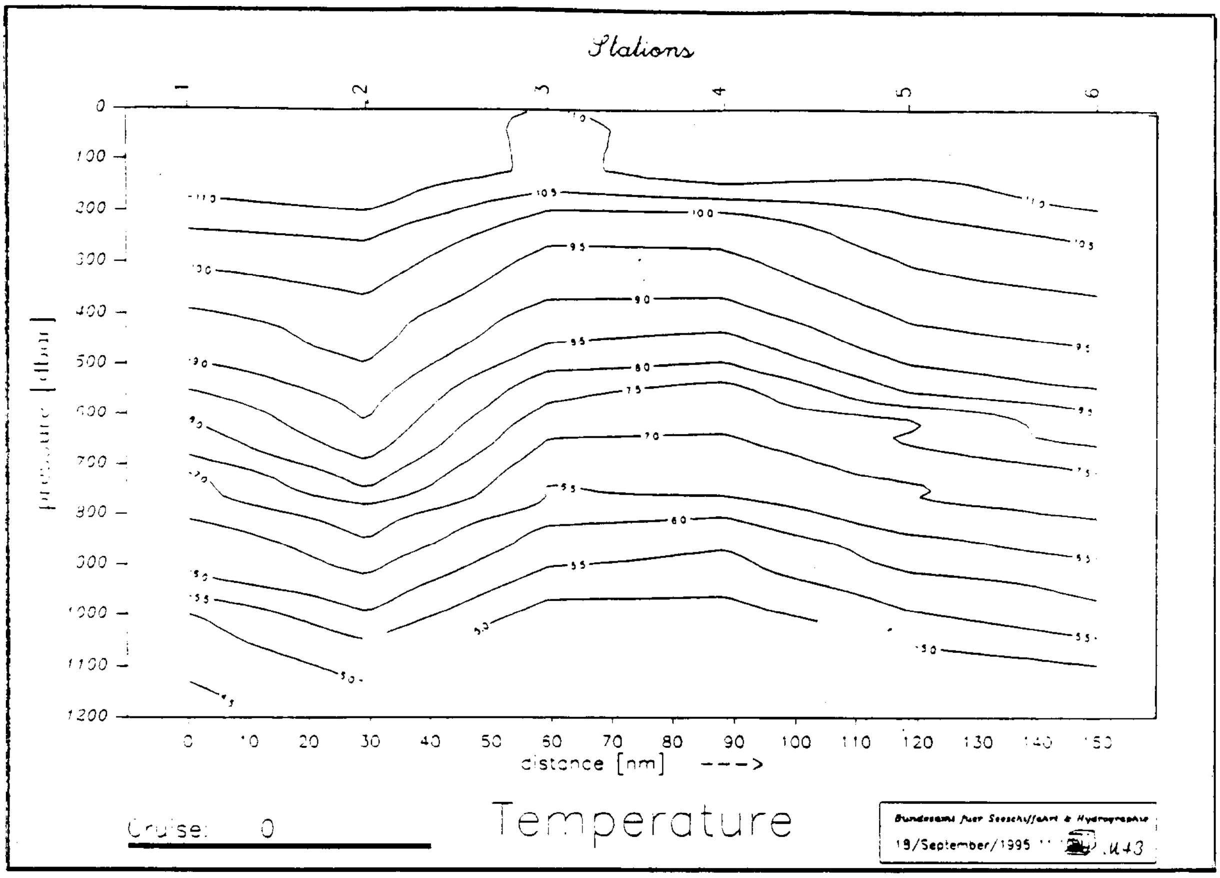
+	CTD stations along WHP section A1 (Sites of XCTD test part B are stat. # 542 and # 546)
o, ●	XBT drop locations
●	XBT/XCTD section with XCTD drops at every second XBT drop location (Sites of XCTD test part A)



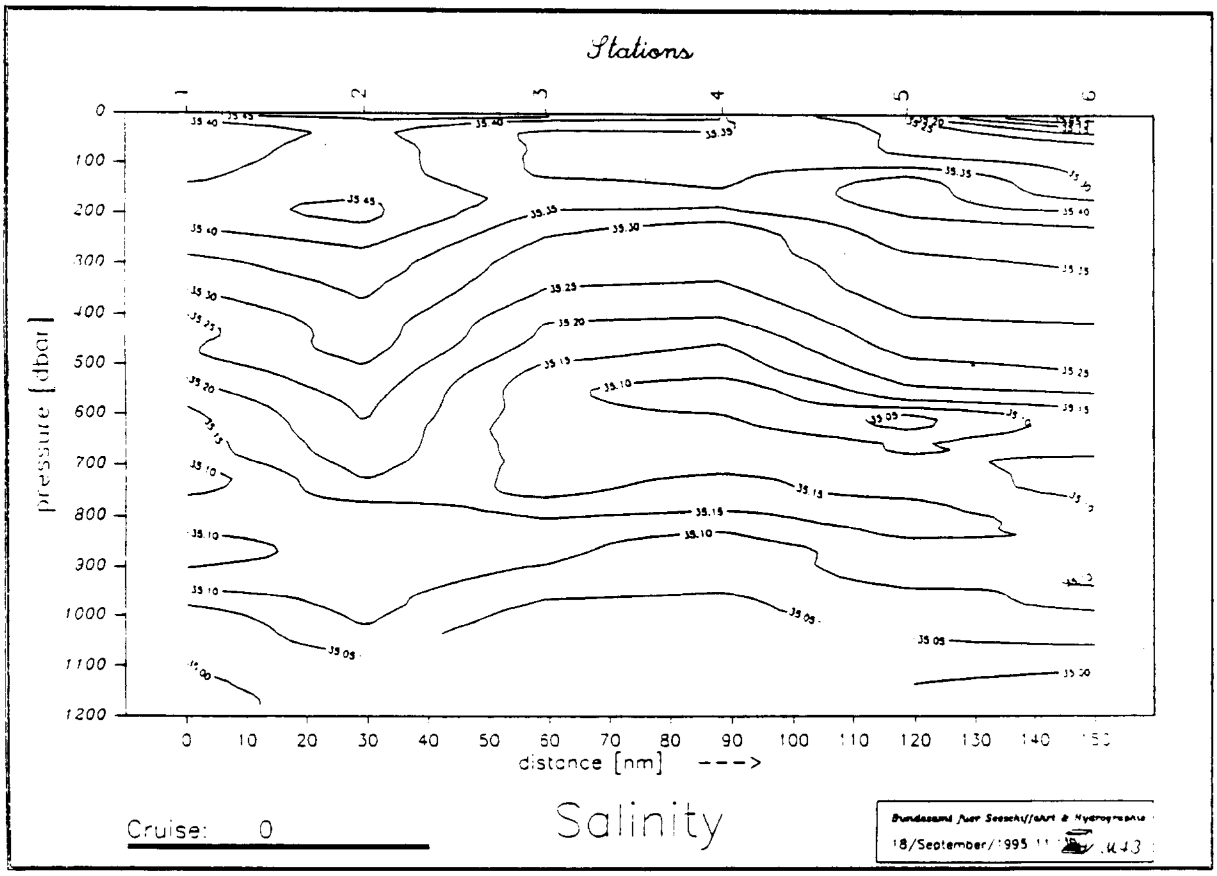
a)

<u>Fig. 2:</u> XCTD test part A

a) Temperature section of XBT (T-5) drop # 114 - # 126
b) Temperature section of XCTD drop # 1 - # 6
c) Salinity section of XCTD drop # 1 - # 6
d) Part of temperature section WHP A1
(CTD stat. # 538 - # 543)
e) Part of salinity section WHP A1
(CTD stat. # 538 - 543)


Stations
pressure [dbar]
distance [nm] --->
Cruise: 0
Temperature
Bundesamt fuer Seeschiffahrt & Hydrographie
18/September/1995

b)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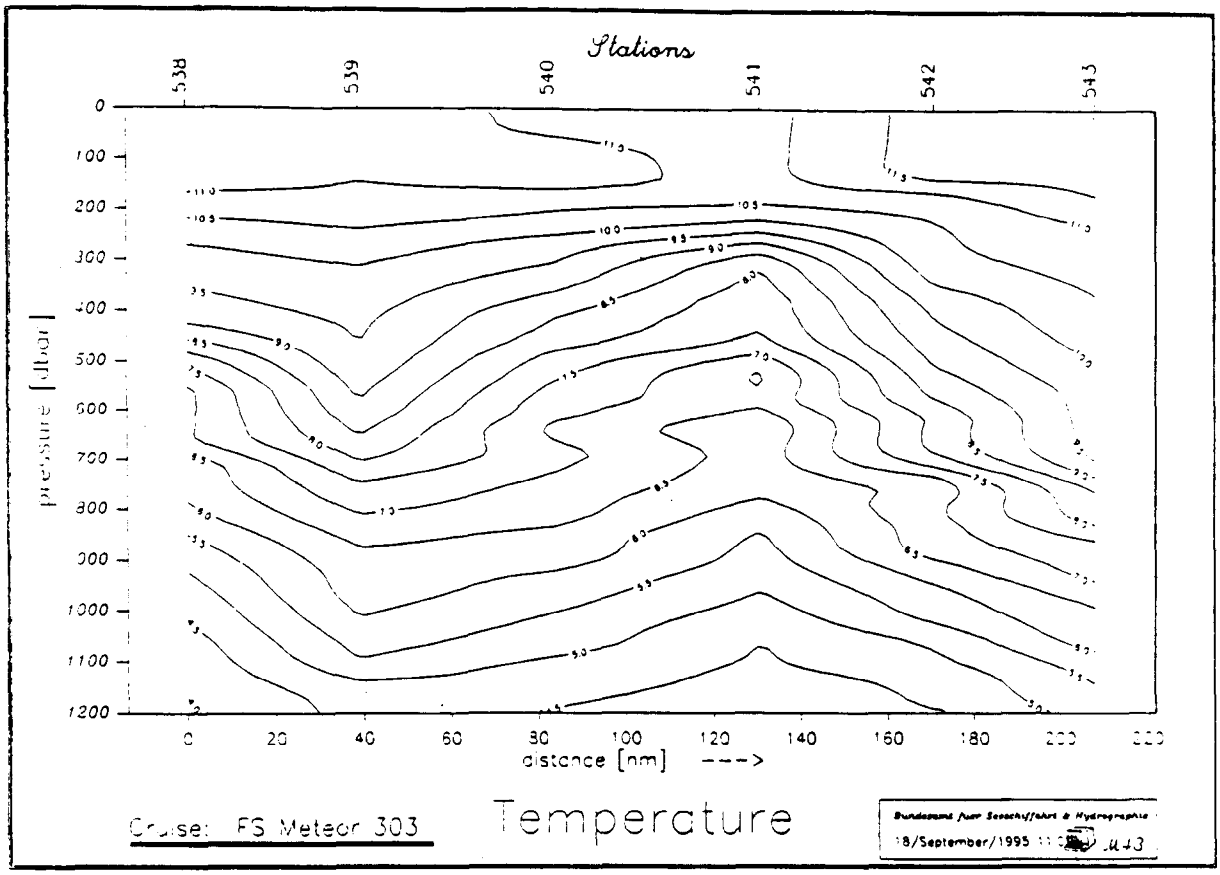
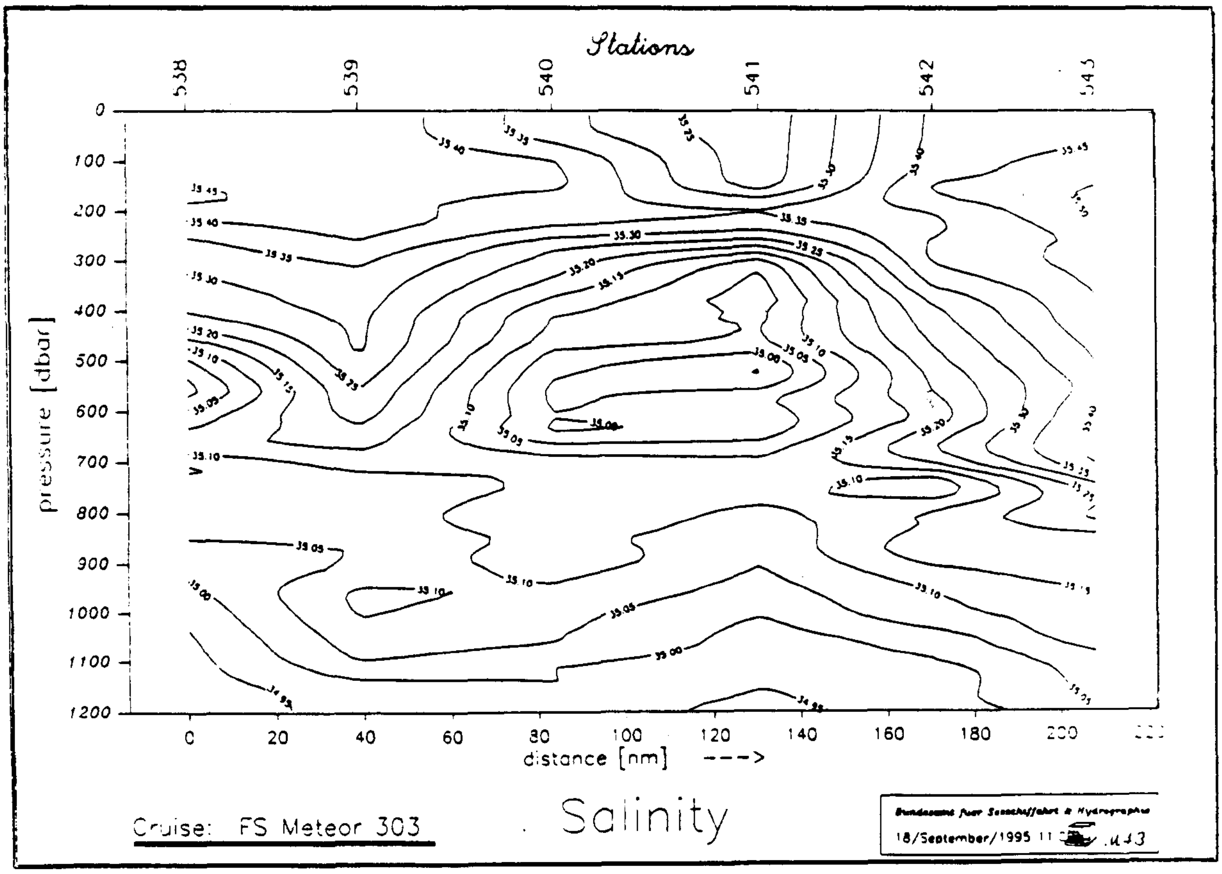
distance [nm] --->
Cruise: 0
Salinity
Bundesamt fuer Seeschiffahrt & Hydrographie
18/September/1995

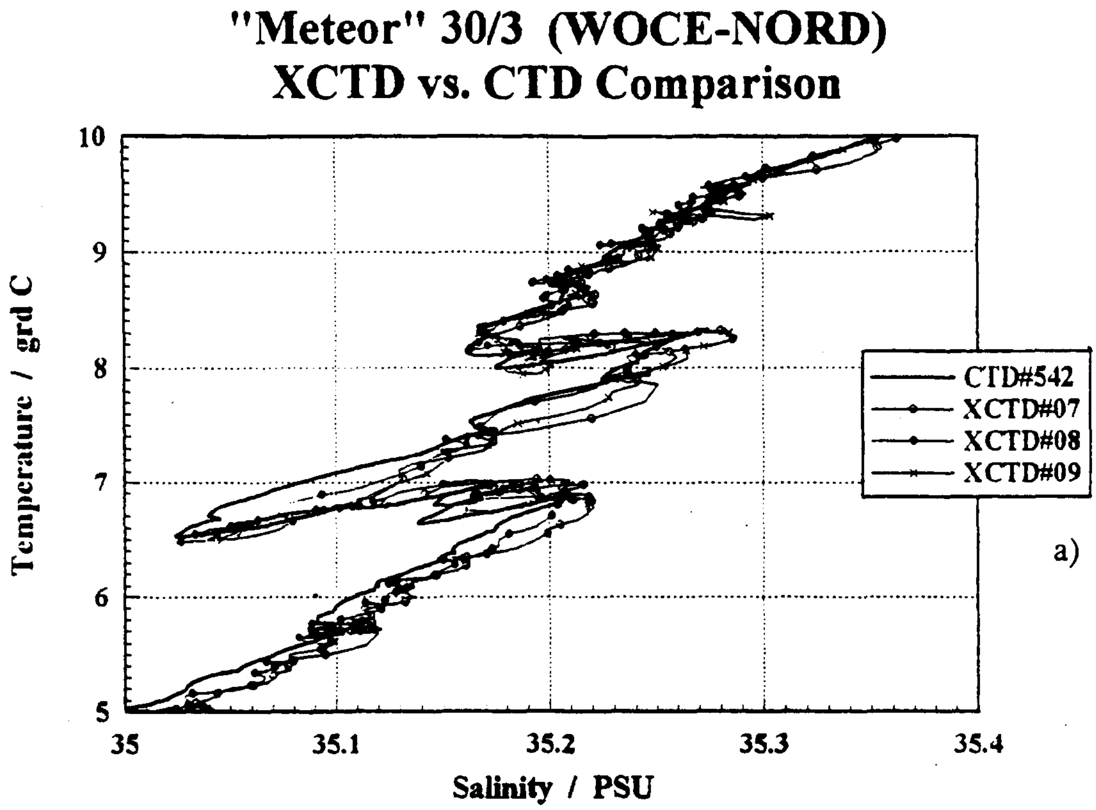
c)


Stations
538
539
540
541
542
543
pressure [dbar]
distance [nm] --->
Cruise: FS Meteor 303
Temperature
18/September/1995

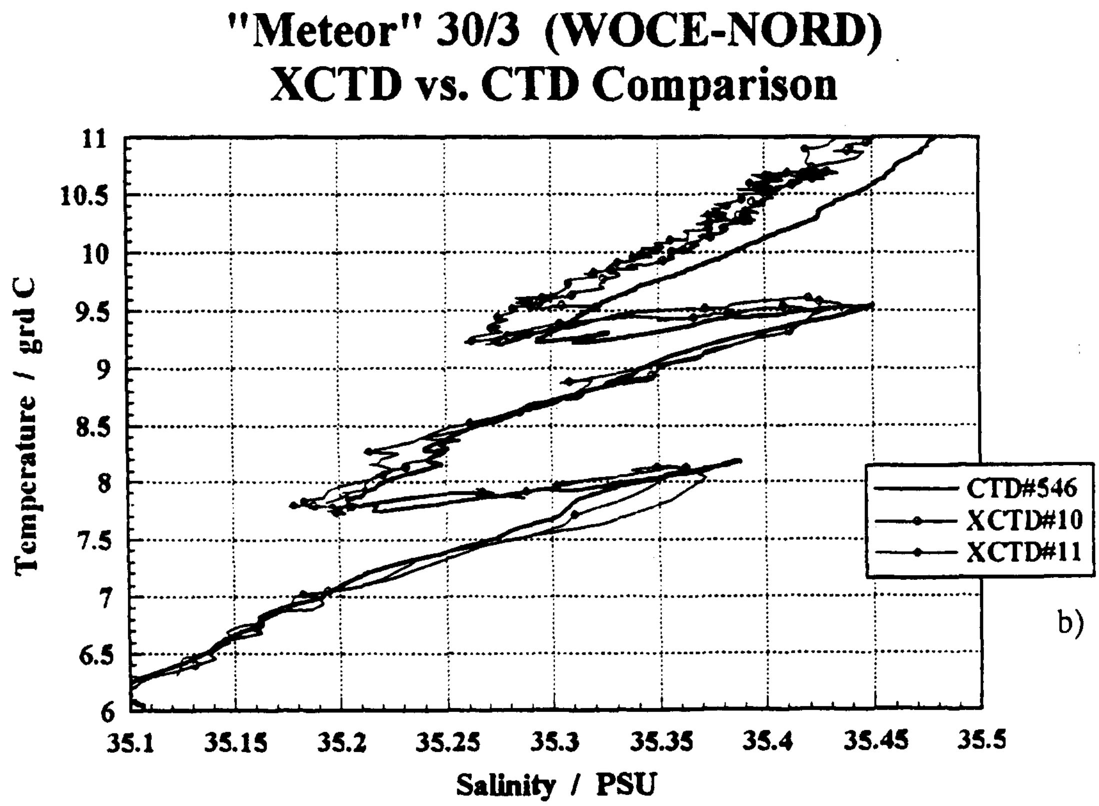
d)


Stations
538
539
540
541
542
543
pressure [dbar]
distance [nm] --->
Cruise: FS Meteor 303
Salinity
18/September/1995

e)

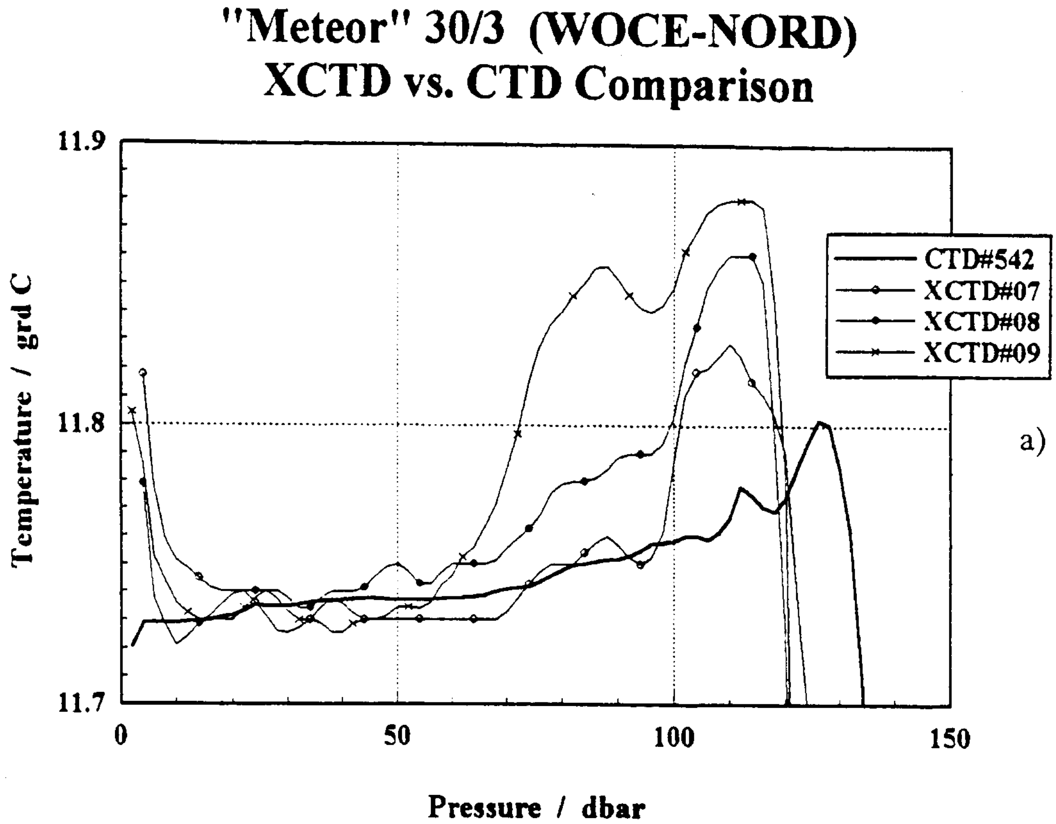


a)



b)

Fig. 3: Enlarged cut of the T/S diagram of CTD and XCTD data
a) at stat. # 542 b) at stat. # 546



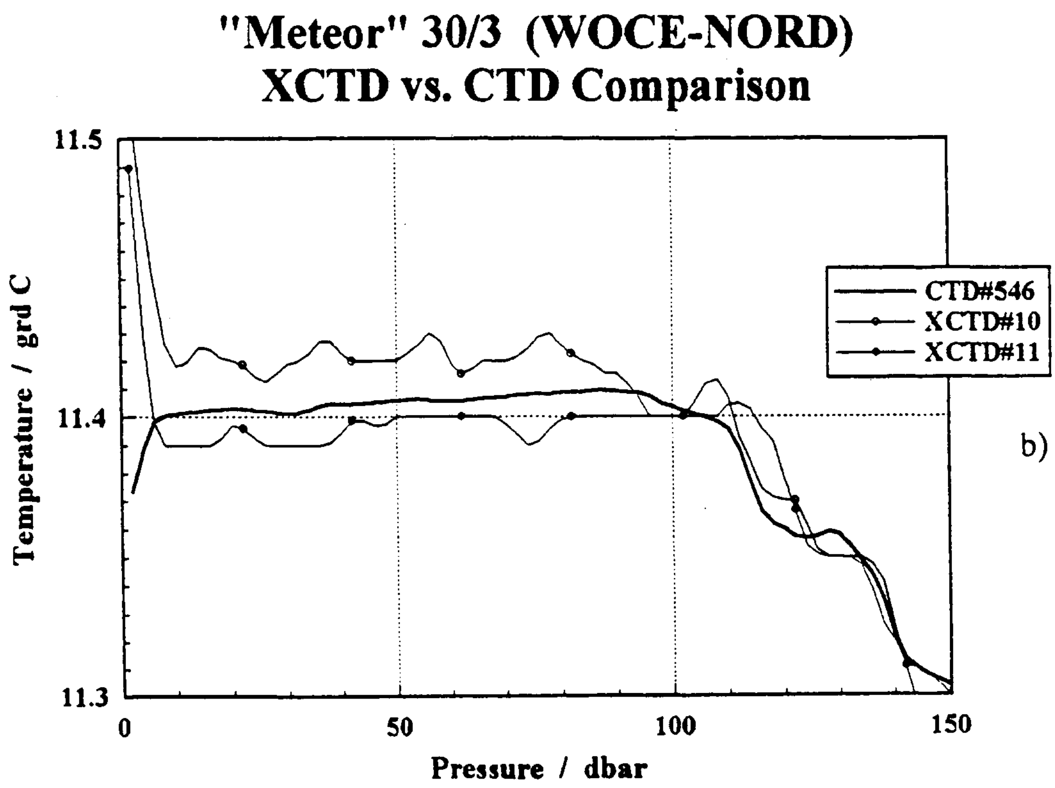
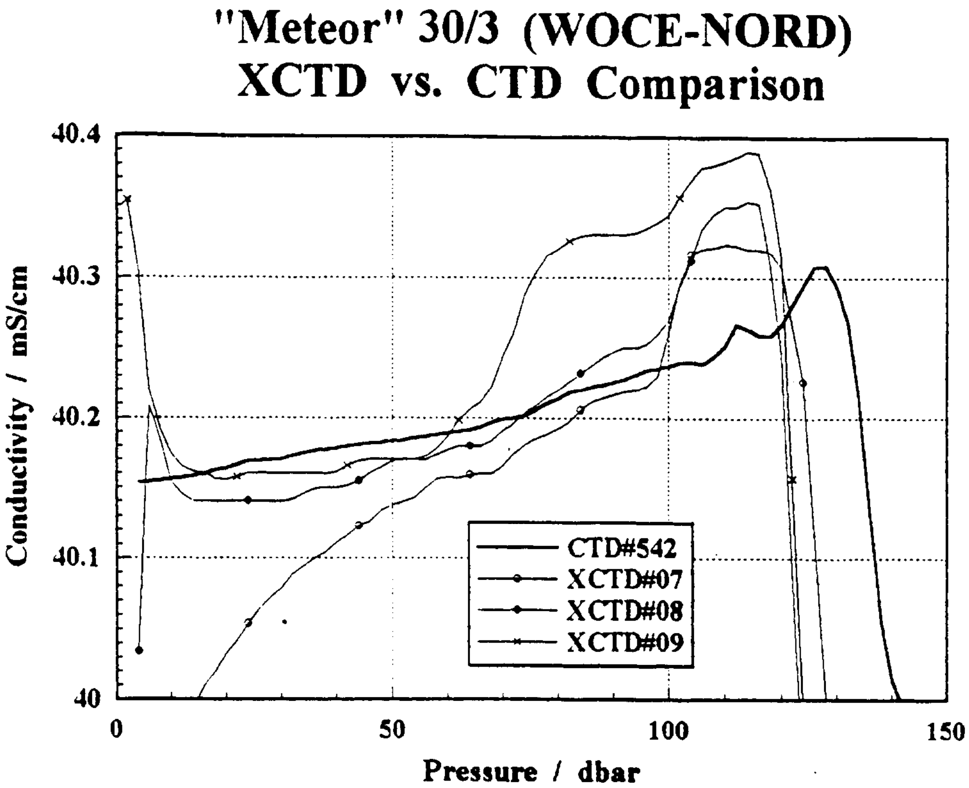
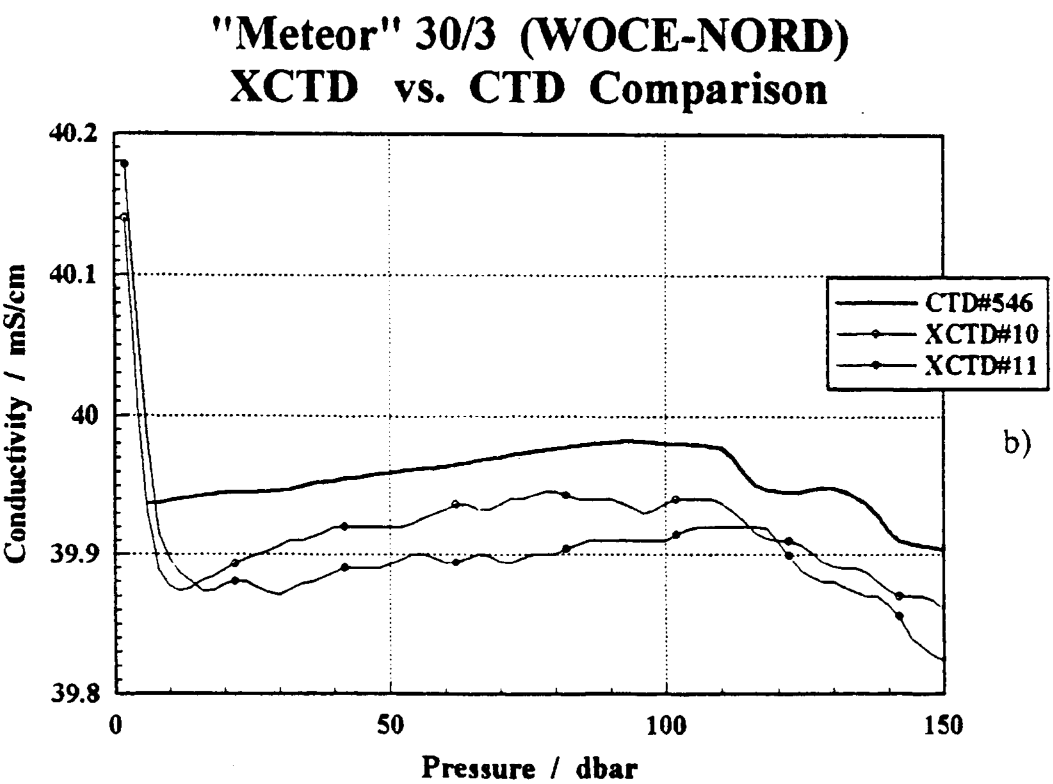


Fig. 4: CTD and XCTD temperature profiles of the upper 150 dbar
a) at stat. # 542 b) at stat. # 546

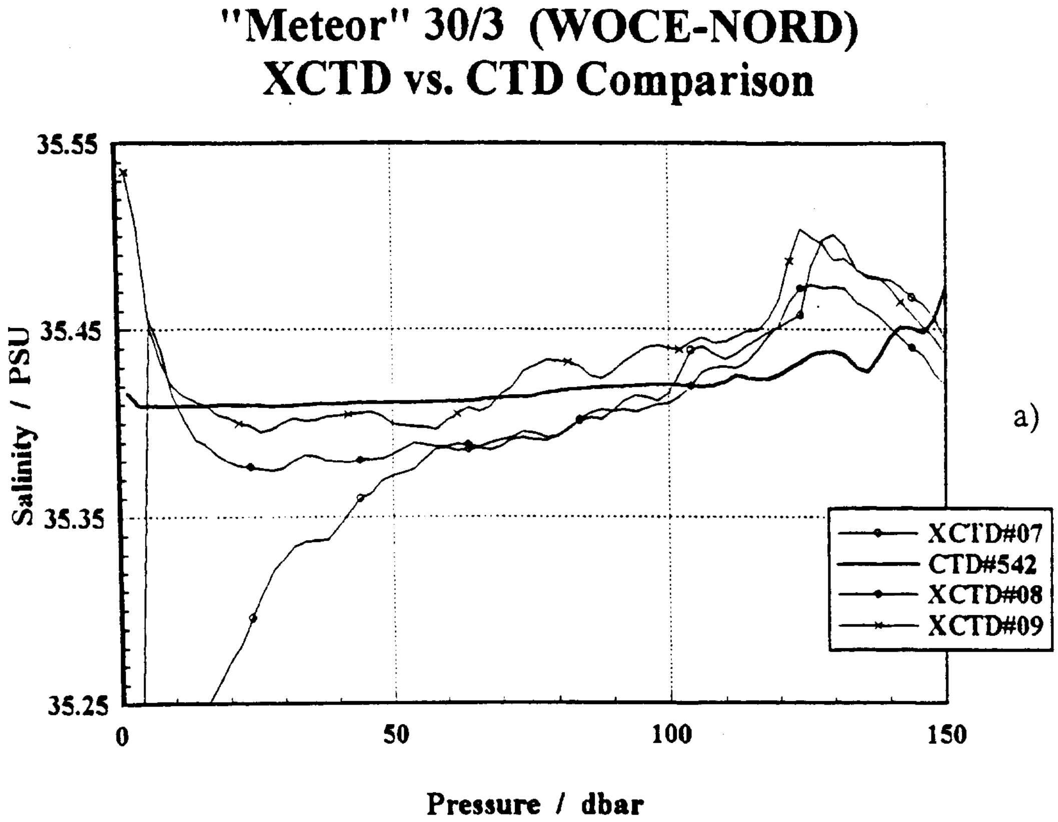


a)



b)

Fig. 5: CTD and XCTD conductivity profiles of the upper 150 dbar
a) at stat. # 542 b) at stat. # 546



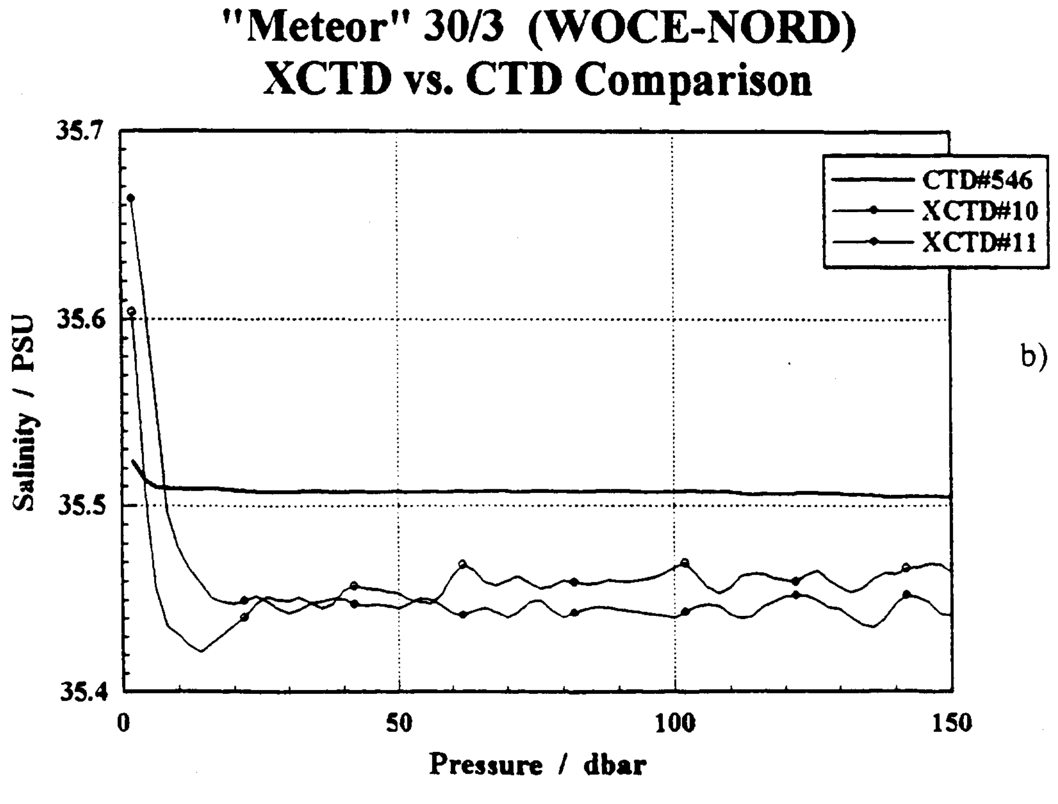
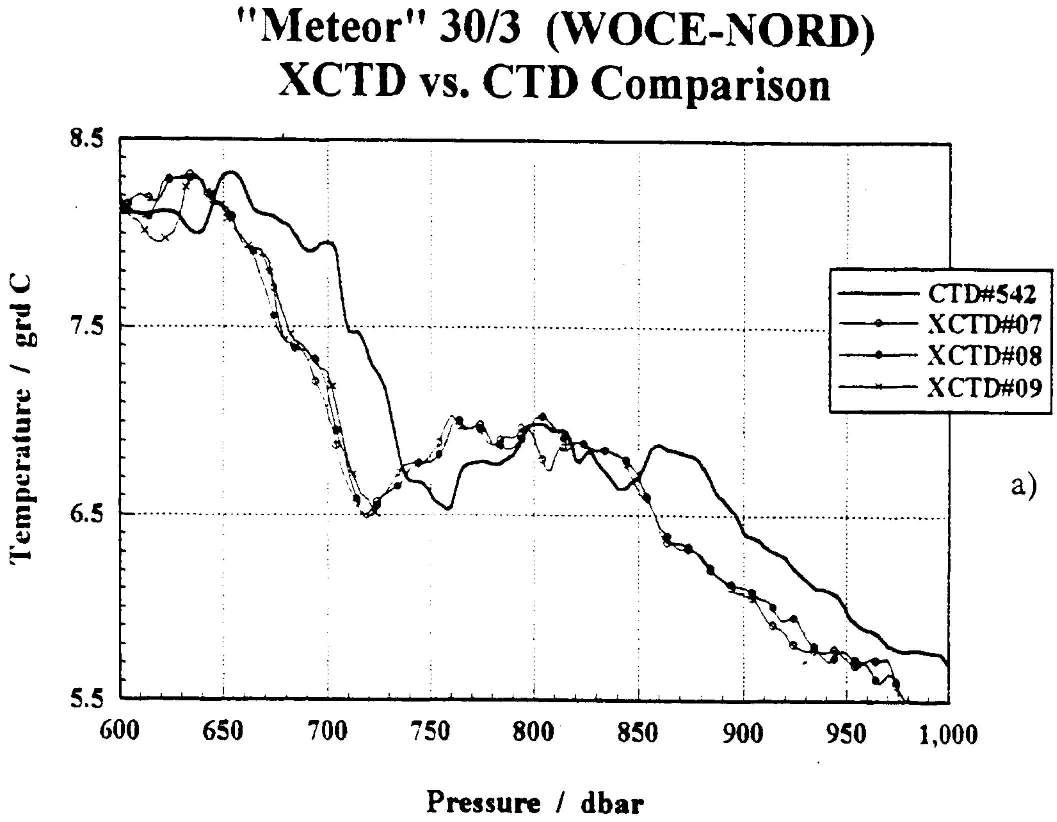
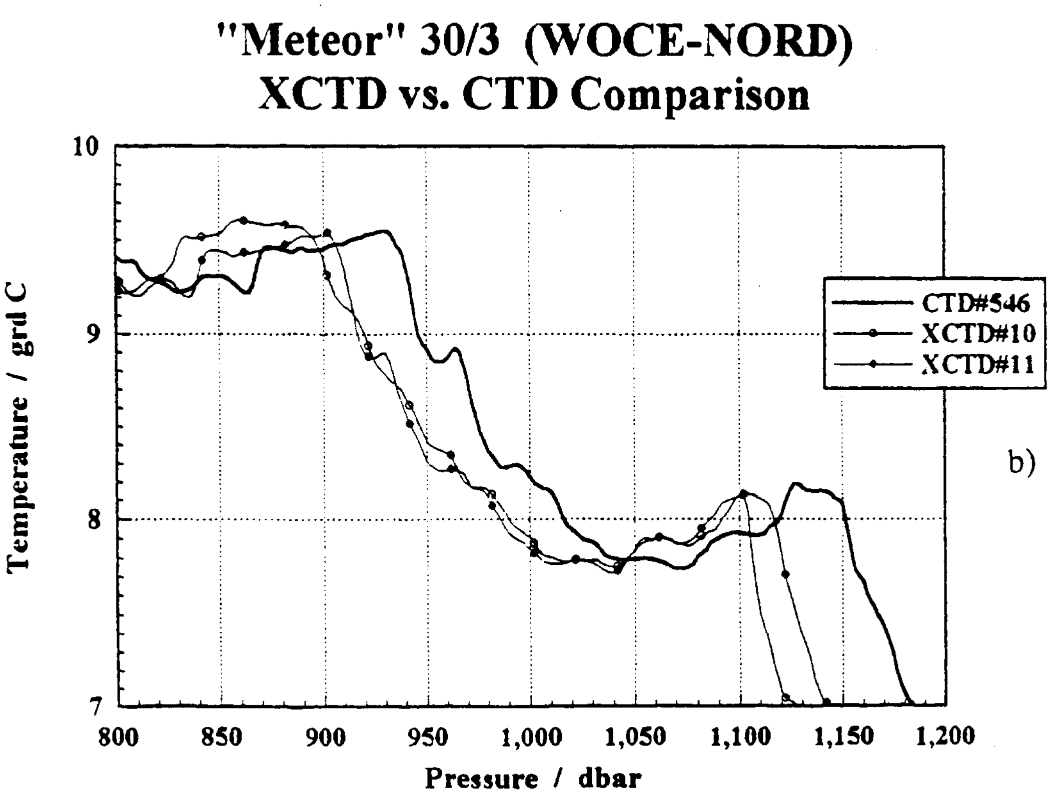


Fig. 6: CTD and XCTD salinity profiles of the upper 150 dbar
a) at stat. # 542 b) at stat. # 546

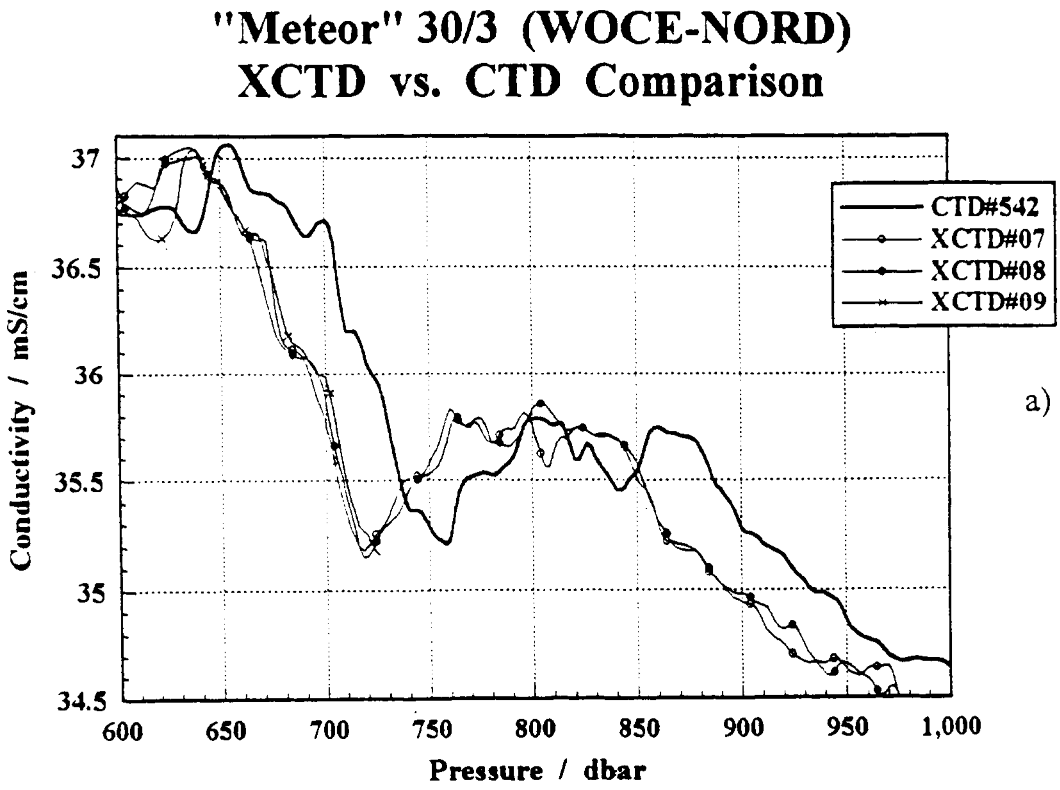


a)

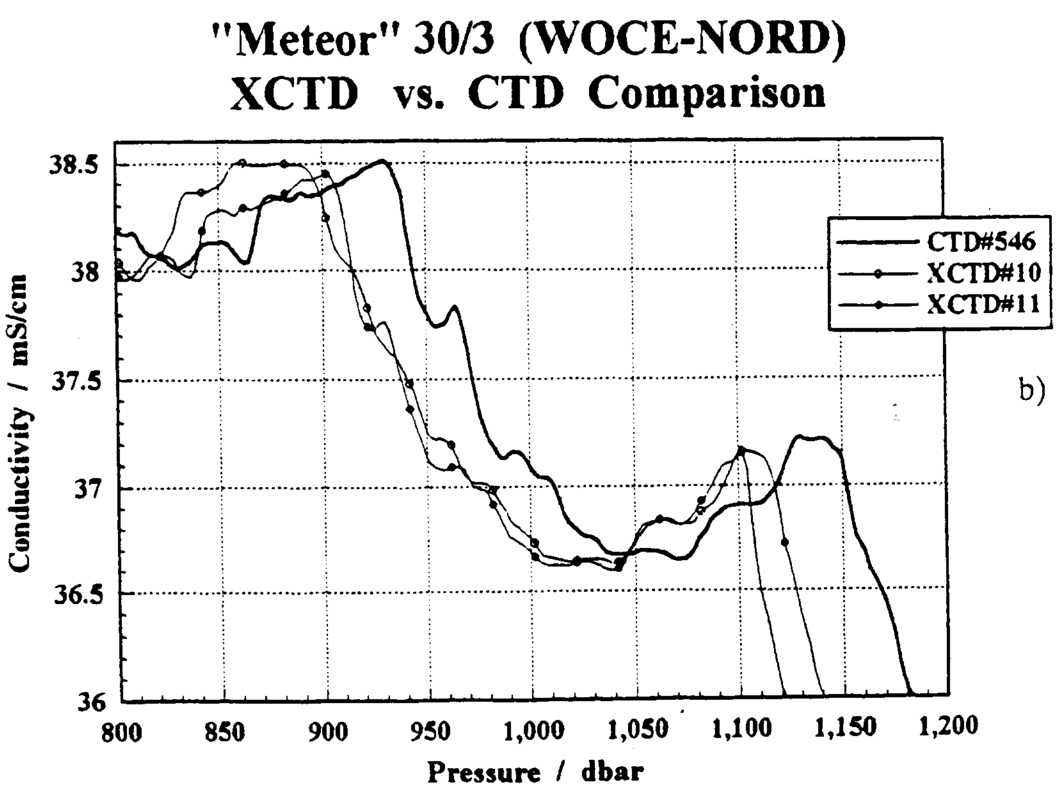


b)

Fig. 7: CTD and XCTD temperature profiles of deeper layers
a) at stat. # 542 b) at stat. # 546

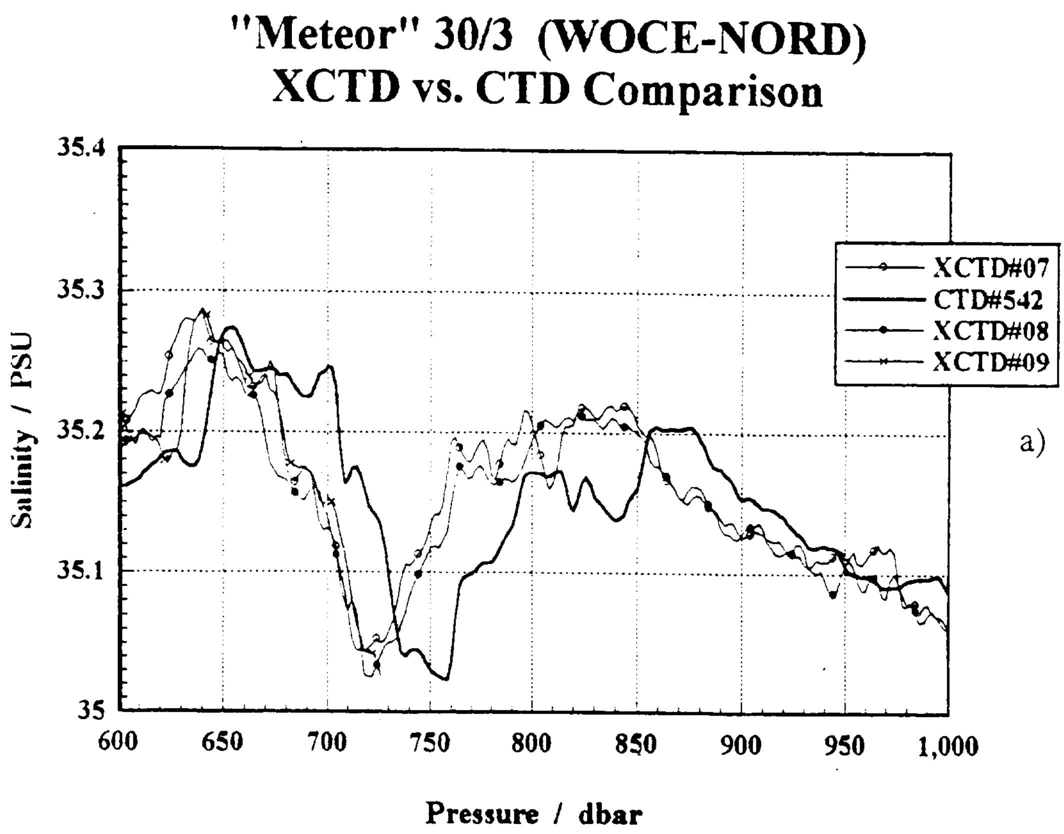


a)

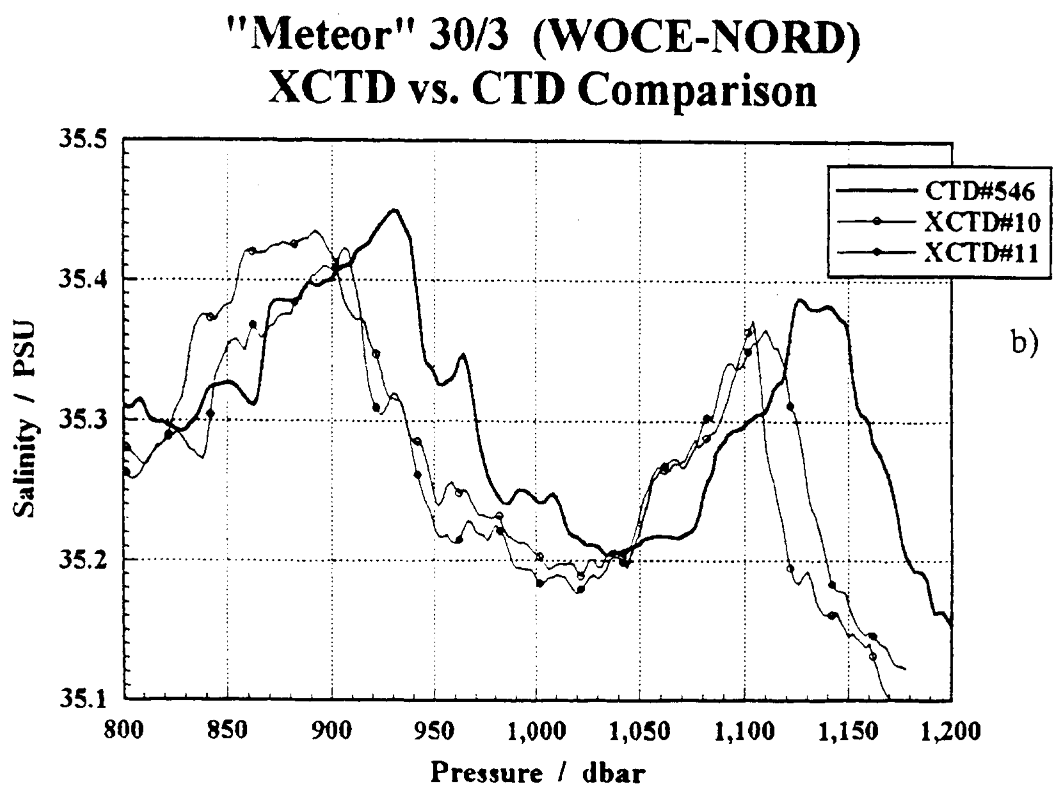


b)

Fig. 8: CTD and XCTD conductivity profiles of deeper layers
a) at stat. # 542 b) at stat. # 546



a)



b)

Fig. 9: CTD and XCTD salinity profiles of deeper layers
a) at stat. # 542 b) at stat. # 546

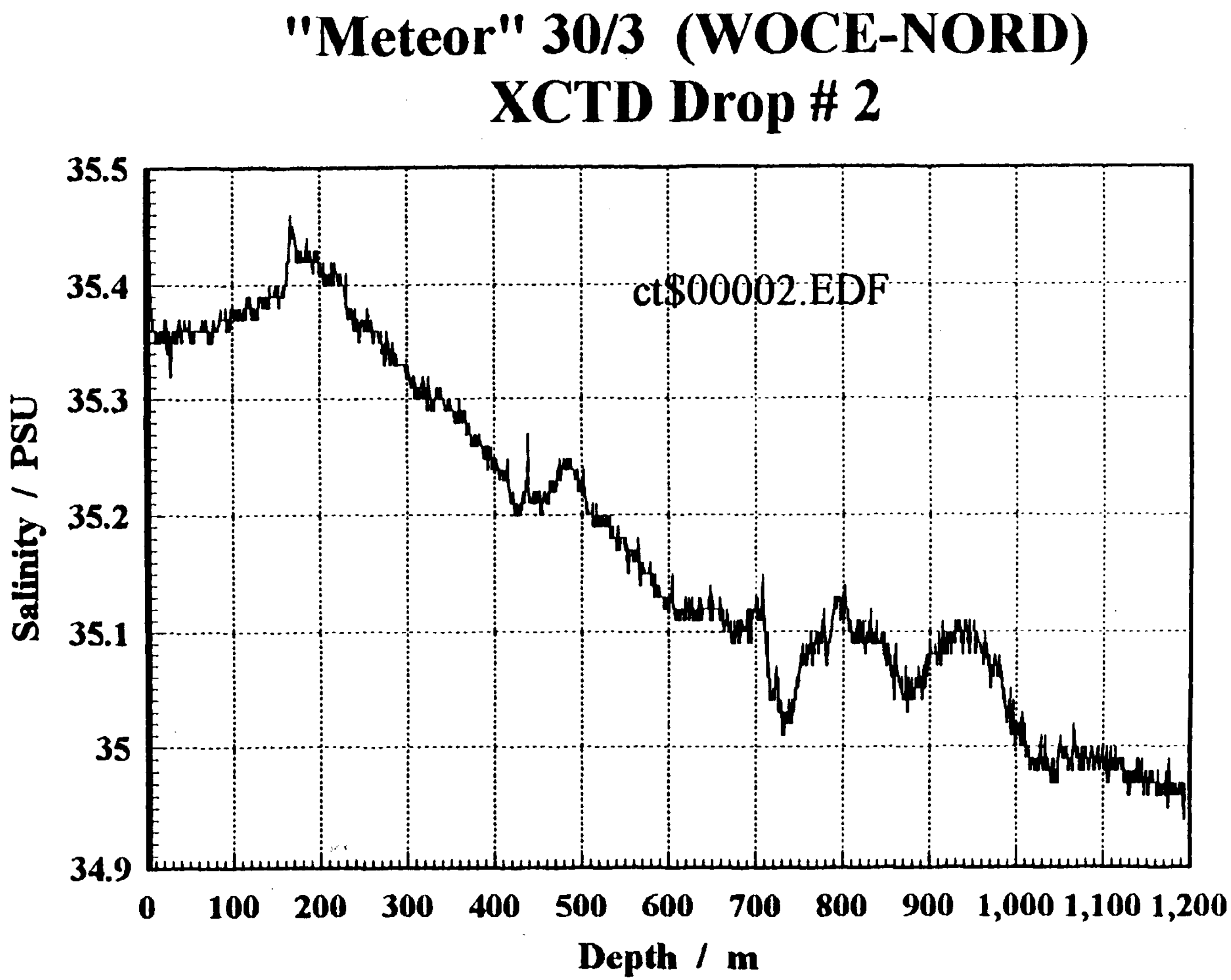


Fig. 10: A typical unprocessed salinity profile (EDF file of XCTD drop # 2)

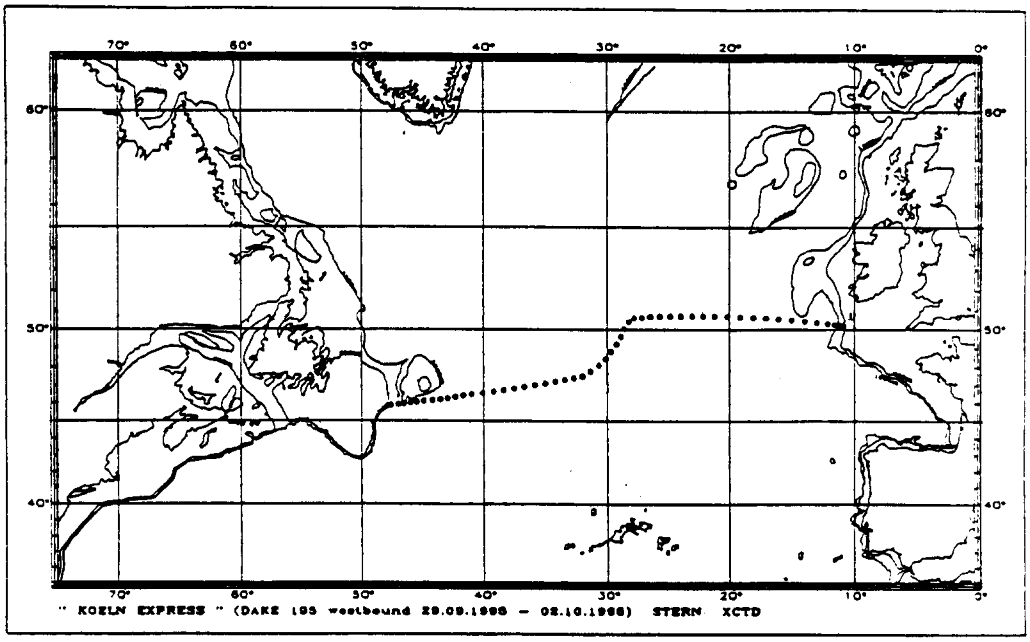


Fig. 11: Transoceanic XCTD section carried out by CMS "Köln Express"

"Köln Express" (Sept. 29 - Oct. 2, 1995)

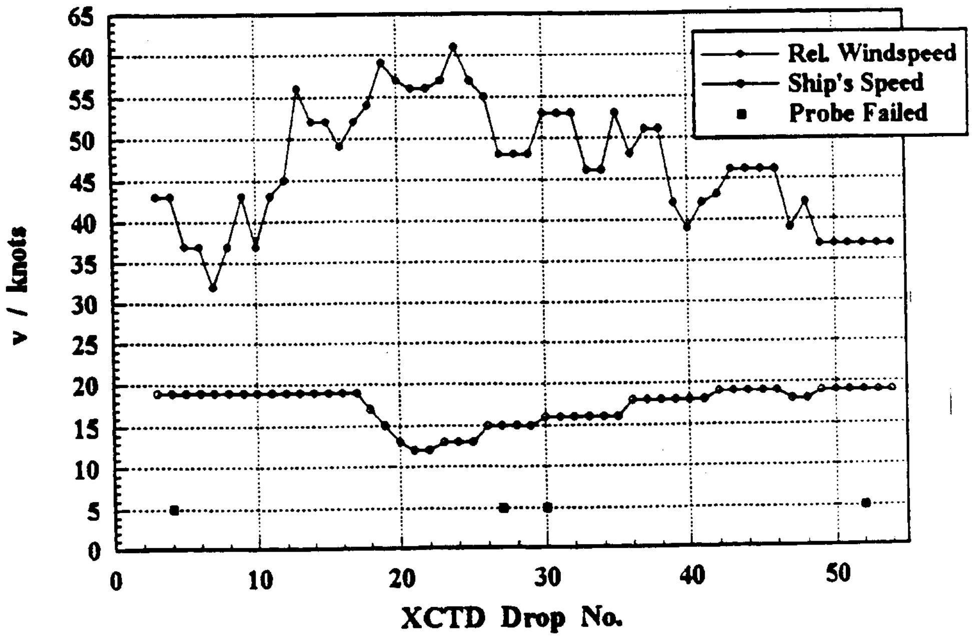


Fig. 12: Relative windspeed and ship's speed during XCTD drops

"Köln Express" (Sept. 29 - Oct. 2, 1995)

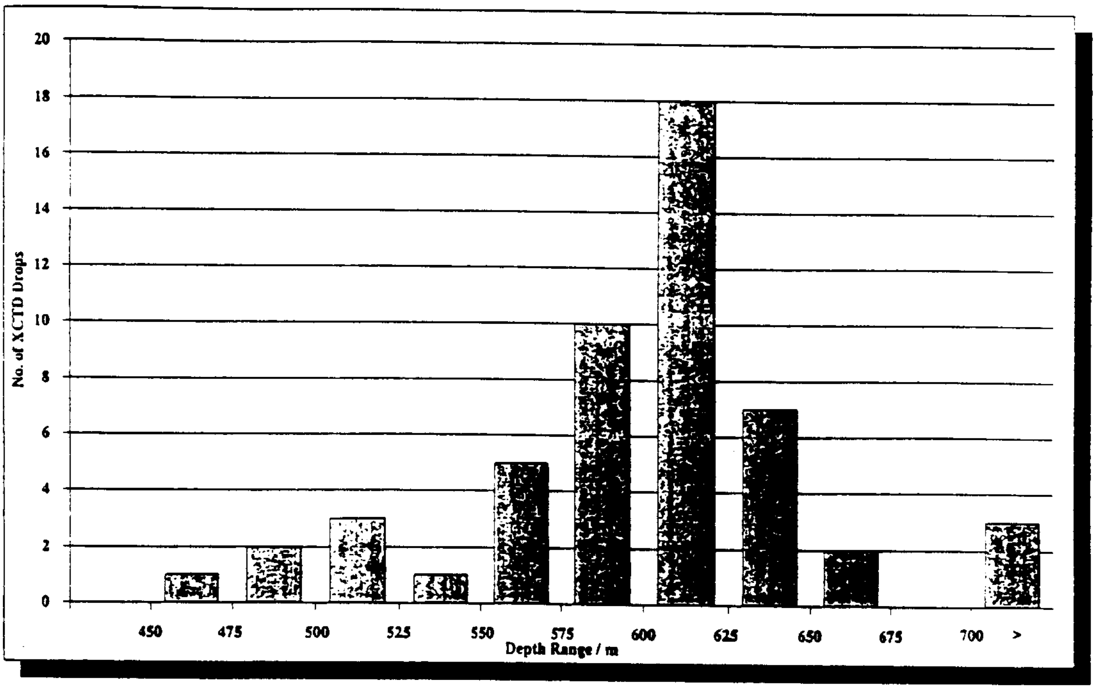


Fig. 13: Depth range of XCTD drops

"Köln Express"(Sept. 29 - Oct. 2, 1995)

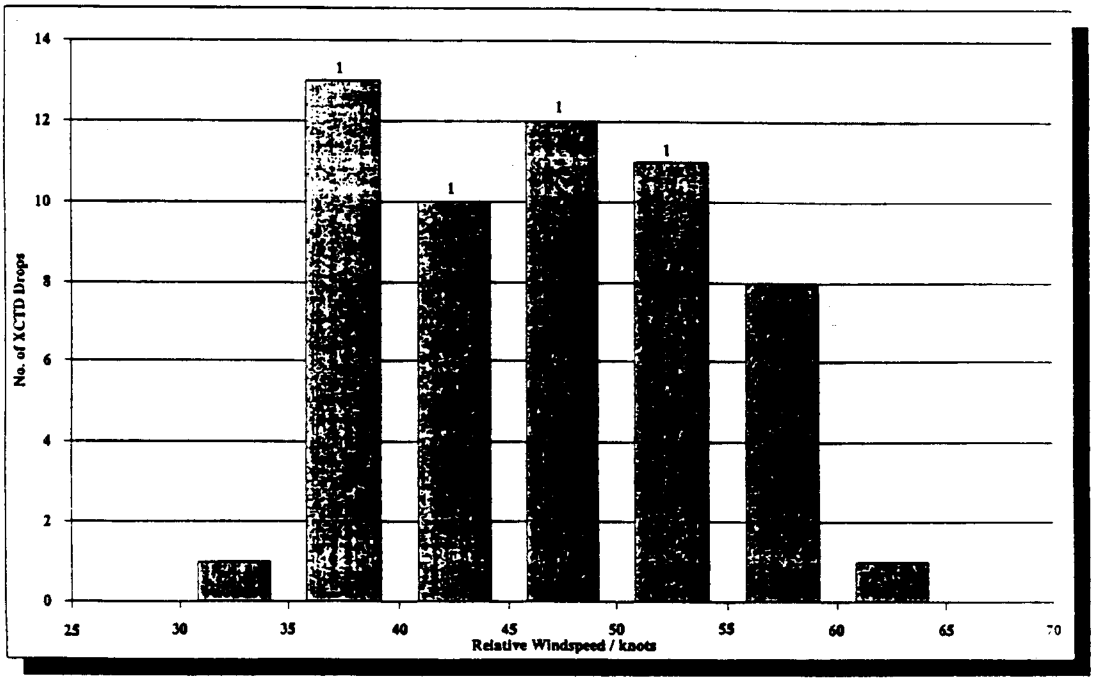


Fig. 14: Relative windspeeds during XCTD drops (1 - probe failed)

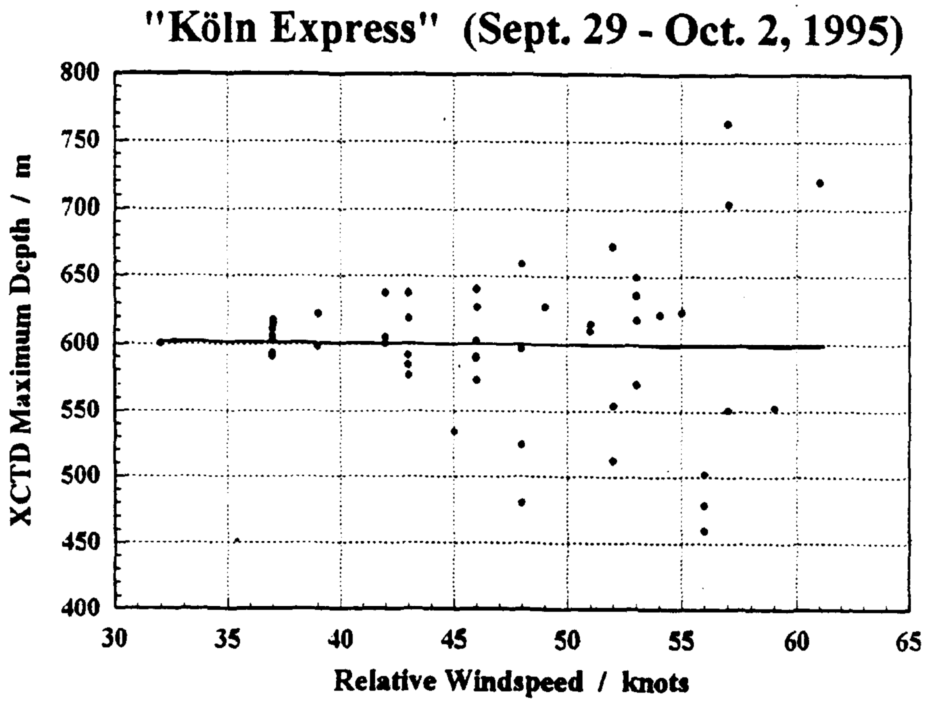


Fig. 15: XCTD depth versus relative windspeed

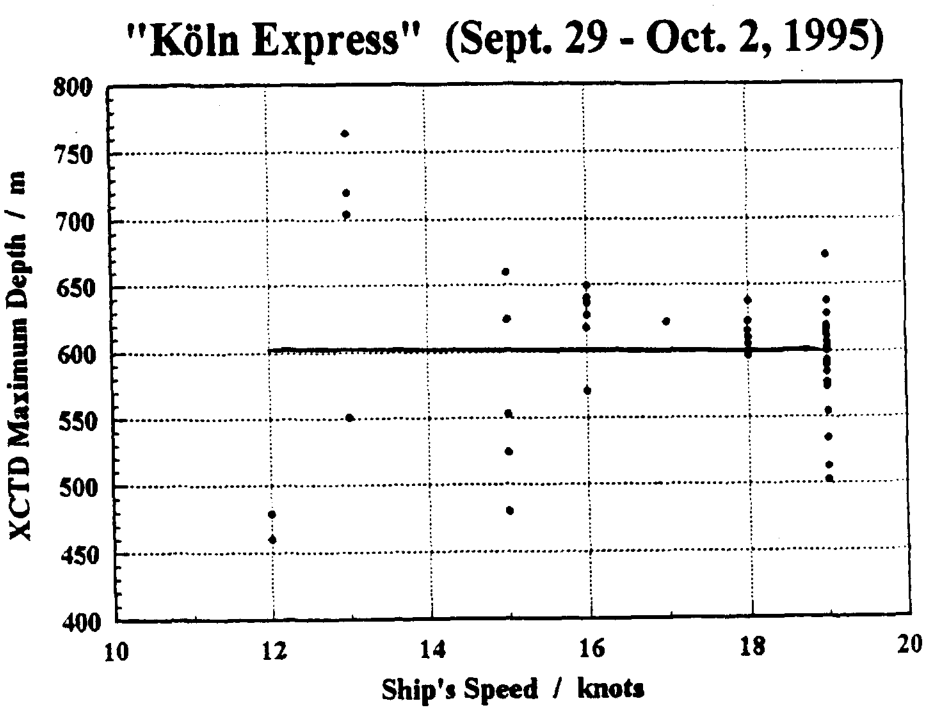


Fig. 16: XCTD depth versus ship's speed

ONBOARD QUALITY CONTROL OF XBT BATHY MESSAGES

P. Rual, ORSTOM, France

ABSTRACT

To improve the quality of the bathy-messages, sent to the Global Transmission System of the World Weather Watch via the Argos satellite, by ORSTOM - C.L.S. service Argos software onboard ships of opportunity, the following operations are implemented: *i)* a combination of a nonlinear median filter in order to despike the eXpandable BathyThermogramme profile prior to onboard quality control, *ii)* plus a linear Hanning filter, to filter out the small scale features before using the Broken stick data reduction method (that gives directly the required number of significant data point without iteration), *iii)* and a final regression fit. Only bathy-messages from temperature profiles that passed the onboard quality control, are sent to the satellite transmitter and the bathy-messages are computed only to the depth of the deepest "good" data point. So very few bathymessages are rejected later on, during the successive quality controls.

1. Introduction.

In order to improve the quality of the XBT (eXpandable BathyThermogramme) bathy-message sent to the GTS (Global Transmission System) of the World Weather Watch, an onboard quality control of the XBT temperature profile is necessary. The number of significant points constituting the bathy-message is limited (15 to 30), so it is important to use the best data reduction method to calculate the significant points. The bathy-message being used by meteorologists but also by atmosphere or ocean modelers, it is necessary to produce a bathy-message not only representing correctly the temperature profile but also representing with a good accuracy the integrated parameters such as the heat content. Dynamic height and geostrophic currents are deduced from the integrated density profile calculated by adding a temperature-salinity relation.

2. Onboard Quality Control.

Prior to any bathy-message calculation, a set of tests is applied to the temperature profile in order to know if it is worth doing.

All the test parameters given here are those used by ORSTOM for the TOGA (Tropical Ocean and Global Atmosphere) program in the tropical oceans, and they are to be modified according to the area of observation.

i) If the maximum depth of the profile is less then 90 meters, the profile is considered too short to be useful, and another launch is asked to the operator.

ii) If the profile is deeper than 200 meters, but its deepest temperature is higher than the 10 meters temperature minus 2°C, the profile is considered to have failed probably due to probe nose breakage, so that the probe thermistor instead of falling with its nominal speed, is floating in the mixed layer. This error is possible due to the fact that the probe depth is not measured but computed from the time elapsed since the probe contact with the sea surface. This test is a good example of a regional test that should be modified if the measuring area contain a region of deep water formation, where the water is mixed from the surface to a very great depth, as it is the case in the Antarctic Ocean.

If these two tests have been passed then the bathy-message is considered worth computing, but the question of its maximum depth is raised.

3. Bathy-message Depth.

The number of significant points (15-30) constituting a bathy-message is much reduced compared to the data points number of a profile (generally one to two per meter). So it is important to try to know the depth of the deepest "good" data point. If this depth becomes the maximum depth of the bathy-message then the later will make use of all its significant points to describe the "good" part of the profile, and the accuracy of the description will be the best obtainable with a given data reduction method.

A series of test are conducted to determine that maximum depth. Again the test parameters are those used by ORSTOM for the TOGA tropical ocean region, and should be modified if necessary.

i) In the first 10 meters, no tests are conducted as it is a region where there is a great variability both due to the ocean or to the instrument. For instance, large temperature change may be due to ice melting or cold rain or to a big difference between the storage temperature of the probe and the sea surface temperature.

ii) Starting from 10 meter, the profile is downward tested until the first of the following is met :

- the end of the profile,
- the preset maximum depth of the bathy-message (512 m with the Argos transmission,
- the first outside range temperature (-2°C, 32°C),
- the first temperature gradient above 3°C/meter, positive or negative,
- the first temperature inversion greater than 1.5°C in the first 200 meters or 0.5°C below.

iii) The temperature minimum of the profile above the data point under test, is kept in memory. The depth of the deepest data point where the temperature is less or equal to the temperature minimum plus 5/100°C (white noise value of an XBT temperature profile) is also kept in memory. This point is considered as the last "good" point of the profile and its depth is taken as the maximum depth of the bathy-message. This point may be several meters above the last data point under test.

4. Data Reduction Methods.

Once determined the fraction of the temperature profile used to compute the bathy-message, the question is, what kind of data reduction method will give the best results in the less possible processing time.

Until recently, with the strip chart recorders, this was made by hand, by skilled observers, but on ships of opportunity, where the operators are volunteers but not specialists, it is better to use an automatic method. The base for all these methods is that the profile is reasonably linear, between two successive significant points, but depending upon the premises, they are divided into two different groups:

i) A tolerance is given in the adjustment of the bathy-message to the full profile, and a certain number of significant points is deduced. If there are too many or not enough points, the tolerance may be modified and the process repeated.

ii) A number of significant points is given and the maximum deviation of the bathy-message to the profile is deduced. If that deviation is too big, then the process may be resumed adding more significant points.

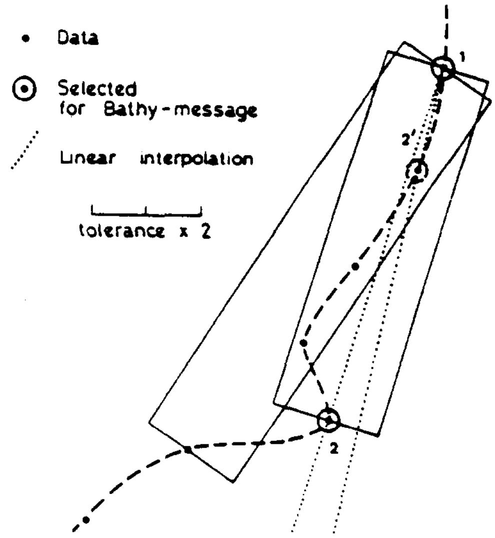


FIG.1. PIPE data reduction method.
a) Select a temperature tolerance.
b) Between 1 and 2 build a pipe with a radius equal to the tolerance.
c) Test all the data points between both ends of the pipe.
d) All of them are inside, so proceed to the data point following 2 and do again b) and c).
e) If any data point outside the pipe (here, data point 2), then select as the new significant point, either the bottom end of the previous pipe (point 2), or the data point opposite to the exit side (point 2').
f) When reaching the last data point, there is N+1 significant points. If it is too much or not enough, start again from a) with another temperature tolerance.

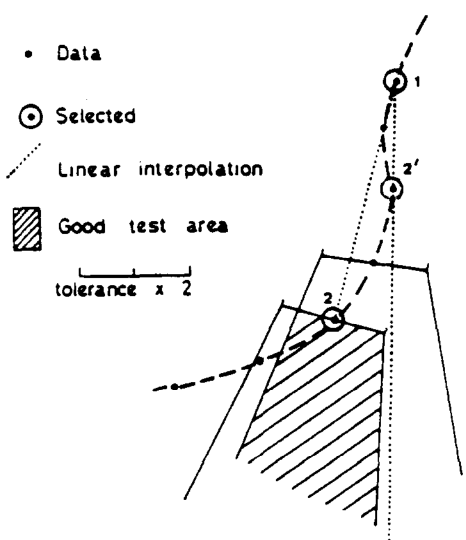


FIG.2. CONE data reduction method.
a) Select a temperature tolerance.
b) Between 1 and 2 build a cone with a base equal to twice the tolerance.
c) Test if the data point following point 2 is inside the intersection of the cone (1,2) with the previous cone.
d) If it is inside, then use it as the base of a new cone and start again b) and c).
e) If it is outside (as it is here), then select as the new significant point, either the cone base (point 2), or the data point opposite to the exit side (point 2').
f) When reaching the last data point, there is N+1 significant points. If it is too much or not enough, start again from a) with another temperature tolerance.

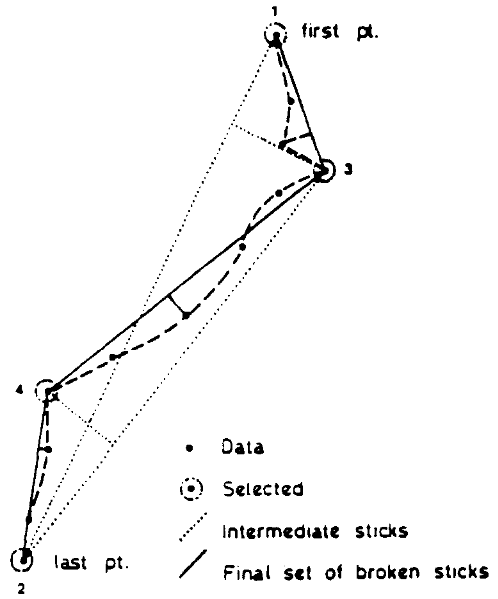


FIG.3. BROKEN STICK data reduction method.

a) Fix the number of significant points needed.

b) Draw a straight line (the stick) between the first and the last data points (1 and 2).

c) Calculate the distance between all the data points and the stick.

d) Break the stick at the data point where the distance is the greatest (point 3).

e) Having now 2 shorter sticks. Calculate the distances to the new sticks.

f) Break the stick, of all the sticks, with the data point the furthest from it (point 4).

g) Start again from b) until the selected number of significant points is reached.

Remark: Attention must be paid when breaking a stick, to check that the 2 new sticks created are not collinear with the preceding or the following stick. If so, then the intermediate point is deselected.

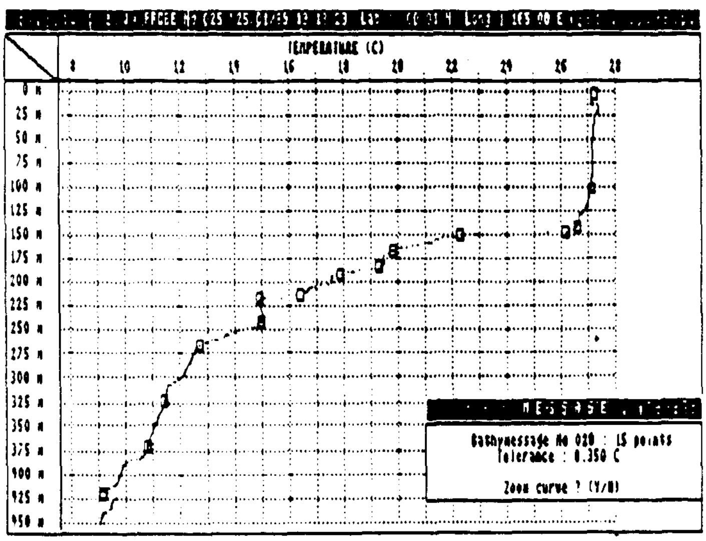


FIG.4. Bathy-message significant points. The squares represent the 15 significant points selected in 18 seconds by the Broken stick data reduction method out of a 500 data points XBT temperature profile. The maximum depth of the calculation was set to 420 meters by onboard quality control, because the temperature inversion below it, is considered too big, higher than half a degree.

a) Methods.

1) Pipe and Cone methods.

There are at least two methods in which the tolerance is given (Frachon 1987), the basic Pipe method, and the more controversial but also more rapid Cone method.

The Pipe method (Fig.1) (Siess, 1982) is equivalent to a rigid pipe with a diameter twice the tolerance, pushed around the profile, each time the profile breaks trough the pipe's wall, a significant point is found in the preceding data point or in the preceding point the most opposite to the exit. The process is then iterated starting with the new significant point. This method is very slow due to the fact that each time a new pipe is build between two points, the position of all the data points, in between, must be tested to check if they are inside or outside the pipe.

The Cone method (Fig.2) (Mesecar and Wagner, 1980; Frachon, 1987) is less satisfactory theoretically but seems to give comparable results and is very rapid as there is no backward control. The last significant point is the summit of the cone, the following point is its base, with a width twice the tolerance. If the third point is within the extrapolation of the cone, then this point is used for the base of a new cone and the next point is tested. There is one restriction, the next cone must always be inside the preceding cone, so if they intersect, only the intersection of the two cones is considered as the new cone (otherwise, it may be possible to mistake a large circle for a straight line!). When the following point is outside the cone then, as with the pipe method, a new significant point is found in the base point or in the preceding point the most opposite to the exit.

2) Broken Stick method.

The Broken Stick method (Fig.3) (Frachon, 1987; Kerr, 1984) is the only method that suppose a preset number of significant data points. Its basis is very different from the first two methods. A straight line (the stick) is drawn between the first and the last points of the profile. The distance between all the data points and the stick is computed and the stick is broken into two pieces at the data point the furthest from the stick. This point becomes a new significant point and the process is repeated, until the given number of significant points is reached. Each stick has a data point the furthest from it, but only one stick is broken at a given time, the stick containing the data point, the furthest of all the furthest data points. At the end of the process the remaining maximum distance of the furthest data point is a measure of the quality of the method and is equivalent to the tolerance of the previous methods. This method is more rapid than the Pipe method but less than the Cone method.

b) Bathy-message problem.

The GTS bathy-message format as well as most of the satellite messages, imposes a maximum length message. In order to make the best use of a message, it is best to fix the maximum number of significant points that fits into a message. The number of significant points being fixed, the obvious method to use is the Broken Stick method (Fig.4). When using one of the other methods, one has to iterate them, and to change the tolerance, until the number of significant points falls within a given range. These iterations may take a long time even with the very rapid Cone method. The empirical relation between the tolerance and the number of significant points in an XBT temperature profile, is nearly hyperbolic. Using an hyperbolic interpolation reduce a lot the number of iterations, but even then, for a 500 data points temperature profile, with a Personal Computer, the mean time to compute a 15 point bathy-message is 18 seconds with the Broken Stick method (+/- 1 second and no iteration), 45 seconds with the Cone method (9 to 90 seconds, with 9 seconds/iteration), and 2.5 minutes with the best dichotomic Pipe method (0.5 to 5 minutes, with 0.5 minute/iteration).

CRUISE :	**SURTROPAC 09**	**JAN. 88**
	50 Drops / 46 Bathymessage	**CORIOLIS**

Method	Heat Content (Mean temperature)	|Error| Mean temperature	$\overline{\sigma}$ (profiles)	|Error Max| (profiles)
Cone	17.557°C	.043°C	.138°C	.404°C
Broken Stick		.032°C	.125°C	.362°C
BS + Regression		.004°C	.087°C	.314°C

TAB.1. Errors between the full XBT temperature profile and the bathy-messages computed using the Cone or the Broken stick method. On the third line, was added to the later a regression fit. A pseudo heat content is given in the first column, the mean of the amplitude of its error is given in the second column. The third and fourth columns present the mean of the temperature standard deviation and the mean amplitude of the maximum temperature error.

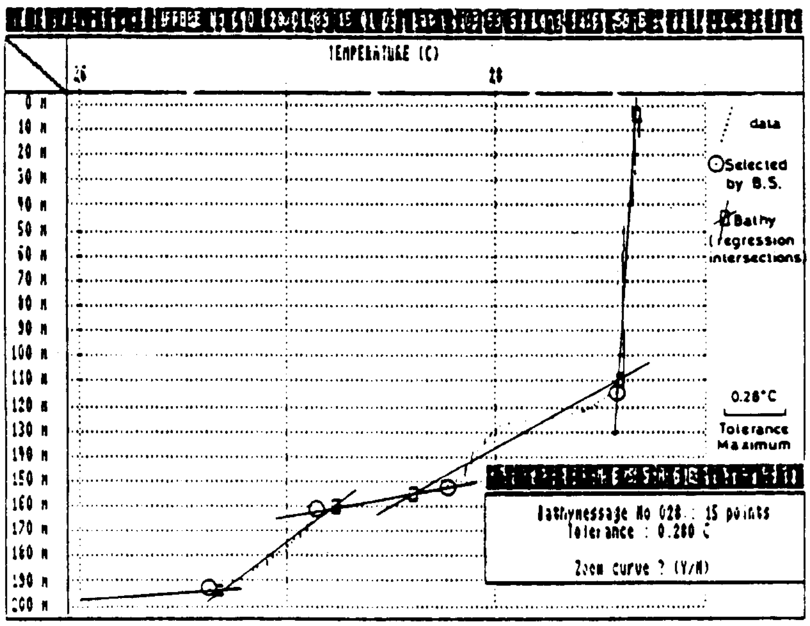


FIG.5. Linear regression fit. The open circles are the significant data points selected by a data reduction method. The squares are the intersections of the regression fit segments constructed from all the data points between two successive significant data points. The straight lines drawn between the squares are a better fit to the curve than the lines between the open circles so the regression lines intersections are chosen as new significant points.

The Broken Stick method is not only quicker but also better, as shown in Table 1, according to a study based on more than 50 temperature profiles and 46 bathy-messages. It results in a mean standard deviation and a mean maximum deviation 10% better than those of the Cone method. The mean heat content itself is 25% better. The Pipe method being too long, was not considered in this case, but its results are very close to the Cone method as seen in a previous study on a few profiles.

c) Final tests.

The final tests purpose is to verify the quality of the data reduction.

1) Pipe and Cone methods.

If the first pass with a standard tolerance does not give the right number of points, another test pass is made using the tolerance maximum (minimum) if the number of significant points is too large (too small). This will determine if it is possible to calculate the right number of points. If the resulting number of significant data points is too small (too large), then hyperbolic interpolations may converge to the required range. In the other case, the bathy-message can not be computed.

2) Broken Stick method.

After each stick breakage, the new maximum deviation between the profile and the bathy-message is computed and is checked against the tolerance minimum (generally, the white noise of the profile). If it is below then the computation stops prematurely, and if the final number of significant points is below the minimum number of points, the bathy-message is considered bad and not sent or recorded. When this is not the case, at the end of the computation, the bathy-message has the optimum number of significant data points, but its maximum deviation from the profile is checked against the tolerance maximum. If it is above then the computation is resumed till the maximum deviation is below the tolerance maximum or till the maximum number of points is reached. In this later case the bathy-message is considered bad and not sent or recorded.

Generally (Mesecar and Wagner, 1980), the tolerance maximum is 1°C and the minimum is 5/100°C, the white noise of the XBT profiles. For the GTS bathy-message format the optimum number of significant points is 20, for an Argos transmitted bathy-message it is 15. The minimum number of points is often 50% of the optimum number, and the maximum number is 10% to 20 % higher. In the case of an Argos transmission, they are respectively, 9 and 17 points, but no more than 15 points are actually transmitted because this is not possible, due to the short length of the Argos messages.

5. Improvements.

a) Linear Regression Fit .

We now have a number of significant data points belonging to the profile, and in between, a certain number of points, per definition, more or less linearly positioned. Then why not replacing these segments of curve by their linear regression fit, and use as new significant points, the intersections of the regression lines (Fig.5).

A test on more than a 150 profiles, shows in Table 2 a drastic improvement, the mean standard deviation is reduced by 30%, the mean maximum error is reduced by 13%, but more important for the modelers, the error in the integrated parameters, as the mean heat content, is reduced by an order of magnitude.

The only problem encountered while using the regression fit is when two successive regression segments are nearly parallel (Fig.6). In that case their intersection may be far from the curve and the solution is to eliminate the intersection as a significant point and to keep the significant data point.

CRUISE : ACT 9 JUL-AUG 88

105 Drops / 78 Bathymessage

Method	Heat Content (Mean temperature)	|Error| Mean temperature	σ (profiles)	|Error Max| (profiles)
Cone	17.098°C	.030°C	.111°C	.339°C
Broken Stick + Regression		.002°C	.068°C	.243°C

TAB.2. Same as Table 1 for another cruise, but only with the results of the Cone method or the Broken stick plus regression fit method.

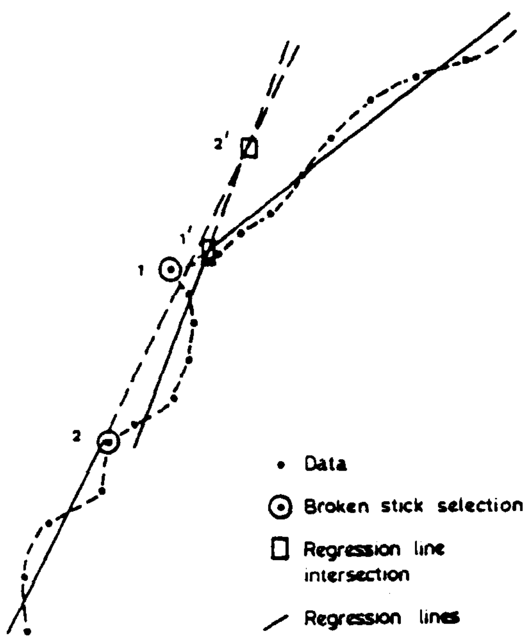


FIG.6. Quasi parallel regression lines problem. Data points 1 and 2 have been selected as significant points by some data reduction method. Points 1' and 2' are the intersections of the regression lines constructed using all the data points between two significant points. Point 1' is a better representation of the local curve and will replace the data point 1 as significant point. The two following regression segments are almost parallel. Point 2' is above 1' or 1 and is very far from the curve, so point 2' is abandoned and point 2 is kept as a significant point.

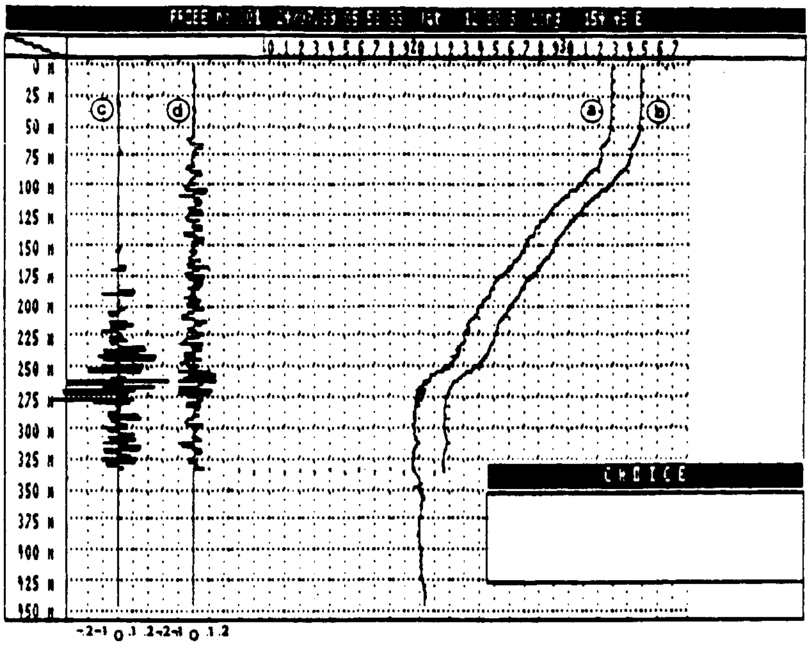


FIG.7. Median and Hanning filter effect on a temperature profile. Profile *a* is the original profile, profile *b* is the filtered profile, offset by 2°C, used to calculate the bathy-message down to 333 meters (temperature minimum). Curve *c* shows the effect of the despiking nonlinear median filter over a window of 5 points, and curve *d* the effect (offset by 5°C) of the low pass linear Hanning filter over a window of 11 points. The scales of the last two curves are multiplied by 10.

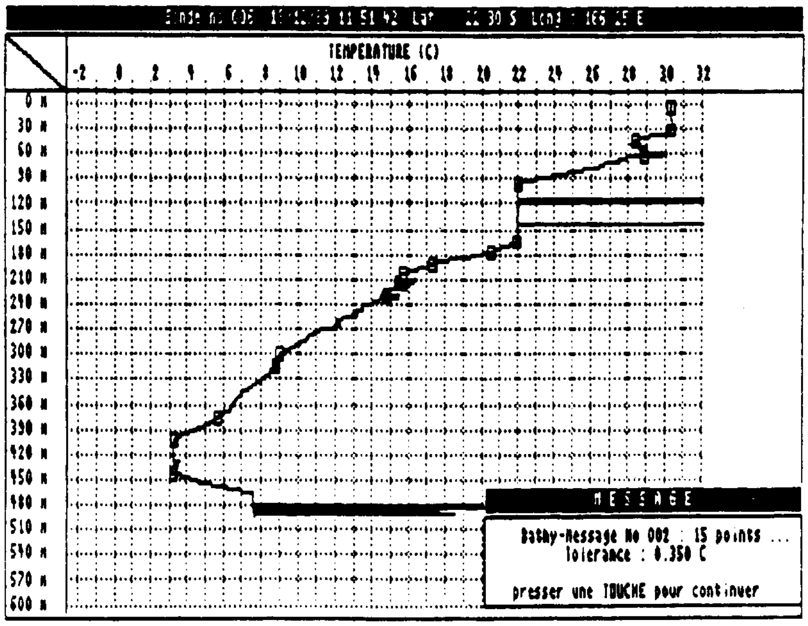


FIG.8. Improved bathy-message. Significant points are represented by the squares on that dummy temperature profile were spikes and contact problems have been amplified. Without despiking, the onboard quality control would have declared the last good data point at 118 meters and the bathy-message would have stopped at that depth. Moreover, Hanning filtering has reduced the effect of small scale features and no significant points are lost to describe them. The regression fit has also adjusted the significant points so that the vertically integrated mean temperature error is less than 2/1000°C.

b) Data Filtering.

1) Median filter.

Due to temporary defective electrical contacts, or any other cause such as radio transmission while launching, more or less isolated spikes may occur during a launch. As the search for the bathy-message maximum depth stops at the first large temperature gradient (>3°C/m), it is useful to use a despiking filter prior to the test. The nonlinear median filter (Sy, 1985) is adequate as it completely filters out the spikes with a width less than the half window, but leaves intact the data as long as the data is monotonous. A 5 meters window seems to be adequate for an XBT profile, it cuts out any spike 2 meters wide or below. A more elaborate median filter with a threshold (Brock, 1986) may also be used in order not to modify any data if it is not a spike above a given amplitude.

2) Hanning Filter.

To describe as well as possible a 500 point curve with 30 significant points or less, one wants to represent the major characteristics of the curve, leaving out the small scale features. At our disposal, now is an efficient bathy-message computing method, but it has a tendency to privilege angular points, as all data reduction methods do. So, prior to the bathy-message computation small scale features should be filtered out by a linear filter such as the Hanning filter (Fig.7) (Etienne, 1970). It is a cosine pondered running mean, a kind of Tukey filter (Matushevskiy and Prival'skiy, 1968) which has almost no secondary maximum. After comparison with CTD profiles, the best filter window seems to be 10-20 meters.

6. Conclusion.

Using a median filter (5 meters window) prior to the first quality control test, then a Hanning filter, (11 meters window) prior to the Broken stick data reduction method, and finally applying a linear regression greatly improves the bathy-message fit with the profile (Fig.8). Temperature errors are reduced by at least 40%, and errors on integrated parameters, such as the heat content, are reduced by an order of magnitude. The maximum depth of the bathy-message may also be increased by the median filter despiking. All these improvements are included in the software developed by ORSTOM and C.L.S. service Argos, for the XBT-ST Argos transmission equipment, that has been on use for more than a year on most of the French TOGA Voluntary Observing Ships network.

Furthermore, when using the Argos satellite transmission system (Table 3), the ratio between the bathy-message sent and transmitted to the GTS is very high (99%), as very few bad profiles pass the onboard quality control, and as the C.L.S. service Argos insert itself the messages, directly onto the GTS, after a rapid quality control. In the TOGA Subsurface Temperature Data Bank, the ratio between the GTS received and archived messages is also very high (99%), as most of the quality control was made during the first steps of the transmission link.

TOGA-VOS, ORSTOM PACIFIC network

January-September 1989

	Number	Step ratio	Global ratio
Probes launched	1945	-	-
Good Profiles (Noumea)	1520	78%	78%
Bathy-messages (service Argos)	1501	99%	77%
Bathy-messages (TOGA Bank)	1486	99%	76%

TAB.3. TOGA-VOS ORSTOM XBT Pacific network efficiency. The 8 ships were equipped with C.L.S.-ARGOS XBT-ST satellite transmission equipment. The second column represents the success rate between two successive lines, the third column, the global success rate between the number of probes launched and the data locally received and archived. The second line indicates the number of XBT profiles received in delayed mode in Noumea, manually quality controlled and archived. the third and fourth lines represent the real time bathy-messages received and archived after quality control, in Toulouse Argos center and in Brest TOGA subsurface temperature data bank.

Acknowledgments. This work has been possible, due to the help of the SURTROPAC ORSTOM Noumea group for the TOGA XBT Voluntary Observing Ship program, and the Toulouse based C.L.S.- service ARGOS group. The Sippican probes were funded by the US TOGA Office under an agreement with the French TOGA Representative.

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REPORT OF THE GTSPP

R. Keeley, MEDS, Canada

Introduction

The Global Temperature-Salinity Pilot Project was conceived to attempt a new way of managing international oceanographic data exchange. Its goals were to improve the flow of data from collectors to archives and through to secondary users. It aimed to improve the rapidity of this data flow, to improve the completeness of data archived, to improve quality control procedures and to generate output data, products and services of value. In order to meet these goals, other services have also developed. This report will summarize the experiences and results of the GTSPP since its beginning in November, 1990. Since this is a meeting more concerned with real-time data, this aspect will be stressed in this report.

Data Flows and Distributions

The GTSPP developed along two lines as will be evident from Figure 1. The first deals with the more immediate data collection through the IGOSS system. In the figure these are referred to as "low resolution" data since the temperature and salinity profiles are usually reported at inflection points. Data also enters the GTSPP through delayed mode avenues as well, typically after the data collectors have made their own assessment of the quality of the data. These profiles are usually represented at one or two meter intervals and are referred to as "high resolution" data. Connections are represented by arrows with data flows marked in the direction of arrow heads. Arrows with dashed lines represent connections that are not systematized. The figure illustrates the multiple sources of data required to make a serious attempt to gather all of the temperature and salinity data collected.

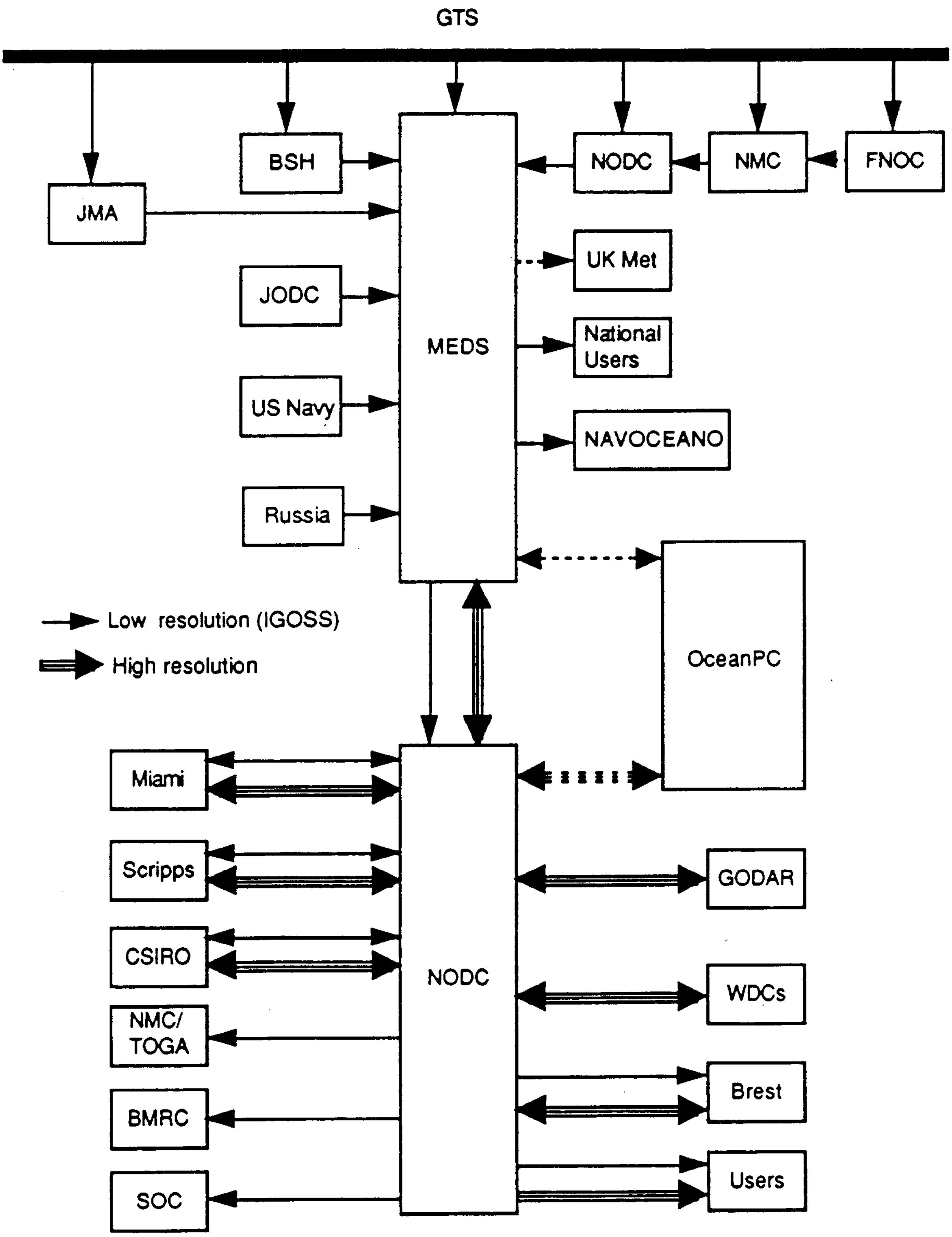

Figure 1: Data flows of the GTSPP

No mention is made in figure 1 of the time scale of the exchanges in the transfer of the data. The low resolution data transfers into and out of MEDS and on the right side of the figure occur every day. The transfers into MEDS on the left side occur once a month. The transfer of data to NODC from MEDS occurs three times a week. Low resolution data transferred from NODC occur once a month except to NMC which happens three times each week. High resolution data transfers occur irregularly as these data are processed.

The data collected in real-time are acquired by MEDS either through the GTS or via other transfers. Figures 2 and 3 represent the volumes of BATHYs and TESACs held in the GTSPP archives up until August, 1995. It is evident that there has been some improvement in the numbers of BATHY reports but that these are largely a consequence of reports derived from moored buoys with thermistor chains. In fact most of these data come from the TOGA/TAO array in the Equatorial Pacific. Overall the numbers of BATHY profiles collected by ships has increased somewhat since 1991.

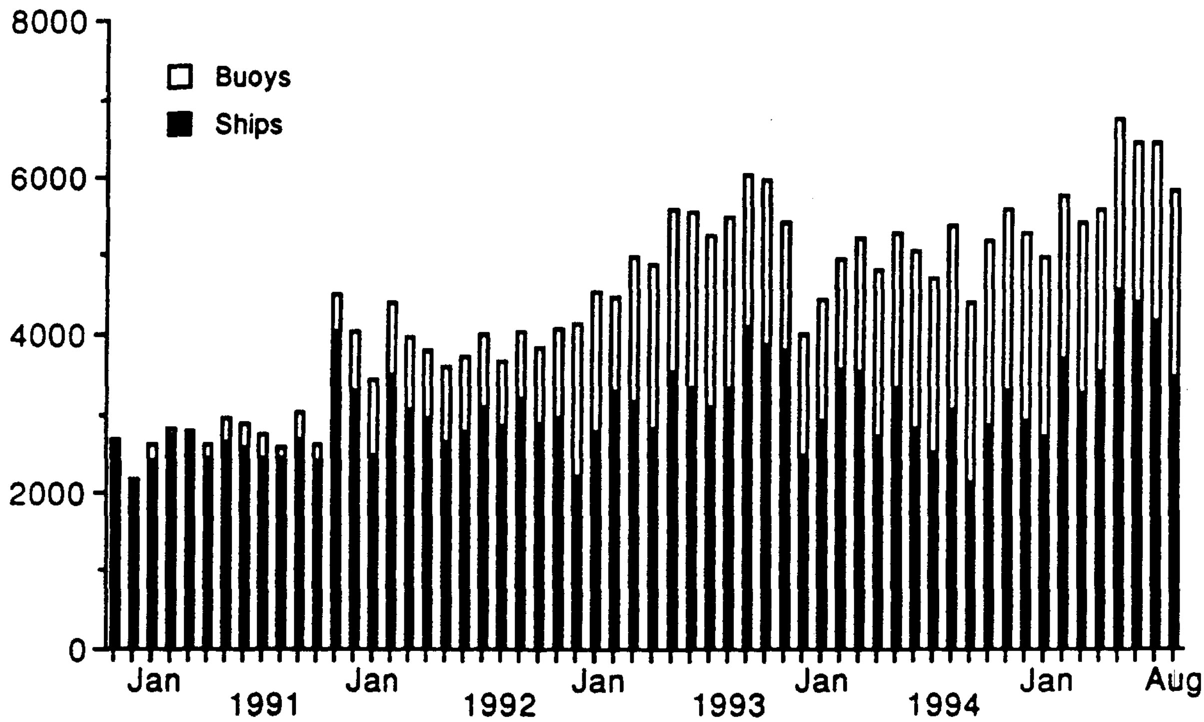

Figure 2: Numbers of BATHYs reported.

The numbers of TESACs reported has shown an increase but there are still almost an order of magnitude fewer TESACs than BATHYs. The fewer numbers of TESACs shows a high degree of variability. There is still a great need to encourage the reporting of salinity data in real-time.

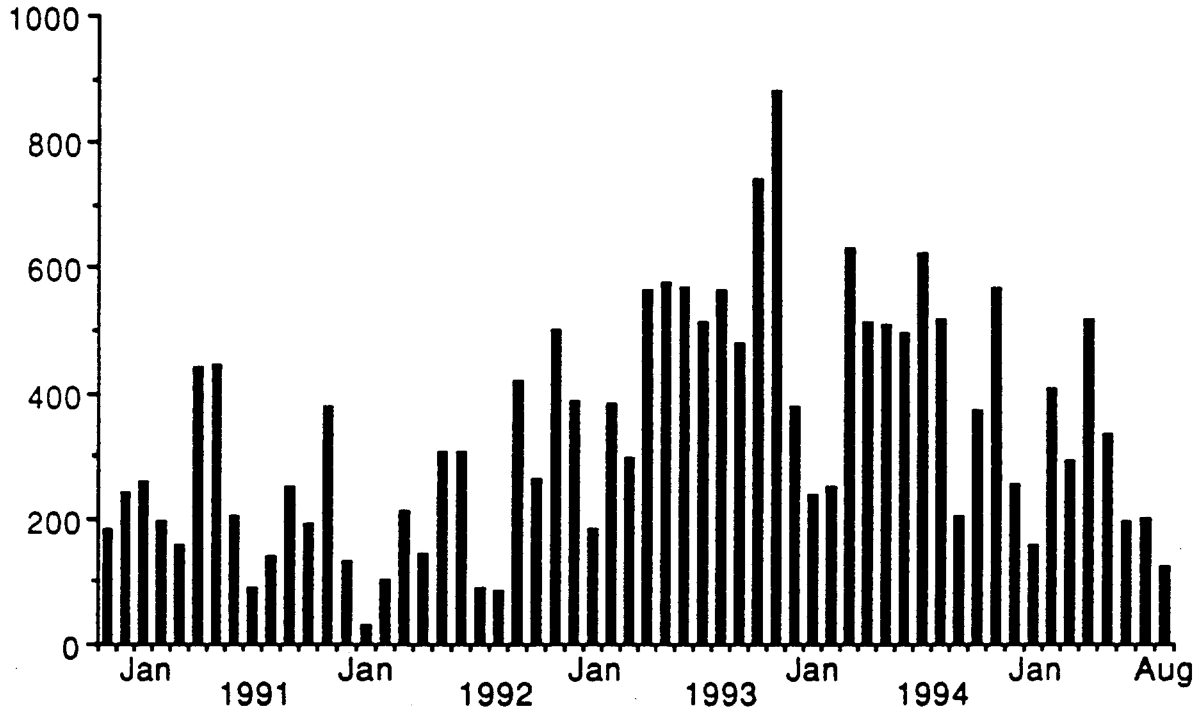

Figure 3: Numbers of reported TESACs.

It is of interest to know the spatial distribution of these reports as well. To be quantitative, the world's ocean were divided into broad regions as shown in figure 4. This is a coarse division but is adequate to illustrate the large differences in the numbers of reports generated from the oceans. Figures 5 and 6 show the distributions of BATHYs and TESACs by region.

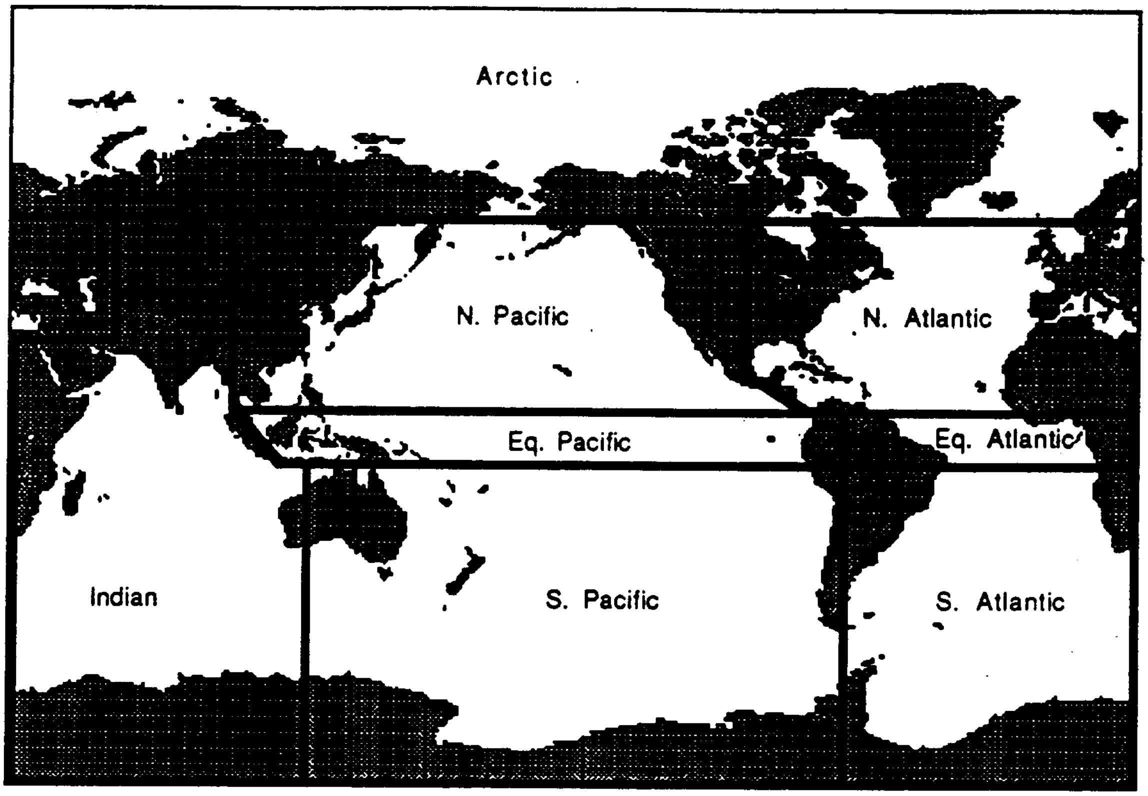

Figure 4: The oceans subdivisions used in counting real-time data.

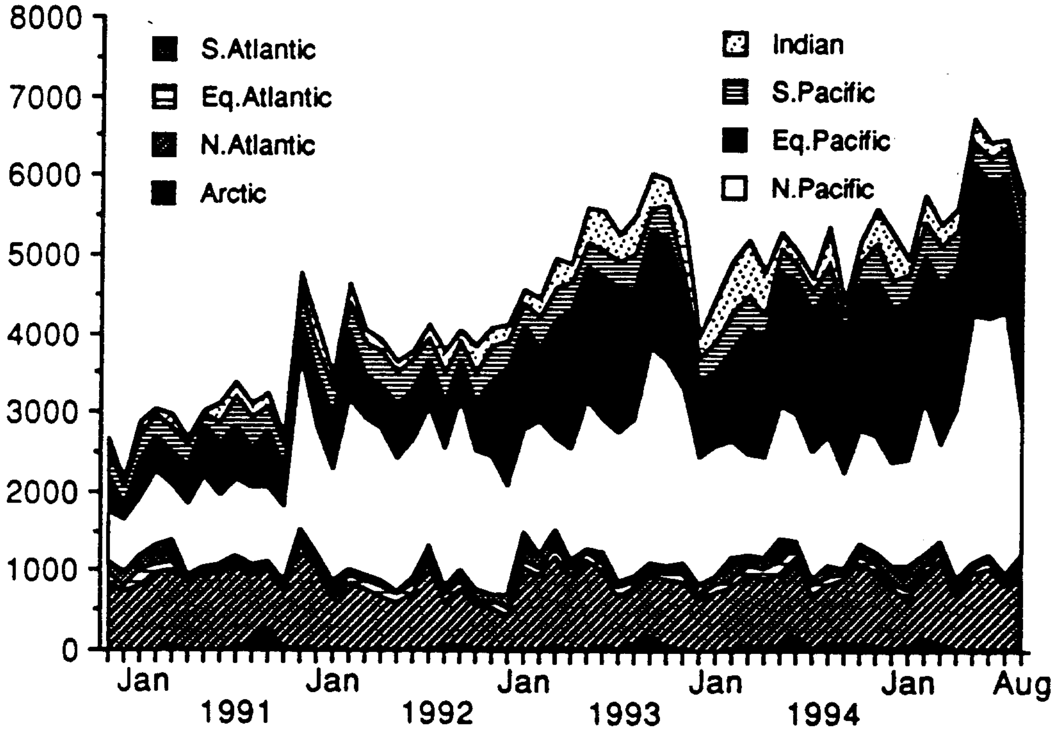

Figure 5: Numbers of BATHY reports by ocean basin.

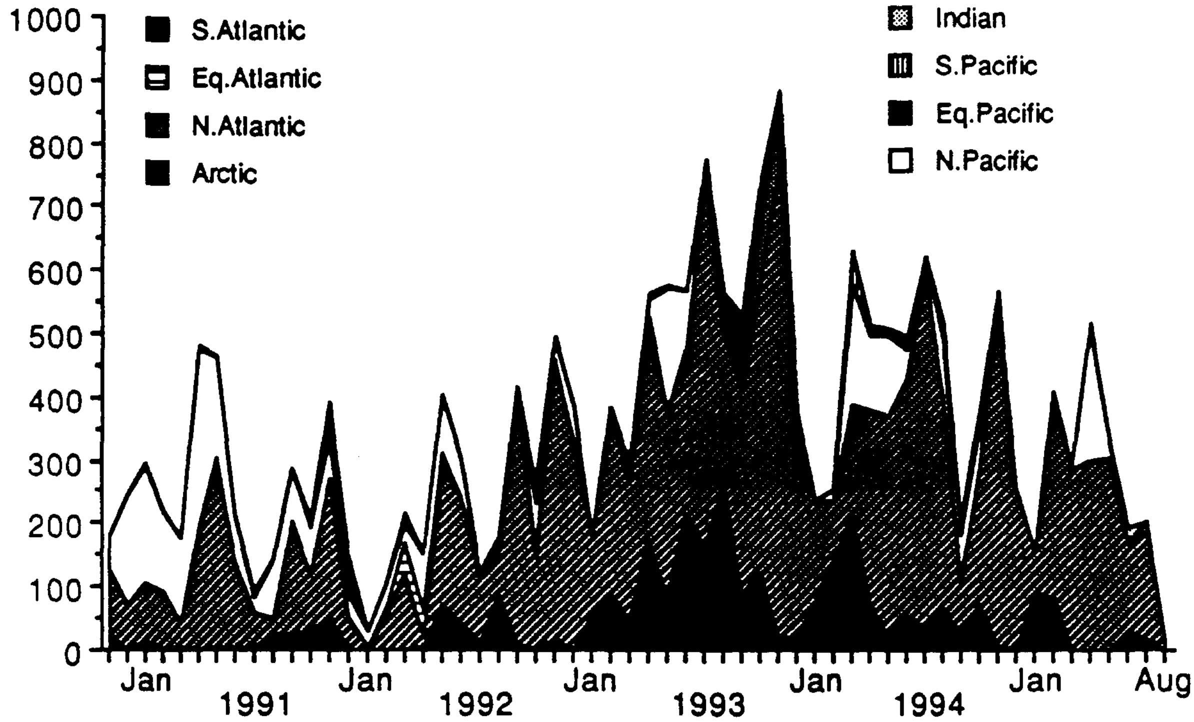

Figure 6: Numbers of TESAC reports by ocean basin.

In figure 5 it is very clear that the North and Equatorial Pacific are the most heavily sampled. The North Atlantic follows closely behind. The numbers of reports from the Equatorial Pacific is influenced largely by reports from the TOGA/TAO array. There are roughly 50 moored buoys many reporting temperature profiles in this region.

Figure 6 shows a different sampling. The North Atlantic and Arctic regions are predominate in this figure. This is due to the fact that TESAC reporting is confined to a very few countries. If this is ever to be a valuable source of salinity observations, other nations must be convinced to report salinity profiles.

One way that this can improve dramatically will be if countries start to report data from Profiling ALACE floats. In fact, the first reports have just been placed on the GTS from such a float operating in the eastern Pacific. This particular float reports every 5 days and encodes the data as a TESAC.

Figure 1 shows the various sources of real-time data extracted from the GTS. It was necessary to use multiple sources since it was known that it is possible for reports not to be sent to everyone (because of the way the GTS operates). The GTSPP has developed software to monitor this and uses the five sources in this monitoring. Figure 7 illustrates the reasons why such multiple sources are required. Here is shown the number of BATHY reports received by the National Weather Service in the U.S. compared to the total number of unique reports available on the GTS each month. Note that the NWS was chosen purely as an example and in fact represents one of the GTS sites that tends to receive more data than others on the system. It is clearly shown that some data are not received every month. What is more, looking at the details of the analysis shows that nearly every month at least one GTS site receives some profiles that none of the others do. Given the present system for data dissemination, and the few numbers of real-time data distributed this way, it is necessary to have multiple sources.

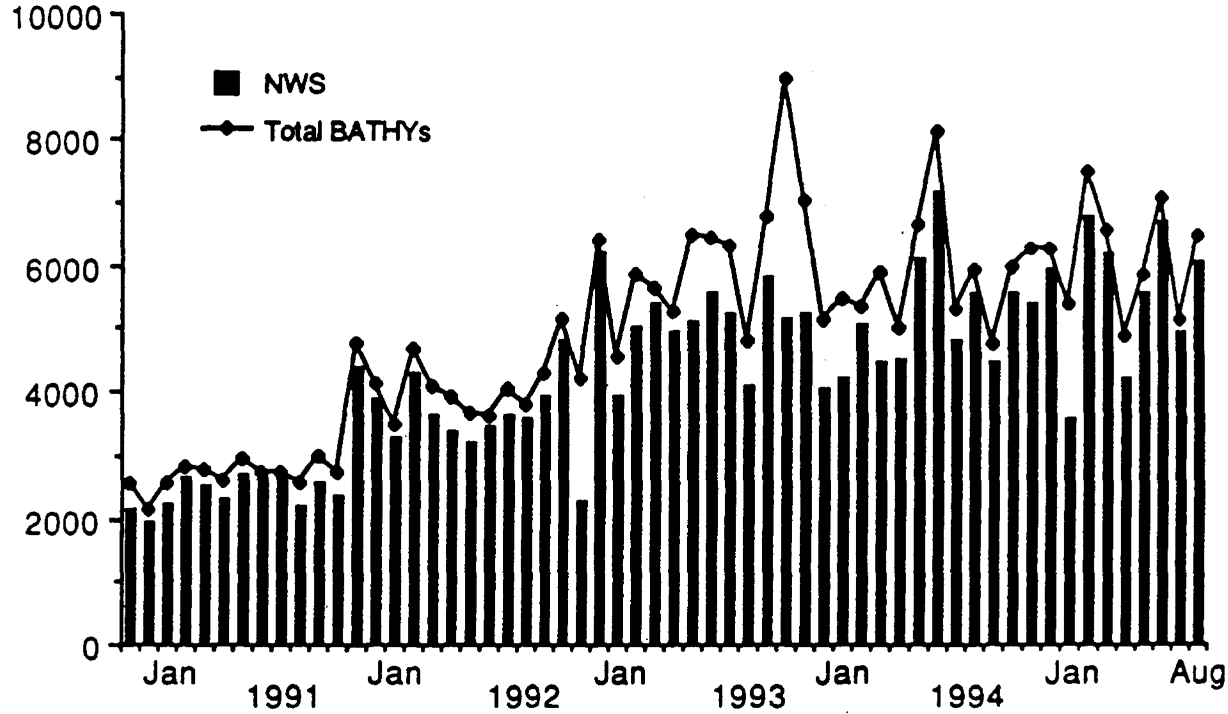

Figure 7: Numbers of BATHY reports received by the NWS compared to the total number available.

Monitoring and Data Quality

When the GTSPP was planned, it was evident that a sharing of work was necessary. To improve cooperation between the many parties involved a standard set of data quality control procedures were developed for both the low and high resolution data. The procedure used on the low resolution data are described in IOC Manuals and Guides #22. Since this publication was printed there have be a few changes to the procedures.

The value of standardized procedures is that they help to describe what has happened to the data and to help others assess what further work must be done when they use the data. The GTSPP employs the flagging convention of IGOSS. That is, data that are deemed correct receive a flag of 1, those considered doubtful a flag of 3, those wrong a flag of 4, and changed values are marked by a flag of 5. The GTSPP evaluates positions, dates/times as well as every observation and marks each with a flag. Figures 8, and 9 illustrate some statistics concerning BATHYs.

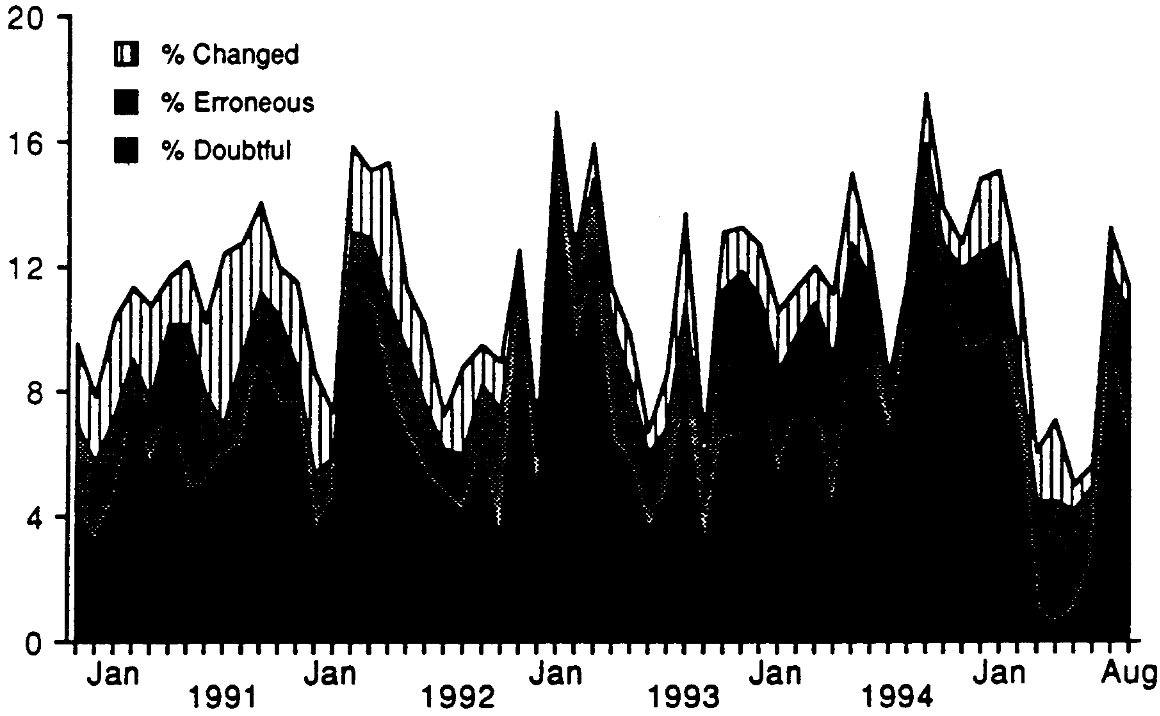

Figure 8: Numbers of BATHYs receiving flags of 3, 4 or 5.

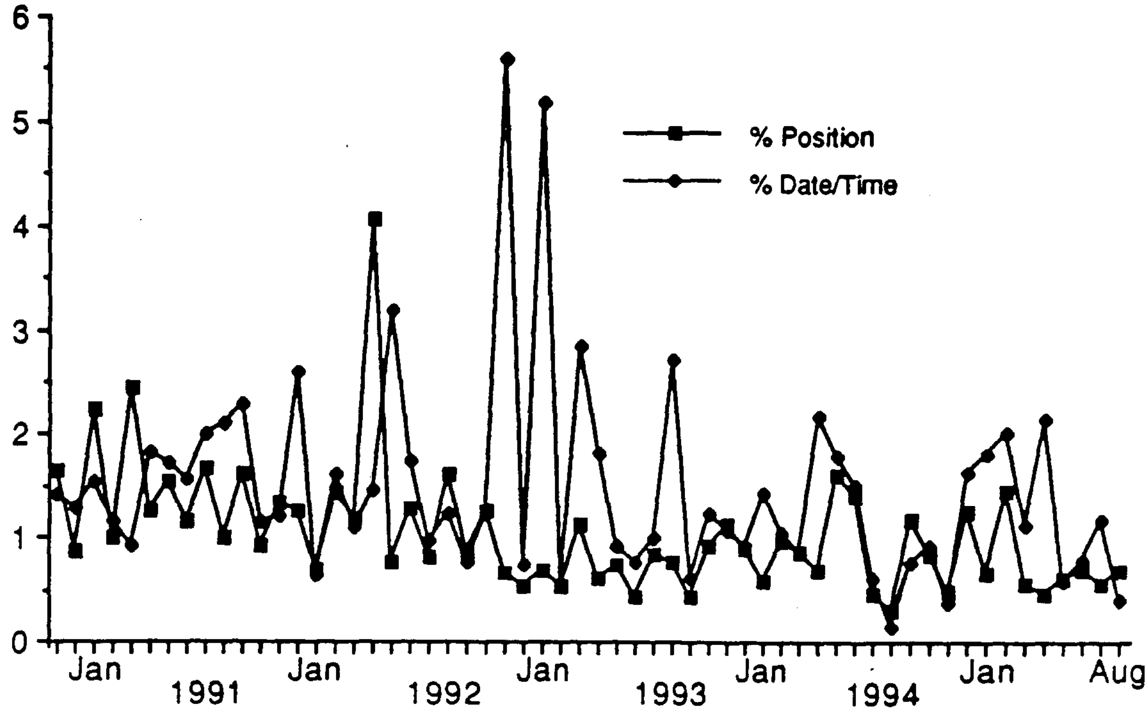

Figure 9: Numbers of BATHYS with position or date/time receiving flags of 3, 4 or 5.

In examining figure 8 it must be realized that a BATHY can be assigned a flag other than 1 if a single observation in the profile does not receive a 1. Given this, it is obvious that the numbers of flagged reports is quite variable but with an average of about 10%. Rates tend to be higher at the start of a year reflecting the fact that often dates are incorrectly encoded at this time. Figure 9 shows that the numbers of BATHYs with positions or dates and times that are suspect varies but with an overall rate of about 2%.

Monitoring the quality of reported data is valuable, but the value increases if something is done to inform the collectors so that actions can be taken to improve the collection procedures where needed. The GTSPP in cooperation with the WOCE UOT program has developed a monthly reporting mechanism whereby both the WOCE Project Office and the IGOSS Technical Coordinator are informed of those ships which appear to have problems in their sampling. A report, a portion of which is shown in figure 10, is generated once each month. From this, the profiles reported from ships showing more than 10% of the profiles collected with test failures in their profiles are examined. Systematic problems are sought and for those where these are found, they are reported as mentioned above. The ships are then contacted to improve their reporting records.

The report also examines the distribution by time of day of all of the reports from each ship. This helps to identify ships that are sampling equally throughout 24 hours and those that are not.

DATA QUALITY STATISTICS / STATISTIQUES SUR LA QUALITE DE DONNEES

CR_NUMBER	DATE			LAT		LONG		BA	TE	REC	POS	DT	PROF	CLIM	AVE	SAMP			
HPEW	95	19950808	19950830	16.03 N	20.71 S	160.00 E	150.55 W	48	0	1	0	0	1	0	2.1	11	15	9	13
J8FG9	95	19950815	19950822	5.67 N	14.58 S	60.31 E	94.72 E	15	0	1	1	0	0	0	1.9	3	3	4	5
J8JA4	95	19950805	19950814	25.16 N	8.81 N	49.13 W	37.38 W	3	0	0	0	0	0	0	0.3	1	0	0	2
JBOA	95	19950818	19950831	34.00 N	20.32 N	125.18 E	139.15 E	27	0	0	0	0	0	0	1.9	11	4	5	7
JCCX	95	19950801	19950807	30.25 N	24.48 N	126.00 E	130.01 E	55	0	1	0	0	1	0	7.9	13	14	15	13
JCOD	95	19950801	19950801	23.50 N	22.50 N	133.38 E	133.56 E	3	0	2	0	0	2	0	3.0	1	2	0	0
JDWX	95	19950801	19950803	41.00 N	34.00 N	142.50 E	143.00 E	17	0	3	0	0	3	0	5.7	6	5	1	5
JFDG	95	19950821	19950825	33.47 N	29.50 N	131.50 E	135.25 E	27	0	1	0	0	1	0	5.4	6	5	7	9
JFPQ	95	19950821	19950827	13.90 N	5.72 N	70.67 E	94.71 E	21	0	5	1	2	3	0	3.0	4	5	7	5
JGQH	95	19950801	19950831	42.50 N	33.33 N	137.00 E	146.98 E	35	0	19	3	0	16	0	1.1	8	11	8	8
JITV	95	19950801	19950830	28.48 N	34.33 S	120.13 E	173.95 E	42	0	33	0	0	33	0	1.4	10	11	11	10
JIVB	95	19950801	19950808	40.50 N	36.50 N	136.00 E	139.83 E	37	0	1	0	0	1	0	4.6	7	10	12	8
JJGC	95	19950817	19950819	28.75 S	31.91 S	11.68 W	4.08 E	9	0	1	0	0	1	0	3.0	3	3	1	2
JKCF	95	19950805	19950805	61.10 N	61.10 N	10.93 W	10.93 W	1	0	0	0	0	0	0	1.0	1	0	0	0
KGJB	95	19950806	19950827	53.80 N	35.33 N	151.28 E	71.65 W	16	0	5	1	1	4	0	0.7	4	3	3	6

Figure 10. A portion of the monthly report prepared to identify ships with reporting problems.

To support the WOCE UOT programme, the US NODC has prepared on-line displays showing the distribution of reports along WOCE lines. These can be accessed by connecting to their WWW site at http://www.nodc.noaa.gov/GTSPP.

One of the goals of GTSPP was to improve the timeliness of data getting to users. Figure 1 illustrates how users can gain access to the GTSPP archive. Figure 11 shows how quickly data collected at sea and sent via the GTS can be accessed by users. The times reported here are differences between the date of collection and the day received by the GTSPP. Generally data are available from the GTSPP within 3 days of data collection. Roughly 80% of reports are received within 3 days.

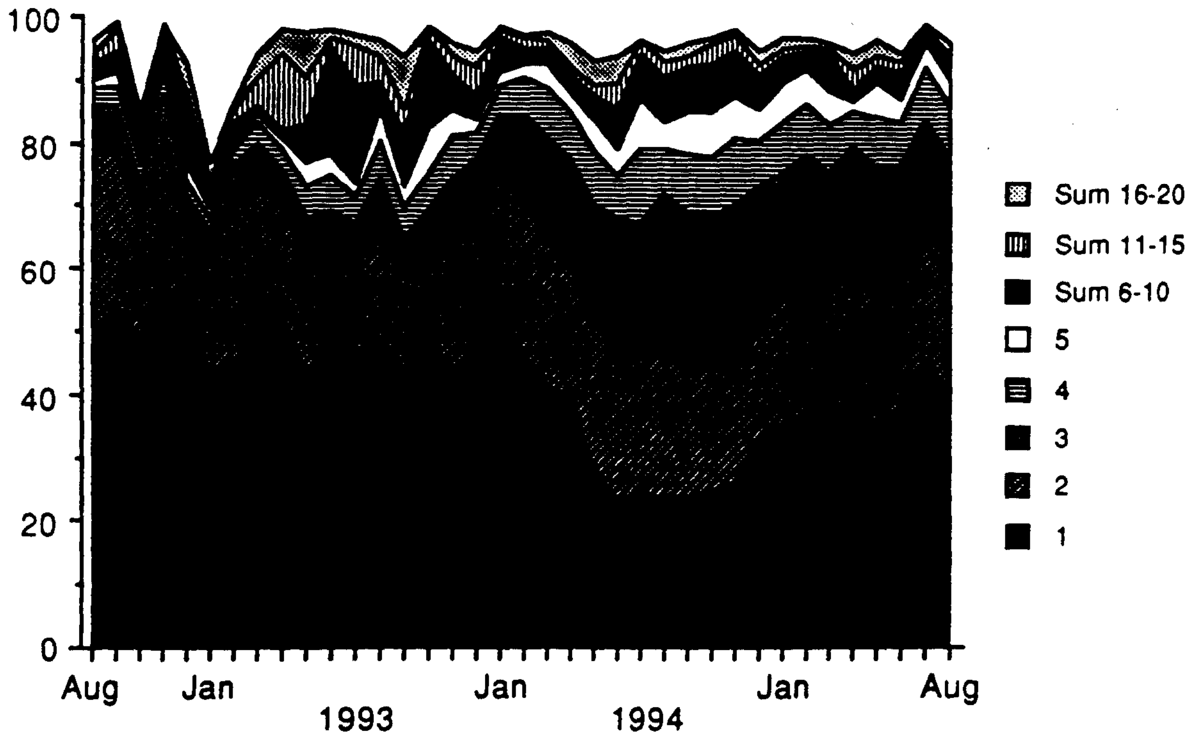

Figure 11: Timeliness of reports of low resolution data.

Products and Services

The GTSPP also supports a number of products and services. In figure 1 is shown a number of users of the data who access the real-time and delayed mode data either from MEDS or the U.S. NODC. MEDS prepares files especially for its clients and these are downloaded at the clients convenience. The NODC places files of both low and high resolution data on its WWW site and permits any users with access to download the most recent data.

GTSPP supports the WOCE UOT programme by furnishing the data on a monthly basis. Files are prepared for the UOT Data Centre in Brest. As well, reports of ship sampling and the quality of data collected are made each month as described earlier.

Besides these, all of the science centres involved in the GTSPP have posted documents detailing the quality control procedures which they employ to examine the high resolution data. Most of these are available through their WWW sites. At Scripps bimonthly products are also posted including data distributions, 0-400m heat storage temperature anomalies and SST anomalies.

Conclusions

The GTSPP project has been able to do much to help in the management of ocean temperature and salinity profile data. It has shown the way by which close cooperation between data centres and science centres can be achieved. It has standardized quality control procedures and encouraged others to document their procedures. It has demonstrated how a division of labour in data management can accomplish a goal that would exceed the capabilities of any one centre. It has produced statistics that help to measure the successes and failings of the international data management system.

As in all projects, there is still work to be done. Not all temperature and salinity data are yet included. There are still many loose ends and delays in acquiring the high resolution data. A considerable effort of the GODAR project has been complementary to the GTSPP in bringing together and making available substantial numbers of historical data. There is still work to be done in the managing the low resolution data as well as broadening the data sources included in the GTSPP. All of this work has been concentrated on managing the temperature and salinity data. There are other types of data for which similar projects could be organized. This can only be done if other nations join together to learn from both the successes and mistakes of the GTSPP to build the needed management systems.