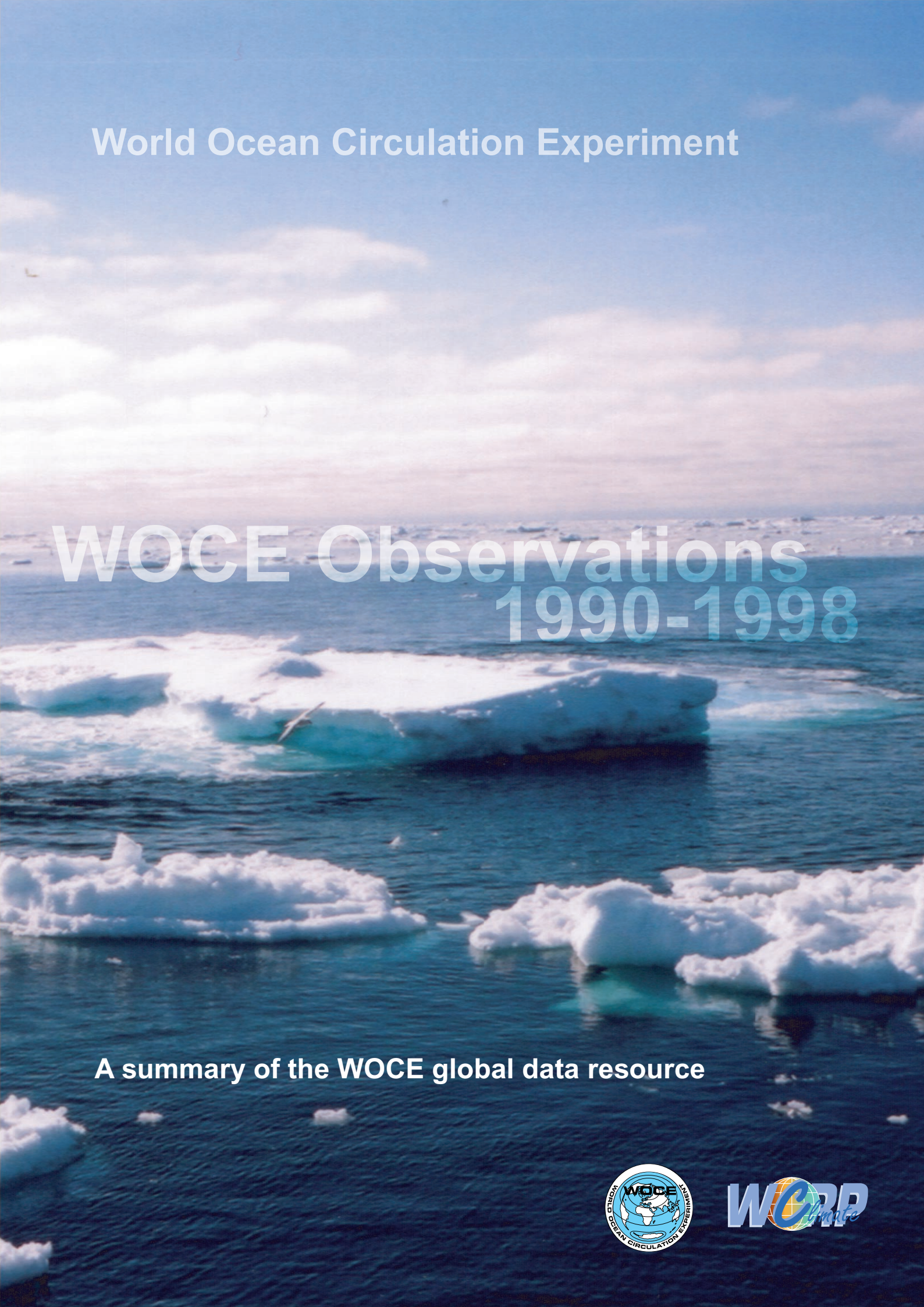

World Ocean Circulation Experiment

WOCE Observations 1990-1998

A summary of the WOCE global data resource

WOCE International Project Office, 2003. "WOCE observations 1990-1998; a summary of the WOCE global data resource". WOCE International Project Office, WOCE Report No. 179/02., Southampton, UK.

Contents

Tables

Introduction

This document is a comprehensive guide to the observations that were made during the World Ocean Circulation Experiment's field phase (1990 to 1998). It was compiled from, and serves to complement the WOCE data resource that was distributed as Version 3 on DVDs in 2002 (WOCE DPC, 2002).

The structure of the document is based on the data streams that emerged from the WOCE field programme and together form the data resource. A series of sections summarise the data collected in each data stream; essentially ordered by the measurement platform rather than scientific objectives. Each section contains a brief overview of the type of data collected and the observational strategies involved. Key references are included for further reading. In summary the document describes what was measured, in what location, at what time and by whom.

The document was compiled by Dr Penny Holliday in the WOCE International Project Office in collaboration with the various elements of the WOCE data system, the Data Assembly and Analysis Centres and the WOCE Data Information Unit.

Printing costs have been provided by a generous grant from the Intergovernmental Oceanographic Commission of UNESCO.

Background

WOCE has been a component project of the World Climate Research Programme (WCRP). Its planning started in the early 1980s following the successful demonstration by the 100-day SeaSat mission in 1978 of the ability of satellites to observe the ocean on global scales. The planning and execution of WOCE was guided by a Scientific Steering Group that first met in August 1983 and by many other Panels and Working Groups. Its scientific objectives are outlined in a Science Plan (WCRP, 1986) and the detailed strategy for implementation in the Implementation Plan (WCRP 1988a,b).

The project was executed by nationally funded contributions to elements of the Implementation Plan. These commitments were first made at an International WOCE Conference in 1988 (WCRP, 1989). Following the end of the field phase, WOCE entered a period of Analysis, Interpretation, Modelling and Synthesis (WOCE AIMS) the objectives and strategy of which can be found in WOCE IPO (1997).

As stated in the Science Plan the scientific goals of the programme were:

- To develop models useful for predicting climate change and to collect the data necessary to test them.

- To determine the representativeness of the specific WOCE data sets for the long term behaviour of the ocean, and to find methods for determining long-term changes in the ocean circulation.

It is not the purpose of this document to review the progress made in meeting these goals, but to summarise the way these goals were pursued. This was done through programmes of *in situ* observations made from ships, floats, drifters and moored arrays, through satellite sensing (e.g. TOPEX-Poseidon, ERS-1, ERS-2), through computer modelling and through theoretical studies. These last two elements were a considerable part of WOCE but find no place in this document. Their role can be seen in the interim project report (Siedler, Church and Gould, 2001) and in the WOCE bibliography (on the Global Data Version 3 DVDs).

Because of the global scale of the project and the limitations of resources it is important to note that the in situ elements of the field programme were conducted in a sequential manner. Observations in the Pacific Ocean were made largely from 1990 to 1995, in the Southern Ocean and South Atlantic largely from 1991 to 1995, in the Indian Ocean largely in 1995, and in the North Atlantic largely from 1996 to 1998. The Arctic Ocean was not observed in WOCE. Special mention should be made of a programme of observations made in the Brazil Basin and known as the Deep Basin Experiment. Global coverage was provided throughout the programme by one or more of the satellites mentioned earlier.

Data Management

The effective management of the data sets collected by WOCE was clearly a high priority. The objectives of the strategy planned by the WOCE Data Management Committee (later the Data Products Committee) were to ensure that:

- All data required to meet WOCE Goals would be available to researchers

- Data would be made available in a timely manner

- The proprietary rights of the scientists who collected the data would be respected

- The data would be of high and uniform standard

- The data and metadata would ultimately be securely archived.

No system that could meet these objectives existed in the late 1980s and WOCE therefore established a series of Data Assembly Centres (DAC) and Special Analysis Centres (SAC). Each DAC and SAC dealt with a single data stream and was located in a laboratory or organisation with appropriate expertise to ensure quality control. WOCE also set the standards for making the essential high quality

Hydrographic and Tracer observations (WHPO, 1994). The WOCE Hydrographic Programme Office also employed independent Data Quality Experts to scrutinise and compare data sets.

The day to day monitoring of the implementation of the observational plan and the progress of the observations through the data system was the responsibility of the WOCE Data Information Unit (DIU). The final archive of the WOCE data resource is at the US National Oceanographic Data Centre (NODC).

A comprehensive description of the WOCE data system can by found in Lindstrom (2001). The overall WOCE project and the status of interpretation of its results up to about 1998 are summarised in Siedler, Church and Gould (2001).

Further Information

The WOCE Data Resource is available from the US National Oceanographic Data Centre. The documents describing the development of the WOCE programme, a bibliography of WOCE references (to 2002) and other products are included in the resource. Contact NODC at: 1315 East-West Highway, SSMC3, 4th Floor, Silver Spring, MD 20910, USA, services@nodc.noaa.gov, www.nodc.noaa.gov.

References

Lindstrom E. J., 2001: Developing the WOCE Global Data System, Chapter 3.5, pp 181 –190 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Siedler, G, J. Church and J. Gould (Eds.) 2001: Ocean Circulation and Climate – Observing and Modelling the Global Ocean. Academic Press , International Geophysics Series No 77, 715pp and Plates.

WOCE Data Products Committee, 2002. WOCE Global Data Version 3.0. WOCE International Project Office, WOCE Report No. 180/02, Southampton, UK.

WOCE Hydrographic Programme Office, 1994: WOCE Operations Manual, WHP Operations and Methods, WHPO 91-1, WOCE International Project Office, WOCE Report No.68/91, November 1994, rev. 1.

WOCE International Project Office, 1997: WOCE Analysis, Interpretation , Modelling and Synthesis (AIMS): Strategy Document. WOCE International Project Office, WOCE Report No.153/97, 51 pp. WOCE International Project Office.

World Climate Research Programme, 1986: Scientific Plan for the World Ocean Circulation Experiment. World Climate Research Programme, WMO/TD-No.122, 83 pp.

World Climate Research Programme, 1988a: World Ocean Circulation Experiment Implementation Plan. Vol. I Detailed requirements. World Meteorological Organisation, WMO/TD-No.242, WCRP-11, Various paginations.

World Climate Research Programme, 1988b: World Ocean Circulation Experiment Implementation Plan. Vol. II Scientific Background. World Meteorological Organisation, WMO/TD-No.243, WCRP-No 12. July 1998, Various paginations.

World Climate Research Programme, 1989: Report of the International WOCE Scientific Conference. UNESCO, Paris, 28 November to 2 December 1988. World Climate Research Programme, WMO/TD-No.295, Various paginations.

1. WOCE Hydrographic Programme

The WOCE Hydrographic Programme or WHP was the cornerstone of the WOCE *in situ* observational strategy. The two principal aims of the WHP were to survey the global ocean in a relatively short time-frame thus providing a "snapshot" picture of the state of the ocean, and to make enough repeated measurements to assess the representativeness of that snapshot and to understand something of the temporal variability in the ocean. The snapshot was to be provided by the "One-Time Survey", a series of zonal and meridional coast-to-coast sections forming a global grid. The issue of temporal variability (seasonal to decadal) was to be addressed by "repeat" sections and time series stations.

One Time Survey

The WOCE Implementation Plan and a series of documents from the WHP Planning Committee specified standards for the One Time sections. The quality of basic measurements such as pressure, temperature, salinity, oxygen and nutrients were all set at the highest levels attainable in the early 1990s and new and improved observational methods were assimilated as their value was proven. Station spacing was required to be at least eddy-resolving (50 km) in the open ocean and closer over significant topography. Each cruise was also expected to collect a suite of tracers and supporting underway data such as surface temperature and salinity, high quality navigation data, meteorological data, bathymetry and shipboard ADCP data. Stations were all full depth (to within 10 m of the bottom) and at least 24 water samples were collected on each station. Cruises that did not meet the requirements of the One Time Survey standards were classified as "repeat" cruises and were nonetheless very valuable to WOCE. Many cruises collected CO_2 measurements in a co-operative effort with the Joint Global Ocean Flux Study (JGOFS).

Virtually all of the planned One Time sections were completed during the WOCE observation period (1990-1998). Notable exceptions were the Atlantic sections A4 (32°N) and A18 (40°W), the Indian Ocean sections I5 (32°S) and I6 (30°E), and Pacific sections P5 (7°S) and P7 (43°S). The early focus of the field programme was on the long Pacific sections, most of which were completed in the early 1990s. Some sections, (P1, P3 and P4), were actually completed to WOCE One Time standards in the late 1980s and were considered as WOCE sections. They were not repeated in the 1990s. Attention then turned to the Indian Ocean, where a co-ordinated USA-led effort completed most of the Indian Ocean sections in 1995. The survey of the Atlantic Ocean was the most spread out in time, with A16 being completed in 1989 and the last sections, A20, A22, A24 and A25 completed in 1997. Details of all the sections are given in Table 1 and the sampled station and section locations are given in Fig. 1. Maps giving the location of various tracer and carbon measurements are given in Fig. 2 to 5.

Repeat Hydrography

The Implementation Plan listed an ambitious number of sections that it was hoped could be repeated between 1 and 4 times per year. Many were re-occupations of the One Time sections, others were regions or basins selected for process studies (sometimes called Special Study Areas). By the end of WOCE there had been many repeated sections, mainly concentrated in the western Pacific and the north Atlantic. However, planned seasonal to decadal variability measurements were not achieved in many other regions. Details of all the sections are given in Table 2, the sampled station locations in Fig. 8, and schematic locations of sections and areas in Fig. 9.

Time Series Stations

The Implementation Plan highlighted a number of time series stations that were already established before WOCE, or for which support had been expressed. The hope was that each single location station could be sampled at least monthly for the entire WOCE period. As such, their locations were often a compromise between scientific rationale and logistical simplicity. In the event only a small number of stations were able to maintain such a high sampling frequency. Details are in Table 3.

Underway Measurements

Tables 1 and 2 give an indication as to whether each cruise collected the supporting underway measurements that were required for the One Time sections and requested for the Repeat sections. For each measurement type, a symbol is present against each cruise for which data were collected and submitted to the appropriate Data Assembly Centre (see the explanatory notes).

Great improvements in the accuracy of navigational measurements, and the development of shipboard Acoustic Doppler Current Profilers (S-ADCPs) occurred very early in WOCE. As a result most One Time sections and many Repeat sections have direct current measurements of the upper 300-400m (Fig. 6 and 10). Later in WOCE a self-contained ADCP which could be lowered with the CTD package was developed (the Lowered or L-ADCP) and consequently several cruises have top-to-bottom direct current measurements too.

High resolution and high quality meteorological data were collected on some One Time sections by instrument packages designed for WOCE. Most research vessels were equipped with at least basic instrumentation so most WHP cruises have associated research-quality meteorological data (Fig. 7 and 11).

Although collecting high resolution bathymetric data was a requirement for all WHP cruises, the early lack

of a pro-active designated WOCE Data Assembly Centre delayed the archival of ocean depth data. However towards the end of the WOCE, substantial effort by the WOCE Data Information Unit and the US National Geophysical Data Centre in identifying and obtaining bathymetry data from WHP cruises led to the eventual availability of most of the One Time Survey data for the WOCE archives and WOCE Global Data Version 3.0 DVDs.

Key references

King, B.A., E. Firing and T.M. Joyce, 2001: Shipboard Observations during WOCE. Chapter 3.1, pp 99-122 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Wallace D.W.R, 2001: Storage and Transport of Excess CO2 in the Oceans: the JGOFS/WOCE Global CO2 survey. Chapter 6.3, pp 489 – 521 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Explanatory Notes for Tables 1 and 2

Line: The WOCE section identifier as given in the Implementation Plan

ExpoCode(s): Each WOCE cruise was given a unique identifier known as an "ExpoCode". The ExpoCodes are made up of country code, ship code and cruise code, often with a cruise leg designator after an underscore symbol. The ExpoCodes allow you to link different elements of the field programme collected on a single cruise, and are a key term for searching the WOCE Data Resource. Some sections were completed in more than one leg of a cruise. Additional leg numbers associated with each section are given in parentheses.

Start Date, End Date: The dates for leaving port and arriving in port.

Principal Scientist, Country, Ship: Co-ordinator for the cruise, their host country and the name of the research vessel.

Stns: The approximate number of CTD stations occupied on the cruise. This value is derived from the number of profiles submitted to the WHP Office, or from documentation provided. It is intended as a guide only. If a single cruise covers more than one section, the total number for that cruise is given here.

CFC, He/Tr, C14, TC: The approximate number of stations for which samples were collected for the tracers Chlorofluorocarbons (CFCs 11, 12, 113 and/or 114), Helium/Tritium isotopes, Carbon isotopes (C^{14} and/or C^{13}) and Total Carbon. The numbers are intended as guides only and represent the numbers of stations on the WOCE Global Data Version 3.0 DVDs (August 2002). The symbol "S" identifies those sections for which documentation indicated data were collected, but for which data were not available at the time of writing.

Other Lines: Many cruises occupied more than one WOCE section; additional ones are listed here. Cruise details are repeated under each section that they occupied. Many current meter mooring arrays were deployed and recovered on WHP cruises; they are also listed here.

ADCP: The symbol "S" indicates shipboard ADCP data collected and available on the WOCE Global Data Version 3.0 DVDs (August 2002). The symbol "L" indicates lowered ADCP data collected (not available on the DVDs).

Met: The symbol "M" indicates research-quality meteorological data collected and available on the WOCE Global Data Version 3.0 DVDs (August 2002).

Bath: The symbol "B" indicates high resolution bathymetric data collected and available on the WOCE Global Data Version 3.0 DVDs (August 2002).

Explanatory Notes for Fig. 1 to 11

The CTD and tracer sample station plots are generated from the position information of profiles on the WOCE Global Data Version 3.0 DVDs (2002). It is possible that some further stations will become available after 2002.

The S-ADCP and Meteorological data are also taken from the data on the Version 3.0 (2002) DVDs. The locations of the high temporal resolution underway data have been subsampled, resulting in some cruise tracks appearing to have lower resolution than is actually the case.

Table 1. WOCE Hydrographic Programme One Time Survey Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
Atlantic Ocean																
A01	06MT30_3	15 Nov 1994	to	19 Dec 1994	Meincke	Germany	Meteor	58	51	S	S			-	M	-
A01E	06MT18_1	02 Sep 1991	to	26 Sep 1991	Meincke	Germany	Meteor	63	58	56	S	S	ACM8	S	M	B
A01W	18HU95011_1	07 Jun 1995	to	05 Jul 1995	Lazier	Canada	Hudson	64	55			49	AR05, AR13, ACM29	S, L	M	B
A02	06MT30_2	12 Oct 1994	to	12 Nov 1994	Koltermann	Germany	Meteor	73	62	S	S			-	M	B
A02	06MT39_3	11 Jun 1997	to	03 Jul 1997	Koltermann	Germany	Meteor	79	62	44				-	M	-
A03	90CT40_1	11 Sep 1993	to	21 Nov 1993	Tereschenkov	Russia	Multanovsky	125						-	-	-
A05	29HE06_1 (_2,_3)	14 Jul 1992	to	15 Aug 1992	Parrilla	Spain	Hesperides	112	S		8	33	ACM1	-	M	B
A06	35A3CITHER1_2	13 Feb 1993	to	19 Mar 1993	Colin	France	L'Atalante	104	102	21		50	A07	S	M	B
A07	35A3CITHER1_1	02 Jan 1993	to	10 Feb 1993	Morliere	France	L'Atalante	120	87			54	A06	S	M	B
A08	06MT28_1	29 Mar 1994	to	11 May 1994	Mueller	Germany	Meteor	114	S	61		92		S, L	M	B
A09	06MT15_3	10 Feb 1991	to	23 Mar 1991	Siedler	Germany	Meteor	110	115	46	8	52		S	M	B
A10	06MT22_5	27 Dec 1992	to	31 Jan 1993	Mueller	Germany	Meteor	111	114	71	S	92		S, L	M	B
A11	74DI199_1	22 Dec 1992	to	01 Feb 1993	Saunders	UK	Discovery	91	44					S	M	B
A12	06AQANTX_4	21 May 1992	to	05 Aug 1992	Lemke	Germany	Polarstern	115	81	46		54	SR04, SCM2, SCM7	S	M	-
A13	35A3CITHER3_2	22 Feb 1995	to	02 Apr 1995	Arhan	France	L'Atalante	135	134	15		49		S	M	B
A14	35A3CITHER3_1	11 Jan 1995	to	11 Feb 1995	Mercier	France	L'Atalante	107	102	19		45		S	M	B
A15	316N142_3	03 Apr 1994	to	21 May 1994	Smethie	USA	Knorr	147	94			93	AR15, ACM10, ACM24	-	M	B
A16C	318MHYDROS4	13 Mar 1989	to	19 Apr 1989	Talley	USA	Melville	71	55		S	71		-	M	B
A16N	32OC202_1 (_2)	23 Jul 1988	to	27 Aug 1988	McCartney	USA	Oceanus	128	76					-	-	B
A16S	318MSAVE5	23 Jan 1989	to	08 Mar 1989	Smethie	USA	Melville	73	60		S	S		-	M	B
A17	3230CITHER2_1 (_2)	04 Jan 1994	to	21 Mar 1994	Memery	France	Maurice Ewing	234	226	S		145		S	M	B
A20	316N151_3	17 Jul 1997	to	10 Aug 1997	Pickart	USA	Knorr	95				79		S, L	M	B
A21	06MT11_5	23 Jan 1990	to	08 Mar 1990	Roether	Germany	Meteor	83	84	59		84	SO4A, SR02, SCM2	S	M	-
A22	316N151_4	15 Aug 1997	to	03 Sep 1997	Joyce	USA	Knorr	77	76			52		S, L	M	B
A23	74JC10_1	20 Mar 1995	to	06 May 1995	Heywood	UK	James Clark Ross	128	99	46				S	M	B
A24	316N151_2	30 May 1997	to	05 Jul 1997	Talley	USA	Knorr	154	131			S		S, L	M	B
A25	74DI230_1	07 Aug 1997	to	17 Sep 1997	Bacon	UK	Discovery	143	119			S		S, L	M	-
Indian Ocean																
IO1E	316N145_12	30 Sep 1995	to	16 Oct 1995	Morrison	USA	Knorr	53	48	10	5	50		S, L	M	-
I01W	316N145_11	29 Aug 1995	to	28 Sep 1995	Morrison	USA	Knorr	104	101	23	19	99	I01E	S, L	M	-
I02E	316N145_14	02 Dec 1995	to	28 Dec 1995	Johnson	USA	Knorr	80	69		14	76		S, L	M	B
I02W	316N145_15	30 Dec 1995	to	22 Jan 1996	Johnson	USA	Knorr	88	84	32	14	85		S, L	M	-
I03	316N145_8	23 Apr 1995	to	05 Jun 1995	Nowlin	USA	Knorr	131	102	26	20	57	ICM3, ICM6	S, L	M	B
I04	316N145_9	11 Jun 1995	to	11 Jul 1995	Toole	USA	Knorr	136	105	18		130	I05W, I07C	S, L	M	B
I05E	316N145_7	10 Mar 1995	to	16 Apr 1995	Talley	USA	Knorr	165	105	38	20	126	I08N, SCM4	S, L	M	B
I05P	74AB29_1	12 Nov 1987	to	17 Dec 1987	Toole	USA	Charles Darwin	108	69	S				-	-	B
IO5W	316N145_9	11 Jun 1995	to	11 Jul 1995	Toole	USA	Knorr	136	105	18		130	I04, I07C	S, L	M	B
I06S	35MF103_1	20 Feb 1996	to	22 Mar 1996	Poisson	France	Marion Dufresne	98	98	59		100		-	M	-
I06S	35MFCIVA_1	23 Jan 1993	to	09 Mar 1993	Poisson	France	Marion Dufresne	128	128	S	21	127		S	M	B
I07C	316N145_9	11 Jun 1995	to	11 Jul 1995	Toole	USA	Knorr	136	105	18		130	I04, I05W	S, L	M	B
I07N	316N145_10	15 Jul 1995	to	24 Aug 1995	Olson	USA	Knorr	149	146	25	22	125		S, L	M	B
I08N	316N145_7	10 Mar 1995	to	16 Apr 1995	Talley	USA	Knorr	165	105	38	20	126	I05E, SCM4	-	M	B
I08S	316N145_5	01 Dec 1994	to	19 Jan 1995	McCartney	USA	Knorr	146	96	18	26	75	I09S	S, L	M	B
I09N	316N145_6	24 Jan 1995	to	06 Mar 1995	Gordon	USA	Knorr	130	123	29	22	130		S, L	M	B

Table 1 (Continued). WOCE Hydrographic Programme One Time Survey Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
I09S	316N145_5	01 Dec 1994	to	19 Jan 1995	McCartney	USA	Knorr	146	96	18	26	75	I08S	S, L	M	B
I10	316N145_13	11 Nov 1995	to	28 Nov 1995	Sprintall	USA	Knorr	61	51	25	6	52		S, L	-	B
Pacific Ocean																
P01	31TTTPS47	04 Aug 1985	to	07 Sep 1985	Talley	USA	Thomas G. Thompson	115	63	33				-	-	B
P01W	90BM9316_1	30 Aug 1993	to	21 Sep 1993	Whitney	Canada	A. Nesmeyanov	38				37		-	M	-
P02C	49EWBO9401_1	15 Jan 1994	to	04 Feb 1994	Fukasawa	Japan	Bosei Maru No. 2	21						-	M	-
P02E	492SSY9310_1 (_2)	14 Oct 1993	to	27 Nov 1993	Bando	Japan	Shoyo	131						-	M	-
P02T	49K6KY9401_1	07 Jan 1994	to	10 Feb 1994	Okuda	Japan	Kaiyo-Maru	61				S		-	-	-
P02W	492SSY9411_1	01 Nov 1994	to	14 Nov 1994	Iwanaga	Japan	Shoyo	32					PR27	-	M	-
P03	31TTTPS24_1 (_2)	30 Mar 1985	to	03 Jun 1985	Swift	USA	Thomas G. Thompson	216	75	10				-	-	-
P04C	32MW893_2	09 Mar 1989	to	24 Mar 1989	Brady	USA	Moana Wave	35	15	5				S	-	B
P04E	32MW893_3	02 Apr 1989	to	19 May 1989	Bryden	USA	Moana Wave	99	92	20				S	-	B
P04W	32MW893_1	06 Feb 1989	to	09 Mar 1989	Toole	USA	Moana Wave	79	51	15				S	-	B
P06C	316N138_4	30 May 1992	to	07 Jul 1992	McCartney	USA	Knorr	111	61	30	18	52		S	M	B
P06E	316N138_3	02 May 1992	to	26 May 1992	Bryden	USA	Knorr	69	59	25	20	34		S	M	B
P06W	316N138_5	13 Jul 1992	to	30 Jul 1992	Toole	USA	Knorr	77	36	18	12	21	PCM9	S	M	B
P08N	492SSY9607_1	12 Jul 1996	to	30 Jul 1996	Yoritaka	Japan	Shoyo	57						-	M	-
P08N	49K6KY9606_1	20 Jun 1996	to	15 Jul 1996	Mizuno	Japan	Kaiyo-Maru	26	25			26		-	M	-
P08N	492SSY9610_1	28 Oct 1996	to	02 Nov 1996	Yoritaka	Japan	Shoyo	20						-	-	-
P08S	49XK9605	17 Jun 1996	to	02 Jul 1996	Yoshioka	Japan	Kaiyo	27			10	10		S	-	-
P09	49RY9407_1 (_2)	07 Jul 1994	to	25 Aug 1994	Kaneko	Japan	Ryofu Maru	105	22	47	S	43		-	M	-
P10	3250TN026_1	05 Oct 1993	to	10 Nov 1993	Hall	USA	Thomas G. Thompson	94	80	33	38	34		S, L	M	B
P11A	09AR9391_2	04 Apr 1993	to	09 May 1993	Rintoul	Australia	Aurora Australis	64				34		-	M	B
P11S	09FA693	24 Jun 1993	to	17 Jul 1993	Church	Australia	Franklin	79						S	M	B
P13	3220CGC92_1 (_2)	04 Aug 1992	to	21 Oct 1992	Bullister	USA	John V. Vickers	85	81	16	40	77		S, L	M	-
P13C	49HH915_1	13 Aug 1991	to	01 Sep 1991	Taira	Japan	Hakuho-Maru	34						-	M	B
P13C	49HH915_2	17 Sep 1991	to	02 Oct 1991	Taira	Japan	Hakuho-Maru	38						-	-	B
P13J	49HH932_1	13 May 1993	to	30 May 1993	Taira	Japan	Hakuho-Maru	22						-	M	-
P14C	316N138_7	01 Sep 1992	to	15 Sep 1992	Roemmich	USA	Knorr	52	51	13	12	S		S	M	B
P14N	325023_1 (24_1)	05 Jul 1993	to	02 Sep 1993	Roden	USA	Thomas G. Thompson	198	139	25		75		S, L	M	B
P14S	31DSCG96_1 (_2)	05 Jan 1996	to	10 Mar 1996	Bullister	USA	Discoverer	179	164		S	171	P15S	S, L	M	-
P15N	18DD9403_1	06 Sep 1994	to	10 Oct 1994	Garrett	Canada	John P. Tully	81	4			37	PR06, PRS1	S	M	-
P15N	18DD9403_2	13 Oct 1994	to	10 Nov 1994	Freeland	Canada	John P. Tully	93				38		S	-	-
P15S	31DSCG96_1 (_2)	05 Jan 1996	to	10 Mar 1996	Bullister	USA	Discoverer	179	164		S	171	P14S	S, L	M	-
P16A	316N138_9	06 Oct 1992	to	25 Nov 1992	Reid	USA	Knorr	128	77	54	37	119	P17A	S	M	B
P16C	31WTTUNES_3	31 Aug 1991	to	01 Oct 1991	Talley	USA	T. Washington	106	56	38	22	21		S, L	M	B
P16N	31DSCGC91_1 (_2)	14 Feb 1991	to	08 Apr 1991	Bullister	USA	Discoverer	64	63	S	26	52		-	M	-
P16S	31WTTUNES_2	16 Jul 1991	to	25 Aug 1991	Swift	USA	T. Washington	97	97	28	26	92	P17S	S, L	M	B
P17A	316N138_9	06 Oct 1992	to	25 Nov 1992	Reid	USA	Knorr	128	77	54	37	119	P16A	S	M	B
P17C	31WTTUNES_1	31 May 1991	to	11 Jul 1991	Tsuchiya	USA	T. Washington	124	79	43	31	30		S, L	M	B
P17E	316N138_10	04 Dec 1992	to	22 Jan 1993	Swift	USA	Knorr	106	59	17	28	105	P19S	S	M	B
P17N	325021_1	15 May 1993	to	26 Jun 1993	Musgrave	USA	Thomas G. Thompson	203	100	41	23	76		S, L	-	-
P17S	31WTTUNES_2	16 Jul 1991	to	25 Aug 1991	Swift	USA	T. Washington	97	97	28	26	92	P16S	S, L	M	B
P18	31DSCG94_1 (_2, _3)	26 Jan 1994	to	27 Apr 1994	Taft, Johnson	USA	Discoverer	185	138	55	33	179		S, L	M	-
P19A	74JC002_1	01 Jan 1992	to	08 Dec 1992	Owens	UK	James Clark Ross	64				13		-	M	-

Table 1 (Continued). WOCE Hydrographic Programme One Time Survey Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
P19C	316N138_12	22 Feb 1993	to	13 Apr 1993	Talley	USA	Knorr	192	108	58	49	186		S, L	M	B
P19S	316N138_10	04 Dec 1992	to	22 Jan 1993	Swift	USA	Knorr	106	59	17	28	105	P17E	S	M	B
P21	318MWESTW_4 (_5)	27 Mar 1994	to	25 Jun 1994	McCartney	USA	Melville	280	257	56		103		S	M	B
P24	49RY9511_2	15 Nov 1995	to	30 Nov 1995	Fujimura	Japan	Ryofu Maru	26	15		4		0	-	-	-
P31	3250031_1	25 Jan 1994	to	19 Feb 1994	Roemmich	USA	Thomas G. Thompson	93	63	S		27	PCM11	S, L	M	B
Southern Ocean																
S03	09AR9404_1	13 Dec 1994	to	02 Feb 1995	Rintoul	Australia	Aurora Australis	105	76			58	S04I, SCM3	S	-	B
SO4	06MT11_5	23 Jan 1990	to	08 Mar 1990	Roether	Germany	Meteor	83	84	59		84	A21, SR02, SCM2	-	M	-
S04	74DI200_1	06 Feb 1993	to	18 Mar 1993	Dickson	UK	Discovery	25	25				ISS01	S	M	B
S04A	06AQANTXIII_4	17 Mar 1996	to	20 May 1996	Fahrbach	Germany	Polarstern	131	118	59			SR04	S	M	-
S04I	09AR9404_1	13 Dec 1994	to	02 Feb 1995	Rintoul	Australia	Aurora Australis	105	76			58	SO3, SCM3	S	-	B
S04I	320696_3	03 May 1996	to	04 Jul 1996	Whitworth	USA	Nathaniel B. Palmer	108	90	32	31	108		S, L	M	B
S04P	90KDIOFFE6_1	14 Feb 1992	to	06 Apr 1992	Koshlyakov	Russia	Akademik Ioffe	113	113	31	30	112		-	-	B
S05	09FA1094	12 Nov 1994	to	05 Dec 1994	Tomczak	Australia	Franklin	69						S	M	-

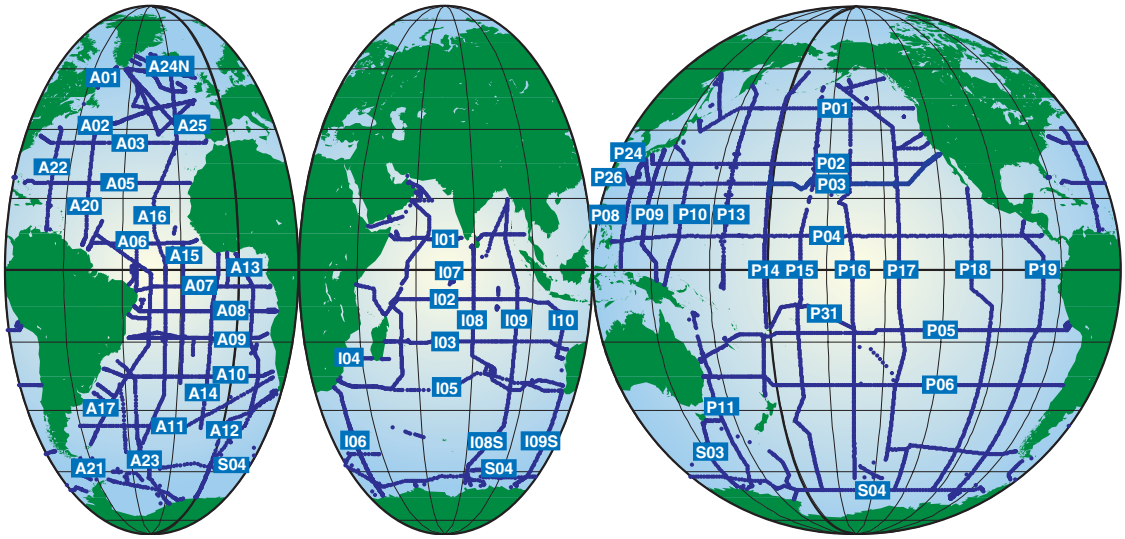

Figure 1. WHP One Time Survey Sections: station positions and line numbers.

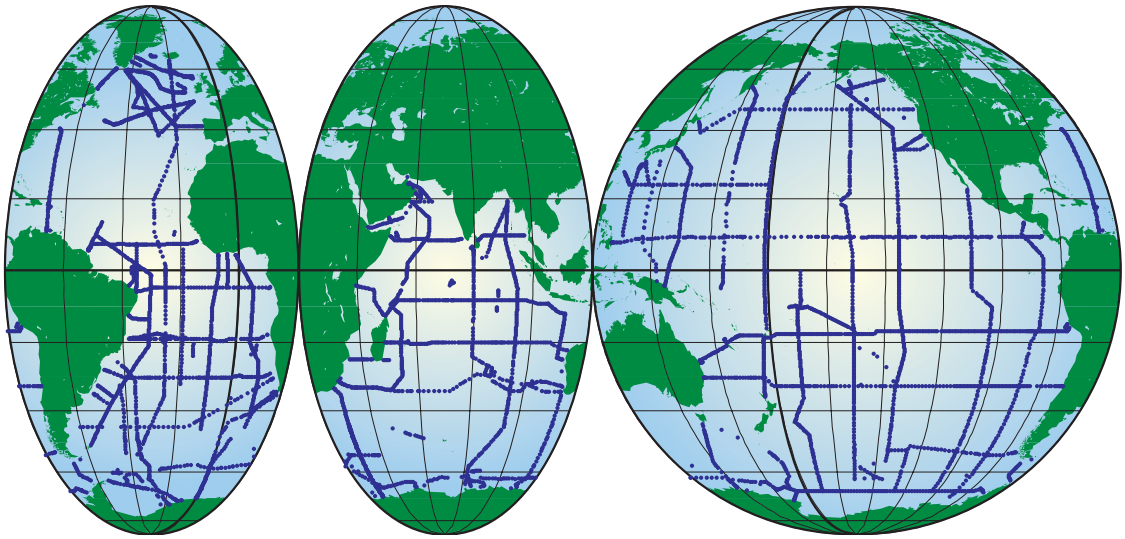

Figure 2. WHP One Time Survey Sections: stations with CFC samples.

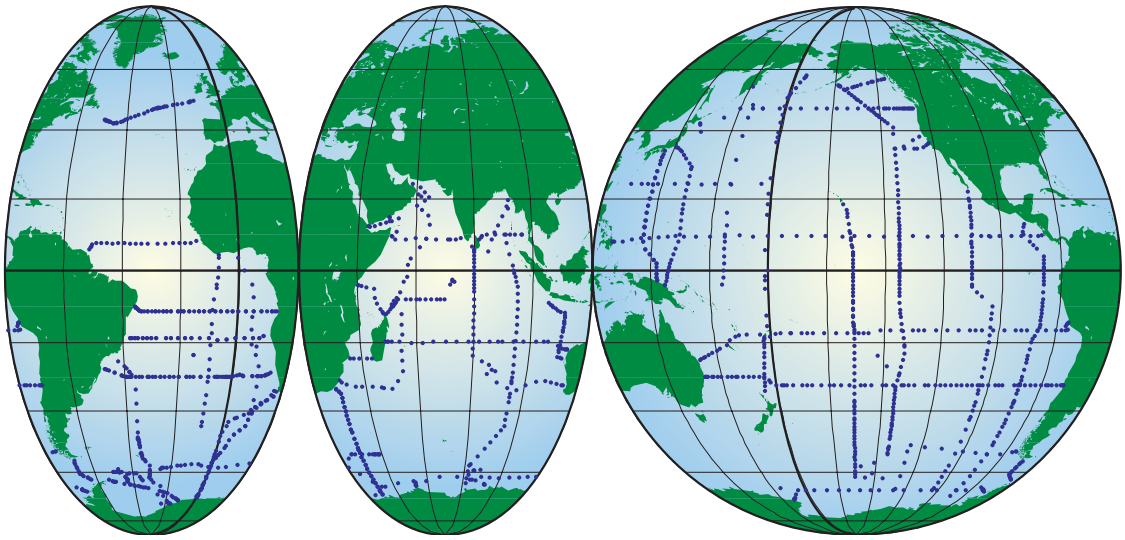

Figure 3. WHP One Time Survey Sections: stations with He/Tr samples.

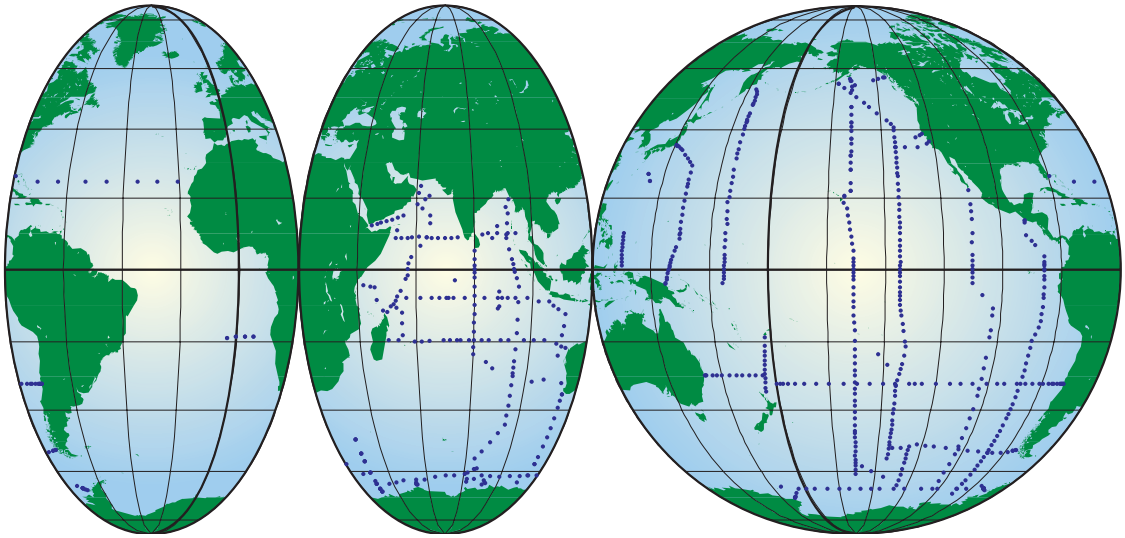

Figure 4. WHP One Time Survey Sections: stations with C^{14} or C^{13} samples.

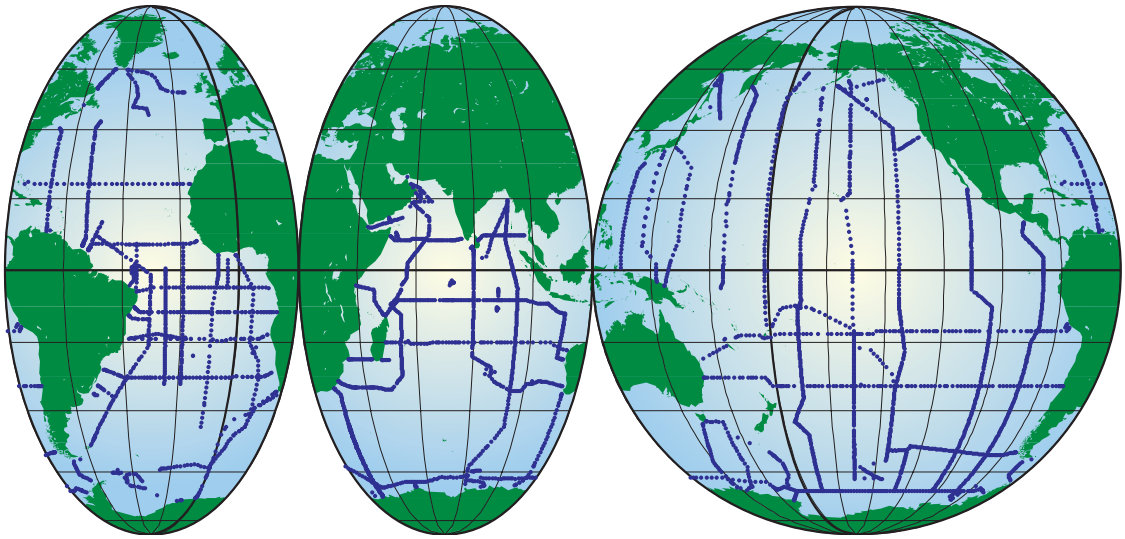

Figure 5. WHP One Time Survey Sections: stations with Total Carbon samples.

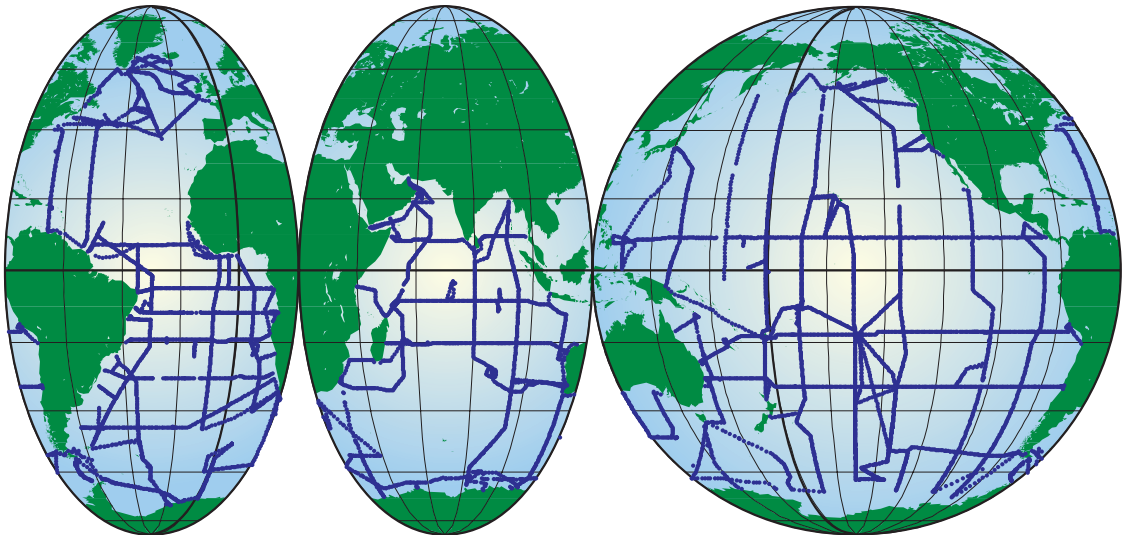

Figure 6. WHP One Time Survey Sections: Shipboard ADCP data.

Table 2. WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
Atlantic Ocean																
AR01	31RBOACES24N_2	08 Jan 1998	to	24 Feb 1998	Bitterman, Lee	USA	Ronald H. Brown	130	76			S		-	M	-
AR02	32OC269_1	29 May 1995	to	15 Jun 1995	Pickart	USA	Oceanus		51					-	-	-
AR02	32EV311_1	04 Dec 1997	to	04 Dec 1997	Unknown	USA	Endeavor	5	5					-	-	-
AR04EW	06MT14_2	01 Oct 1990	to	27 Oct 1990	Schott	Germany	Meteor	55	23	S	S		AR15, ACM7	S, L	M	-
AR04EW	06MT16_3	23 May 1991	to	17 Jun 1991	Schott	Germany	Meteor	58	18				AR15, ACM7	S, L	M	-
AR04EW	32IC244_10	20 Sep 1992	to	01 Oct 1992	Iselin	Canada	Columbus	14						-	-	-
AR04EW	06MT22_2	23 Oct 1992	to	15 Nov 1992	Rhein	Germany	Meteor	65	43	S			AR15, ACM7, ACM10	S, L	M	-
AR04EW	06MT27_3	19 Feb 1994	to	26 Mar 1994	Schott	Germany	Meteor	102	96	S			AR15, ACM7, ACM10	S, L	M	B
AR04EW	316N142_2	30 May 1994	to	07 Jun 1994	unknown	France	Knorr	16						-	-	-
AR04EW	35LLETAMBOT1_1 (_2)	09 Sep 1995	to	11 Oct 1995	Gouriou	France	Le Noroit	99	78			54	AR15	S, L	M	-
AR04EW	33LKETAMBOT2_1 (_2)	15 Apr 1996	to	16 May 1996	Gouriou	France	Edwin Link	119	109			99	AR15	S, L	-	-
AR05	18HU91007_1	24 Apr 1991	to	24 May 1991	Hendry	Canada	Hudson	105					AR20, AR22	-	M	-
AR05	18HU95011_1	07 Jun 1995	to	05 Jul 1995	Lazier	Canada	Hudson	64	55			49	A01W, AR13, ACM29	S, L	M	-
AR05	06MT39_4	07 Jul 1997	to	07 Aug 1997	Schott	Germany	Meteor	111	S				AR07W, AR12, ACM29	-	M	-
AR05N	90P436_1	03 Oct 1997	to	18 Dec 1997	Sokov	Russia	Prof. Shtokman	96					AR07E, AR22	-	-	-
AR06	07AL991_1 (_2,_3,_4)	20 Aug 1991	to	25 Oct 1991	Hagen	Germany	Von Humboldt	132					AR16	-	M	-
AR06	06HF2092_1 (_2,_3)	03 Jan 1992	to	06 Feb 1992	John	Germany	Heincke	194					AR16	-	M	B
AR06	07AL692_1 (_2)	02 Sep 1992	to	26 Sep 1992	Hagen	Germany	Von Humboldt	116					AR16	-	M	-
AR07E	64TR90_3	01 Jul 1990	to	23 Jul 1990	van Aken	Netherlands	Tyro	33						-	M	-
AR07E	64TR91_1	08 Apr 1991	to	01 May 1991	van Aken	Netherlands	Tyro	40				40		-	M	-
AR07E	74AB62_1	01 Aug 1991	to	04 Sep 1991	Gould	UK	Charles Darwin	95	S				AR12	S	M	-
AR07E	06AZ129_1	12 Sep 1992	to	06 Oct 1992	Sy	Germany	Valdivia	57					ACM8	-	-	-
AR07E	06AZ144	21 May 1994	to	08 Jun 1994	Bersch	Germany	Valdivia	37					ACM8	-	-	-
AR07E	06AZ152	26 May 1995	to	23 Jun 1995	Bersch	Germany	Valdivia	55					ACM8	-	-	-
AR07E	06AZ161_2	19 Aug 1996	to	05 Sep 1996	Bersch	Germany	Valdivia	55						-	-	-
AR07E	06MT39_5	14 Aug 1997	to	14 Sep 1997	Sy	Germany	Meteor	71	S				AR25	S, L	M	-
AR07E	90P436_1	03 Oct 1997	to	18 Dec 1997	Sokov	Russia	Prof. Shtokman	96					AR07W, AR22	-	-	-
AR07W	18DA90012_1	02 Jul 1990	to	09 Jul 1990	Lazier	Canada	Dawson	31	15					-	-	-
AR07W	18HU91015_1	26 May 1991	to	04 Jun 1991	Hendry	Canada	Hudson		25	S			S	-	M	-
AR07W	18HU92014_1	27 May 1992	to	14 Jun 1992	Lazier	Canada	Hudson		54	34			29 AR13	-	M	-
AR07W	18HU93019_1	17 Jun 1993	to	28 Jun 1993	Lazier	Canada	Hudson		27	22			S	-	M	-
AR07W	18HU94008_1	24 May 1994	to	12 Jun 1994	Lazier	Canada	Hudson		54	30			20 AR13, ACM29	-	M	B
AR07W	18HU96006_1	12 May 1996	to	01 Jun 1996	Lazier	Canada	Hudson		45	27			27 ACM29	S, L	-	B
AR07W	18HU96026_1	16 Oct 1996	to	20 Nov 1996	Clarke	Canada	Hudson		104				AR27	L	-	-
AR07W	18HU97009_1	09 May 1997	to	11 Jun 1997	Clarke	Canada	Hudson		130	90			95 AR13, AR27, ACM29	S	-	-
AR07W	06MT39_4	07 Jul 1997	to	07 Aug 1997	Schott	Germany	Meteor		111	S			AR05, AR12, ACM29	-	M	-
AR07W	18HU98023_1	22 Jun 1998	to	09 Jul 1998	Jones	Canada	Hudson		43	22			23 ACM29	S, L	-	B
AR08	08BD0491_1	12 Sep 1991	to	15 Sep 1991	Piola	Argentina	Oca Balda		35					-	M	-
AR08	08EH0492_1	09 May 1992	to	11 May 1992	Piola	Argentina	Holmberg		24					-	M	-
AR08	08EA0192_1	13 Oct 1992	to	16 Oct 1992	Piola	Argentina	El Austra		20					-	M	-
AR08	08BD0493_1	27 Mar 1993	to	30 Mar 1993	Piola	Argentina	Oca Balda		13					-	M	-
AR08	08BD0993_1	22 Aug 1993	to	24 Aug 1993	Piola	Argentina	Oca Balda		12					-	M	-
AR08	08BD0394_1	06 Mar 1994	to	07 Mar 1994	Piola	Argentina	Oca Balda		60					-	M	-
AR08	08EH1094_1	18 Sep 1994	to	25 Sep 1994	Piola	Argentina	Holmberg		17					-	M	-

Table 2 (Continued). WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
AR08	08PD0196_1	29 Mar 1996	to	06 Apr 1996	Piola	Argentina	Puerto Deseardo	50						-	M	-
AR09	32309308_1	16 Jun 1992	to	05 Jul 1992	unknown	USA	Maurice Ewing	35					ACM4	-	-	-
AR09	74DI202	07 May 1993	to	03 Jun 1993	Gordon	USA	Discovery	70					ACM4	-	-	B
AR09	91AF105	24 Oct 1993	to	11 Nov 1993	unknown	South Africa	unknown	25					ACM4	-	-	-
AR10	74AB68_1	08 May 1992	to	08 Jun 1992	Watson	UK	Charles Darwin	44						-	M	B
AR10	32OC254_2	21 Sep 1992	to	21 Oct 1992	Ledwell	USA	Oceanus	52						-	-	-
AR10	32OC254_3	29 Oct 1992	to	16 Nov 1992	Oakey	USA	Oceanus	133						-	-	-
AR10	18HU92053_1	05 Apr 1993	to	14 May 1993	Oakey	Canada	Hudson	163				15		-	M	-
AR10	74AB78_1	22 Apr 1993	to	24 May 1993	Watson	UK	Charles Darwin	205						-	M	-
AR11	32OC240_2	26 Apr 1991	to	03 Jun 1993	Luyten	USA	Oceanus	66						S	-	-
AR11	90VE43_1	10 Jul 1991	to	07 Sep 1991	Panteleev	Ukraine	Akademik Vernadsky	692						-	-	-
AR11	90MD46_1	26 Sep 1991	to	01 Nov 1991	Zhurbas	Russia	D. Mendeleev	74						-	M	-
AR11	32OC250_4	25 Mar 1992	to	24 Apr 1992	Schmitt	USA	Oceanus	156						-	-	-
AR11	74AB73_1	30 Sep 1992	to	26 Oct 1992	Jenkins	USA	Charles Darwin	58		57			ACM25/26	-	M	-
AR11	32OC254_4	24 Nov 1992	to	17 Dec 1992	Joyce	USA	Oceanus	6					ACM25/26	S	M	-
AR11	32OC258_3	18 May 1993	to	17 Jun 1993	Luyten	USA	Oceanus	75					ACM25/26	S	-	-
AR11	90P431_1	11 Oct 1993	to	23 Oct 1993	Ivanov	Russia	Prof. Shtokman	38						-	-	-
AR11	33SW9404_1	15 Oct 1994	to	28 Oct 1994	unknown	USA	Seward Johnson	43						-	-	-
AR12	74AB58_1	25 Apr 1991	to	15 May 1991	Pollard	UK	Charles Darwin	17	16			S		S	M	B
AR12	74AB59_1	18 May 1991	to	10 Jun 1991	Leach	UK	Charles Darwin	18	17					S	M	B
AR12	74AB62_1	01 Aug 1991	to	04 Sep 1991	Gould	UK	Charles Darwin	95	S				AR07E	S	M	B
AR12	64PE95N_1	18 Jul 1995	to	14 Aug 1995	van Aken	Netherlands	Pelagia	105						-	-	-
AR12	64PE96N_1	18 Jun 1996	to	15 Jul 1996	van Aken	Netherlands	Pelagia	81						-	-	-
AR12	74DI223	28 Sep 1996	to	18 Nov 1996	Leach, Pollard	UK	Discovery	85						L	M	-
AR12	06MT39_2	15 May 1997	to	06 Jun 1997	Zenk, Mueller	Germany	Meteor	74	S				AR24	-	-	-
AR12	64PE110_1	08 Aug 1997	to	29 Aug 1997	van Aken	Netherlands	Pelagia	63						-	-	-
AR12	64PE122_1	18 Aug 1998	to	02 Sep 1998	van Aken	Netherlands	Pelagia	44						-	-	-
AR13	18HU92014_1	27 May 1992	to	14 Jun 1992	Lazier	Canada	Hudson	54	34			29	AR07W	-	M	-
AR13	18HU93039_1	05 Nov 1993	to	16 Dec 1993	Clarke	Canada	Hudson	107	98			90	AR19, AR22, ACM6	-	M	-
AR13	18HU94008_1	24 May 1994	to	12 Jun 1994	Lazier	Canada	Hudson	54	30			20	AR07W	-	M	-
AR13	18HU94030_1	12 Oct 1994	to	10 Nov 1994	Clarke	Canada	Hudson	101	94			80		-	M	B
AR13	18HU95003_1	19 Apr 1995	to	17 May 1995	Clarke	Canada	Hudson	99	81			74	ACM6	L	M	B
AR13	18HU95011_1	07 Jun 1995	to	05 Jul 1995	Lazier	Canada	Hudson	64	55			49	A01W, AR05, ACM29	S, L	M	-
AR13	18HU97009_1	09 May 1997	to	11 Jun 1997	Clarke	Canada	Hudson	130	90			95	AR07W, AR27, ACM29	S	-	-
AR13	06AZ172	14 Jul 1998	to	30 Jul 1998	unknown	Germany	Valdivia	47	S					-	-	-
AR15	06MT14_2	01 Oct 1990	to	27 Oct 1990	Schott	Germany	Meteor	55	23	S	S		AR04EW, ACM7	L	M	-
AR15	06MT15_1 (_2)	30 Dec 1990	to	07 Feb 1991	Zenk	Germany	Meteor	111					ACM3/12	S	M	B
AR15	06MT16_3	23 May 1991	to	17 Jun 1991	Schott	Germany	Meteor	58	18				AR04EW, ACM7	S, L	M	-
AR15	35A3ROMANCHE_1	11 Aug 1991	to	07 Sep 1991	Mercier	France	L'Atalante	71	S				ACM11	-	M	-
AR15	06MT22_2	23 Oct 1992	to	15 Nov 1992	Rhein	Germany	Meteor	65	43	S			AR04EW, ACM7, ACM10	S, L	M	-
AR15	35A3ROMANCHE_2	12 Nov 1992	to	01 Dec 1992	Mercier	France	L'Atalante	26	S				ACM11	-	M	-
AR15	06MT22_3	18 Nov 1992	to	30 Nov 1992	Mueller	Germany	Meteor	25						S	M	B
AR15	06MT22_4	02 Dec 1992	to	22 Dec 1992	Zenk	Germany	Meteor	?						S	M	B
AR15	06MT27_3	19 Feb 1994	to	26 Mar 1994	Schott	Germany	Meteor	102	96	S			AR04EW, ACM7, ACM10	S, L	M	-
AR15	316N142_3	03 Apr 1994	to	21 May 1994	Smethie	USA	Knorr	147	94			93	A15, ACM10, ACM24	-	M	-
AR15	06MT28_2	15 May 1994	to	14 Jun 1994	Zenk	Germany	Meteor	44						S	M	B

Table 2 (Continued). WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
AR15	06AQANTXII_1	18 Oct 1994	to	22 Nov 1994	Krause	Germany	Polarstern	51						-	M	-
AR15	35A3ROMANCHE_3	27 Oct 1994	to	15 Nov 1994	Mercier	France	L'Atalante	29						-	-	-
AR15	35LLETAMBOT1_1 (_2)	09 Sep 1995	to	11 Oct 1995	Gouriou	France	Le Noroit	99	78			54	AR04EW	S, L	M	-
AR15	35A3CITHER3_2	22 Feb 1995	to	02 Apr 1995	Arhan	France	L'Atalante	135	134	15		49	A15	S	-	-
AR15	33LKETAMBOT2_1 (_2)	15 Apr 1996	to	16 May 1996	Gouriou	France	Edwin Link	119	109			99	AR04EW	L	-	-
AR15	90P436_1	03 Oct 1997	to	18 Dec 1997	Sokov	Russia	Prof. Shtokman	96					AR04EW	-	-	-
AR15	06MT41_3	17 Apr 1998	to	17 May 1998	Zenk	Germany	Meteor	24						-	M	-
AR16	06HF991_1 (_2,_3)	09 Mar 1991	to	11 Apr 1991	John Andres	Germany	Heincke	132						-	M	-
AR16	07AL991_1 (_2,_3,_4)	20 Aug 1991	to	25 Oct 1991	Hagen	Germany	Von Humboldt	132					AR06	-	M	-
AR16	06HF2092_1 (_2,_3)	03 Jan 1992	to	06 Feb 1992	John	Germany	Heincke	194					AR06	-	M	-
AR16	07AL692_1 (_2)	02 Sep 1992	to	26 Sep 1992	Hagen	Germany	Von Humboldt	116					AR06	-	M	-
AR16	29CSMORENA	10 May 1993	to	01 Jun 1993	Cabanas	Spain	Cornide De	92				S	ACM27/28	-	-	-
AR18	74AB62A	06 Sep 1991	to	28 Sep 1991	Srokosz	UK	Charles Darwin	25						-	-	-
AR18	58JH1092_1	12 Jul 1992	to	28 Jul 1992	Blindheim	Norway	Johan Hjort	31		S	S	S	ACM8	-	M	-
AR18	34AR10_1 (_2)	23 Aug 1993	to	24 Sep 1993	Launiainen	Finland	Aranda	98	S				ACM8		M	-
AR18	58JH0894_1	23 Jul 1994	to	16 Aug 1994	Blindheim	Norway	Johan Hjort	73	S	S	S		ACM8	-	M	-
AR18	46BS1495	05 Sep 1995	to	14 Sep 1995	Malmberg	Iceland	Bjarni Saemundsson	73	S				ACM8	-	-	-
AR18	37AR97_12	05 Aug 1997	to	25 Sep 1997	Launiainen	Finland	Aranda	28	S				ACM8	-	-	-
AR19	06GA226_2	12 Jun 1993	to	31 Jul 1993	Sy	Germany	Gauss	81					ACM6	-	-	-
AR19	18HU93039_1	05 Nov 1993	to	16 Dec 1993	Clarke	Canada	Hudson	107	98			90	AR13, AR22, ACM26	-	M	-
AR19	06GA276_2	04 May 1996	to	09 Jun 1996	Koltermann	Germany	Gauss	81						-	M	-
AR19	06GA316_1	05 May 1998	to	20 May 1998	Koltermann	Germany	Gauss	73						-	-	-
AR20	18HU91007_1	24 Apr 1991	to	24 May 1991	Hendry	Canada	Hudson	105					AR04EW, AR22	-	M	-
AR21	3175MB91	01 Jun 1991	to	01 Jul 1991	Wanninkhof	USA	Malcolm Baldridge	33						-	-	-
AR21	3175MB93	07 Apr 1993	to	30 Aug 1993	Wanninkhof	USA	Malcom Baldrige	88	S			S		-	M	-
AR21	74DI233_1	23 Apr 1998	to	01 Jun 1998	Smythe-Wright	UK	Discovery	139	S			S		S, L	M	-
AR22	18HU91007_1	24 Apr 1991	to	24 May 1991	Hendry	Canada	Hudson	105					AR05, AR20	-	M	-
AR22	18HU93039_1	05 Nov 1993	to	16 Dec 1993	Clarke	Canada	Hudson	107	98			90	AR13, AR19	-	M	-
AR22	90P436_1	03 Oct 1997	to	18 Dec 1997	Sokov	Russia	Prof. Shtokman	96					AR05N, AR07E	-	-	-
AR24	316N147_2	02 Nov 1996	to	03 Dec 1996	McCartney	USA	Knorr	190				S		S, L	M	-
AR24	06MT39_2	15 May 1997	to	06 Jun 1997	Zenk, Mueller	Germany	Meteor	74	S				AR12	-	-	-
AR24	316N154_2	05 Oct 1997	to	19 Nov 1997	Curry	USA	Knorr	163				S		S, L	M	-
AR25	74CZ88_6	21 Jun 1988	to	09 Jul 1988	Dickson	UK	Cirolana	29					ACM8	-	-	-
AR25	74CD50_1	29 Jun 1990	to	22 Jul 1990	Gould	UK	Charles Darwin	55					ACM8	-	-	-
AR25	06AZ129_1	12 Sep 1992	to	06 Oct 1992	Sy	Germany	Valdivia	57					AR07E	-	-	-
AR25	06MT39_5	14 Aug 1997	to	14 Sep 1997	Sy	Germany	Meteor	71	S				AR07E	-	-	-
AR25	06AZ173_1	15 Aug 1998	to	01 Sep 1998	Meincke	Germany	Valdivia	35	S				ACM8	-	-	-
AR26	06MT37_2	06 Jan 1997	to	21 Jan 1997	Mueller	Germany	Meteor	72				S		S, L	M	-
AR26	06PO233_1	05 Sep 1997	to	10 Oct 1997	Mueller	Germany	Poseidon	?						S, L	-	-
AR26	06PO237_3	02 Apr 1998	to	17 Apr 1998	Mueller	Germany	Poseidon	?						S, L	-	-
AR26	06MT42_1	16 Jun 1998	to	16 Jul 1998	Mueller	Germany	Meteor	45				S		S, L	M	-
AR26	18HU93019_1	17 Jun 1993	to	28 Jun 1993	Lazier	Canada	Hudson	27	22			S		-	-	-
AR27	18HU96026_1	16 Oct 1996	to	20 Nov 1996	Clarke	Canada	Hudson	104					AR07W	L	-	-
AR27	316N147_5	02 Feb 1997	to	20 Mar 1997	Pickart	USA	Knorr	?	S	S		S		-	-	-
AR27	18HU97009_1	09 May 1997	to	11 Jun 1997	Clarke	Canada	Hudson	130	90			95	AR07W, AR14, ACM29	S	-	-
AR27	06AZ172	14 Jul 1998	to	30 Jul 1998	unknown	Germany	Valdivia	47	S				AR13	-	-	-

Table 2 (Continued). WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
Indian Ocean																
IR01W	06BE89_1	03 Aug 1993	to	30 Aug 1993	Schott	Germany	Sonne	99	54				ISS02	S	-	-
IR01W	06MT32_1	25 Mar 1995	to	26 Apr 1995	Schott	Germany	Meteor	106	S				ISS02, IR03N, ICM7	S	M	-
IR01W	3175MB95_04	31 May 1995	to	30 Jun 1995	Molinari	USA	Malcom Baldrige	94					IR03	S, L	M	-
IR01W	06BE128	07 Jan 1998	to	29 Jan 1998	unknown	Germany	Sonne	86	S					S	M	-
IR03	3175MB95_02	21 Mar 1995	to	22 Apr 1995	Ffield	USA	Malcom Baldrige	19					ISS01	S, L	M	-
IR03N	06MT32_1	25 Mar 1995	to	26 Apr 1995	Schott	Germany	Meteor	106	S				IR01W, ISS02, ICM7	S	M	-
IR03N	06MT32_4	08 Jun 1995	to	15 Jul 1995	Quadfasel	Germany	Meteor	100	S			S	ISS02, CIM7	S	M	-
IR04	06BESO73_1	23 Dec 1990	to	19 Jan 1991	Schott	Germany	Sonne	41		S			ICM8	-	M	-
IR04	06BE88_1	03 Jul 1993	to	01 Aug 1993	Quadfasel	Germany	Sonne	44						S	-	-
IR04	3175MB95_07	22 Sep 1995	to	25 Oct 1995	Molinari	USA	Malcom Baldrige	101						S, L	M	-
IR06	35MF62JADE_1	30 Jul 1989	to	09 Sep 1989	Fieux	France	Marion Dufresne	85					ICM4	S	M	-
IR06	35MF71JADE_1	17 Feb 1992	to	23 Mar 1992	Fieux	France	Marion Dufresne	149					ICM4	-	M	-
IR06	09FA9503_1	01 Apr 1995	to	22 Apr 1995	Wijffels	Australia	Franklin	71					ICM6	S	M	-
IR06	09FA9508_1	13 Sep 1995	to	14 Oct 1995	Wjiffels	Australia	Franklin	120					ICM6	S	M	-
ISS01	35MF68SUZIL	12 Apr 1991	to	20 May 1991	Park	France	Marion Dufresne	73						-	M	-
ISS01	35MF75_1	29 Mar 1993	to	18 May 1993	Gaillard	France	Marion Dufresne	142						-	M	-
ISS01	74DI200_1	06 Feb 1993	to	18 Mar 1993	Dickson	UK	Discovery	25	25				SCM06	S	M	B
ISS01	74DI201_1	23 Mar 1993	to	03 May 1993	Pollard	UK	Discovery	96	S				SCM9	-	M	B
ISS01	74DI207	19 Feb 1994	to	30 Mar 1994	Dickson	UK	Discovery	32	32				SCM6	S	M	B
ISS01	74DI213_1	06 Jan 1995	to	21 Feb 1995	Pollard, Read	UK	Discovery	105	83				SCM9	S	M	-
ISS01	74DI214_1	25 Feb 1995	to	08 Mar 1995	Bryden	UK	Discovery	?					ICM1	S, L	M	-
ISS01	3175MB95_02	21 Mar 1995	to	22 Apr 1995	Ffield	USA	Malcom Baldrige	19					IR03	L	M	-
ISS02	06MT32_1	25 Mar 1995	to	26 Apr 1995	Schott	Germany	Meteor	106	S				IR01W, ICM7	S	M	-
ISS02	3175MB95_04	31 May 1995	to	30 Jun 1995	Molinari	USA	Malcom Baldrige	94					IR01W, IR03N	-	-	-
ISS02	06MT32_4	08 Jun 1995	to	15 Jul 1995	Quadfasel	Germany	Meteor	100	S			S	IR03, ICM7	S	M	-
ISS02	06MT32_6	16 Aug 1995	to	19 Sep 1995	Schott	Germany	Meteor	115	S				IR03N, ICM7	S	M	-
ISS03	09FA9506	21 Mar 1995	to	22 Apr 1995	McDougall	Australia	Franklin	?					SCM4	-	-	-
ISS03	09FA0695	17 Jun 1995	to	09 Jul 1995	McDougall	Australia	Franklin	41						-	-	-
ISS03	09FA9605	07 May 1996	to	31 May 1996	McDougall	Australia	Franklin	91				S	ICM6, SCM4	S	M	-
ISS03	09FA9606	01 Jun 1996	to	11 Jun 1996	McDougall	Australia	Franklin	15					ICM6	S	M	-
ISS03	09FA0896	12 Sep 1996	to	28 Sep 1996	McDougall	Australia	Franklin	?						-	-	-
Pacific Ocean																
PR01	49RY9201_2	11 Feb 1992	to	17 Feb 1992	Hirota	Japan	Ryofu Maru	16						-	M	-
PR01S	49GD9101_1	04 Jan 1991	to	12 Jan 1991	Kadoya	Japan	Sogen Maru	35					PR23	-	M	-
PR01S	49XK9307_3C	12 Feb 1994	to	03 Mar 1994	Muneyama	Japan	Kaiyo	16						-	M	-
PR02	49RY9006_2 (_3)	03 Jul 1990	to	03 Aug 1990	Hirota	Japan	Ryofu Maru	33						-	M	-
PR02	49RY9011_1 (_2)	02 Nov 1990	to	28 Nov 1990	Wakaki	Japan	Ryofu Maru	28						-	M	-
PR02	49RY9101_1	18 Jan 1991	to	06 Feb 1991	Ohyama	Japan	Ryofu Maru	33						-	M	-
PR02	49RY9106_2	25 Jun 1991	to	26 Jul 1991	Imai	Japan	Ryofu Maru	33						-	M	-
PR02	49RY9201_1	19 Jan 1992	to	06 Feb 1992	Hirota	Japan	Ryofu Maru	33						-	M	-
PR02	49RY9206_2 (_3)	28 Jun 1992	to	29 Jul 1992	Oyama	Japan	Ryofu Maru	33						-	M	-
PR02	49RY9301_1	19 Jan 1993	to	06 Feb 1993	Hirota	Japan	Ryofu Maru	33						-	M	-
PR02	49RY9306_2 (_3)	29 Jun 1993	to	31 Jul 1993	Hirota	Japan	Ryofu Maru	32						-	M	-

Table 2 (Continued). WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
PR02	49RY9401_1	18 Jan 1994	to	07 Feb 1994	Kaneko	Japan	Ryofu Maru	?						-	M	-
PR03	49RY9011_3	04 Dec 1990	to	19 Dec 1990	Wakaki	Japan	Ryofu Maru	22						-	M	-
PR03	49RY9111_1	15 Nov 1991	to	01 Dec 1991	Kikuchi	Japan	Ryofu Maru	13						-	M	-
PR03	49RY9210_2	23 Oct 1992	to	05 Nov 1992	Kawae	Japan	Ryofu Maru	15						-	M	-
PR03	32MW9305	06 Jun 1993	to	14 Jun 1993	unknown	USA	Moana Wave	24						-	-	-
PR03	31MW9505	28 Jun 1995	to	07 Jul 1995	unknown	USA	Moana Wave	33						-	-	-
PR03N	49KF9010_1	20 Oct 1990	to	31 Oct 1990	Kubo	Japan	Kofu Maru	15						-	M	-
PR03N	49KF9110_1	12 Oct 1991	to	22 Oct 1991	Tohmine	Japan	Kofu Maru	20						-	M	-
PR03N	49KF9210_1 (_2)	04 Nov 1992	to	14 Nov 1992	Iwao	Japan	Kofu Maru	19						-	M	-
PR04	49RY9006_1	14 Jun 1990	to	30 Jun 1990	Hirota	Japan	Ryofu Maru	35						-	M	-
PR04	49RY9106_1	06 Jun 1991	to	22 Jun 1991	Imai	Japan	Ryofu Maru	35						-	M	-
PR04	49RY9206_1	09 Jun 1992	to	25 Jun 1992	Oyama	Japan	Ryofu Maru	27						-	M	-
PR04	49RY9306_1	09 Jun 1993	to	26 Jun 1993	Hirota	Japan	Ryofu Maru	35						-	M	-
PR05	18DD9204_1	08 Sep 1992	to	29 Sep 1992	Whitney	Canada	John P. Tully	49					PR06	-	M	-
PR05	18DD9309_1	14 May 1993	to	01 Jun 1993	Whitney	Canada	John P. Tully	56					PR06	-	M	-
PR05	18EN9202_1	26 Mar 1992	to	13 Apr 1992	Perkin	Canada	Endeavour	67					PR06	-	M	-
PR05	18DD9402_1	10 May 1994	to	25 May 1994	Whitney	Canada	John P. Tully	6					PRO6	-	-	-
PR06	18EN9105_1	17 Oct 1991	to	01 Nov 1991	Bellegay	Canada	Endeavour	8						-	M	-
PR06	18DD9201_1	03 Feb 1992	to	14 Feb 1992	Whitney	Canada	John P. Tully	41					PR05	-	M	-
PR06	18EN9202_1	26 Mar 1992	to	13 Apr 1992	Perkin	Canada	Endeavour	67					PR05	-	M	-
PR06	18DD9204_1	08 Sep 1992	to	29 Sep 1992	Whitney	Canada	John P. Tully	49					PR05	-	M	-
PR06	18DD9303_1	26 Feb 1993	to	17 Mar 1993	Perkin	Canada	John P. Tully	27						-	M	-
PR06	18DD9309_1	14 May 1993	to	01 Jun 1993	Whitney	Canada	John P. Tully	56					PR05	-	M	-
PR06	18DD9401_1	07 Feb 1994	to	21 Feb 1994	Perkin	Canada	John P. Tully	35						-	M	-
PR06	18DD9402_1	10 May 1994	to	25 May 1994	Whitney	Canada	John P. Tully	6					PR05	-	M	-
PR06	18DD9403_1	06 Sep 1994	to	10 Oct 1994	Garrett	Canada	John P. Tully	81	4			37	P15N, PRS01	S	M	-
PR06	18DD9501_1	07 Feb 1995	to	23 Feb 1995	Whitney	Canada	John P. Tully	50			S	S		-	M	-
PR06	18DD9505_1	08 May 1995	to	26 May 1995	Whitney	Canada	John P. Tully	42						-	M	-
PR06	18DD9512_1	22 Aug 1995	to	13 Sep 1995	Boyd	Canada	John P. Tully	29						-	M	-
PR06	18DD9601_1	19 Feb 1996	to	08 Mar 1996	Whitney	Canada	John P. Tully	27						-	M	-
PR06	18DD9609_1	06 May 1996	to	30 May 1996	Boyd	Canada	John P. Tully	9						-	M	-
PR06	18DD9618_1	12 Aug 1996	to	06 Sep 1996	Whitney	Canada	John P. Tully	39					PR05	-	M	-
PR11	09FA1089_1 (_2)	15 Aug 1989	to	27 Sep 1989	Church, Tomczak	Australia	Franklin	163					PR13N	S	M	B
PR11	09FA290_1 (_2)	26 Feb 1990	to	07 Apr 1990	Church	Australia	Franklin	143					PR13N	S	M	B
PR11	09FA1091_1 (_2)	15 Nov 1991	to	15 Dec 1991	Church	Australia	Franklin	120					PR31, PCM2	S	M	B
PR11	09FA0792	19 Sep 1992	to	06 Oct 1992	Church	Australia	Franklin	31					PCM2	S	M	B
PR11	09FA0793	11 Sep 1993	to	05 Oct 1993	Church	Australia	Franklin	73					PR13N, PCM2	S	M	B
PR11	09FA0394	10 Mar 1994	to	03 Apr 1994	Church	Australia	Franklin	48					PR13N	S	M	B
PR13N	09FA1089_1 (_2)	15 Aug 1989	to	27 Sep 1989	Church, Tomczak	Australia	Franklin	163					PR11	S	M	B
PR13N	09FA290_1 (_2)	26 Feb 1990	to	07 Apr 1990	Church	Australia	Franklin	143					PR11	S	M	B
PR13N	09FA1091_1 (_2)	15 Nov 1991	to	15 Dec 1991	Church	Australia	Franklin	120					PR11	-	-	B
PR13N	09FA0793	11 Sep 1993	to	05 Oct 1993	Church	Australia	Franklin	73					PR11, PCM2	S	M	B
PR13N	09FA0394	10 Mar 1994	to	03 Apr 1994	Church	Australia	Franklin	48					PR11	S	M	B
PR14	20VDPR1493_1	07 Oct 1993	to	16 Oct 1993	Nunez	Chile	Vidal Gormez	45						-	M	-
PR14	20VDPR1494_1	04 Oct 1994	to	25 Oct 1994	Jara	Chile	Vidal Gormez	50						-	M	-
PR14	20VDPR1495_1	23 May 1995	to	16 Jun 1995	Garcia	Chile	Vidal Gormez	49						-	M	-

Table 2 (Continued). WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
PR14	20VDPR1496_1	05 Aug 1996	to	29 Aug 1996	Gutierrez	Chile	Vidal Gormez	46						-	M	-
PR14	20VDPR1497_1	15 Mar 1997	to	10 Apr 1997	Gutierrez	Chile	Vidal Gormez	50						-	M	-
PR15	35COSURTPAC_3	09 Jan 1985	to	02 Feb 1985	Rebert	France	Coriolis	?						-	-	-
PR15	35COSURTPAC_4	27 Jun 1985	to	19 Jul 1985	Eldin	France	Coriolis	31						-	-	-
PR15	35COSURTPAC_5	08 Jan 1986	to	04 Feb 1986	Henin	France	Coriolis	2						-	-	-
PR15	35COSURTPAC_6	15 Jun 1986	to	12 Jul 1986	Eldin	France	Coriolis	33						-	-	-
PR15	35LUSURTPAC_12	28 Jun 1989	to	28 Jul 1989	Henin	France	Le Suroit	45						-	-	-
PR15	35LUSURTPAC_13	29 Nov 1989	to	29 Dec 1989	Henin	France	Le Suroit	56						-	-	-
PR15	33DSGP495_1	25 Apr 1995	to	15 May 1995	Meinig	USA	Discoverer	9						S	-	-
PR15	33KMGP396_1	19 Jun 1996	to	16 Jul 1996	Shepherd	USA	Ka'imimoana	7						S	-	-
PR15	33KMGP497_1	08 Jun 1997	to	03 Jul 1997	Shepherd	USA	Ka'imimoana	18						S	-	-
PR15	33KMGP498_1	06 Jul 1998	to	02 Aug 1998	Moore	USA	Ka'imimoana	17						S	-	-
PR15S	3715CG90_1 (_2)	22 Feb 1990	to	16 Apr 1990	Wisegarver	USA	Malcolm Baldrige	?						-	-	-
PR16	3175EP190_1	21 Apr 1990	to	22 May 1990	McPhaden	USA	Malcolm Baldrige	11						-	-	-
PR16	31DSEP390_2	26 Nov 1990	to	06 Dec 1990	Moore	USA	Discoverer	27						-	M	-
PR16	3175EP191_1	23 Mar 1991	to	19 Apr 1991	Mangum	USA	Malcolm Baldrige	13						-	M	-
PR16	31DSEP391_1	15 Oct 1991	to	13 Nov 1991	Mangum	USA	Discoverer	13						S	M	-
PR16	31DSEP692_2	12 Oct 1992	to	18 Nov 1992	Wanninkhof	USA	Discoverer	22						S	M	-
PR16	3175EP193_1	21 Feb 1993	to	18 Mar 1993	Neander	USA	Malcolm Baldrige	13						-	M	-
PR16	3175EP293_2	17 Apr 1993	to	14 May 1993	Shepherd	USA	Malcolm Baldrige	1						-	M	-
PR16	31DSEP393_1	23 Aug 1993	to	18 Sep 1993	Mangum	USA	Discoverer	22						S	-	-
PR16	3175EP194_1	14 Apr 1994	to	11 May 1994	Koehn	USA	Malcolm Baldrige	2						-	M	-
PR16	3175EP294_2	16 May 1994	to	17 Jun 1994	Stratton	USA	Malcolm Baldrige	6						-	M	-
PR16	3175EP394_1	03 Aug 1994	to	29 Aug 1994	Mangum	USA	Malcolm Baldrige	7						-	M	-
PR16	3175EP494_2	30 Aug 1994	to	26 Sep 1994	Zimmerman	USA	Malcolm Baldrige	10						-	M	-
PR16	31DSGP195_1	30 Jan 1995	to	02 Mar 1995	Moore	USA	Discoverer	15						S	M	-
PR16	3175GP895_2	19 Dec 1995	to	17 Jan 1996	Mangum	USA	Malcolm Baldrige	1						-	-	-
PR16	31DSGP595_1	02 Aug 1995	to	24 Aug 1995	Moore	USA	Discoverer	17						-	M	-
PR16	3175GP196_1	03 May 1996	to	31 May 1996	Zimmerman	USA	Malcolm Baldrige	17						-	-	-
PR16	33KMGP696_2	27 Sep 1996	to	27 Oct 1996	Freitag	USA	Ka'imimoana	15						S	-	-
PR16	33KMGP197_1	03 Feb 1997	to	05 Mar 1997	McCarty	USA	Ka'imimoana	8						S	-	-
PR16	33KMGP597_1	31 Jul 1997	to	29 Aug 1997	Freitag	USA	Ka'imimoana	14						S	-	-
PR16	33KMGP198_1	05 Feb 1998	to	13 Mar 1998	Ablondi	USA	Ka'imimoana	17						S	-	-
PR16	33RBGP698_1	13 Oct 1998	to	14 Nov 1998	Shanley	USA	Ronald H. Brown	16						-	-	-
PR17	49SU9102_3	24 Feb 1991	to	28 Feb 1991	Sato	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9104_2	03 May 1991	to	07 May 1991	Okada	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9107_2	18 Jul 1991	to	21 Jul 1991	Ishikawa	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9109_2	13 Oct 1991	to	17 Oct 1991	Sato	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9202_4	25 Feb 1992	to	29 Feb 1992	Sato	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9204_1	24 Apr 1992	to	30 May 1992	Sato	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9207_2	19 Jul 1992	to	24 Jul 1992	Hayashi	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9209_2	26 Sep 1992	to	03 Oct 1992	Terashima	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9302_2	12 Feb 1993	to	14 Feb 1993	Sato	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9305_1	26 May 1993	to	05 Jun 1993	Takatani	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9307_1 (_2)	13 Jul 1993	to	28 Jul 1993	Okada	Japan	Shumpu Maru	6						-	M	-
PR17	49SU9309_3	02 Oct 1993	to	06 Oct 1993	Yoshioka	Japan	Shumpu Maru	3						-	M	-

Table 2 (Continued). WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
PR17	49SU9402_2	13 Feb 1994	to	20 Feb 1994	Hayashi	Japan	Shumpu Maru	2					PCM5	-	M	-
PR17	49SU9404_1	28 Apr 1994	to	06 May 1994	Yoshioka	Japan	Shumpu Maru	6					PCM2	-	M	-
PR17	49SU9407_1	15 Jul 1994	to	21 Jul 1994	Yoshioka	Japan	Shumpu Maru	6					PCM2	-	M	-
PR17	49SU9409_2	01 Oct 1994	to	06 Oct 1994	Utunomiya	Japan	Shumpu Maru	6					PCM2	-	M	-
PR17	49SU9504_1	24 Apr 1995	to	01 May 1995	Unknown	Japan	Shumpu Maru	11				S	PCM2	-	M	-
PR17	49SU9506_2	30 Jun 1995	to	07 Jul 1995	Hinata	Japan	Shumpu Maru	11				S	PCM2	-	M	-
PR17	49SU9508_1	21 Aug 1995	to	28 Aug 1995	Hayashi	Japan	Shumpu Maru	11					PCM2	-	M	-
PR18	49TU9101_2	24 Jan 1991	to	31 Jan 1991	Miyagi	Japan	Chofu Maru	25						-	M	-
PR18	49TU9104_1	27 Apr 1991	to	07 May 1991	Aoyama	Japan	Chofu Maru	25						-	M	-
PR18	49TU9107_2	03 Aug 1991	to	10 Aug 1991	Hinata	Japan	Chofu Maru	28						-	M	-
PR18	49TU9110_1	16 Oct 1991	to	29 Oct 1991	Moriyama	Japan	Chofu Maru	26						-	M	-
PR18	49TU9204_1	25 Apr 1992	to	06 May 1992	Hinata	Japan	Chofu Maru	26						-	M	-
PR18	49TU9207_1	24 Jul 1992	to	31 Jul 1992	Moriyama	Japan	Chofu Maru	31						-	M	-
PR18	49TU9210_1	05 Oct 1992	to	17 Oct 1992	Tomiyama	Japan	Chofu Maru	26						-	M	-
PR18	49TU9301_1	19 Jan 1993	to	27 Jan 1993	Kimura	Japan	Chofu Maru	26						-	M	-
PR18	49TU9304_1	26 Apr 1993	to	06 May 1993	Hinata	Japan	Chofu Maru	26						-	M	-
PR18	49TU9307_1	21 Jul 1993	to	30 Jul 1993	Moriyama	Japan	Chofu Maru	26						-	M	-
PR18	49TU9310_1	18 Oct 1993	to	25 Oct 1993	Tomiyama	Japan	Chofu Maru	26						-	M	-
PR18	49TU9401_1	18 Jan 1994	to	24 Jan 1994	Kimura	Japan	Chofu Maru	26						-	M	-
PR18	49TU9404_1	26 Apr 1994	to	02 May 1994	Suzuki	Japan	Chofu Maru	25						-	M	-
PR18	49TU9407_1	20 Jul 1994	to	29 Jul 1994	Okada	Japan	Chofu Maru	26						-	M	-
PR18	49TU9410_1	06 Oct 1994	to	08 Oct 1994	Kimura	Japan	Chofu Maru	26						-	-	-
PR18	49TU9501_1	17 Jan 1995	to	23 Jan 1995	Hinata	Japan	Chofu Maru	15						-	M	-
PR19	49TU9010_3 (_4)	13 Nov 1990	to	21 Nov 1990	Kaneko	Japan	Chofu Maru	26						-	M	-
PR19	49TU9110_3	05 Nov 1991	to	11 Nov 1991	Moriyama	Japan	Chofu Maru	22						-	M	-
PR19	49TU9210_4	08 Nov 1992	to	19 Nov 1992	Tomiyama	Japan	Chofu Maru	40						-	M	-
PR19	49TU9310_2 (_3)	29 Oct 1993	to	11 Nov 1993	Tomiyama	Japan	Chofu Maru	40						-	M	-
PR19	49TU9410_2	16 Oct 1994	to	20 Oct 1994	Kimura	Japan	Chofu Maru	22						-	-	-
PR20	21OR257_1	11 Oct 1990	to	18 Oct 1990	Liu	Taiwan, ROC	Ocean Researcher	33						-	-	-
PR20	21OR287_1	26 Jun 1991	to	04 Jul 1991	Liu	Taiwan, ROC	Ocean Researcher	31						-	-	-
PR20	21OR334_1	29 Oct 1992	to	07 Nov 1992	Liu	Taiwan, ROC	Ocean Researcher	19						-	-	-
PR21	21OR266_2	26 Dec 1990	to	30 Dec 1990	Liu	Taiwan, ROC	Ocean Researcher	11						-	-	-
PR21	21OR287_2	08 Jul 1991	to	12 Jul 1991	Liu	Taiwan, ROC	Ocean Researcher	13						-	-	-
PR23	49RY9201_2	11 Feb 1992	to	17 Feb 1992	Hirota	Japan	Ryofu Maru	16					PR01	-	-	-
PR23	49XK9207_1 (_2,_3)	06 Oct 1992	to	29 Oct 1992	Muneyama	Japan	Kaiyo	41					PR24	-	M	-
PR23	49XK9307_3A	12 Feb 1994	to	03 Mar 1994	Muneyama	Japan	Kaiyo	15			S	S		-	M	-
PR23	49XK9406_1	14 Jan 1995	to	24 Jan 1995	Aoyama	Japan	Kaiyo	16	S				PR24	S	M	-
PR24	49XK9207_1 (_2,_3)	06 Oct 1992	to	29 Oct 1992	Muneyama	Japan	Kaiyo	41					PR23	-	M	-
PR24	49XK9307_3B	12 Feb 1994	to	03 Mar 1994	Muneyama	Japan	Kaiyo	16						-	M	-
PR24	49XK9406_1	14 Jan 1995	to	24 Jan 1995	Aoyama	Japan	Kaiyo	16	S				PR23	S	M	-
PR27	492SSY9411_1	01 Nov 1994	to	14 Nov 1994	Iwanaga	Japan	Shoyo	32					PR02W	-	M	-
PR31	09FA1091_1 (_2)	15 Nov 1991	to	15 Dec 1991	Church	Australia	Franklin	120					PR11, PCM3	S	M	-
PR32	3175CG90_1 (_2)	22 Feb 1990	to	16 Apr 1990	Wisegarver	USA	Malcom Baldrige	105	S	43				-	-	-
PR32	316N138_8	15 Sep 1992	to	27 Sep 1992	Rudnick	USA	Knorr	12					PCM11	-	M	-
PR33	09FA0691	12 Jul 1991	to	01 Aug 1991	Lindstrom	Australia	Franklin	44					PCM15	-	-	-
PR33	09FA0692	14 Jul 1992	to	04 Aug 1992	Lindstrom	Australia	Franklin	44					PCM15	-	-	-

Table 2 (Continued). WOCE Hydrographic Programme Repeat Sections

Line	ExpoCode(s)	Start Date		End Date	Principal Scientist	Country	Ship	Stns	CFC	He/ Tr	C14	TC	Other Lines	ADCP	Met	Bath
Southern Ocean																
SR01	06AQANTX_5	10 Aug 1992	to	23 Sep 1992	Peterson	USA	Polarstern	63						-	M	-
SR01	74DI198_1	11 Nov 1992	to	17 Dec 1992	Turner	UK	Discovery	39				1		S	M	-
SR01	20VDSR0193_1	02 Nov 1993	to	25 Dec 1993	Cabezas	Chile	Vidal Gormaz	17						-	M	-
SR01	74JC00_1	20 Nov 1993	to	18 Dec 1993	King	UK	James Clark Ross	30						S	M	-
SR01	74JC00_2	13 Nov 1994	to	12 Dec 1994	King	UK	James Clark Ross	29						-	-	B
SR01	20VDSR0194_1	08 Nov 1994	to	08 Dec 1994	Maturana	Chile	Vidal Gormaz	18						-	M	-
SR01	20VDSR0195_1	04 Dec 1995	to	15 Dec 1995	Rojas	Chile	Vidal Gormaz	17						-	M	-
SR01	20VDSR0196_1	28 Nov 1996	to	13 Dec 1996	Jara	Chile	Vidal Gormaz	15						-	M	-
SR01	74JC16_1	15 Nov 1996	to	20 Nov 1996	King	UK	James Clark Ross	29						S, L	M	-
SR01	20VDSR0198_1	26 Nov 1998	to	15 Dec 1998	Andueza	Chile	Vidal Gormaz	14						-	M	-
SR01	74JC27_1	27 Dec 1997	to	07 Jan 1998	King	UK	James Clark Ross	54						L	M	-
SR02	06AQANTVIII_2	17 Nov 1990	to	30 Dec 1990	Fahrbach	Germany	Polarstern	85		S			SR04, SCM2, SCM7	-	M	-
SR02	06MT11_5	23 Jan 1990	to	08 Mar 1990	Roether	Germany	Meteor	83	84	59		84	A21, S04, SCM2	-	M	-
SR03	09AR9101_1	25 Sep 1991	to	27 Oct 1991	Rintoul	Australia	Aurora Australis	25	23				SCM3	-	-	-
SR03	09AR9309_1	11 Mar 1993	to	03 Apr 1993	Rintoul	Australia	Aurora Australis	63					SCM3	-	M	B
SR03	09AR9407_1	01 Jan 1994	to	01 Mar 1994	Tilbrook	Australia	Aurora Australis	101					IO8A, SCM3	-	M	B
SR03	09AR9501_1	17 Jul 1995	to	02 Sep 1995	Bindoff	Australia	Aurora Australis	62					SCM3	S	M	B
SR03	09AR9604_1	19 Jan 1996	to	31 Mar 1996	Bindoff	Australia	Aurora Australis	131						-	-	-
SR03	09AR9601_1	22 Aug 1996	to	22 Sep 1996	Rintoul	Australia	Aurora Australis	66					SCM3	S	M	B
SR04	06AQANTVIII_2	11 Oct 1989	to	30 Oct 1989	Fahrbach	Germany	Polarstern	84				S	SR02, SCM2, SCM7	-	M	-
SR04	06AQANTIX_2	17 Nov 1990	to	30 Dec 1990	Fahrbach	Germany	Polarstern	85		S			SCM7	S	M	-
SR04	06AQANTX_4	21 May 1992	to	05 Aug 1992	Lemke	Germany	Polarstern	115	81	46		54	A12, SCM2, SCM7	-	M	-
SR04	06AQANTX_7	12 Mar 1992	to	22 Jan 1993	Fahrbach	Germany	Polarstern	85				S	SCM2, SCM7	S	M	-
SR04	06AQANTXIII_4	17 Mar 1996	to	20 May 1996	Fahrbach	Germany	Polarstern	131	118	59			S04A	S	M	-
SR04	06AQANTXV_4	31 Mar 1998	to	21 May 1998	Fahrbach	Germany	Polarstern	151						-	-	-

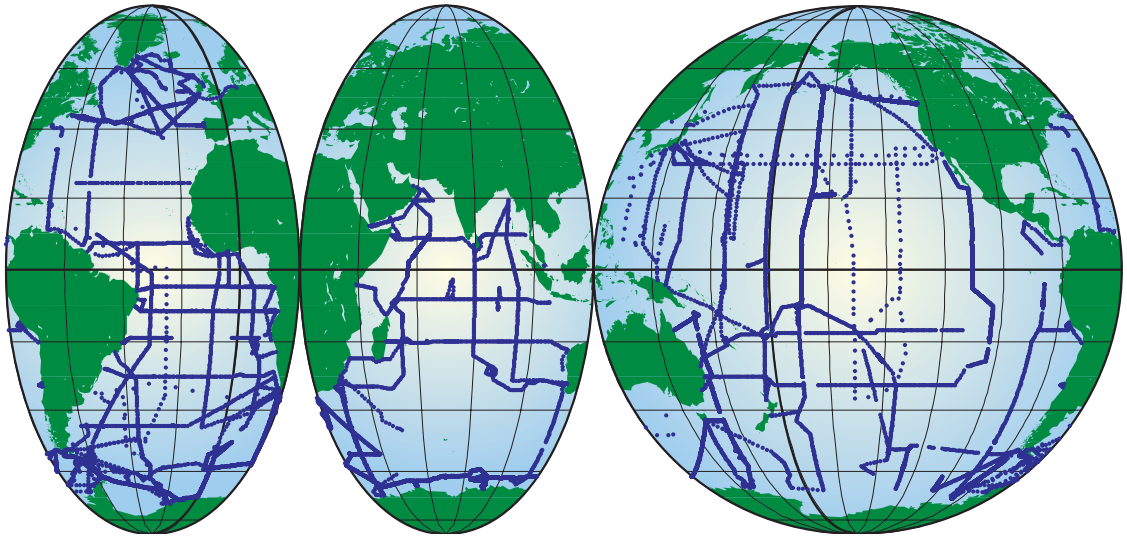

Figure 7. WHP One Time Survey Sections: surface meteorology data.

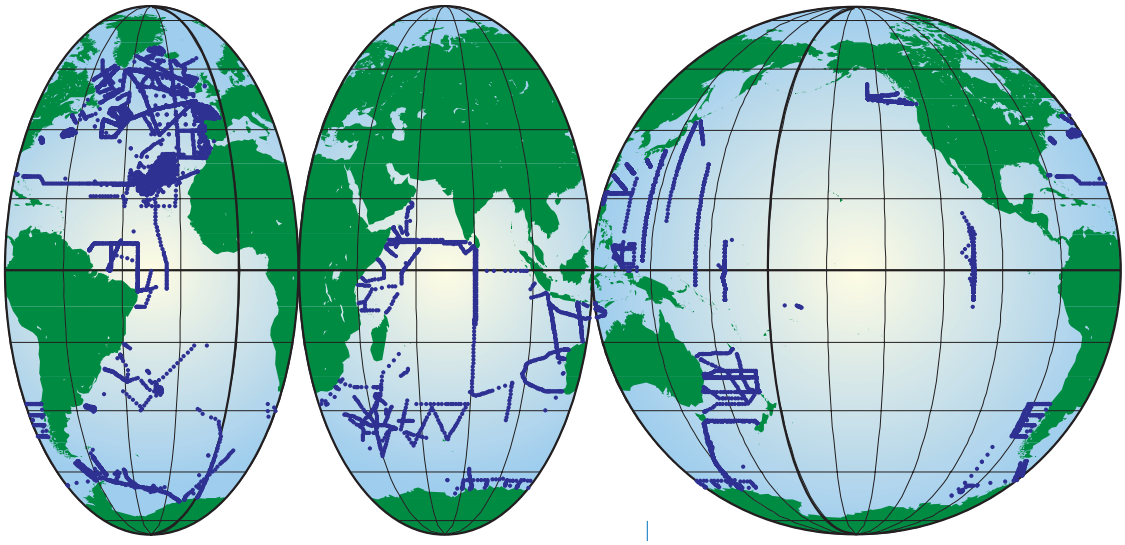

Figure 8. WHP Repeat Sections: station positions.

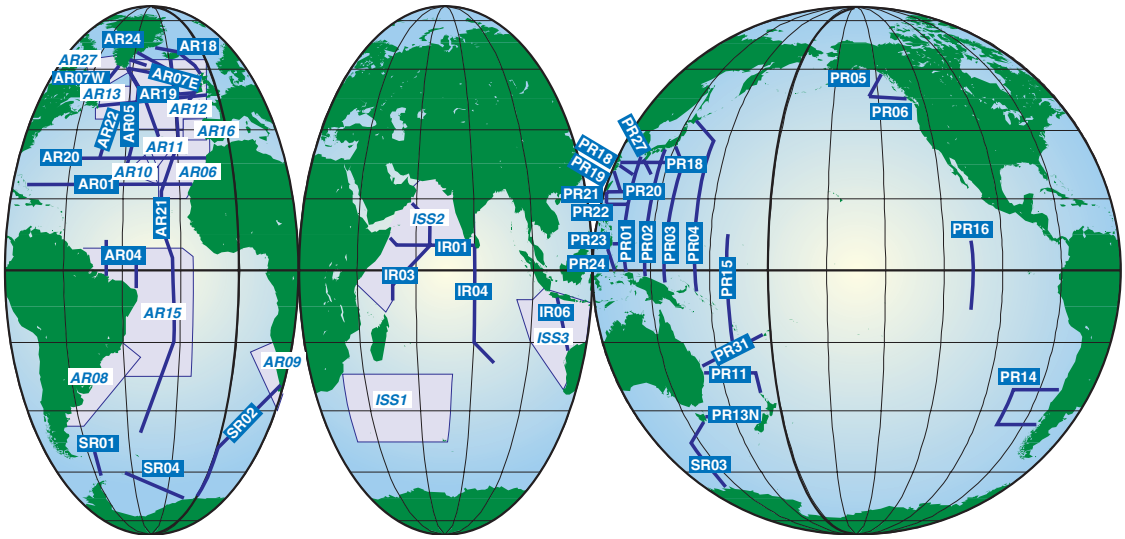

Figure 9. WHP Repeat Sections: schematic location of sections (white-on-blue labels) and areas (blue-on-white labels).

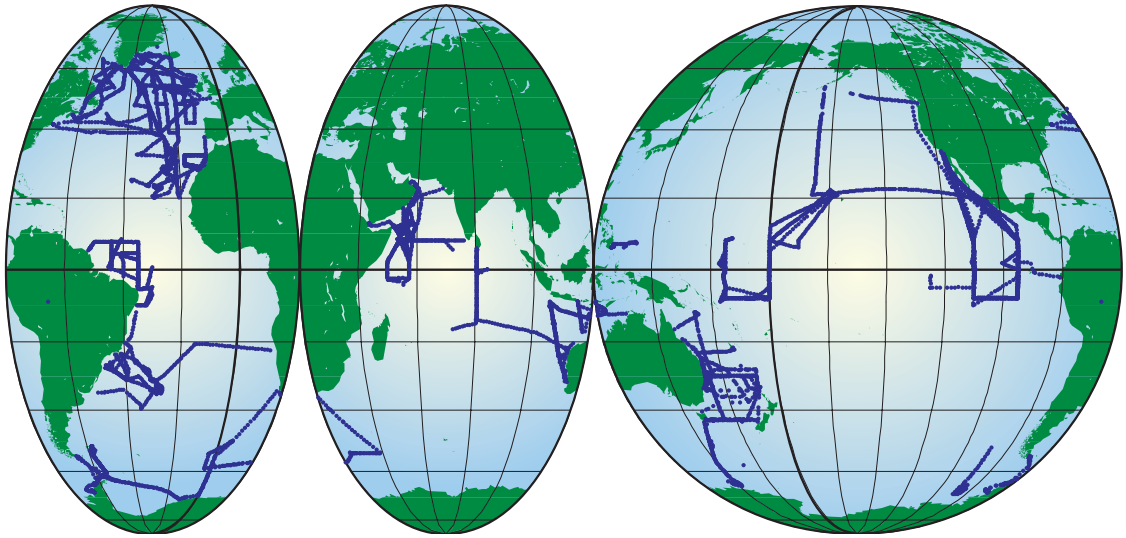

Figure 10. WHP Repeat Sections: shipboard ADCP data.

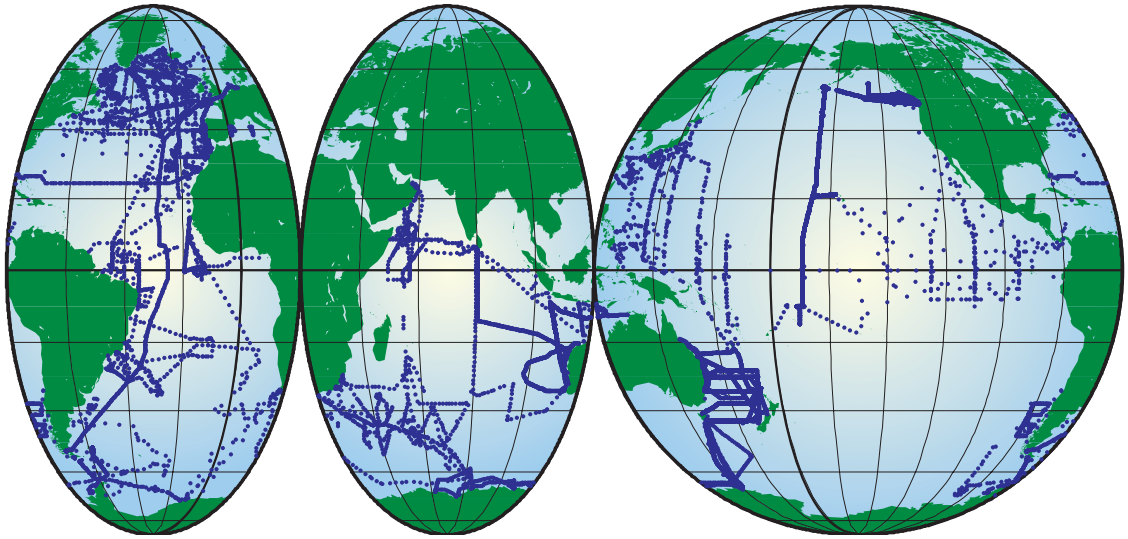

Figure 11. WHP Repeat Sections: surface meteorology data.

Table 3. WOCE Hydrographic Programme Time Series Stations

WOCE Number	Name	Long name or Location	Lat	Lon	Country	Start	End	Sampling rate
Atlantic Ocean								
ARS01	BATS	Bermuda Atlantic Time Series Study	31°50'N	64°10'W	USA	Oct-88	ongoing	monthly
ARS02	Station 27	St John's, Newfoundland	47°32'N	52°35'W	Canada	1946	ongoing	3-4 per month
ARS08	ESTOC	European Station for Time Series in the Ocean, Canaries	29°10'N	15°30'W	Spain, Germany	Jan-94	ongoing	monthly
-	OWS M	Ocean Weather Station Mike	66°00'N	2°00'E	Norway	1948	ongoing	several per month
Pacific Ocean								
PRS01	OWS P	Ocean Weather Station Papa and Line P	50°00'N	145°00'W	Canada	Feb-91	Jun-97	2-3 per year
PRS02	HOTS	Hawaii Ocean Time Series	22°45'N	158°00'W	USA	Oct-88	ongoing	monthly
PSR03	-	California Coast. Pilot study only, associated with CalCOFI (California Cooperative Oceanic Fisheries Investigations).	32°00'N	122°00'W	USA	Oct-93	Jan-94	1 per year
Southern Ocean								
SRS01	KERFIX	Kerguelen Island	50°40'S	68°25'E	France	Jan-90	Mar-95	monthly

2. In Situ Sea Level Measurements

WOCE required in situ sea level measurements for calibration of altimetric satellite missions, estimates of surface geostrophic currents, validation of numerical models, and for assessing the representativeness of the WOCE years in the context of the long term behaviour of the ocean. The Implementation Plan specified that data should be collected at hourly or preferably 6-minute intervals and should be supplemented with sea level atmospheric pressure data. For rapid altimeter calibration WOCE needed the 6-minute or hourly data to be delivered within two months of collection, but also required hourly data that had been processed and quality controlled to a higher level to be delivered 12-18 months after collection.

The WOCE sea level station network was heavily dependent on the activities of the Intergovernmental Oceanographic Commission's Global Sea-Level Observing System (GLOSS) (www.pol.ac.uk/psmsl/programmes/gloss.info.html) that provided a framework for tide-gauge measurements for both scientific programmes and long-term monitoring. The Implementation Plan listed two sets of stations; the first to deliver data in the rapid mode, and the second to increase the coverage of high precision global sea level data. In practice, WOCE was able use expanded coverage due to the efforts of GLOSS, the University of Hawaii Sea Level Center (UHSLC), and the Permanent Service for Mean Sea Level (PSMSL). In addition to enlarging the number of active tide-gauges, the UHSLC in particular was very successful in increasing the number of stations transmitting data in real-time.

Key references

Mitchum, G., Cheney, R., Fu, L.-L., Le Provost, C., Menard, Y., and Woodworth, P. 1999. The future of sea surface height observations. Chapter 2.3 (pp 120-136) *in "Observing the Oceans in the 21st Century (Koblinsky & Smith eds.),* ISBN 0642 70618 2, Bureau of Meteorology, Melbourne, Australia, 604pp.

Nerem R. S. and G.T. Mitchum, 2001. Sea Level Change, Chapter 8 (pp 329-349) *in "Satellite Altimetry and Earth Sciences". L-L. Fu and A. Cazenave, Eds.* Academic Press International Geophysics Series, Vol 69.

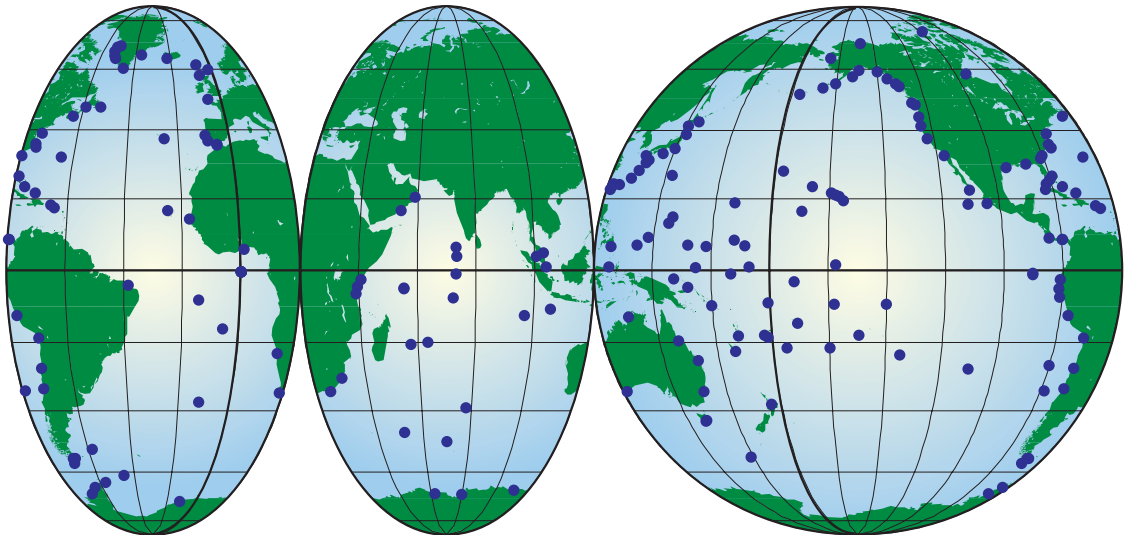

Figure 12. WOCE in situ Sea Level Stations.

Table 4. WOCE Sea Level Stations

Station Name	Responsible Country	GLOSS No.	UH No.	Lat	Lon	Duration of Data
North Atlantic Ocean						
Dakar	Senegal	253	223	14.67	-017.43	1982-1989;1992-2002
Porto Grande	Cape Verde	254	216	16.87	-024.98	1990-1993
St. Croix, Virgin Is.	USA	9011	-	17.70	-064.77	1991-1993;1996-2000
San Juan, Puerto Rico	USA	206	245	18.46	-066.12	1985-2002
South Caicos	United Kingdom	296	-	22.00	-072.00	1991-1992
Siboney	Cuba	215	-	23.09	-082.47	1990
Exuma	USA	12	256	23.77	-076.11	1992-1993
Key West, FL	USA	216	242	24.55	-081.81	1926-1954;1969-1995;1997-2002
Virginia Key, Biscayne Bay	USA	9023	755	25.73	-080.16	1994-2000
Miami, Haulover Pier	USA	218	241	25.90	-080.12	1982-1992
Settlement Point	USA	211	257	26.77	-079.00	1985-2002
Galveston, Pier 21, FL	USA	-	775	29.32	-094.80	1985-2002
Pensacola, FL	USA	-	762	30.40	-087.22	1985-2002
Fort Pulaski, GA	USA	-	752	32.03	-080.90	1985-2002
Bermuda, St Georges Is.	USA	221	259	32.37	-064.70	1968-1989;1991-1999
Charleston, South Carolina	USA	9039	261	32.78	-079.93	1985-2002
Cape Hatteras, N.C.	USA	9006	-	35.14	-075.31	1992-1995;1996-2000
Ceuta (Spanish N. Africa)	Spain	249	207	35.90	-005.32	1971-1991
Gibraltar	United Kingdom	248	-	36.12	-005.35	1961-1990;1993-2000
Duck, N.C.	USA	219	260	36.18	-075.74	1979-2002
Lagos	Portugal	9103	-	37.10	-008.67	1986-1997;1999-2000
Ponta Delgada, Azores	Portugal	245	211	37.74	-025.67	1978-1980;1982-1991; 1993-1995;1998-2002
Cascais	Portugal	246	209	38.70	-009.42	1960-1962;1964-1976; 1979-1995;2000
Atlantic City, NJ	USA	220	264	39.35	-074.42	1985-2002
Halifax	Canada	222	275	44.67	-063.58	1920-2002
Basques	Canada	-	273	47.57	-059.13	1997-2002
St. John's	Canada	223	276	47.57	-052.70	1961-2002
Newlyn	United Kingdom	241	294	50.10	-005.55	1915-2002
Stornoway	United Kingdom	238	295	58.22	-006.38	1974-1983;1985-2002
Churchill	Canada	9056	274	58.77	-094.18	1961-2002
Lerwick	United Kingdom	236	293	60.15	-001.13	1959-1978;1980-2002
Qaqortoq, Greenland	Denmark	9020	299	60.72	-046.03	1991-1999
Torshavn, Faroe Is.	Denmark	237	-	62.00	-006.77	1985-2001
Reykjavik	Iceland	229	-	64.15	-021.93	1984-1997
Nuuk/Godthaab, Greenland	Denmark	225	-	64.17	-051.73	1985-1999
Maniiitsoq, Greenland	Denmark	9102	-	65.41	-052.91	1997-1999
Ammassalik, Greenland	Denmark	228	297	65.50	-037.00	1990-1999
Sisimiut, Greenland	Denmark	9021	296	66.93	-053.67	1991-1999
Aasiaat, Greenland	Denmark	-	-	68.70	-052.87	1997-1999
Ilulissat, Greenland	Denmark	9019	298	69.22	-051.10	1992-1997
Little Cornwallis Island	Canada	153	705	75.38	-096.95	1986-1994
South Atlantic Ocean						
Forster	Germany	9099	-	-70.77	-011.87	1991
Rothera	United Kingdom	9100	-	-67.57	-068.13	1992-1999
Faraday, Argentine Is.	United Kingdom	188	-	-65.25	-064.27	1959-1971;1984-1997;1999
Esperanza, Antarctica	Argentina	185	601	-63.40	-057.00	1996-1998
Signy, South Orkney Is.	United Kingdom	306	-	-60.70	-045.60	1988-1997;1999
Diego Ramirez	Chile	180	599	-56.51	-068.72	1991;1993-1998
Puerto Williams	Chile	9003	-	-54.93	-067.62	1964-1998
Ushuaia	Argentina	181	600	-54.81	-068.30	1996-2002
Port Stanley	United Kingdom	305	290	-51.75	-057.93	1964-1969;1974; 1988-1989;1991-2001
Edinburgh, Tristan da Cunha	United Kingdom	266	-	-37.05	-012.30	1984-1998
Simonstown	South Africa	268	221	-34.19	018.44	1958-1996
Walvis Bay	South Africa	314	-	-22.93	014.50	1959-1973;1976-1989;1991-1998
St. Helena	United Kingdom	264	292	-15.97	-005.70	1986-2002
Ascension	United Kingdom	263	291	-7.90	-014.37	1983-2002
Fortaleza	Brazil	9107	283	-3.72	-038.47	1995-2002
Indian Ocean						
Davis	Australia	277	-	-68.00	079.50	1993-1999
Mawson	Australia	22	-	-67.60	062.88	1991-1999
Casey	Australia	278	-	-66.28	110.53	1996-1999
Kerguelen Island	France	23	180	-49.35	070.22	1993-2002
Crozet Island	France	21	178	-46.43	051.87	1993-2001
St. Paul Island	France	24	179	-38.72	077.58	1994-2002

Table 4 (continued). WOCE Sea Level Stations

Station Name	Responsible Country	GLOSS No.	UH No.	Lat	Lon	Duration of Data
Port Elizabeth	South Africa	76	184	-33.96	025.63	1973;1978-1997;2000
Esperance	Australia	54	176	-33.87	121.90	1985-2002
Durban	South Africa	13	181	-29.87	031.05	1970-1997;2000
Port Louis Harbour	Mauritius	18	103	-20.16	057.50	1942-1947;1964-1965;1986-2002
Rodrigues, Port Mathurin	Mauritius	19	105	-19.67	063.42	1986-2002
Darwin	Australia	62	168	-12.47	130.85	1984-2002
Cocos Is. (Keeling)	Australia	46	171	-12.12	096.90	1985-2002
Christmas Is.	Australia	47	170	-10.42	105.67	1986-1987;1990-1991
Diego Garcia Is.	USA	26	104	-7.29	072.39	1969;1988-2001
Zanzibar	Tanzania	297	151	-6.16	039.19	1985-2002
Point La Rue	Seychelles	9042	121	-4.67	055.53	1993-2002
Port Victoria, Hodoul Is.	Seychelles	273	111	-4.62	055.46	1977-1982;1986-1992
Mombasa	Kenya	8	101	-4.07	039.66	1986-2002
Lamu	Kenya	9105	149	-2.27	040.90	1989;1995-2002
Gan	USA	27	109	-0.69	073.15	1987-2002
Male (Hulhule)	Republic of Maldives	28	108	4.19	073.53	1989-2002
Lumut	Malaysia	43	143	4.23	100.62	1990-1995
Hanimaadhoo	Republic of Maldives	9041	117	6.77	073.17	1991-2002
Salalah	Oman	4	114	16.94	054.01	1989-2000
Masirah	Oman	9104	113	20.69	058.87	1996-2002
North Pacific Ocean						
Kapingamaringi, Carolines	USA	117	29	1.10	154.78	1985-2002
Tanjong Pagar	Singapore	44	699	1.27	103.85	1985-2002
Tarawa, Gilbert Is.	Republic of Kiribati	113	2	1.36	172.93	1974-2002
Manado (Bitung)	Indonesia	69	-	1.44	125.19	1986-1990
Christmas, Line Is.	USA	146	11	1.98	-157.47	1955-1963;1965-1972;1974-2002
Cendering	Malaysia	293	320	5.27	103.18	1990-1995
Lome	Togo	-	224	6.13	001.28	1989-1993
Pohnpei, Caroline Is.	USA	115	1	6.99	158.24	1969-1971;1974-1998;2002
Davao	Philippines	71	372	7.08	125.63	1984-1990
Majuro	USA	112	5	7.11	171.37	1968-1972;1974-2002
Malakal	USA	120	7	7.33	134.46	1969-2002
Truk Atoll	Federal State Micronesia, USA	116	54	7.45	151.85	1963-1995
Kwajalein	USA	111	55	8.73	167.73	1946-2002
Naos Island	Panama	9049	300	8.92	-079.53	1991-1997
Balboa	Panama	168	302	8.97	-079.57	1985-2002
Quepos	Costa Rico	167	87	9.40	-084.17	1961-1965;1971-1995
Yap, Caroline Is.	USA	119	8	9.51	138.13	1951-1952;1969-2002
Guam	USA	149	53	13.43	144.65	1948-2002
Saipan	USA	118	28	15.23	145.74	1978-2002
Johnston Is., HI.	USA	109	52	16.75	-169.52	1947-2002
Socorro Is.	Mexico	162	90	18.73	-111.02	1992-1997
Manzanillo	Mexico	163	395	19.05	-104.33	1953-1959;1961-1982;1992-2002
Wake Is., Marshall Is.	USA	105	51	19.28	166.62	1950-1967;1969-2002
Hilo, HI	USA	287	60	19.73	-155.07	1927-1932;1946-2002
Kahului, HI.	USA	9025	59	20.90	-156.47	1950-2000
Honolulu, HI.	USA	108	57	21.31	-157.87	1905-2002
Nawiliwili, HI.	USA	9024	58	21.97	-159.35	1954-2002
Cabo San Lucas	Mexico	161	34	22.88	-109.91	1973-2002
Chen Kung	Taiwan; China	9058	-	23.09	121.38	1993-1994
French Frigate Shoals, HI.	USA	107	14	23.87	-166.29	1974-2002
Hualien	Taiwan; China	9014	-	23.97	121.58	1984-1993
Ishigaki	Japan	9015	365	24.33	124.15	1975-1999
Suao	Taiwan; China	9057	-	24.59	121.87	1981-1992
Naha	Japan	81	355	26.22	127.67	1966-2002
Chichijima	Japan	103	47	27.10	142.18	1975-2002
Midway Is., HI.	USA	106	50	28.22	-177.37	1947-2002
Naze	Japan	9016	359	28.38	129.50	1965-1974;1976-1998
Nishinoomote	Japan	9017	363	30.73	131.00	1965-1998
Aburatsu	Japan	82	354	31.57	131.42	1961-2002
San Diego (La Jolla), CA	USA	159	569	32.72	-117.17	1906-2002
Nagasaki	Japan	83	362	32.73	129.87	1964;1968-2002
Kushimoto	Japan	85	353	33.47	135.78	1961-2002
Mera	Japan	86	352	34.92	139.83	1965;1967-2002
Fort Point, CA.	USA	158	551	37.81	-122.47	1901-2002
Ofunato	Japan	87	351	39.07	141.72	1965-2002
Crescent City, CA.	USA	9043	556	41.75	-124.18	1951-2002
Hakodate	Japan	88	364	41.78	140.73	1967-2002

Table 4 (Continued). WOCE Sea Level Stations

Station Name	Responsible Country	GLOSS No.	UH No.	Lat	Lon	Duration of Data
Kushiro	Japan	89	350	42.97	144.38	1963-2002
South Beach, OR	USA	157	592	44.63	-124.05	1985-2002
Neah Bay, Washington	USA	9068	558	48.37	-124.62	1934-2002
Tofino	Canada	156	542	49.15	-125.92	1963-1999
Adak, Aleutian Is.	USA	302	40	51.86	-176.64	1955-2002
Dutch Harbor, Alaska	USA	102	41	53.88	-166.53	1992-2002
Prince Rupert	Canada	155	540	54.32	-130.32	1909-1922;1963-2002
Sand Point, AK	USA	100	574	55.33	-160.50	1996-2002
Ketchikan, Alaska	USA	9046	571	55.33	-131.63	1949-2002
Sitka, AK	USA	154	559	57.05	-135.35	1985-2002
Kodiak Is., Alaska	USA	9047	39	57.73	-152.51	1975-2002
Yakutat Bay, Alaska	USA	9055	570	59.55	-139.74	1961-2002
Seward, AK	USA	150	560	60.12	-149.43	1985-2002
Nome, AK	USA	74	595	64.50	-165.43	1992-2002
Prudhoe Bay, AK.	USA	151	579	70.20	-148.25	1992-2002
South Pacific Ocean						
Macquarie Is.	Australia	130	-	-54.48	158.97	1993-1999
Hobart	Australia	9018	339	-42.88	147.33	1985;1987-1995
Spring Bay	Australia	56	335	-42.55	147.93	1985-2002
Moturiki	New Zealand	9022	-	-37.65	176.18	1995
Fort Denison, Sydney	Australia	57	333	-33.85	151.23	1985-2002
Juan Fernandez	Chile	176	21	-33.62	-078.83	1977-1979;1981-1988;1990-2002
Valparaiso	Chile	175	81	-33.03	-071.63	1944-1974;1977-1978;1982-2002
Pascua (Easter) Island	Chile	137	22	-27.15	-109.45	1957-1958;1962-1963;1977-2002
Caldera	Chile	9002	88	-27.07	-070.83	1980-2000
San Felix	Chile	177	35	-26.28	-080.13	1987-1993;1996-1997
Bundaberg	Australia	59	332	-24.83	152.35	1985-2002
Rikitea, Gambier	France; USA	138	16	-23.13	-134.95	1969-2002
Noumea, New Caledonia	France	123	19	-22.29	166.44	1967-2002
Rarotonga	USA	139	23	-21.21	-159.78	1977-2002
Nuku'alofa	Tonga	9051	38	-21.13	-175.17	1990-2002
Townsville	Australia	60	334	-19.25	146.83	1985-2002
Arica	Chile	9001	83	-18.47	-070.33	1982-1999
Suva	Fiji; USA	122	18	-18.13	178.43	1972-2002
Port Vila	Vanuatu	9026	46	-17.77	168.30	1977-1982;1993-2002
Lautoka	Fiji; USA	9108	402	-17.60	177.43	1992-2002
Papeete, Tahiti	France; USA	140	15	-17.53	-149.57	1969-2002
Pago Pago, Samoa	USA	144	56	-14.28	-170.68	1948-2002
Callao	Peru	173	93	-12.05	-077.15	1950-1965;1970-2002
Honiara, Solomon Is.	USA	66	9	-9.43	159.96	1974-2002
Penrhyn, Cook Is.	USA	143	24	-8.98	-158.05	1977-2002
Nuku Hiva, Marquesas Is.	France; USA	142	31	-8.93	-140.08	1982-1998
Funafuti, Ellice Is.	USA	121	25	-8.53	179.20	1977-2002
Lobos De Afuera	Peru	9048	84	-6.93	-080.72	1982-1999
Talara	Peru	9054	92	-4.58	-081.28	1992-1996
Rabaul	Papau New Guinea	65	10	-4.20	152.18	1966-1971;1974-2002
Kanton Is., Phoenix Is.	USA	145	13	-2.81	-171.72	1949-1967;1972-2001
La Libertad	Ecuador	172	91	-2.20	-080.92	1985-2002
Lombrum	Papua New Guinea	9027	400	-2.03	147.37	1994-2002
Santa Cruz, Galapagos Is.	Ecuador	9053	30	-0.75	-090.31	1978-2002
Nauru, Gilbert Is.	USA	114	4	-0.53	166.91	1974-2002
Baltra, Galapagos Is.	Ecuador	169	3	-0.44	-090.29	1968-1977;1985-2002

3. Surface Drifters

To provide a global perspective, subsurface floats and surface drifters were deployed as Lagrangian measurements of the velocity field, measuring the large-scale, low-frequency ocean currents over large areas and for long periods. The floats (section 4) were to measure the deep currents, and the drifters the near-surface currents. The objectives of the global velocity programme were specifically:

- *to measure the velocity at one subsurface level to be used in conjunction with hydrography in establishing the full-column absolute geostrophic velocity field and its associated transports of heat and tracers;*

- *to characterise large-scale transport in the upper layer to determine the magnitudes of both the geostrophic and the ageostrophic, wind-driven flow;*

- *to characterise eddy activity and the effect of eddies on transport by mapping eddy energy, single particle diffusivity and Lagrangian time scales with global coverage at the surface and subsurface reference level;*

- *to provide observational resolution above the basic global standard in regions where it is needed.*

The drifter or Surface Velocity Programme (SVP) was mainly developed as an operational project in conjunction with TOGA. WOCE required that drifters be drogued at 15m depth in order to accurately capture the currents of the near surface layer. New designs of drifters were developed that had better water following and survival performance. The measurement of atmospheric pressure, temperature and sometimes salinity was also possible.

The Implementation Plan estimated that 2200 drifters would be required for mapping the global surface velocities, assuming an expected life of 2.5 years per drifter. In addition, there were further requirements for individual experiments (e.g. 840 for the North Atlantic Core Project 3 basin scale enhancement). The total estimate was for 3728 drifters, though some experiments were not allocated a number. Given this figure, the total number of 4215 buoys shown in Table 5 indicates that the global requirement was met. However Fig. 13 shows that there were areas such as the southern Pacific and Indian oceans where measurements were sparse and the mapping of surface velocities more difficult.

Table 5 summarises the drifter deployments by Experiment Number which is assigned to each drifter by the Principle Investigator and Service Argos, the satellite transmission system. The period during which drifters were deployed under each experiment number is given, as are the latitude and longitude ranges. Some drifters were deployed prior to WOCE; these have been included in the table since they contribute to the WOCE objectives. Since the programme was largely operational, only the country is given and not the names of the numerous individuals involved in deploying drifters.

Key Reference

Niiler, P., 2001: The World Ocean Surface Circulation. Chapter 4.1, pp193 – 204 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Table 5. The Surface Velocity Programme: surface drifter deployments

Expt. No.	Country	Deployment Dates			Latitude Range			Longitude Range			Buoys
North Atlantic											
129	USA	Mar 1998	to	Dec 1998	10.37	to	34.17	-079.86	to	-051.19	36
232	USA	Oct 1990	to	Oct 1990	06.05	to	07.86	-052.71	to	-050.10	2
243	USA	Aug 1998	to	Aug 1998	48.08	to	48.08	-033.99	to	-033.99	1
289	USA	Nov 1998	to	Nov 1998	04.03	to	12.24	-063.98	to	-022.16	3
425	USA	Oct 1989	to	May 1991	37.96	to	39.01	-073.01	to	-070.68	58
466	France	Jun 1991	to	Dec 1994	61.74	to	76.11	-021.22	to	012.10	98
878	Netherlands	Jul 1990	to	Apr 1991	53.37	to	58.33	-024.50	to	-019.99	7
1111	USA	Jan 1993	to	Sep 1994	37.58	to	41.76	-022.50	to	-009.07	30
1119	USA	Oct 1995	to	Sep 1997	62.54	to	65.85	-026.10	to	-015.40	52
1325	USA	Apr 1994	to	Dec 1998	00.08	to	66.07	-079.48	to	-014.84	160
1420	USA	Jan 1995	to	May 1998	40.61	to	42.85	-070.52	to	-065.02	120
1448	Russia, USA	Oct 1996	to	Sep 1997	41.83	to	59.46	-054.67	to	017.73	22
1556	USA	Oct 1998	to	Oct 1998	13.28	to	13.28	-065.11	to	-065.11	1
1844	Iceland, USA	May 1998	to	Jun 1998	63.58	to	64.71	-024.10	to	-021.28	3
1955	USA	Dec 1998	to	Dec 1998	06.21	to	08.82	-056.34	to	-049.54	4
6129	USA	Jul 1991	to	Oct 1993	28.00	to	39.99	-044.40	to	-019.51	68
7129	USA	Mar 1992	to	Jul 1994	18.35	to	60.93	-071.88	to	-017.01	107
8325	USA	Feb 1997	to	Sep 1998	00.61	to	66.58	-064.00	to	-011.44	49
9044	France, USA	Oct 1993	to	Oct 1993	32.27	to	35.57	-032.45	to	-021.73	23
9124	USA	Aug 1998	to	Dec 1998	02.21	to	16.61	-079.01	to	-045.79	14

Table 5 (Continued). The Surface Velocity Programme: surface drifter deployments

Expt. No.	Country	Deployment Dates			Latitude Range			Longitude Range			Buoys
9129	USA	Oct 1993	to	Oct 1993	34.55	to	34.55	-027.31	to	-027.31	1
9325	Iceland, USA	Mar 1997	to	Aug 1998	00.69	to	56.58	-061.07	to	-013.18	11
9435	Canada, France, Iceland, USA	Aug 1992	to	Oct 1998	12.50	to	58.00	-052.63	to	-013.93	52
9484	UK, USA	Jan 1993	to	Jun 1998	34.67	to	64.33	-054.99	to	-028.42	27
9600	USA	Aug 1997	to	Aug 1997	09.94	to	15.02	-055.02	to	-040.02	7
30271	France, USA	Jun 1997	to	Jun 1997	01.54	to	05.24	-022.48	to	-019.88	10
31599	USA	Apr 1998	to	Aug 1998	10.01	to	26.94	-071.23	to	-035.10	8
										Total	**974**
South Atlantic											
243	USA	Sep 1994	to	Dec 1998	-64.89	to	-04.99	-055.00	to	017.93	94
289	USA	Nov 1998	to	Nov 1998	-48.88	to	-48.88	-058.04	to	-058.04	1
425	USA	Nov 1989	to	Jan 1992	-65.32	to	-63.51	-066.48	to	-059.78	37
1195	Brazil	Feb 1993	to	Dec 1998	-56.18	to	-12.36	-055.11	to	-034.62	33
1239	Argentina, USA	Mar 1994	to	Oct 1997	-45.27	to	-38.80	-060.03	to	-050.74	8
1325	USA	Sep 1994	to	Nov 1998	-62.25	to	-10.02	-062.64	to	019.32	81
1556	USA	Oct 1996	to	Jan 1997	-55.44	to	-37.79	-051.16	to	015.05	14
8325	USA	Oct 1996	to	Dec 1998	-59.99	to	-00.02	-067.18	to	012.15	24
8556	USA	Jan 1998	to	Jan 1998	-50.86	to	-44.01	-032.08	to	-019.99	5
9325	USA	Jan 1998	to	Dec 1998	-50.00	to	-40.03	-049.98	to	-030.26	7
9484	UK, USA	Sep 1997	to	Sep 1997	-50.89	to	-50.89	-056.91	to	-056.91	1
										Total	**305**
Indian Ocean											
129	USA	Oct 1985	to	May 1986	-10.70	to	14.74	051.62	to	086.02	10
133	Australia	Jan 1992	to	Dec 1994	-34.72	to	-14.23	105.76	to	119.07	3
221	Japan, USA	Feb 1990	to	Nov 1997	-60.05	to	21.50	054.03	to	115.06	56
243	South Africa, USA	Feb 1997	to	Jul 1998	-41.75	to	-04.42	020.99	to	088.80	9
336	India	Aug 1997	to	Dec 1998	-06.61	to	15.43	064.75	to	087.50	15
1195	Brazil	Nov 1998	to	Nov 1998	-49.84	to	-49.84	128.53	to	128.53	1
1325	Taiwan ROC, USA	Jul 1994	to	Dec 1996	-60.08	to	21.68	020.13	to	139.89	75
1326	Taiwan ROC, USA	Dec 1998	to	Dec 1998	21.69	to	21.69	108.02	to	108.02	3
1556	USA	Dec 1996	to	Dec 1996	-57.52	to	-52.25	108.24	to	120.11	3
8325	USA	Sep 1998	to	Nov 1998	-17.81	to	14.96	069.90	to	106.97	10
9085	Australia, Taiwan ROC, USA	Apr 1994	to	Jan 1998	-53.90	to	-11.75	088.48	to	133.84	13
9325	France, USA	Dec 1997	to	Dec 1998	-16.06	to	-07.02	059.89	to	089.86	11
9435	France, Taiwan ROC, USA	Jul 1997	to	Dec 1998	-47.04	to	01.25	058.40	to	084.29	6
9600	USA	Mar 1997	to	May 1997	00.00	to	20.06	056.93	to	090.01	12
										Total	**227**
North Pacific Ocean											
73	USA	Jun 1979	to	Jun 1979	00.00	to	08.00	-110.00	to	-104.00	9
114	USA	Dec 1979	to	Aug 1980	00.00	to	13.50	-110.30	to	-085.00	6
129	USA	Aug 1980	to	Dec 1998	00.00	to	21.23	-170.29	to	165.26	207
221	Japan, USA	Feb 1988	to	Oct 1997	00.00	to	47.00	-180.00	to	179.98	155
271	USA	Oct 1989	to	Mar 1993	00.00	to	11.93	-140.58	to	169.02	38
289	USA	Nov 1982	to	May 1985	00.00	to	05.69	-119.57	to	-082.35	14
425	Taiwan ROC, USA	May 1987	to	Oct 1989	38.10	to	48.07	-145.06	to	-123.67	18
699	USA	Jul 1988	to	Aug 1988	04.32	to	07.94	124.99	to	131.42	6
705	USA	Jul 1988	to	Jan 1989	00.25	to	09.92	125.59	to	143.58	25
1002	Korea	May 1992	to	May 1998	28.44	to	35.00	122.99	to	129.68	31
1325	Taiwan ROC, USA	Sep 1993	to	Dec 1998	00.00	to	55.46	-179.98	to	179.97	406
1326	Russia, Taiwan ROC, USA	May 1996	to	May 1996	36.33	to	36.76	130.00	to	130.12	2
1346	France, Taiwan ROC, USA	Aug 1994	to	Jul 1996	01.02	to	21.31	-161.16	to	-153.91	59
1348	Taiwan ROC, USA	Aug 1994	to	Oct 1998	43.09	to	44.72	-127.08	to	-124.17	35
1420	USA	Jan 1997	to	Jan 1997	33.94	to	34.23	-121.30	to	-120.44	5
1425	USA	Jun 1991	to	Jan 1995	00.00	to	48.21	-179.90	to	175.49	206
1448	Russia, USA	Nov 1998	to	Nov 1998	41.24	to	41.24	-136.74	to	-136.74	1
1556	USA	Jul 1995	to	Aug 1997	00.03	to	49.80	-172.58	to	-124.52	44
2425	USA	Jul 1988	to	Sep 1988	31.99	to	38.76	-127.54	to	-118.71	28
3425	USA	Jun 1988	to	Jul 1988	37.25	to	39.39	-126.31	to	-123.34	43
4425	USA	Sep 1987	to	Oct 1989	46.40	to	48.59	-145.00	to	-137.66	46
5425	USA	May 1987	to	Jul 1987	37.74	to	39.00	-126.17	to	-123.59	24
8002	Korea	Apr 1998	to	May 1998	29.55	to	31.91	125.44	to	126.52	4
8129	USA	Jul 1979	to	May 1980	00.65	to	19.86	-163.96	to	-149.88	36
8325	Taiwan ROC, USA	Mar 1997	to	Dec 1998	00.00	to	54.55	-179.92	to	173.05	131
8426	USA	Oct 1994	to	Oct 1994	00.03	to	05.94	-170.05	to	142.39	3
8556	Taiwan ROC, USA	Jan 1998	to	Dec 1998	27.17	to	57.01	-145.03	to	-126.91	18
9002	Korea	Oct 1994	to	Oct 1994	28.47	to	37.86	125.38	to	147.49	3
9124	Taiwan ROC, USA	Oct 1998	to	Oct 1998	12.16	to	12.28	-081.43	to	-080.59	2
9129	Japan, USA	Sep 1988	to	May 1994	00.00	to	52.92	-177.95	to	178.13	270
9196	USA	May 1993	to	Aug 1994	38.92	to	39.54	-128.04	to	-124.90	50
9203	USA	Jul 1993	to	Sep 1993	37.36	to	38.03	-126.16	to	-124.43	23
9323	Canada	Dec 1992	to	Oct 1993	45.49	to	48.25	-165.10	to	-143.57	4

Table 5 (Continued). The Surface Velocity Programme: surface drifter deployments

Expt. No.	Country	Deployment Dates			Latitude Range			Longitude Range			Buoys
9325	Taiwan ROC, USA	Aug 1994	to	Aug 1994	16.66	to	16.66	-169.58	to	-169.58	34
9411	Canada	Jul 1990	to	Sep 1994	28.91	to	54.77	-179.41	to	179.95	56
9600	USA	Nov 1997	to	Nov 1997	09.98	to	39.96	111.98	to	136.01	10
										Total	**2052**
South Pacific Ocean											
40	USA	Feb 1979	to	Jun 1979	-10.00	to	-03.18	-086.93	to	-079.00	5
73	USA	Jun 1979	to	Jun 1979	-10.15	to	-02.00	-110.00	to	-083.65	9
114	USA	Dec 1979	to	Aug 1980	-05.76	to	-00.52	-133.65	to	-094.92	4
129	USA	Aug 1980	to	Nov 1992	-17.68	to	-00.01	-149.36	to	165.58	168
133	Australia	Jan 1992	to	May 1995	-45.44	to	-24.38	144.51	to	167.17	20
221	Japan, USA	Feb 1988	to	Mar 1997	-64.75	to	-00.01	-179.99	to	179.97	19
271	USA	Oct 1989	to	Jan 1993	-08.04	to	-00.01	-170.18	to	177.14	36
289	USA	Nov 1982	to	Dec 1984	-15.00	to	-00.01	-092.50	to	-078.48	8
705	USA	Jul 1988	to	Oct 1988	-02.02	to	-00.05	140.01	to	142.40	7
735	Australia	Mar 1989	to	Mar 1989	-11.49	to	-09.19	146.60	to	154.13	5
1266	Italy	Apr 1994	to	Mar 1996	-63.74	to	-49.06	-179.98	to	177.86	11
1325	USA	Oct 1993	to	Dec 1998	-66.97	to	-00.01	-179.98	to	179.96	245
1326	Russia, Taiwan ROC, USA	Aug 1998	to	Aug 1998	-32.74	to	-26.01	-112.02	to	-079.79	6
1425	USA	Jul 1991	to	Jan 1995	-41.84	to	-00.02	-177.83	to	166.22	108
1556	USA	Sep 1996	to	Aug 1997	-00.56	to	-00.26	-159.91	to	-155.20	2
7129	USA	Apr 1994	to	Apr 1994	-01.69	to	-01.69	-088.07	to	-088.07	1
8129	USA	May 1980	to	May 1980	-01.99	to	-00.03	-149.97	to	-149.88	3
										Total	**657**
										Global Total	**4215**

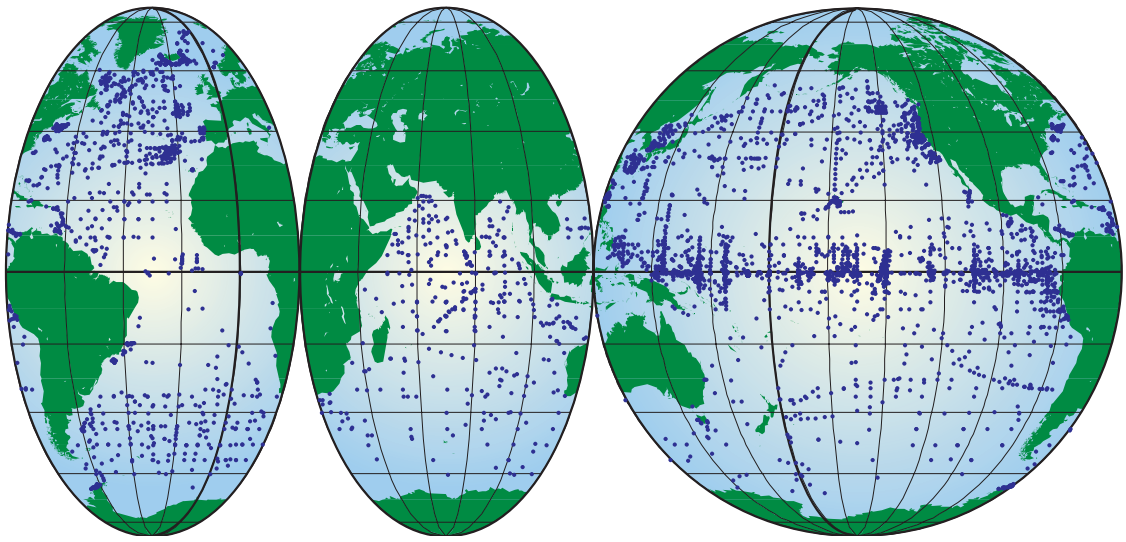

Figure 13. The Surface Velocity Programme: surface drifter deployment locations.

4. Subsurface Floats

The objectives of the float programme are outlined in Section 3 (Surface Drifters) because the strategies were designed in terms of an integrated global velocity programme. The original float sampling strategy was for 1100 floats to be deployed at 2500m to measure the global circulation (to be combined with hydrography and satellite altimetry), and 1600 floats deployed at varied depths for individual experiments to follow water masses, measure deep flows and currents, measure eddy kinetic energy levels, or observe mixing processes. The total 2143 floats deployed during the WOCE period has broadly exceeded expectations, though not all the experiments in the Implementation Plan were carried out.

A variety of floats were developed and used during WOCE. In the late 1980s the available operational floats were the Sound Fixing and Ranging (SOFAR) acoustically-tracked floats (floats carried sound sources and were tracked from fixed hydrophones) and the RAFOS floats (fixed moored sound sources with hydrophones on the floats) relayed their acoustic data via a satellite system (Argos) when the buoys surfaced at the end of their mission. The RAFOS floats were smaller and less expensive than SOFAR, and during the WOCE programme their expected individual lifetimes rose from 1 to 5 years with improved technology.

New floats derived from RAFOS and SOFAR floats were developed for WOCE; the ALFOS/MARVOR floats were also tracked acoustically but surfaced repeatedly rather than at the end of their mission. SOFAR floats that cycled between specified density surfaces (Bobbers) were developed for the Core Project 3 Deep Basin Experiment. Acoustic ranges of up to 2500 km were possible enabling a basin the size of the N Atlantic to be covered.

The 1988 Implementation Plan discussed the potential usage of Autonomous LAgrangian Circulation Explorer

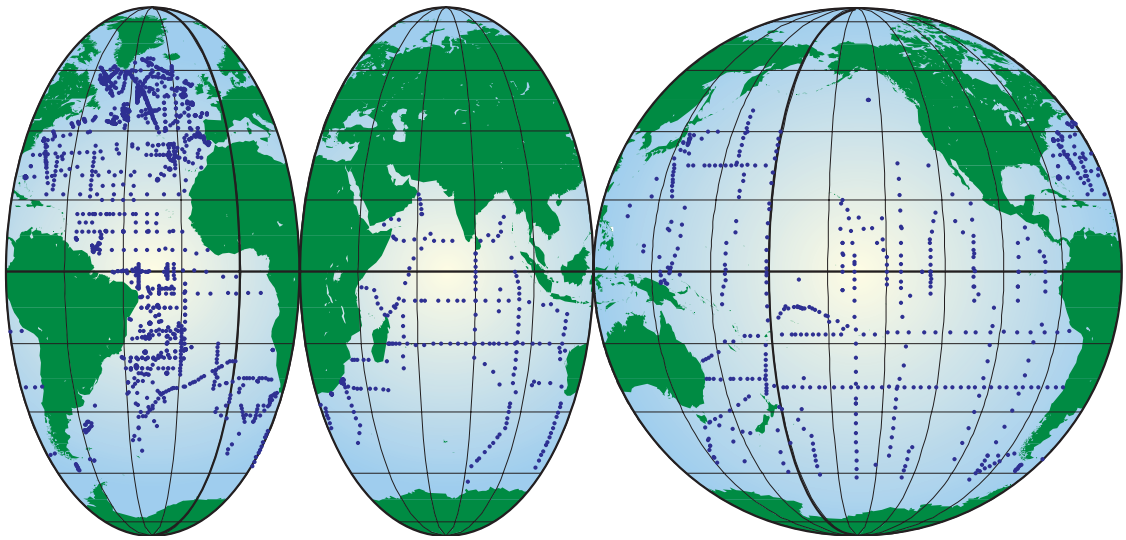

Figure 14. WOCE Subsurface Floats: deployment locations.

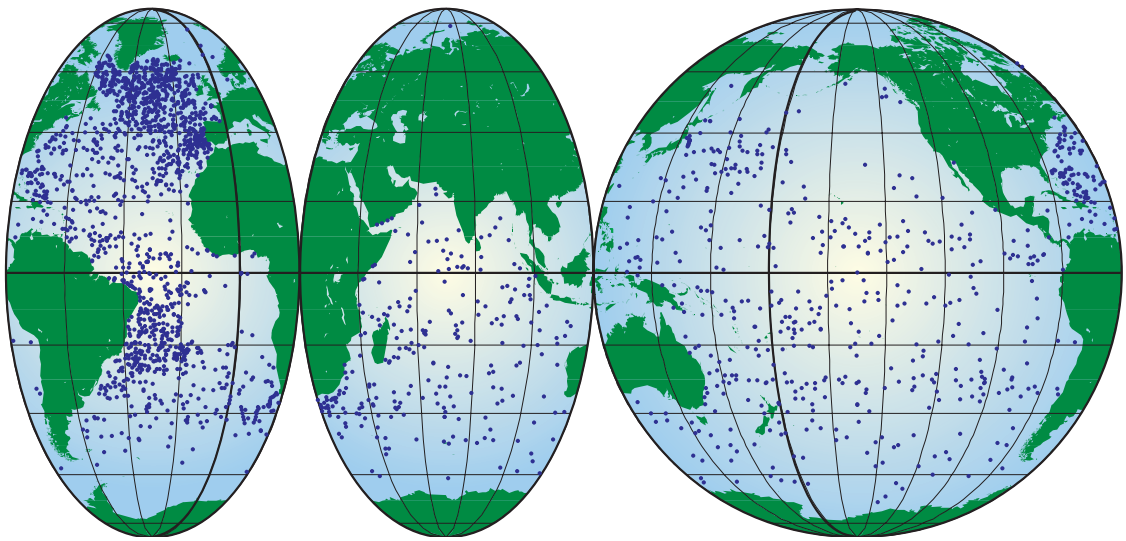

Figure 15. WOCE Subsurface Floats: latest locations in mid-2002.

(ALACE) floats as a new, cheaper technology that did not require sound source or listening stations and hence could be deployed globally. The ALACE was a neutrally buoyant float that surfaced at regular intervals by inflating an external bladder (and hence changing its density), transmitted temperature and pressure data, and positioned by the Argos satellite system before returning to its operating depth. During WOCE the ALACE floats were improved and deployed with great success, and their expected life span rose to 5 years. The ALACE technology was improved still further with the addition of a CTD sensor package that could measure and transmit profiles of temperature and salinity each time the float surfaced. Such floats were known as Profiling ALACE or P-ALACE floats.

Table 6 lists the float deployments during WOCE, specifying the depth of deployment, the time period of operation and the kind of float used. Also given are a Float Data Assembly Centre identification codes (DAC ID) for use with the Global Data Version 3.0 DVDs, and WOCE ExpoCodes for deployment cruises where appropriate. Many floats were deployed from non-WOCE cruises and hence have no ExpoCode. Some data sets of interest were never submitted to the WOCE archives but remained with the principal investigator (indicted by the code "PI"). Fig.14 shows the launch locations of all the floats, and Fig. 15 shows a "snapshot" of float positions as archived on the WOCE Global Data Version 3.0 DVDs. Many of those floats continued to report locations and profiles after the WOCE archive was finalised. The WOCE archive includes profiles as well as drift data for all the P-ALACE floats.

Key reference

Davis, R.E. and W Zenk, 2001: Subsurface Lagrangian Observations during the 1990s. Chapter 3.2, pp123 – 139 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Table 6. WOCE Subsurface Float Deployments

PI (Project)	Country	Depth	Dates	Floats	Type	DAC ID	ExpoCodes
North Atlantic							
Deep Western Boundary Current							
Leaman (Abaco)	USA	1100-3100	1989 to 1994	23	RAFOS	AB	n/a
Richardson, Schmitz (Tropical Atlantic)	USA	350-3300	1989 to 1992	58	SOFAR, Bobbers	TA	n/a
Bower, Pickart (BOUNCE)	USA	800, 3000	1994 to 1997	26	RAFOS	WBC	n/a
Mediterranean Outflow							
Zenk	Germany	600-1000	1990 to 1994	36	RAFOS	IBG	n/a
Bower (AMUSE)	USA	600-1400	1993 to 1995	44	RAFOS	AM	n/a
Richardson (Meddy Expt)	USA	1100	1993 to 1995	10	RAFOS	MD	n/a
Subduction and Tracer Release Experiment							
Price, Richardson	USA	125-1000	1991 to 1993	29	SOFAR, Bobbers	TR SB	74AB68_1 320C240_2
Davis	USA	900	1992 to 1995	12	ALACE	SUB	32OC250_2
North Atlantic Current							
Rossby	USA	100-1100	1993 to 1996	103	RAFOS	NAC	32OC258_4 18HU93039_1 18HU94030_1
ACCE							
Davis	USA	700-1500	1996 to 2000	77	PALACE	DAC	316N147_1 316N147_2 316N151_2 316N154_2 18HU96026_1 18HU97009_1
Owens	USA	600, 1400	1996 to 2001	74	PALACE	OAC	316N147_2 316N154_2
Bower, Richardson	USA	800	1996 to 1999	63	RAFOS, ALFOS	WWP	316N147_2 316N151_2 316N154_2
Riser	USA	600-1000	1997 to 2001	71	PALACE	NAR	n/a
Leaman	USA	1000	1997 to 2000	35	PALACE	ACL	n/a
Schmitt	USA	1000	1997 to 2000	40	PALACE	TAS	SJ9703 SJ9821
Molinari, Garzoli	USA	1000	1997 to 2001	29	PALACE	ACM	n/a
Rossby, Prater, Carr	USA	275	1997 to 2000	55	RAFOS	ACU	316N151_1 316N151_2 316N158_5 58AA97_20
North Brazil Current Rings							
Fratantoni, Richardson	USA	200-1000	1998 to 2000	14	RAFOS	(PI)	n/a

Table 6 (Continued). WOCE Subsurface Float Deployments

PI (Project)	Country	Depth	Dates	Floats	Type	DAC ID	ExpoCodes
Labrador Sea							
Davis	USA	400, 1400	1994 to 2000	34	PALACE, ALACE	SIO	316N147_1 18HU95011_1 06MT30_3
Prater, Rossby	USA	350	1996 to 1997	15	RAFOS	LSU	316N147_5 18HU96026_1 18HU97009_1
Lawrence	Canada	1500	1996 to 1999	5	PALACE	(PI)	n/a
Owens	USA	400, 1400	1997 to 2001	28	PALACE	OLS	316N147_5 316N156
Schott	Germany	1500	1997 to 2001	15	PALACE	SLS	316N147_1 06MT39_4 18HU98023_1
Eurofloats							
Speer	France	1750	1996 to 2001	21	MARVOR	ERM	n/a
Zenk	Germany	1000	1996 to 1998	18	RAFOS, dual release RAFOS	ERF	06PO212 06MT37_2
Canigo (Canary-Gibraltar)							
Knoll, Cantos	Germany, Spain	500	1997 to 1999	16	RAFOS	CAN	35THCAMBIOS97
Ambar	Portugal	800-1200	1997 to 1999	20	RAFOS	CAN	35THCAMBIOS97
ARCANE							
LeCann	France	450-1500	1996 to 2001	24	MARVOR	(PI)	n/a
Serpette, LeCann, Paillet	France	450-2000	1996 to 1998	14	MARVOR	(PI)	n/a
North Atlantic Basin							
Gould, Bacon (Irminger Sea)	UK	1500	1996 to 2000	7	PALACE	ACG	74DI223
Zenk (Iceland Basin)	Germany	1400	1997 to 2000	36	RAFOS	(PI)	n/a
Koltermann	Germany	1500	1997 to 2002	21	PALACE	NAB	06GA316_1 06GA350_1 06MT045_2
South Atlantic							
Deep Basin Experiment							
Owens, Hogg	USA	2500, 4000	1992 to 1998	151	RAFOS	DBW	32OC266_2 (_3) EW9307 32IC92_10 35LUSAMBA1 33SW96_01 316N142_3 EW9306
Zenk	Germany	2500, 4000	1992 to 1996	73	RAFOS	DBK	06MT22_4 06MT28_1 06AQANTXII_1
Owens, Ledwell	USA	3700, 4000	1996 to 1997	11	RAFOS	TT	33SW96_1 33SW97_1 33SW98_1
DRAKE							
Davis	USA	690-800	1990 to 2000	14	ALACE	DP	31DSCG94_2
Falkland							
Davis	USA	800-1000	1994 to 2000	20	ALACE	WAT	08PD0196 08PD0297 06AQANTXII_1
KAPEX							
Boebel	S. Africa	650-1050	1997 to 1999	35	RAFOS	KP	06AQANTXIV_4
Richardson	USA	700	1997 to 1999	30	RAFOS	(PI)	n/a
Rossby	USA	60-660	1997 to 1999	48	RAFOS	KP	06AQANTXIV_4
SAMBA							
Ollitrault	France	800	1994 to 2000	100	MARVOR	(PI)	n/a
WHP Lines							
Davis (A12)	USA	1000	1996 to 1997	12	PALACE	WAT	06AQANTX_4
Davis (A23)	USA	1000	1995 to 2000	10	ALACE	WAT	74JC10_1
Indian Ocean							
WHP Lines							
Davis (I07N)	USA	1000	1994 to 2000	17	ALACE, PALACE	WIN	316N145_10
Davis (I08S)	USA	1000	1994 to 2000	29	ALACE, PALACE	WIN	316N145_5
Davis (I01)	USA	1000	1995 to 2000	16	PALACE	WIN	316N145_11 (_12)
Davis (I02)	USA	1000	1995 to 2000	27	ALACE, PALACE	WIN	316N145_14 (_15)
Davis (I03)	USA	1000	1995 to 2000	28	ALACE, PALACE	WIN	316N145_8
Davis (I05W)	USA	1000	1995 to 2000	20	ALACE, PALACE	WIN	316N145_9
Davis (I08N)	USA	1000	1995 to 2000	20	ALACE, PALACE	WIN	316N145_7
Davis (I09N)	USA	1000	1995 to 2000	20	ALACE, PALACE	WIN	316N145_6
Davis (I10)	USA	1000	1995 to 2000	9	PALACE	WIN	316N145_13
Davis (I06)	USA	1000	1996 to 2000	12	PALACE	WIN	35MFCIVA_1
Davis (S4/20E)	USA	850-1000	1996 to 2000	17	ALACE, PALACE	WIN	06AQANTXIII_4

Table 6 (Continued). WOCE Subsurface Float Deployments

PI (Project)	Country	Depth	Dates	Floats	Type	DAC ID	ExpoCodes
Pacific Ocean							
WHP Lines							
Davis (P06)	USA	900	1992 to 1999	49	ALACE	WPA	316N138_3 (_4,_5)
Davis (P10)	USA	800-950	1993 to 1998	11	ALACE	WPA	3250TN026_1
Davis (P13)	USA	800-950	1992 to 2000	11	ALACE	WPA	3220CGC92_1
Davis (P14)	USA	800-1000	1992 to 2000	23	ALACE	WPA	316N138_7 325024_1
Davis (P15S)	USA	1000	1996 to 2000	13	ALACE	WPA	31DSCG96_1 31DSCG96_2
Davis (P16)	USA	800-1000	1991 to 2000	28	ALACE	WPA	316N138_9 31WTTUNES_2 (_3)
Davis (P17)	USA	750-1450	1991 to 2000	31	ALACE	WPA	316N138_9 316N138_10 31WTTUNES_1 (_2)
Davis (P18)	USA	800-900	1994 to 2000	19	ALACE	WPA	31DSCGC94_2 (_3)
Davis (P19)	USA	750-1000	1993 to 2000	25	ALACE	WPA	316N138_10 316N138_12
Davis (P21)	USA	800-900,1450	1994 to 2000	38	ALACE	WPA	318MWESTW_4 (_5)
Davis (P31)	USA	1400-1550	1992 to 1999	26	ALACE	WPA	316N138_8 3250031_1
Davis (SR3)	USA	750-1300	1991 to 1996	12	PALACE	WPA	09AR9101_1 09AR9309_1
Tasman Sea							
Davis	USA	800-950	1995 to 2000	11	ALACE	WPA	n/a
Northwest (Kuroshio Extension)							
Riser	USA	1000	1992 to 1995	53	RAFOS	NPR	3220CGC92_1 325023_1 325027_1
Shikuma	Japan	400-800	1992 to 1995	22	ALACE, RAFOS, ALFOS	(PI)	n/a
West Tropical							
Zenk	Germany	800-900	1996 to 1998	14	RAFOS	TP	06BE113_1 06BE113_2
Eastern Pacific							
Freeland	Canada	800-1350	1995 to 2000	5	PALACE	IOS	18DD9711_1
CORC (Equatorial Pacific)							
Davis	USA		1997 to 2000	61	ALACE	-	n/a
South Pacific							
Davis	USA		1996 to 2000	6	ALACE	-	n/a
			Global Total	**2143**			

5. Moored Current Meter Arrays

Moored arrays of current meters were essential for direct measurements of ocean current structure and transport. Estimates of heat flux across hydrographic sections required accurate determination of the western boundary currents, and arrays were designed for this purpose. In addition, arrays were deployed across confined abyssal passages so that deep circulation could be measured at such "choke points". Single moorings and incoherent (spacing larger than the mesoscale), large-scale arrays provided insights into the vertical structure and variability of the eddy field (eddy statistics). These were previously undetermined in large parts of the worlds oceans. Some special projects such as the Deep Basin Experiment and the North Atlantic Gyre dynamics study included current meter arrays as well as CTDs, floats, drifters etc.

Current meter arrays often have associated observations that were collected at the time of deployment and recovery (hydrographic stations, ADCPs, deep floats etc). Many arrays included additional instrumentation such as moored ADCPs, inverted echo-sounders, and thermistor chains; the Table lists the depths of all instruments but does not distinguish between those that provided velocity, temperature or other parameters.

The time that a current meter can remain in the water is dependent on the battery-life and frequency of sampling as well as being constrained by the logistics (ship availability) for deployment and recovery. Typically arrays were deployed for one or two years at a time, many being repeatedly recovered and re-deployed to obtain the long temporal coverage required for variability studies. The instruments record internally, so data were retrieved only when the current meters were recovered. Arrays that were not recovered and hence provided no data are not included in Table 7. Approximately two-thirds of the arrays described in the WOCE Implementation Plan were deployed. The majority of the heat flux, boundary current and deep flow arrays were implemented, but many of the special project, eddy statistics and choke point arrays were not.

Table 7 gives details of the WOCE moored current meter arrays, and their locations are shown in Fig. 16. In the table, current meter depths are indicated by asterisks; each asterisk represents a single current meter in the array. Solid lines separate each designated array site, while finely dashed lines divide individual deployments at that site. The two right hand columns indicate hydrographic data collected around the current meter arrays and provide ExpoCodes that can be used to locate the cruises in the WOCE Hydrographic Programme tables (Tables 1 and 2).

Key reference

Hogg N. G. 2001: Quantification of the Deep Circulation. Chapter 4.5, pp259 – 270 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Table 7. WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
Atlantic Ocean													
ACM1	USA	Lee, Johns	26.51	-076.84	***				900	Oct 1988	Jun 1990	A05	29HE06_1
(STACS10)			26.49	-076.45	**	*	**		4850	Oct 1988	Jun 1990		
			26.48	-076.10	***	*	**		4810	Oct 1988	Jun 1990		
(WATTS)	USA	Lee, Johns	26.53	-076.85	***				900	Jun 1990	Feb 1992		
			26.50	-076.45	***	*	**	*	4838	Jun 1990	Feb 1992		
			26.50	-076.10	***	*	**	*	4808	Jun 1990	Feb 1992		
			26.50	-075.68	****	**	**	*	4685	Jun 1990	Feb 1992		
			26.49	-075.82	***	***	**		4800	Jun 1990	Feb 1992		
(ACCP-1)	USA	Lee, Johns	26.53	-076.85	***				824	Feb 1992	Sep 1993		
			26.49	-076.52	****	**	**	*	4849	Feb 1992	Oct 1993		
			26.49	-075.69	****	**	**	*	4685	Feb 1992	Oct 1993		
			26.50	-073.80	****	**	**	*	5050	Feb 1992	Sep 1993		
			26.49	-071.17	****	**	**	*	5488	Feb 1992	Sep 1993		
(ACCP-2)	USA	Lee, Johns	26.53	-076.85	***				856	Sep 1993	Oct 1995		
			26.50	-075.68	******	***	****	*	4689	Oct 1993	Oct 1995		
			26.51	-073.00	****	***	****	*	5000	Oct 1993	Oct 1995		
(ACCP-3)	USA	Lee, Johns	26.51	-076.85	***				1006	Oct 1995	Jun 1997		
			26.41	-076.50		***	****	**	4840	Oct 1995	Jun 1997		
			26.50	-076.10	******	***	****	**	4807	Oct 1995	Jun 1997		
			26.41	-075.68	**	***	**	**	4711	Oct 1995	Jun 1997		
			26.50	-072.00	**	***	***	**	5284	Oct 1995	Jun 1997		

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
ACM3/12	Germany,	Hogg	-28.47	-044.47	**		**		3632	Jan 1991	Dec 1992	AR15	06MT15_2
(Deep	USA		-29.04	-043.49	**		***		3950	Jan 1991	Dec 1992		06MT22_2
Basin			-29.53	-042.70			**		4019	Jan 1991	Dec 1992		
Experiment)		-	30.09	-041.74	**		**		3814	Jan 1991	Dec 1992		
			-30.59	-040.79			*		3721	Jan 1991	Feb 1993		
			-31.08	-039.16			*		4160	Jan 1991	Dec 1992		
ACM4	USA	Pillsbury,	-30.44	014.71	**				1035	Jun 1992	Oct 1993	AR09	91AF105
(BEST)		Gordon	-30.28	013.23	**		*		3127	Jun 1992	Oct 1993		74DI202
			-29.99	008.83	**			*	5003	Jun 1992	Oct 1993		32309308_1
			-30.00	006.00	**		*	*	5180	Jun 1992	Oct 1993		
ACM6	Canada	Hendry	43.10	-049.03	**	*			1493	Aug 1993	Sep 1993	AR19	06GA226_2
			43.07	-048.63	**	*			2449	Aug 1993	Jul 1995		
			42.95	-048.18	**	*	**		3262	Aug 1993	May 1995	AR13	18HU93039_1
			42.72	-047.39	**	*	***		3894	Aug 1993	Jul 1995		18HU95003
			42.57	-046.69	**	*	**	*	4392	Aug 1993	Mar 1995		
			42.35	-046.01	**	*	**	**	4701	Aug 1993	May 1995		
			42.10	-045.32	**		***	*	4786	Aug 1993	Feb 1995		
			41.91	-044.58	**	*	*	**	4888	Aug 1993	May 1995		
ACM7	Germany	Schott	00.09	-044.39	******				545	Sep 1989	Oct 1990	AR04	06MT14_2
			00.83	-044.07	***	*	**		3989	Sep 1989	May 1990		06MT16_3
			02.48	-043.97	*	*	**		4191	Sep 1989	Apr 1990		06MT22_2
	Germany	Schott	00.09	-044.39	******				545	Oct 1990	Sep 1991		06MT27_3
			00.42	-044.25	********	**	***		3340	Oct 1990	Sep 1991		
			01.55	-044.01	********		****		4108	Oct 1990	Sep 1991		
	Germany	Schott	00.24	-044.31	*******	**	**		2880	Oct 1992	Mar 1994		
			00.62	-044.17	*******	**	***		3660	Oct 1992	Mar 1994		
			01.19	-044.04	******	**	**	*	4110	Oct 1992	Mar 1994		
ACM8	UK	Dickson	62.90	-035.86		*	*		2640	Sep 1986	Jun 1987	AR25	74CZ88_6
(Denmark Strait Overflow)			63.43	-036.57		**			2046	Sep 1986	Jun 1987		74CZ89_6
	UK	Dickson	63.71	-036.97	*	*			1220	Jun 1987	Jul 1988		
			63.61	-037.03		**			1648	Jun 1987	Jul 1988	AR18	58JH1092_1
			63.49	-036.29		**			1986	Jun 1987	Jun 1988		34AR10_1
			63.28	-035.89		*	*		2355	Jun 1987	Jun 1988		58JH0894_1
			63.12	-035.56		*	*		2572	Jun 1987	Jun 1988		46BS1495
			62.90	-035.11		*	*		2706	Jun 1987	Jun 1988		37AR97_12
			62.64	-034.51			**		2835	Jun 1987	Jun 1988		
	UK	Dickson	63.48	-036.30		***			1984	Aug 1988	Jun 1989	AR25	06MT39_5
	UK	Dickson	63.62	-036.73		**			1660	Jul 1988	Jun 1989		06AZ173_1
			63.70	-036.99	*	*			1260	Jul 1988	Jun 1989		06MT45_4
			63.28	-035.87		*	**		2345	Jul 1988	Jun 1989		
			63.12	-035.54		*	*		2569	Jul 1988	Jun 1989		
			62.91	-035.11		*	**		2706	Jul 1988	Jun 1989		
			62.65	-034.52			***		2827	Jul 1988	Jun 1989		
			62.24	-033.81			***		2917	Jul 1988	Jun 1989		
	UK	Dickson	62.78	-034.80			**		2756	Jul 1989	Mar 1990		
			63.00	-035.34			***		2634	Jul 1989	Mar 1990		
			63.20	-035.73			**		2463	Jul 1989	Aug 1990		
			63.38	-036.09		*	**		2153	Jul 1989	Mar 1990		
			63.56	-036.51		***			1767	Jul 1989	Mar 1990		
			63.66	-036.86		***			1445	Jul 1989	Mar 1990		
	UK	Dickson	64.75	-030.55		**	*		2200	Mar 1990	Jul 1990		
			64.91	-030.67		***			2005	Mar 1990	Jul 1990		
			65.17	-030.78	*	**			1500	Mar 1990	Jul 1990		
			65.26	-030.85	*	*			1200	Mar 1990	Jul 1990		
			65.30	-031.12	**	*			1080	Mar 1990	Jul 1990		
	UK	Dickson	63.62	-032.93		*	***		2738	Jul 1990	Jul 1991		
			64.27	-033.63		***			2001	Jul 1990	Jul 1991		
			64.43	-033.78		***			1731	Jul 1990	Jul 1991		
			64.55	-033.93	*	**			1494	Jul 1990	Jul 1991		
			64.72	-034.11	*	*			1142	Jul 1990	Jul 1991		
	UK	Dickson	63.27	-035.87			***		2323	Feb 1995	Nov 1995		
			63.48	-036.31		***			1952	Feb 1995	Nov 1995		
	UK	Dickson	63.49	-036.28		***			1949	Dec 1996	Aug 1997		
			63.27	-035.87			***		2323	Dec 1996	Aug 1997		
ACM8	Germany	Meincke	52.34	-016.35	***		***		3510	Sep 1991	Aug 1992	A01E	06MT18_1
			59.00	-032.81	**	**			2110	Sep 1991	Sep 1992		
			59.14	-034.03	**		**		2855	Sep 1991	Jun 1992	AR07E	06AZ129_1
	Germany	Meincke	52.38	-016.36	***	*	**		3481	Aug 1992	Aug 1993		06AZ144
			54.29	-025.86	*		*		3030	Sep 1992	Sep 1993		06AZ152

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
			59.14	-034.07	*		**		2630	Sep 1992	Oct 1993		
	Germany	Meincke	54.41	-025.86	*	*			3299	Sep 1993	May 1994	AR25	06AZ161_1
	Germany	Meincke	54.42	-025.90	*	*	*		3300	May 1994	Jun 1995		
			59.15	-034.00	**		**		2850	May 1994	Jun 1995		
	Germany	Meincke	59.59	-041.16			**		2312	Oct 1995	Jul 1996		
	Germany	Meincke	59.42	-040.61			*		2689	Jul 1996	Aug 1997		
ACM8	UK	Saunders	61.74	-015.40			*		2291	Jul 1990	Aug 1991	AR25	74CD50_1
(Iceland-Faroes Overflow)			63.14	-017.30		*			1028	Jul 1990	Aug 1991		
			63.00	-017.11		*			1301	Jul 1990	Aug 1991		
			62.72	-016.82		***			1800	Jul 1990	Aug 1991		
			62.44	-016.47		**	*		2056	Jul 1990	Apr 1991		
			62.06	-016.06		*	*		2235	Jul 1990	Aug 1991		
			61.83	-015.62		*	*		2306	Jul 1990	Aug 1991		
ACM9	USA, Spain	Candela	35.92	-005.75	*********				274	Oct 1994	Apr 1995		
					*********								
					*********								
			35.92	-005.75	*********				285	Apr 1995	Oct 1995		
					*********								
					*********								
			35.92	-005.75	*********				263	Oct 1995	Apr 1996		
					*********								
					***								
			35.92	-005.75	*********				265	Apr 1996	Sep 1996		
					*********								
					*******								
ACM10	USA	McCartney	00.84	-035.90			**	**	4486	Sep 1992	Jun 1994	AR04	32IC24_10
(Deep Basin Experiment)			00.50	-035.90			*	**	4540	Sep 1992	Jun 1994		06MT22_2
			-00.01	-035.99			****	***	4536	Sep 1992	May 1994		316N142_4
			-00.50	-035.90			*	**	4485	Oct 1992	May 1994		06MT27_3
			-00.98	-035.93			*	**	4396	Oct 1992	May 1994		
			-01.33	-036.08			*	*	4449	Oct 1992	Jun 1994	A15	316N142_3
ACM11	France	Mercier	00.73	-014.77		**	***	*	4235	Nov 1992	Oct 1994	AR15	35A3ROMAN
(Deep Basin Experiment)			00.69	-014.77			*	***	4375	Nov 1992	Oct 1994		-CHE_1 (_2)
			00.66	-014.76		**	***	**	4325	Nov 1992	Nov 1994		
			-00.87	-013.54		**	***	**	4225	Nov 1992	Nov 1994		
			-00.90	-013.52			*	****	4625	Nov 1992	Nov 1994		
			-00.92	-013.51			*	***	4425	Nov 1992	Nov 1994		
			-00.93	-013.50		**	***	*	4160	Nov 1992	Nov 1994		
ACM12/3	Germany	Zenk	-27.90	-046.70	****				1179	Jan 1991	Nov 1992	AR15	06MT15_2
(Deep Basin Experiment)			-27.99	-046.34	***	*	*		2187	Jan 1991	Nov 1992		06MT22_4
			-28.27	-045.23	***	*	**		3258	Jan 1991	Nov 1992		06MT28_2
			-31.20	-039.77	**		**		3965	Mar 1991	Dec 1992		
			-31.14	-039.43	*	*	**	***	4675	Jan 1991	Dec 1992		
			-31.15	-038.82	**		**		3652	Mar 1991	Dec 1992		
ACM13	Germany	Zenk	-26.87	-034.79	*			**	4864	Dec 1992	Apr 1995		
(Deep Basin Experiment)			-34.26	-028.88	*		***	*	4120	Dec 1992	May 1994		
			-34.43	-027.86				**	4350	Dec 1992	May 1994		
			-34.38	-027.71	*		**	*	4550	Dec 1992	May 1994		
			-34.51	-027.32				*	4330	Dec 1992	May 1994		
			-34.59	-027.06				**	4485	Dec 1992	May 1994		
			-34.54	-026.98	********	*	*	*	4325	Dec 1992	Apr 1994		
					**********								
			-31.62	-028.81			**		3720	Dec 1992	May 1994		
ACM24	USA	Weatherly	-18.74	-037.26	*	*	**		3491	Oct 1993	Sep 1994	A15	316N142_3
(Deep Basin Experiment)			-18.67	-036.76		*	**		3773	Sep 1993	Mar 1995		
			-18.56	-035.67	*	*	**		4015	Sep 1993	Sep 1994		
			-18.43	-034.87	*	*		*	4153	Sep 1993	Sep 1994		
			-18.29	-033.92	*	*	*	*	4372	Sep 1993	Sep 1994		
			-18.12	-032.61		*	*	*	4440	Sep 1993	Mar 1995		
			-17.74	-030.01				***	4788	Sep 1993	Mar 1995		
			-18.87	-037.80		**			1738	Oct 1993	Mar 1995		
ACM25/26	USA	Weller	18.00	-033.99	*******				5300	Jun 1991	Nov 1991	AR11	74AB73_1
(Subduction)					*******								32OC254_4
			18.00	-022.00	*******				3297	Jun 1991	Sep 1991		32OC258_3
					*****								
			25.53	-028.95	********	*	*		5670	Jun 1991	Feb 1992		
			32.91	-033.89	*********				3608	Jul 1991	Aug 1991		

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
			32.91	-033.89	********				3608	Jul 1991	Aug 1991		
			33.00	-022.00	********				5274	Jun 1991	Feb 1992		
	USA	Weller	18.00	-022.01	********	*			3297	Feb 1992	Oct 1992		
			18.00	-034.01	*******	*			5300	Feb 1992	Jun 1992		
					*******								
			25.53	-028.95	********	*	*		5670	Feb 1992	Oct 1992		
					*********								
			32.91	-033.89	********	*			3608	Feb 1992	Oct 1992		
					********								
			32.91	-033.89	********				3608	Feb 1992	Oct 1992		
			33.00	-022.00	********				5274	Feb 1992	Oct 1992		
					********								
	USA	Weller	18.00	-022.01	**********				3297	Oct 1992	Jun 1993		
			18.00	-022.01	*****	*			3297	Oct 1992	Jun 1993		
			18.09	-033.90	********	*			5300	Oct 1992	May 1993		
					*******								
			25.53	-028.95	********	*			5670	Oct 1992	Jun 1993		
					*********								
			32.91	-033.89	********	*			3608	Oct 1992	Mar 1993		
					*********								
			33.00	-022.00	********	*			5274	Oct 1992	Jun 1993		
					*********								
ACM27 (Morena)	Spain	Cabanas	42.27	-010.15	**	**			2700	May 1993	May 1994	AR16	29CSMORENA
			42.22	-009.80	**		*		2337	May 1994	Nov 1994		
			42.22	-009.51	**	*			1338	May 1994	Nov 1994		
ACM28 (Morena)	Portugal	Fuiza	41.00	-009.48	**	*			1293	May 1993	Jun 1995	AR16	29CSMORENA
			41.00	-009.75	*	*	*		2543	May 1993	Jun 1995		
			41.02	-010.25	*	*	*		4085	Nov 1993	Sep 1994		
			41.04	-010.91	**		*		3853	Nov 1993	Sep 1994		
ACM29 (Labrador Sea)	Canada	Rhines, Lazier	56.75	-052.46	**	**	**		3510	May 1994	Jun 1995	AR07W	18HU94008_1
			56.75	-052.46	*		**		3502	Jun 1995	May 1996		18HU96006_1
			55.12	-054.10		*			1067	Jun 1995	May 1996		18HU96026_1
	Canada	Rhines, Lazier	56.74	-052.44	*	*	**		3513	Oct 1996	May 1997		18HU97009_1
			55.12	-054.09	*				1000	May 1996	May 1997		06MT39_4
			55.48	-053.66	*	**	*		2801	Oct 1996	Jun 1998		18HU98023_1
			56.16	-052.97	**		*		3397	Oct 1996	Oct 1996		
	Canada	Rhines, Lazier	56.73	-052.48		*	*		3518	May 1997	Jun 1998	A01W	18HU95011_1
			55.12	-054.09	*				1061	May 1997	Jun 1998		
Indian Ocean													
ICM1 (ACE)	UK	Bryden	-31.09	030.43	*				1480	Mar 1995	Apr 1995	ISS01	74DI214_1
			-31.17	030.54	**	**			2498	Mar 1995	Nov 1995		
			-31.34	030.78	**	**			2900	Mar 1995	Apr 1996		
			-31.57	031.11	**	*	*		2900	Mar 1995	Apr 1996		
			-31.91	031.47	**	**			3446	Feb 1995	May 1995		
ICM3	USA	Whitworth	-20.00	049.50			***		3293	Jun 1995	Jan 1997	I03	316N145_8
		Nowlin	-20.00	049.79			***		3971	Jun 1995	Jan 1997		318SOJOURN4
			-20.00	050.33			***	*	4615	May 1995	Jan 1997		
			-19.98	050.82			***	*	4809	May 1995	Jan 1997		
			-19.99	051.63			***	*	4928	May 1995	Jan 1997		
			-20.00	052.52			***	*	4936	May 1995	Jan 1997		
			-20.00	069.63			**		3817	May 1995	Jan 1997		
			-20.00	070.07			**		3872	May 1995	Jan 1997		
			-20.00	070.63			**		3634	May 1995	Jan 1997		
			-20.00	071.55			***		3875	May 1995	Jan 1997		
			-20.00	072.49			*	*	4113	May 1995	Jan 1997		
			-20.00	073.33			*	**	4883	May 1995	Jan 1997		
			-20.00	074.30			*	**	4507	May 1995	Jan 1997		
			-20.00	088.36			**		2879	May 1995	Jan 1997		
			-20.00	088.79			**	**	4469	May 1995	Feb 1997		
			-20.00	089.25			*	**	5104	May 1995	Feb 1997		
			-20.00	089.71			**	*	4571	May 1995	Feb 1997		
			-20.00	090.56			*	*	4954	May 1995	Feb 1997		
			-20.00	092.59			**	*	5235	May 1995	Feb 1997		
ICM4 (JADE)	France	Fieux	-10.98	121.74	*****				1850	Aug 1989	Sep 1990	IR06	35MF62JADE_1
			-11.25	122.88	*****	*			1850	Aug 1989	Sep 1990		35MF71JADE_1
			-11.27	122.92	********	**			1600	Mar 1992	Feb 1993		
					********								
					********								

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
			-11.42	122.98	******** ********* *********				1600	Mar 1992	Apr 1993		
			-08.50	125.15	******** **	**			3100	Nov 1995	Nov 1996		
ICM6	Australia	Tomczak, Church	-22.22	113.73	******** ******** ********				252	Aug 1994	Jun 1996	I03	316N145_8
			-22.21	113.66	******** ******** ********				630	Aug 1994	May 1996	IR06	06FA9503_1 09FA9508_1
			-22.19	113.53	******** ******** *********				998	Aug 1994	Dec 1995	ISS03	09FA9605_1 09FA9606_1
			-22.10	112.99	***	*			1604	Aug 1994	Dec 1995		
			-22.06	112.65	***	*	*		3050	Aug 1994	Jun 1996		
ICM7	Germany	Schott, Quadfasel	11.85	051.85	*******				1020	Mar 1995	Oct 1996	ISS02	06MT32_1
			12.05	052.04	****				1100	Mar 1995	Oct 1996		06MT32_4
			11.38	053.01	******				700	Mar 1995	Oct 1996		06MT32_6
			11.02	053.24	****	*	**		3820	Apr 1995	Oct 1996		
			10.60	053.43	*******		**		4060	Apr 1995	Oct 1996		
			10.20	053.63	*****	*	*	*	4305	Apr 1995	Oct 1996		
			09.67	053.94	******		**	*	4609	Apr 1995	Oct 1996		
			08.75	054.33	******		*		4940	Apr 1995	Oct 1996		
			07.84	053.91	*****	*			5120	Apr 1995	Oct 1996		
			06.99	053.40	******	*			5120	Apr 1995	Oct 1996		
			07.01	054.80	****	*		*	5120	Apr 1995	Oct 1996		
			07.01	056.08	****		*		4710	Apr 1995	Oct 1996		
ICM8	Germany	Schott, Quadfasel	05.65	080.52	********	*			3020	Dec 1990	Mar 1992	IR04	06BESO73_1
			05.00	080.50	****	*	**		4295	Jan 1991	Mar 1992		
			04.18	080.49	********	*			4330	Jan 1991	Mar 1992		
	Germany	Schott, Quadfasel	04.99	080.55	*****	*			4329	Jul 1993	Sep 1994		
			03.59	080.52	******	*			4382	Jul 1993	Sep 1994		
			02.17	080.50	******		*		4490	Jul 1993	Sep 1994		
			00.75	080.49	******	*			4598	Jul 1993	Sep 1994		
			00.01	080.50	****** *****	*	*	*	4666	Jul 1993	Sep 1994		
			-00.72	080.51	******	*			4609	Jul 1993	Sep 1994		
ICM10	USA	Murray	12.72	043.19	*				48	May 1995	Jan 1996		
			12.74	043.23	***				147	May 1995	Jan 1996		
			12.76	043.28	***				203	May 1995	Mar 1996		
			12.75	043.28	******** ******** *****				220	May 1995	Mar 1996		
			12.78	043.35	**				48	Jun 1995	Jan 1996		
			13.68	042.48	***				87	May 1995	Jun 1996		
			13.71	042.54	*****				162	May 1995	Mar 1996		
			13.71	042.54	******* *******				158	May 1995	Mar 1996		
			13.74	042.61	**				55	May 1995	Jan 1996		
			13.34	042.90	********** **********				215	Jun 1995	Apr 1996		
			12.49	043.59	***				305	Jun 1995	Apr 1996		
			12.40	043.88	*				507	May 1995	Apr 1995		
			12.22	043.67	*				456	May 1995	Apr 1995		
			12.64	043.91	*				13	May 1995	Feb 1995		
			13.68	042.18	*				13	Jun 1995	Feb 1995		
			12.73	043.47	*				12	Jun 1995	Feb 1996		
			12.73	043.13	*				14	Jun 1995	Feb 1996		
			13.68	042.18	*					Mar 1995	Dec 1996		
			12.71	043.20	*				43	Apr 1996	Nov 1996		
			12.72	043.24	******* *******				165	Apr 1996	Nov 1996		
			12.27	043.28	******** ******** *******				234	Apr 1996	Nov 1996		
			12.38	043.32	*				49	Apr 1996	Nov 1996		
			13.68	042.47	**				83	Apr 1996	Nov 1996		
			13.71	042.54	******				159	Apr 1996	Nov 1996		

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
			13.71	042.54	******* ******				158	Apr 1996	Nov 1996		
			13.74	042.61	**				51	Apr 1996	Nov 1996		
			12.49	043.58	*				305	Apr 1996	Nov 1996		
			12.40	043.88	**				509	Apr 1996	Nov 1996		
			12.40	043.87	**				457	Apr 1996	Nov 1996		
			13.68	042.18	*				13	Mar 1996	Dec 1996		
Pacific Ocean													
PCM1	Taiwan ROC, USA	Lui, Lee, Johns	24.54	122.17	***				464	Sep 1994	Oct 1995		
			24.54	122.17	****				464	Sep 1994	May 1996		
			24.37	122.42	****				538	Sep 1994	May 1996		
			24.12	123.00	*******				595	Sep 1994	May 1996		
			24.06	123.11	*******				484	Sep 1994	May 1996		
			24.48	122.30	*				450	Sep 1994	Oct 1995		
			24.31	122.56	*				500	Sep 1994	May 1995		
			24.24	122.72	**				950	Sep 1994	Oct 1995		
	Taiwan ROC, USA	Lui, Lee, Johns	24.31	122.56	*				500	May 1995	Mar 1996		
	Taiwan ROC, USA	Lui, Lee, Johns	24.37	122.42	*				538	Aug 1995	May 1996		
	Taiwan ROC, USA	Lui, Lee, Johns	24.54	122.17	***				464	Oct 1995	May 1996		
			24.24	122.72	*				950	Oct 1995	May 1996		
			24.23	122.73	*				915	Oct 1995	May 1996		
			24.23	122.73	*				949	Oct 1995	May 1996		
			24.17	122.86	*				820	Sep 1994	May 1996		
			24.17	122.86	***				832	Oct 1995	May 1996		
PCM2 (Eastern Boundary Current)	USA	Chereskin, Niiler	37.05	-127.70	****				4750	Aug 1992	Aug 1994		
			37.22	-127.62	****				4742	Aug 1992	Aug 1994		
			37.15	-127.41	****				4663	Aug 1992	Apr 1993		
			36.98	-127.50	****				4757	Aug 1992	Aug 1994		
			37.11	-127.54	*****				4752	Aug 1992	Mar 1994		
			37.82	-125.85	***				4320	Aug 1992	Aug 1994		
			38.41	-124.13	****				3504	Jul 1992	Aug 1994		
			38.51	-124.24	****				3408	Jul 1992	Aug 1994		
			38.61	-124.34	****				3438	Aug 1992	Mar 1993		
			38.43	-124.36	****				3619	Aug 1992	Aug 1994		
	USA	Niiler	38.61	-124.34	****				3438	Apr 1993	Aug 1994		
PCM3	Australia	Church	-30.04	153.51	**				95	Nov 1991	Sep 1992	PR11	09FA1091_1
			-30.06	153.54	**				200	Nov 1991	Sep 1992		09FA0792
			-30.06	153.56	*****				700	Nov 1991	May 1992		90LANZOI3008
			-30.12	153.65	**	**			2051	Nov 1991	Sep 1992		09FA0793
			-30.18	153.94	***	*	**		4400	Nov 1991	Sep 1992		
			-30.12	154.35	**	**	**		4590	Nov 1991	Sep 1992		
	Australia	Church	-30.04	153.51	*				95	Sep 1992	Sep 1993		
			-30.06	153.54	**				200	Sep 1992	Dec 1992		
			-30.08	153.58	***				700	Sep 1992	Oct 1993		
			-30.12	153.65	**	*			2050	Sep 1992	Nov 1993		
			-30.13	153.97	*				4435	Sep 1992	Oct 1993		
			-30.13	154.33	***	*	**		4500	Sep 1992	Nov 1993		
PCM5 (ASUKA)	Japan	Imawaki, Umatani	32.46	133.16	*				819	Oct 1993	Sep 1994	PR17	49SU9402_2
			32.30	133.27	*	*			1160	Oct 1993	Sep 1994		49SU9402_1
			32.15	133.36	*	*			1543	Oct 1993	Sep 1994		49SU9407_1
			31.95	133.47	*	*	*		2527	Oct 1993	Sep 1994		49SU9409_2
			31.68	133.59	*	*	*	*	4720	Oct 1993	Sep 1994		49SU9504_1
			31.25	133.85	*	*			4494	Oct 1993	Sep 1994		49SU9506_2
			30.47	134.28	*	*	*		4470	Oct 1993	Sep 1994		49SU9508_1
			29.04	135.18	*	*	*		4856	Oct 1993	Sep 1994		
			26.54	136.42	*	*			4821	Oct 1993	Sep 1994		
	Japan	Imawaki, Umatani	32.47	133.18	*				811	Sep 1994	Nov 1995		
			32.30	133.28	*	*			1162	Sep 1994	Nov 1995		
			32.14	133.36	*	*			1592	Sep 1994	Nov 1995		
			31.97	133.45	*	*	*		2392	Sep 1994	Nov 1995		
			31.71	133.64	*	*		*	4637	Sep 1994	Nov 1995		
			31.23	133.86	*				4422	Sep 1994	Nov 1995		
			29.04	135.17	*	*	*		4844	Sep 1994	Nov 1995		
			26.53	136.44	*	*	*		4936	Sep 1994	Nov 1995		
PCM6 (KERE)	USA	Owens, Warren	36.40	150.23			*	*	5829	Jun 1993	Jul 1995		
			37.59	149.47		*	**		5922	Jun 1993	Jul 1995		

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
			38.40	148.90		*	**		5569	Jun 1993	Jul 1995		
			39.20	148.33		*			5675	Jun 1993	Jul 1995		
			40.00	147.77		*			5271	Jun 1993	Jul 1995		
			40.60	147.35		*	**		5280	Jun 1993	Jul 1995		
			41.21	146.88			*		5336	Jun 1993	Jun 1995		
			41.81	146.42		*	**	*	6972	Jun 1993	Jun 1995		
			42.30	146.11			**		4102	Jun 1993	Jun 1995		
PCM7 (KERE)	USA	Hallock	36.44	142.11			**		3270	Jul 1992	Jun 1993		
			36.08	142.37			*	*	4600	Jul 1992	Jun 1993		
			35.51	142.71	*	*			6380	Jul 1992	Jun 1993		
			34.49	143.38	*		*	*	5500	Jul 1992	Jun 1993		
	USA	Hallock	36.44	142.11			*		3270	Jun 1993	May 1994		
			36.09	142.37			**	*	4600	Jun 1993	May 1994		
			35.55	142.66	*	*	*	*	6380	Jun 1993	May 1994		
			34.49	143.38	*		**	*	5500	Jun 1993	May 1994		
PCM9	USA, NZ	Nowlin, Pillsbury	-32.50	-178.75			*		3036	Feb 1991	Dec 1992	P06	316N138_5 (MAPKIWI)
			-32.51	-178.55			***		4115	Feb 1991	Dec 1992		
			-32.49	-178.39			**		4668	Feb 1991	Dec 1992		
			-32.49	-178.18				**	5335	Feb 1991	Dec 1992		
			-32.53	-177.84			**	**	6100	Feb 1991	Dec 1992		
			-32.52	-177.49			**	*	9021	Feb 1991	Dec 1992		
			-32.48	-177.03			**	*	6327	Feb 1991	Dec 1992		
			-32.50	-176.09			**	*	5852	Feb 1991	Dec 1992		
			-32.50	-175.33			**	*	5770	Feb 1991	Dec 1992		
			-32.47	-174.56			**		5718	Feb 1991	Dec 1992		
			-32.51	-173.82			**	*	5730	Feb 1991	Nov 1992		
			-32.50	-173.05			**	*	5945	Feb 1991	Nov 1992		
			-32.50	-172.19				**	5446	Feb 1991	Nov 1992		
			-32.52	-171.40			**	*	5226	Feb 1991	Nov 1992		
			-32.50	-171.05			**	**	5697	Feb 1991	Nov 1992		
			-32.47	-170.47			*	**	5240	Feb 1991	Nov 1992		
			-32.48	-169.68			**	*	5607	Feb 1991	Feb 1991		
			-32.50	-168.92			**		5275	Feb 1991	Nov 1992		
			-32.45	-168.23			**	*	5553	Feb 1991	Nov 1992		
PCM11 (Samoan Passage)	USA	Rudnick, Pillsbury	-09.69	-170.47			**	*	4343	Sep 1992	Feb 1994	PR32	316N138_8
			-09.84	-169.99				***	5004	Sep 1992	Feb 1994		
			-09.92	-169.74			**	****	5235	Sep 1992	Feb 1994	P31	3250031_1
			-10.00	-169.49			*	****	5385	Sep 1992	Feb 1994		
			-10.09	-169.25			*	****	5245	Sep 1992	Feb 1994		
			-10.22	-168.83			**	**	4455	Sep 1992	Feb 1994		
PCM15 (Vitaz Strait Transport)	USA	Murray	-06.07	147.84	*****				1130	Feb 1992	Jun 1992	PR33	09FA0691
			-06.15	147.71	***				690	Feb 1992	Jul 1992		09FA0692
			-06.00	147.92	***				1020	Feb 1992	Jul 1992		
			-05.98	147.98	***				940	Feb 1992	Jul 1992		
			-06.07	147.84	******				1130	Jul 1992	Apr 1993		
			-06.15	147.71	***				690	Jul 1992	Apr 1993		
			-06.12	147.77	*****				950	Jul 1992	Apr 1993		
			-06.00	147.92	****				1020	Jul 1992	Apr 1993		
			-05.98	147.98	***				940	Jul 1992	Apr 1993		
Southern Ocean													
SCM2	Germany	Farhbach	-50.16	005.77	*		*		3779	Dec 1986	Feb 1988	SR02	06AQANTVIII_2
			-64.92	-002.54	*			**	5053	Jan 1987	Jan 1988		06MT11_5
			-64.90	-002.56	*			*	5053	Jan 1988	Sep 1988		
			-50.16	005.74	*		*		3757	Mar 1988	Oct 1988	A12	06AQANTX_4
			-54.34	-003.38			*		2734	Dec 1990	Jan 1992		
			-57.63	004.05			**	*	4467	Mar 1991	Dec 1991	SR04	6AQANTX_7
			-54.35	-003.39	**	*	*		2710	May 1992	Dec 1992		
			-50.10	005.92	**	*	**		3730	May 1992	Dec 1992		
			-57.63	004.05	**	*	*	*	4410	May 1992	Dec 1992		
			-54.33	-003.30	**	*	*		2754	Dec 1992	Apr 1994		
			-50.10	005.90	*				3748	Dec 1992	Dec 1994		
			-54.34	-003.34	*	*			2734	Apr 1994	Dec 1994		
			-50.15	005.83	*	*	**		3778	Apr 1994	Dec 1994		
			-59.47	-003.21		*	*		5030	Apr 1994	Dec 1994		
			-59.46	-003.19	**	*	*	*	5100	Dec 1994	Feb 1996		
			-54.34	-003.29	**	*	*		2730	Dec 1994	Feb 1996		
			-50.19	005.99	**	*	**		3838	Dec 1994	Feb 1996		
			-48.89	011.54	**	*	**	*	4176	Dec 1995	Jan 1996		

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
			-59.03	-000.02	****		*	**	4592	Apr 1996	Jan 1997		
			-57.00	000.00	**		**		3900	Apr 1996	May 1998		
			-63.99	-000.01	****		*	*	5177	Apr 1996	May 1998		
			-66.00	000.16	**	*	*		3471	Apr 1996	May 1998		
			-66.50	-000.01	****	*		*	4518	Apr 1996	May 1998		
			-69.00	000.00	*	*			3352	Apr 1996	Feb 1997		
			-69.40	000.00	**	*			2051	Apr 1996	Feb 1997		
			-54.34	-003.29	**	*	*		2700	Apr 1996	Jan 1997		
			-59.06	000.05	**	*		*	4700	Jan 1997	May 1998		
			-69.00	000.00	*	*	**		3352	Feb 1997	Apr 1998		
			-69.40	000.00	**	*			2051	Feb 1997	Apr 1998		
			-69.00	-000.06	**	*			3450	Apr 1998	Jan 1999		
			-69.40	-000.01	**	*			2850	Apr 1998	Jan 1999		
			-59.07	000.08	***			*	4700	May 1998	Aug 1998		
			-56.98	000.02	***		*		3800	May 1998	Mar 1999		
			-63.98	000.04	****** *****		*	*	5200	May 1998	Mar 1999		
			-66.50	-000.02	*********	*		*	4550	May 1998	Jan 1999		
			-66.01	000.18	****	*	*		3500	Jan 1999	Dec 2001		
			-66.50	-000.02	*********	*		*	4500	Jan 1999	Dec 2001		
			-68.99	-000.03	**	*	*		3400	Jan 1999	Dec 2001		
			-69.40	-000.02	*	*			2050	Jan 1999	Dec 2001		
			-59.07	000.07	***	*		*	4700	Mar 1999	Dec 2001		
			-56.97	000.02	****				3800	Mar 1999	Dec 2001		
			-56.92	000.05	***	*	*		3800	Mar 1999	Dec 1999		
			-63.96	000.04	*********	*		*	5200	Mar 1999	Dec 2001		
			-46.17	001.02			*		3700	Mar 1999	Mar 2001		
			-54.50	000.03		*			1800	Mar 1999	Mar 2001		
			-54.50	000.03		*			1800	Mar 1999	Jul 1999		
SCM3	Australia	Rintoul	-50.72	143.38	*				3570	Oct 1991	Sep 1992	SO3	09AR9404_1
			-50.72	143.38		*			3570	Mar 1992	Sep 1992		
			-50.71	143.40	**	*	*		3580	Mar 1993	Jan 1995	SR03	09AR9101_1
			-50.42	143.53		*	*		3500	Mar 1993	Dec 1994		09AR9309_1
			-51.03	143.24	**	*	**		3800	Mar 1993	Jan 1995		09AR9407_1
			-50.55	142.71	**	*	*		3770	Mar 1993	Jan 1995		09AR9501_1
			-50.42	143.53	***	*	*		3492	Mar 1995	Mar 1997		09AR9601_1
			-50.99	143.25	***	*	*		3912	Mar 1995	Mar 1997		
SCM4	Australia	McDougal	-32.36	102.12			*		3912	Jul 1995	Mar 1996	ISS03	09FA9506
			-32.40	102.37			**		4072	Jul 1995	Jul 1996		09FA9605
			-32.55	102.82			*	**	4929	Jul 1995	Apr 1996		09FA9608
			-32.67	103.20			***	*	5004	Jul 1995	Mar 1996		
			-33.00	104.24			*	**	5491	Jul 1995	Aug 1996	I05E	316N145_7
			-33.34	105.38			**	**	5607	Jun 1995	Mar 1996		
			-33.77	106.85			**	*	5168	Jun 1995	Aug 1996		
			-34.17	109.29			**	*	4786	Jun 1995	Aug 1996		
			-34.17	109.63			**		3650	Jun 1995	Feb 1996		
SCM6 (ADOX)	UK	Dickson	-48.58	061.51		*	*		3565	Mar 1993	Mar 1994	ISS01	74DI200_1
			-48.20	059.63		*	*	*	4366	Mar 1993	Mar 1994		74DI207
			-48.00	058.64			**	*	4460	Mar 1993	Aug 1993		
			-47.76	058.05	**	*	****		4230	Mar 1993	Mar 1994		
			-47.62	056.81		*	**	*	4353	Mar 1993	Mar 1994		
			-47.42	055.61			**	*	4110	Mar 1993	Mar 1994		
			-47.02	054.09			****		3774	Mar 1993	Mar 1994		
			-46.84	053.34		*	*		3345	Mar 1993	Mar 1994		
			-45.44	048.00			*		3036	Mar 1993	Feb 1994		
SCM7	Germany	Fahrbach	-62.37	-057.92	*	*			1992	Nov 1985	Nov 1986	A12	06AQANTX_4
			-72.56	-020.60	******	*	*		3415	Oct 1986	Feb 1987		
	Germany	Farhbach	-72.88	-019.63	**				461	Feb 1987	Jan 1988	SR04	06AQANTVIII_2
			-70.43	-008.29	**				468	Feb 1987	Jan 1988		06AQANTIX_2
	Germany	Farhbach	-71.13	-012.18	**				642	Jan 1988	Feb 1988		06AQANTX_7
			-71.13	-012.20	*				682	Mar 1988	Jan 1989		
	Germany	Farhbach	-71.04	-011.74	**				676	Feb 1989	Feb 1990		
			-71.05	-011.76	**				430	Feb 1989	Mar 1989		
			-70.94	-011.96	*	*			1522	Feb 1989	Dec 1989		
			-70.71	-012.36	**	*	*		2123	Feb 1989	Dec 1989		
	Germany	Farhbach	-63.49	-052.12	**				927	Sep 1989	Nov 1990		
			-65.61	-036.50	*	*	*	*	4742	Sep 1989	Nov 1990		
			-63.76	-050.91	**		**		2461	Sep 1989	Nov 1990		
			-69.65	-015.74	**		*	*	4728	Oct 1989	Dec 1990		

Table 7 (Continued). WOCE Moored Current Meter Arrays

Array	Country	Principal Investigator	Lat	Lon	Current Meter Depths (m) 0-1000	1000-2000	2000-4000	>4000	Water Depth	Start	Stop	Assoc. Hydrogr. Line	Expocode
			-70.49	-013.12	**		**		2364	Oct 1989	Dec 1990		
			-70.99	-011.82	**				2364	Oct 1989	Dec 1990		
	Germany	Farhbach	-71.05	-011.76	*				467	Jan 1990	Nov 1990		
	Germany	Farhbach	-71.10	-020.79				**	4440	Feb 1990	Feb 1991		
	Germany	Farhbach	-63.49	-052.11	**				950	Nov 1990	Jun 1991		
			-63.75	-050.91	*	*	**		2460	Nov 1990	Dec 1992		
			-65.64	-036.50	**		*	*	4710	Nov 1990	Nov 1992		
			-63.95	-049.15			**		3480	Nov 1990	Jan 1992		
			-64.42	-045.85	*			*	4390	Nov 1990	Jan 1992		
			-64.82	-042.49	*		*	*	4650	Nov 1990	Feb 1992		
			-65.67	-037.71				**	4730	Nov 1990	Dec 1991		
			-65.97	-033.34				*	4800	Nov 1990	Dec 1991		
			-69.66	-015.72	*	*			4750	Dec 1990	Jan 1992		
			-70.50	-013.15	*	*			2450	Dec 1990	Jan 1992		
			-70.91	-011.96	**				1555	Dec 1990	Dec 1992		
			-71.05	-011.69	*				378	Dec 1990	Feb 1992		
			-68.83	-017.91				*	4740	Dec 1990	Nov 1991		
			-70.32	-013.66	*	*	*	*	4330	Dec 1990	Mar 1991		
			-70.38	-013.54	**		*		2900	Dec 1990	Jan 1992		
			-66.62	-027.12				*	4860	Dec 1990	Nov 1992		
			-66.28	-030.30	**		*	*	4750	Dec 1990	Nov 1992		
			-67.06	-024.87				**	4840	Dec 1990	Nov 1992		
	Germany	Farhbach	-73.63	-026.12			***		3360	Feb 1991	Oct 1991		
	Germany	Farhbach	-71.06	-011.74	**				380	Feb 1992	Dec 1992		
	Germany	Farhbach	-71.05	-011.73	*				360	Dec 1992	Jan 1993		
			-66.62	-027.12	*	*	*	*	4830	Dec 1992	Mar 1995		
	Germany	Farhbach	-63.75	-050.91	*	*	**		2498	Jan 1993	Feb 1995		
			-65.63	-036.49	*	*	*	*	4736	Jan 1993	Mar 1995		
			-64.42	-045.85	*	*	*	*	4420	Jan 1993	Jan 1995		
SCM9 (SWINDEX)	UK	Pollard	-45.42	047.83	***	*	**		2864	Apr 1993	Jan 1995	ISS01	74DI201_1
			-44.74	045.73	**	*			1614	Apr 1993	Jan 1995		74DI213_1
			-44.56	041.32	**	*			2710	Apr 1993	Jan 1995		
			-43.40	036.07	**	*	*	*	4262	Apr 1993	Jan 1995		
			-41.86	032.83		*	*	*	5900	Apr 1993	Jan 1995		

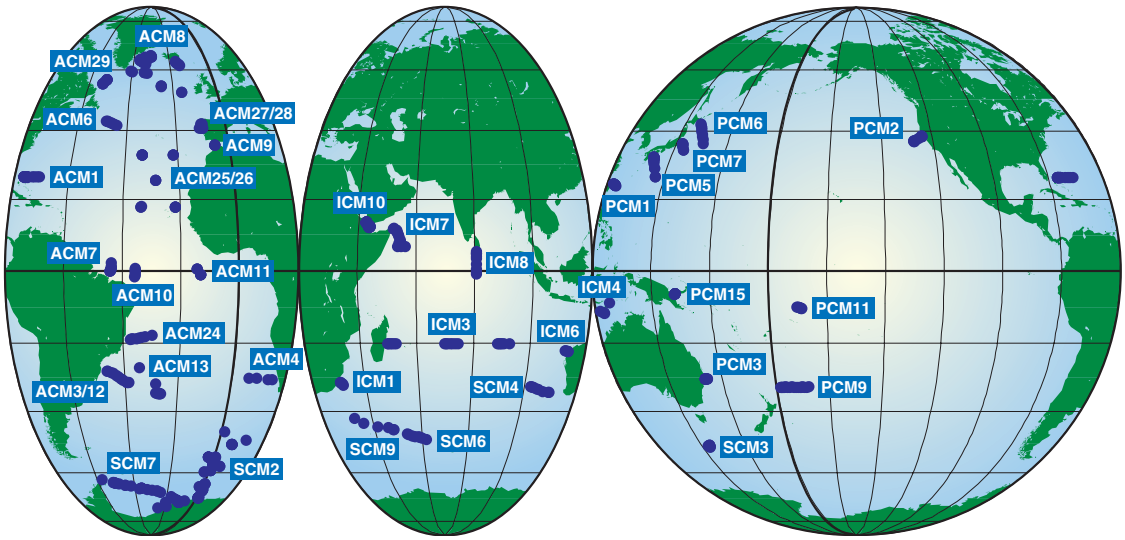

Figure 16. WOCE Moored Current Meter Arrays.

6. Satellite Missions

In part the origins of WOCE lie in the brief (100 day) mission of SeaSat in 1978. SeaSat demonstrated the ability to measure sea surface height and scatterometer wind fields on an almost global basis and opened up the era of global ocean science. The timing of WOCE was set to coincide with the next generation of ocean satellite missions. The key missions were the European Space Agency's ERS-1 and the joint NASA/CNES mission TOPEX-Poseidon. Table 8 summarises the main parameters and missions for WOCE. ERS-1 was a multi-purpose mission with the inevitable compromises that that implies. It carried a radar altimeter, a microwave scatterometer (with a shared duty cycle with the Synthetic Aperture Radar sensor) an Along-Track Scanning Radiometer (ATSR). ERS-1 was launched on July 17 1991 and spent much of its life in a 35 day repeat orbit, with the exception of a period from April 1994 to March 1995 when it moved to a 168 day geodetic orbit. It continued to operate until June 1996 when it went into backup mode following an almost 1 year tandem operation with its replacement ERS-2. ERS-2 was launched in April 1995 carrying similar sensors to ERS-1 and continues to operate at the end of 2002.

While ERS-1 and 2 were multi-purpose earth observing satellites (with missions designed for land, ocean and cryosphere research) TOPEX-Poseidon was a dedicated ocean observing satellite and with a single mission: to obtain the highest quality radar altimetry. TOPEX-Poseidon was launched on August 10 1992 into a 10 day orbit extending to latitude 66° for a planned 3-year initial mission with consumables on board for a possible further 5-years. It is astonishing that it continued to operate more than 10 years after launch to an accuracy that greatly exceeds that planned.

The delays in the launch of ERS-1 and TOPEX-Poseidon resulted in the extension of the WOCE *in situ* observing period by two years to the end of 1997 in order to maximise the period when both satellite and *in situ* observations would be available.

In August 1996 the Japanese NASDA ADEOS satellite was launched with the NASA scatterometer NCSAT on board. ADEOS disappointingly operated only until June 1997 when the solar array failed. A number of platforms delivered additional information on Sea Surface Temperature, significant wave height, and from 1997, ocean colour (see Table 8 for more details).

Data Centres

There were a variety of data centres across the world which specialised in producing corrected and gridded data sets from satellite sensors. For WOCE requirements there were four principal centres:

i) Centre ERS d'Archivage et de Traitement (CERSAT); holding wind vector data from ERS-1, ERS-2, NSCAT, and Quikscat (http://www.ifremer.fr/cersat).

ii) Physical Oceanography Distributed Active Archive Center (PODAAC); holding wind vectors from NSCAT and Quikscat, all parameters from TOPEX/Poseidon, AVHRR SST Pathfinder and MCSST (http://podaac.jpl.nasa.gov/),

iii) Goddard DAAC Ocean Colour Support Team; holding Seawifs ocean color and productivity (http://seawifs.gsfc.nasa.gov/SEAWIFS.html).

iv) AVISO; holding sea surface height from ERS-1, ERS-2, and TOPEX/Poseidon (http://alti.cnes.fr).

Key references

Fu, Lee-Leung, 2001: Ocean Circulation and Variability from Satellite Altimetry, Chapter 3.3, pp 141 – 172 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Liu W T and K B Katsaros, 2001: Air-Sea Fluxes from satellite data, Chapter 3.4, pp 173 – 180 in "Ocean Circulation and Climate – Observing and Modelling the Global Ocean", Gerold Siedler, John Church and John Gould, Eds., Academic Press, International Geophysics Series No 77, 715pp and plates.

Table 8. Satellite Missions

I. Parameters Relevant to WOCE

Variable	Satellite	Instruments	Start	End	Spatial Resolution	Accuracy
Sea Surface Temperature	NOAA-NASA (the NOAA-7, -9, -11 and -14 satellites)	AVHRR (Advanced Very High Resolution Radiometer)	Jun 1981	beyond 1998	Instrument gives 1.1 km resolution, with swath width of 2400-3000 km. Local Area coverage at 1.1 km res only broadcast to local receiving antennas. Global coverage at 9 km res. Corrected "Pathfinder"dataset is 0.5°.	Thermal resolution of 0.12 K at 300 K
	ERS-1 and ERS-2	ATSR (Along Track Scanning Radiometer and Microwave Sensor)	Jul 1991	beyond 1998	1 km x 1 km. Swath width 500 km.	Radiometer accuracy < 0.1 K, absolute accuracy < 0.5 K.
Sea Surface Height (and Significant Wave Height)	ERS-1 and ERS-2	The RA (Radar Altimeter) measures sea surface height and significant waveheight. The AMI (Active Microwave Instrument) includes function (Synthetic Aperture Radar) for length and direction of surface waves.	Jul 1991	beyond 1998	RA has a footprint of 16-20 km, AMI has spatial resolution of 30 m and gives wave images of 5 km x 5 km ("imagettes") every 200-300 km.	RA surface height accuracy is better than 10 cm. Single frequency altimeter does not measure ionospheric delay. AMI wave direction and length accuracy of 20° and 25% respectively.
	TOPEX/Poseidon (Topography Experiment for Ocean Circulation)	Two altimeters: ALT (NASA Radar Altimeter, also known as NRA) operational for 90% of the time, and SSALT (Single Frequency Solid State Altimeter) operational for the remaining 10%.	Oct 1992	beyond 1998	2-12 km footprint, depend on waveheight.	ALT accuracy 2.4 cm, SSALT accuracy 2.5cm. Orbit accuracy better than 3 cm.
Wind Speed	ERS-1 and ERS-2	AMI (Active Microwave Instrument) in scatterometer or Wind Mode (known as AMI-SCAT or AMI-Wind).	Jul 1991	beyond 1998	50 km resolution with separation of 25 km across a swath of 500 km	Instrument accuracy ±20° wind direction and ± 2 ms^{-1} wind speed. IFREMER algorithm improves accuracies to 1ms^{-1} and 14°. Accurate in the presence of light rain.
	ADEOS-1	NSCAT (NASA scatterometer, a microwave radar instrument).	Aug 1996	Jun 1997	Ground resolution of 50 km. Sampled in two 600 km swaths separated by 300 km.	Wind speed accuracy 2 ms^{-1}, direction accuracy 20°, not under rainy conditions.
Ocean Colour	OrbView-2 (SeaStar)	SeaWiFS (Sea-Viewing Wide Field-of-View Sensor)	Aug 1997	beyond 1998	Two modes: Local Area Coverage (LAC for 20 minutes per day) and Global Area Coverage (GAC). Spatial resolution for LAC is 1.13 km with a swath of 2800 km, and for GAC is 4.5km with a swath of 1500km.	
	ADEOS-1	OCTS (Ocean Colour and Temperature Sensor)	Aug 1996	Jun 1997	700m resolution and 1400 km swath.	

II. Satellite Summary

Satellite	Launch	Mission End	Orbit	Orbital Period	Altitude	Repeat Cycle	Ocean Parameters (Instruments)
ERS-1	Jul 1991	Jun 1996	Sun-synchronous polar orbit	101 mins	785 km	various (3, 35, 168 days)	Sea surface height (radar altimeter), sea surface wind vector (AMI/scatterometer, C-band), sea surface temperature (ATSR)
ERS-2	Apr 1995	after 1998	Sun-synchronous polar orbit	101 mins	785 km	35 days	Sea surface height (radar altimeter), sea surface wind vector (AMI/scatterometer, C-band), sea surface temperature (ATSR)
TOPEX/Poseidon	Aug 1992	after 1998	Non-sun-synchronous orbit	120 mins	1334 km	10 days	Sea surface height (radar altimeter)
OrbView-2 (SeaStar)	Aug 1997	after 1998	Sun-synchronous orbit	99 mins	705 km	15 days	
ADEOS-1	Aug 1996	Jun 1997	Sun-synchronous subrecurrent polar orbit	101 mins	790 - 804 km	41 days	Sea surface wind vector (scatterometer, K-band)
NOAA-NASA series	Jun 1981	after 1998	Near-polar, sun-synchronous orbit	102 mins	830 - 900 km	9 days	Sea surface temperature (AVHRR)

8. Upper Ocean Thermal Programme

Temperature data from the upper ocean was measured using Expendable Bathy Thermographs (XBTs) deployed from voluntary observing ships (VOS). XBTs measure temperature down to 450 or 750 m, and it was originally intended that XCTDs (expendable CTDs) would also be deployed to measure salinity. However the development of XCTDs was a long process and they were not deployed widely in WOCE. The WOCE XBT network was run in close co-operation with another WCRP programme, the Tropical Ocean Global Atmosphere (TOGA), and the more operational IOC/WMO organisation IGOSS (Integrated Global Ocean Services System).

The objectives of the UOT programme were:

- to measure changes in the heat and salt content of the upper ocean on basin scales;

- to estimate the statistics of the thermal field in the upper kilometre, including the variance of the eddy field and the spatial and temporal covariances;

- to observe the variations of large scale geostrophic velocity in the upper kilometre and of the zonal and meridional fluxes of heat and salt on time-scales of seasons to years.

Sampling was mainly from commercial vessels which ran regular routes and were serviced in port by technical staff who supplied the XBTs and received the data from the ship. There were two modes of sampling, wide spatial coverage from the low density network which sampled at 4 profiles per day, with one section each month, and a small number of eddy-resolving high density sections sampling at 12-16 profiles per day and one section each season. The low density network was supplemented by data from fishing, research and navy vessels which were also made available through the data system, but were not funded through WOCE.

The targetted combined TOGA and WOCE XBT yearly requirement for low density sampling at all latitudes was around 12000 profiles in the Atlantic, 6500 in the Indian and 29000 in the Pacific. These numbers include some Southern Ocean sections, but in that region there were only a few VOS (Antarctic supply and research vessels) and consequently the coverage was low and infrequent. Full coverage on all lines was never achieved either because of a shortage of XBTs, or due to lack of available vessels to equip. However WOCE, TOGA and IGOSS did significantly increase the XBT coverage at all latitudes during the 1990s. Fig. 17 shows a map of the coverage in just one quarter of 1994 (April-June), a time when sampling rates were at their highest. Fig. 18 shows a schematic map of the line numbers used in Table 9.

The high density network was most successful in the Pacific where several lines were operational from early in the 1990s. In the Atlantic the AX03 section at approximately 48°N was operated throughout the WOCE period, and eventually more Atlantic and some Indian sections were established later in the programme.

The data archive from the UOT programme actually contains temperature (and sometimes salinity) profiles from sources in addition to XBTs. Profiles from CTDs, profiling floats (PALACEs), and bottle casts are included. Fig. 19 shows the relative numbers of each of these categories, and demonstrates the way that the UOT data archive is much larger than that from just XBTs along the designated WOCE transects. In the complete data archive the profiles may take one of two forms; high and low resolution. "BATHY" (temperature only), "TESAC" (temperature and salinity) and PALACE profiles are low resolution profiles transmitted over the Global Transmission System while CTDs and XBTs are high resolution profiles.

Key references

McCarthy, M.C., Talley, L.D., and Roemmich, D. 2000: Seasonal to interannual variability from expendable bathythermograph and TOPEX/Poseidon altimeter data in the South Pacific subtropical gyre. Journal of Geophysical Research, 105(C8), 19535-19550.

Molinari, R.L. 1999: Lessons learned from operating global ocean observing networks. Bulletin of the American Meteorological Society, 80(7), 1413-1419.

Roemmich, D., and Gilson, J. 2001: Eddy transport of heat and thermocline waters in the North Pacific: a key to interannual/decadal climate variability? Journal of Physical Oceanography, 31(3), 675-687.

Smith, N., Harrison, D.E., Bailey, R., Alves, O., Delcroix, T., Hanawa, K., Keeley, B., Meyers, G., Molinari, R.L., and Roemmich, D. 1999: The upper ocean thermal network. Chpt 3.3 pp 259 – 284, in; Observing the Oceans in the 21st Century (Koblinsky & Smith eds.), ISBN 0642 70618 2, Bureau of Meteorology, Melbourne, Australia, 604pp.

Table 9. WOCE Upper Ocean Thermal Programme; XBT deployments

	1990		1991		1992		1993		1994		1995		1996		1997		1998		Country
	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	
Global High Density																			
AX03	5	339	4	284	4	280	6	513	3	251	3	240	2	300	7	412	2	262	Ger
AX07											2	384	6	966	4	784	3	580	USA
AX10															4	306	3	357	USA
AX22													2	130	2	260	6	368	USA
IX01											3	263							AA
IX06													1	77			1	78	AA
IX15									1	83	4	491							Japan
IX21									1	64	4	225							USA
IX28							5	152	11	687	5	403	6	378	6	357	4	301	AA, Fr
PX06	4	240	4	227	4	235	5	276	3	174	4	256	4	256	3	215	5	350	USA
PX09	4	607	4	586	4	595	5	716	3	412	4	589	4	567					USA
PX10			1	123	2	260	3	404	4	527	4	535	4	559	4	520	4	531	Fr, ROC, USA
PX30/31			3	291	3	239	4	303	4	342	4	384	2	190	4	381	3	331	AA, USA
PX34			4	317	4	319	4	256	3	205	4	274	4	247	3	240	2	111	AA
PX37			1	86	2	166	3	262	4	336	4	367	4	331	4	366	5	417	ROC, USA
PX38									2	254	2	352	3	342	4	398	3	334	USA
PX39							2	184	3	264	4	369	4	326					USA
PX44			1	75	2	176	3	259	4	359	4	367	4	380	4	384	4	384	ROC, USA
PX50							1	245	4	1029	4	1001	3	790	4	1078	4	950	USA
PX81															2	375	4	874	USA
Suva-LA															3	534	5	1016	USA
Atlantic Ocean Low Density																			
AX01	3	54			3	134	4	98	3	169	7	158	3	70	6	217	2	56	Ger, UK, USA
AX02	2	36	8	108	6	138	5	103	15	325	14	328	11	256	9	205	25	503	Can, Fr, Ger, USA
AX03	22	589	7	276	7	340	7	333	6	246	5	201	8	319	7	295	10	307	Fr, Ger, USA
AX04	24	531	17	642	22	615	23	551	14	278	47	1028	27	422	4	150	29	648	Fr, USA
AX05	15	190	7	381	16	406	18	576	25	475	1	33	2	49	7	151	7	142	Fr, NL, RUS, USA
AX06	2	37					5	270	7	264	8	288	7	185	3	79			Fr, USA
AX07	24	405	20	404	9	111	15	308	19	463	26	643	14	460	15	1125	21	1321	RUS, UK, USA
AX08	9	142	10	808	16	816	5	266	5	336	10	535	12	510	21	1128	24	1130	USA
AX09	25	465	0	286	23	242													Fr
AX10			8	77	1	28	5	42	12	161	28	346	28	346	32	379	20	277	USA
AX11	36	871	6	599	32	1022	20	840	22	647	22	691	28	789	24	722	18	703	Fr, Ger, RUS, UK, USA
AX12	12	273	13	782	7	598	9	968	6	417	2	248	2	156	1	42			Ger, RUS, UK, USA
AX13							1	17	4	197			1	14	5	41			Ger, USA
AX14									4	107	9	98	4	51					USA
AX15	25	661	15	402	14	351	4	97	16	256	4	107	8	245	16	380	15	379	Fr, Ger, USA
AX16							1	55											Ger
AX17	3	42	3	152	4	89	2	43	5	93	4	93	2	53	9	260	4	95	Ger, USA
AX18	9	154	2	50	4	99	3	132			1	70	1	38			2	76	Ger, USA
AX19			1	36			2	150											Ger, UK, USA
AX20	13	166	12	196	12	254	21	590	28	474	25	568	13	395	21	606	21	484	Fr, UK, USA
AX21	2	77	1	48	1	7					1	24	2	17	3	104			Ger, USA
AX22	2	91					4	78											Argentina, Ger
AX25	3	209	2	444	1	140	1	29			1	82							Ger, USA
AX26			2	25			23	440	20	315	6	91	4	56	3	45			Fr, USA
AX27			5	187	5	155	10	173	9	130	8	191	3	98					Ger, UK, USA
AX29	19	378	13	431	30	670	33	967	46	1352	35	934	17	478	13	422	4	108	Fr, USA
AX32	49	804	14	671	12	317	11	277	11	416	12	439	12	314	12	316	8	213	USA
AX34																	12	277	USA
AX35									3	101			6	133	7	184	2	44	USA
Totals		*6175*		*7005*		*6532*		*7403*		*7222*		*7196*		*5454*		*6851*		*6763*	
Indian Ocean Low Density																			
IX01	19	539	27	623	29	591	27	681	29	708	30	798	23	607	26	571	21	399	AA, Fr, Japan, USA
IX02															7	296	4	192	Fr, USA
IX03	26	692	0	158	22	405	24	708	28	706	8	158	15	331	8	174			Fr
IX06	11	189	3	43	15	248	12	250	10	179	11	342	15	433	16	425	11	232	Fr, Ger, USA
IX07	3	45	4	60	4	33	4	133	6	164	16	536	21	677	4	201	14	497	Fr, USA
IX08											5	102	4	61			1	23	USA
IX09	25	372	27	593	23	269	26	346	25	283	20	281	17	319	14	276	8	128	AA, Japan, USA
IX10	35	462	17	334	14	137	22	356	37	575	14	180	24	348	26	356	14	199	AA, Fr, Japan, USA
IX11			4	38							7	174	0	174					Fr, AA
IX12	21	583	13	666	15	668	15	693	12	547	12	610	12	557	13	602	13	597	AA, USA

Table 9 (Continued). WOCE Upper Ocean Thermal Programme; XBT deployments

	1990		1991		1992		1993		1994		1995		1996		1997		1998		Country
	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	sects	obs	
IX15	1	15			1	54	4	67	5	113	5	113	2	18					AA, USA
IX18							2	34							1	22	3	68	USA
IX19	1	16					1	22											Fr, RUS
IX21	11	87	1	16			8	64	13	119	18	217	27	314	13	201	11	180	Fr, USA
IX22	7	164	8	115	8	166	17	269	7	182	8	163	8	170	9	384	5	222	AA, Japan, USA
IX23					1	62													AA
IX25											3	64	3	49					USA
IX26	1	11					2	25			4	328	1	298					AA, USA
IX28	1	6									3	46	1	17			9	475	AA, USA
IX29							1	20											AA
Totals		*3181*		*2646*		*2633*		*3668*		*3576*		*4112*		*4373*		*3508*		*3212*	
Pacific Ocean Low Density																			
PX01	5	93	0	205	14	633	17	650	14	626	12	641	8	416	2	160	5	309	USA
PX02	21	321	20	336	20	398	17	351	25	477	20	400	17	285	12	201	27	343	AA, Fr, USA
PX03	28	462	30	578	12	229	15	375	17	423	24	679	24	611	21	488	11	365	AA, Fr, USA
PX04	6	71	9	122	6	199	6	187	6	209	8	196	10	314	10	253	12	313	Fr, Japan
PX05	57	1691	49	1777	35	1090	38	1211	16	443	15	743	17	596	13	382	10	292	AA, Fr, Japan, RUS, USA
PX06							0	80	6	74	10	112	10	93	18	177	20	202	Fr, USA
PX08	28	445	26	1050	23	1070	16	897	13	716	18	1027	19	899	24	1345	21	1287	USA
PX09	26	413	19	413	19	324	19	322	12	208	8	185	18	433	6	174	18	109	AA, Fr, USA
PX10	32	455	18	316	38	577	35	504	42	650	38	612	29	812	14	403	11	435	Fr, ROC, USA
PX11	6	140	18	600	9	212	14	273	6	130	8	179	8	172	6	192	5	222	AA, Japan
PX12	32	390	32	334	25	418	28	401	27	538	32	709	34	639	18	391	16	657	AA, Fr, USA
PX13	27	421	16	645	20	539	17	417	12	391	14	502	18	740	18	726	16	500	Fr, USA
PX14			1	25	8	401	9	251	12	572	21	1231	14	793	2	159			USA
PX15	1	37	2	54			10	339	6	175	4	187	0	20			1	35	Fr, Japan, RUS, USA
PX16	7	285									1	63							Japan, USA
PX17	18	438	16	546	13	466	10	380	19	633	19	655	20	696	10	328	5	184	Fr, USA
PX18	40	1030	25	1101	19	450	25	533	21	451	16	342	17	359	16	474	22	715	Fr, USA
PX20	106	2377	30	645	24	664	10	166	6	150	5	141	1	46			1	17	Japan, USA
PX21																	6	190	USA
PX22	6	89	6	386	1	46	8	66	8	66									Japan, USA
PX24	4	109			1	124	1	23					1	42					Japan, RUS, USA
PX25			5	141	9	244	4	76	2	79	1	51					2	389	USA
PX26	105	1818	99	2902	154	2941	113	2069	108	2120	82	1729	78	1981	62	1590	89	2016	Fr, Japan, RUS, USA
PX28	7	107	25	229	1	18							1	22			1	18	AA, USA
PX29					2	33	2	50	8	118									USA
PX30			7	75					2	25	1	7					10	48	Fr, USA
PX31	33	731	36	1217	31	879	14	354	26	384	8	146	1	70	7	248	28	1403	AA, Fr, USA
PX32															12	124	12	109	AA
PX34	3	30	20	209	35	269	57	421	4	36	23	191	13	97	6	63	5	290	AA, USA
PX35			8	271	4	199													AA, USA
PX36							1	23	1	29									USA
PX37	104	1747	25	354	58	649	51	448	39	325	27	300	20	311	7	106	10	238	AA, Fr, USA
PX38	12	127	6	173	9	93	2	17					0	16			6	144	USA
PX39	21	214	20	519	24	211	28	268	11	112	4	47	9	90	3	37	5	61	AA, Fr, USA
PX43	6	53	6	106	13	106	20	212	9	110									Fr, USA
PX44			21	173	42	358	46	347	36	300	24	206	4	51	4	57	8	139	AA, Fr, ROC, USA
PX45															5	139	2	66	Japan
PX46									8	228	4	230	4	132	2	75	1	52	Japan
PX47							14	63			3	70							USA
PX49							3	23	12	100	7	82	14	178	13	128	17	171	Japan, USA
PX50							4	132	5	160	17	858	9	614	6	378			USA
PX51					19	574	16	608	9	348	8	214	1	40	9	329	4	157	AA, Fr, Japan, USA
PX52					3	97	1	23	2	61	3	107							Fr
PX53					9	359	1	43	5	181	14	417	17	388	7	248	6	193	Fr, Japan
PX80															6	214	7	223	USA
Totals		*14094*		*15502*		*14870*		*12603*		*11648*		*13259*		*11956*		*9589*		*11892*	
Global Totals		***23450***		***25153***		***24035***		***23674***		***22446***		***24567***		***21783***		***19948***		***21867***	

8. Surface Salinity Measurements

The measurement of surface salinity was not explicitly identified in the Implementation Plan as an element of the WOCE field programme. However its importance as an indicator of climate change and specifically of precipitation changes has been increasingly recognised and research ships occupying WOCE sections were therefore encouraged to collect and report surface temperature and salinity data as part of their suite of underway measurements.

The plan for the management of WOCE data did not initially include a Data Assembly Centre (DAC) for surface salinity and instead it was suggested that data be sent to the WOCE Hydrographic Programme Office (WHPO). This plan proved unworkable with the WHPO focussing on the more pressing requirements of managing the subsurface one-time and repeat hydrographic data. As part of the WCRP's TOGA (Tropical Ocean Global Atmosphere) project and in co-operation with Integrated Global Observing Services System (IGOSS), France had implemented a network of Voluntary Observing Ships (VOS) that were making surface salinity and temperature measurements, initially with "bucket" samples and later with automated thermosalinographs. The data were being compiled and archived at the IFREMER centre in Brest, where it was agreed that WOCE data would also be acquired and managed. Control of the quality of underway surface salinity data is difficult without the analysis of regular bottle samples, so the data centre did not carry out data quality checks on the data other than time and location checks. Many (but not all) of the surface salinity data from WOCE cruises were checked and calibrated by the chief scientists but this cannot be guaranteed and therefore data quality for this stream is not uniform.

Table 10 shows the research ship cruises for which surface salinity data were collected and submitted to the DAC. Fore data collected on WHP cruises the section number, Principal Investigator (PI) and ExpoCode are given. Fort data collected either on passage or during cruises which were not WHP sections, the cruise identification (as recorded by the Surface Salinity DAC), is given in the ExpoCode column and no section number or PI is given. The locations of data in this category are shown in Fig. 20. The locations of additional data collected under the French VOS network during the WOCE period are shown in Fig. 21.

Key References

Lagerloef, G. and Delcroix, T. 1999: Sea Surface Salinity: A regional case study for the Tropical Pacific. Ch 2.4 pp 137 - 148, in Observing the Oceans in the 21st Century (Koblinsky & Smith eds.), ISBN 0642 70618 2, Bureau of Meteorology, Melbourne, Australia, 604pp.

Reverdin, G., Verbrugge, N., and Valdimarsson, H. 1999. Upper ocean variability between Iceland and Newfoundland, 1993-1998. Journal of Geophysical Research, 104(C12), 29599-29611.

Table 10. WOCE Surface Salinity Sampling

Section	PI	Country	Ship	ExpoCode	Dates			Obs
Atlantic Ocean								
A01	Pfannkuche	Germany	Meteor	06MT30_1	Sep 1994	to	Sep 1994	2828
A01	Meincke	Germany	Meteor	06MT30_3	Nov 1994	to	Dec 1994	3183
A01E	Meincke	Germany	Meteor	06MT18_1	Sep 1991	to	Sep 1991	1415
A06, A07	Colin, Morliere	France	Atalante	35A3CITHER1_1 (_2)	Jan 1993	to	Mar 1993	18269
A08	Mueller	Germany	Meteor	06MT28_1	Mar 1994	to	May 1994	5401
A09	Siedler	Germany	Meteor	06MT15_3	Feb 1991	to	Mar 1991	4385
A10	Mueller	Germany	Meteor	06MT22_5	Dec 1992	to	Jan 1993	5285
A11	Saunders	UK	Discovery	74DI199_1	Dec 1992	to	Jan 1993	926
A13, A14	Arhan, Mercier	France	Atalante	35A3CITHER3_1 (_2)	Jan 1995	to	Apr 1995	18267
A21, S04, SR02	Roether	Germany	Meteor	06MT11_5	Feb 1990	to	Mar 1990	4937
A23	Heywood, King	UK	James Clark Ross	74JC10_1	Mar 1995	to	May 1995	958
AR04EW, AR15	Schott	Germany	Meteor	06MT16_3	May 1991	to	Jun 1991	1507
AR04EW, AR15	Rhein	Germany	Meteor	06MT22_2	Oct 1992	to	Nov 1992	5438
AR04EW, AR15	Schott	Germany	Meteor	06MT27_3	Feb 1994	to	Mar 1994	4262
AR04EW, AR15, SR02	Schott	Germany	Meteor	06MT14_2	Oct 1990	to	Oct 1990	5065
AR06, AR16	Hagen	Germany	Humboldt	07AL991_1	Aug 1991	to	Oct 1991	4874
AR06, AR16	John	Germany	Heincke	06HF2092_1	Jan 1992	to	Jan 1992	585
AR06, AR16	Hagen	Germany	Humboldt	07AL692_1	Sep 1992	to	Oct 1992	4639
AR07E, AR12	Gould	UK	Charles Darwin	74AB62_1	Aug 1991	to	Sep 1991	755
AR12	Pollard	UK	Charles Darwin	74AB58_1	Apr 1991	to	May 1991	360
AR12	Leach	UK	Charles Darwin	74AB59_1	May 1991	to	Aug 1991	480
AR12	van Aken	Netherlands	Pelagia	64PE95N_1	Jul 1995	to	Aug 1995	1141
AR12	Leach, Pollard	UK	Discovery	74DI223	Sep 1996	to	Nov 1996	1135
AR13, AR07W	Lazier	Canada	Hudson	18HU94008_1	May 1994	to	Jun 1994	2626
AR15	Zenk	Germany	Meteor	06MT15_1	Dec 1990	to	Jan 1991	2613
AR15	Zenk	Germany	Meteor	06MT15_2	Jan 1991	to	Feb 1991	3644
AR15	Mercier	France	Atalante	35A3ROMANCHE_1	Aug 1991	to	Sep 1991	9259
AR15	Mercier	France	Atalante	35A3ROMANCHE_2	Nov 1992	to	Nov 1992	5174
AR15	Mueller	Germany	Meteor	06MT22_3	Nov 1992	to	Dec 1992	4102

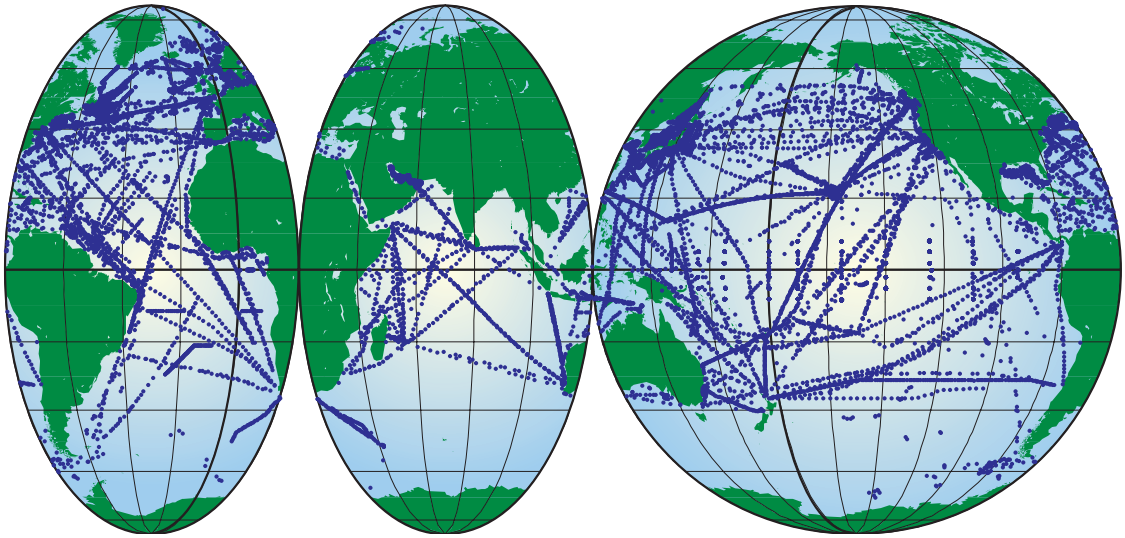

Figure 17. The WOCE Upper Ocean Thermal programme; XBT locations in April-June 1994.

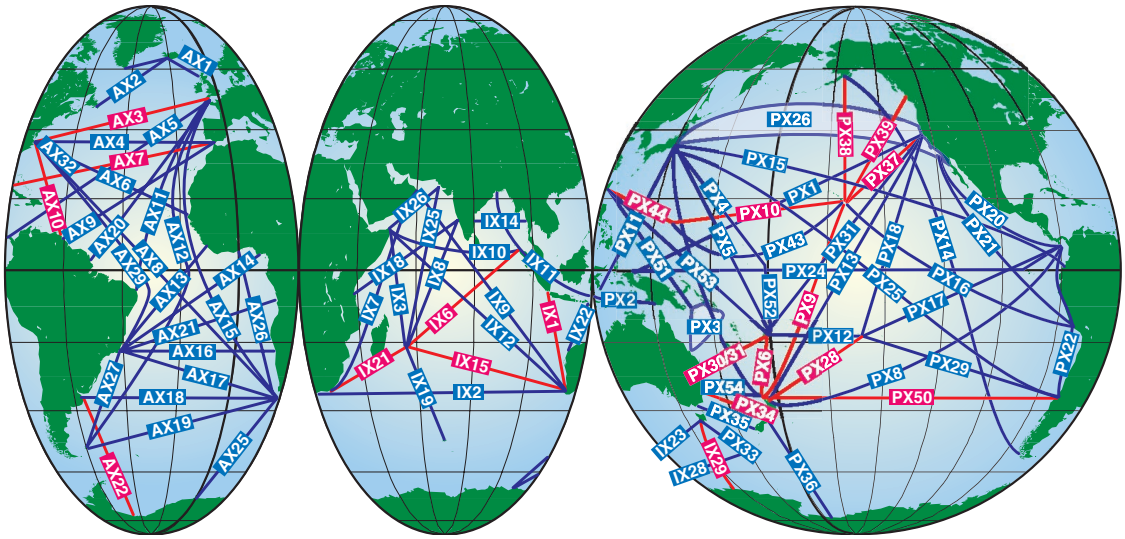

Figure 18. The WOCE Upper Ocean Thermal programme; line locations (blue - low density, red - high density).

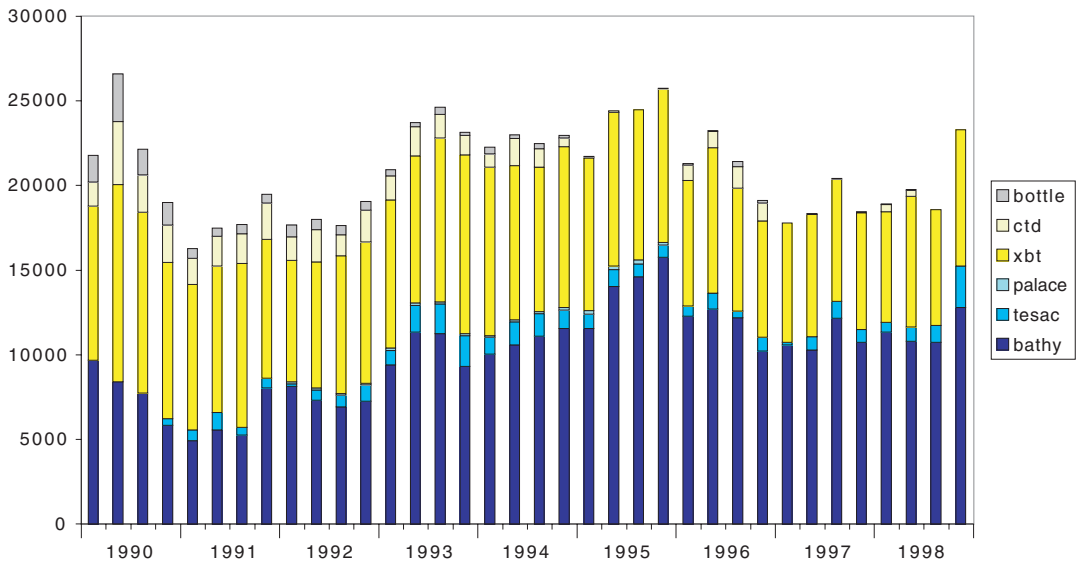

Figure 19. The global Upper Ocean Thermal data set (number of profiles types per quarter of the year).

Table 10 (Continued). WOCE Surface Salinity Sampling

Section	PI	Country	Ship	ExpoCode	Dates			Obs
AR15	Zenk	Germany	Meteor	06MT22_4	Dec 1992	to	Dec 1992	1752
AR15	Zenk	Germany	Meteor	06MT28_2	May 1994	to	Jun 1994	3974
AR16	John, Andres	Germany	Heincke	06HF991_1	Mar 1991	to	Apr 1991	330
AR18	Srokosz	UK	Charles Darwin	74AB62A	Sep 1991	to	Sep 1991	363
-	-	Germany	Meteor	M1040	Jul 1989	to	Aug 1989	5999
-	-	Germany	Polarstern	various	Sep 1989	to	Dec 1992	1637
-	-	Germany	Meteor	M1110	Oct 1989	to	Oct 1989	1529
-	-	Germany	Meteor	M1120	Oct 1989	to	Nov 1989	2659
-	-	Germany	Meteor	M1130	Nov 1989	to	Dec 1989	2464
-	-	Germany	Meteor	M1140	Dec 1989	to	Jan 1990	3448
-	-	Germany	Meteor	M1210	Mar 1990	to	Apr 1990	5065
-	-	Germany	Meteor	M1220	Apr 1990	to	May 1990	4684
-	-	Germany	Meteor	M1230	Jun 1990	to	Jun 1990	2197
-	-	Germany	Meteor	M1310	Jul 1990	to	Jul 1990	1624
-	-	Germany	Meteor	M1320	Aug 1990	to	Aug 1990	4293
-	-	Germany	Meteor	M1410	Sep 1990	to	Oct 1990	2941
-	-	Germany	Meteor	M1430	Oct 1990	to	Nov 1990	10815
-	-	Germany	Meteor	M1610	Apr 1991	to	Apr 1991	1234
-	-	Germany	Meteor	M1620	May 1991	to	May 1991	2307
-	-	Germany	Meteor	M1710	Jul 1991	to	Aug 1991	3593
-	-	Germany	Meteor	M1720	Aug 1991	to	Aug 1991	2744
-	-	Germany	Meteor	06MT19_1	Sep 1991	to	Oct 1991	1945
-	-	Germany	Heincke	EBC9110	Oct 1991	to	Oct 1991	236
-	-	Germany	Polarstern	SCHIPX1A	Nov 1991	to	Dec 1991	3324
-	-	Germany	Meteor	M2020	Jan 1992	to	Feb 1992	4329

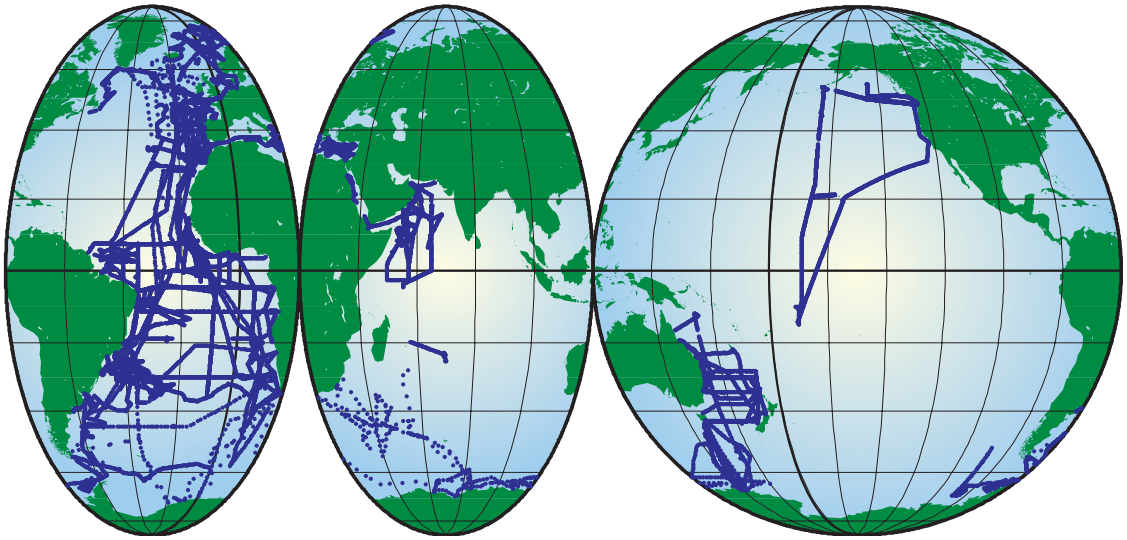

Figure 20. Surface Salinity data collected on WOCE cruises.

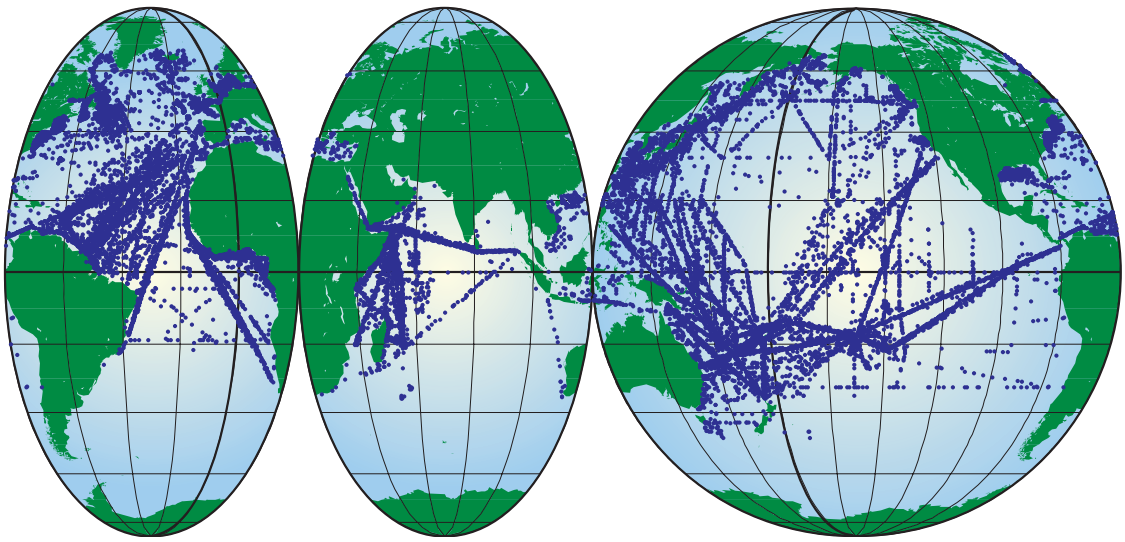

Figure 21. Surface Salinity data collected by Voluntary Observing Ships.

Table 10 (Continued). WOCE Surface Salinity Sampling

Section	PI	Country	Ship	ExpoCode	Dates			Obs
-	-	Germany	Meteor	M2030	Feb 1992	to	Mar 1992	1532
-	-	Germany	Meteor	M2110	Mar 1992	to	Apr 1992	1939
-	-	Germany	Meteor	M2120	Apr 1992	to	May 1992	1398
-	-	Germany	Meteor	M2130	May 1992	to	May 1992	3219
-	-	Germany	Meteor	M2140	Jun 1992	to	Jun 1992	2478
-	-	Germany	Meteor	M2150	Jul 1992	to	Jul 1992	3541
-	-	Germany	Meteor	M2160	Aug 1992	to	Aug 1992	2477
-	-	Germany	Meteor	M2210	Oct 1992	to	Oct 1992	4369
-	-	Germany	Meteor	NU22_LEG5	Dec 1992	to	Jan 2024	3537
-	-	Germany	Polarstern	SCHIPX8	Jan 1993	to	Feb 1993	3362
-	-	Germany	Meteor	M2310	Feb 1993	to	Mar 1993	6611
-	-	Germany	Meteor	M2320	Mar 1993	to	Mar 1993	1868
-	-	Germany	Meteor	M2330	Mar 1993	to	Apr 1993	4778
-	-	Germany	Meteor	M2400	Apr 1993	to	May 1993	4848
-	-	Germany	Meteor	M2510	May 1993	to	Jun 1993	2753
-	-	Germany	Meteor	M2520	Jun 1993	to	Jun 1993	1594
-	-	Germany	Meteor	M2530	Jul 1993	to	Jul 1993	1307
-	-	Germany	Meteor	M2540	Jul 1993	to	Aug 1993	3726
-	-	Germany	Meteor	M2610	Aug 1993	to	Sep 1993	1125
-	-	Germany	Polarstern	SHIPXI1	Oct 1993	to	Nov 1993	5231
-	-	Germany	Meteor	M2630	Nov 1993	to	Nov 1993	5465
-	-	Germany	Meteor	M2710	Dec 1993	to	Jan 1994	2180
-	-	Germany	Meteor	M2720	Jan 1994	to	Feb 1994	3182
-	-	Germany	Polarstern	SHIPXI5	May 1994	to	Jun 1994	3267
-	-	Germany	Meteor	M2910	Jul 1994	to	Jul 1994	2940
-	-	Germany	Meteor	M2920	Jul 1994	to	Aug 1994	4052
-	-	Germany	Meteor	M2930	Aug 1994	to	Sep 1994	4874
-	-	Germany	Meteor	M3110	Jan 1995	to	Feb 1995	6379
Indian Ocean								
IR01W, IR03, ISS02	Schott	Germany	Meteor	06MT32_1	Apr 1995	to	Apr 1995	2387
IR03, ISS02	Quadfasel	Germany	Meteor	06MT32_4	Jun 1995	to	Jul 1995	4804
IR03N, ISS02	Schott	Germany	Meteor	06MT32_6	Aug 1995	to	Sep 1995	5797
ISS01	Dickson	UK	Discovery	74DI200_1	Feb 1993	to	Mar 1993	929
ISS01	Dickson	UK	Discovery	74DI207	Feb 1994	to	Mar 1994	886
-	-	UK	Discovery	DI209	Aug 1994	to	Aug 1994	90
-	-	Germany	Meteor	M3120	Feb 1995	to	Mar 1995	2371
-	-	Germany	Meteor	M3130	Mar 1995	to	Mar 1995	2011
-	-	Germany	Meteor	M3220	May 1995	to	May 1995	592
-	-	Germany	Meteor	M3230	May 1995	to	Jun 1995	3542
-	-	Germany	Meteor	M3250	Jul 1995	to	Aug 1995	4597
-	-	Germany	Meteor	M3310	Oct 1995	to	Oct 1995	2127
-	-	Germany	Meteor	M3320	Nov 1995	to	Nov 1995	2069
Pacific Ocean								
P15N, PR06, PRS1	Garrett, Freeland	Canada	John P. Tully	18DD9403_1 (_2)	Sep 1994	to	Dec 1994	26706
PR05, PR06	Perkin	Canada	Endeavour	18DD9202_1	Mar 1992	to	Apr 1992	63
PR05, PR06, PRS01	Whitney	Canada	John P. Tully	18DD9204_1	Sep 1992	to	Sep 1992	9215
PR05, PR06, PRS01	Whitney	Canada	John P. Tully	18DD9402_1	May 1994	to	May 1994	5040
PR06	Bellegay	Canada	Endeavour	18DD9105_1	Oct 1991	to	Oct 1991	34
PR06	Perkin	Canada	John P. Tully	18DD9303_1	Mar 1993	to	Mar 1993	9303
PR11	Church	Australia	Franklin	09FA0792	Sep 1992	to	Oct 1992	2994
PR11, PR13	Church, Tomczak	Australia	Franklin	09FA1089_1 (_2)	Aug 1989	to	Sep 1989	7281
PR11, PR13	Church	Australia	Franklin	09FA290_1 (_2)	Feb 1990	to	Apr 1990	6758
PR11, PR13	Church	Australia	Franklin	09FA1091_1 (_2)	Nov 1991	to	Dec 1991	5724
PR11, PR13	Church	Australia	Franklin	09FA0793	Sep 1993	to	Oct 1993	4017
PR11, PR13	Church	Australia	Franklin	09FA0394	Mar 1994	to	Apr 1994	4185
PR11S	Church	Australia	Franklin	09FA693	Jun 1993	to	Jul 1993	3571
Southern Ocean								
ISS01	Pollard	UK	Discovery	74DI201_1	Mar 1993	to	Apr 1994	809
ISS01	Pollard, Read	UK	Discovery	74DI213_1	Jan 1995	to	Feb 1995	1010
P11A	Rintoul	Australia	Aurora Australis	09AR9391_2	Apr 1993	to	May 1993	1980
S03, S04	Rintoul	Australia	Aurora Australis	09AR9404_1	Dec 1994	to	Feb 1995	2670
SR03	Rintoul	Australia	Aurora Australis	09AR9309_1	Mar 1993	to	Apr 1993	1599
SR03	Rintoul	Australia	Aurora Australis	09AR9601_1	Aug 1996	to	Sep 1996	1055
SR03, I08	Tilbrook	Australia	Aurora Australis	09AR9407_1	Jan 1994	to	Mar 1994	3945
-	-	France	Austrolabe	ASTRO-R1	Dec 1993	to	Dec 1993	1431
-	-	France	Austrolabe	ASTRO-R2	Dec 1993	to	Jan 1994	1461
-	-	France	Austrolabe	ASTRO-R3	Jan 1994	to	Feb 1994	1508
-	-	France	Austrolabe	ASTRO-R4	Feb 1994	to	Feb 1994	1409
-	-	France	Austrolabe	ASTRO-R5	Feb 1994	to	Mar 1994	1372
-	-	France	Austrolabe	ASTRO-R6	Nov 1994	to	Nov 1994	1862
-	-	France	Austrolabe	ASTRO-R7	Dec 1994	to	Jan 1995	1558
-	-	France	Austrolabe	ASTRO-R8	Jan 1995	to	Feb 1995	1790
-	-	France	Austrolabe	ASTRO-R9	Feb 1995	to	Mar 1995	1678

WOCE International Project Office, 2003. "WOCE Observations 1990 - 1998; a summary of the WOCE global data resource". WOCE International Project Office, WOCE Report No. 179/02, Southampton, UK.