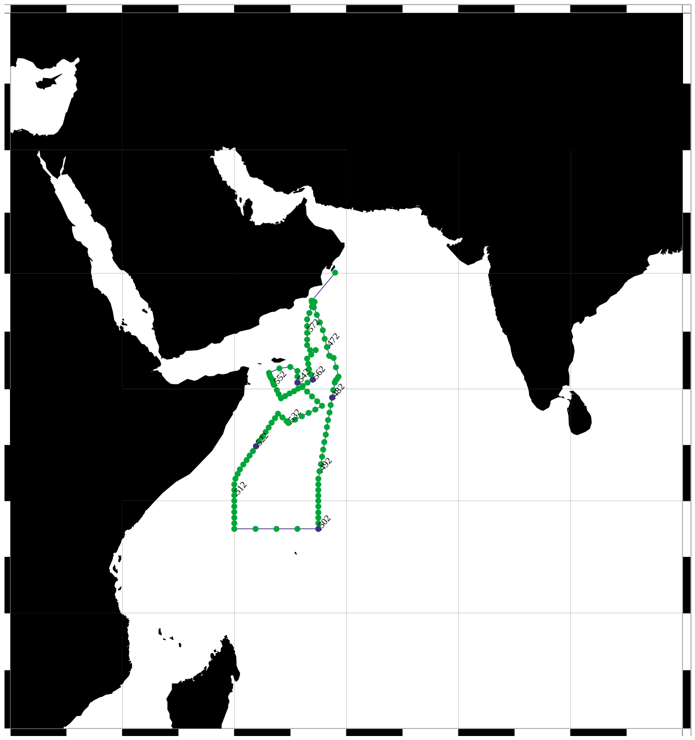
A. Cruise Narrative: ISS02, IR01W, IR03N (western Arabian Sea)



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**ISS02, IR01W, IR03N**
Expedition designation (EXPOCODE)	**06MT32_6**
Chief Scientist/affiliation	**Friedrich Schott**
Dates	1995 AUG 17 – 1995 SEP 19
Ship	*R/V Meteor*
Ports of call	Muscat, Oman to Muscat, Oman
Number of stations	CTD: 116 XBT: 114
Geographic boundaries of the stations	23°N 49°E 61°E 3°S
Floats and drifters deployed	0
Moorings deployed or recovered	0
Contributing Authors	Prof. Friedrich Schott
	Monika Rhein
	Olaf Plähn

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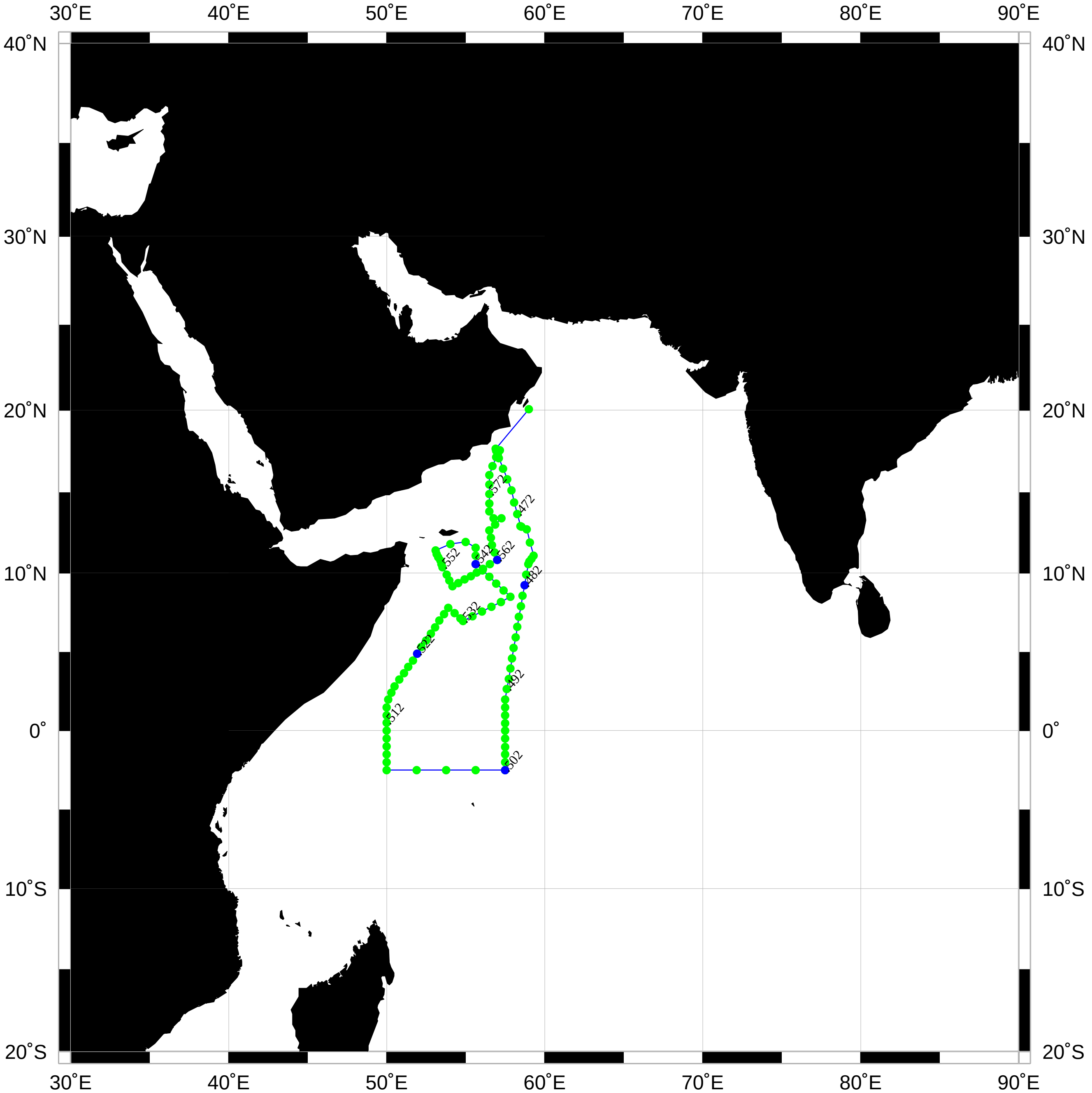
Station locations for ISS02; Sept. 1995 (Schott)



Produced from .sum file by WHPO-SIO

B. Scientific program

The cruise was designated to derive hydrographic data in the Arabian Sea during the summer monsoon as part of the WOCE Indian Ocean program.

Participants

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Chlorofluorocarbons

(Monika Rhein and Olaf Plähn

Sample collection and technique

All samples were collected from 10 L Niskin bottles. The bottles had been cleaned prior to the cruise using isopropanol. All 'O' rings, valves, and taps were removed, washed in isopropanol and baked in a vacuum oven for 24 hours. The rubber bands on all bottles were replaced by stainless steel springs. The personnel for all water sampling and handling procedures at the bottles wore one-way gloves to protect the valves from grease.

About 100 mL of water were taken from the water bottles with a gastight glass syringe (Becton and Dickinson). Then 15-25 mL of the samples were transfered to a purge and trap unit and analyzed on board following the procedures described in Bullister and Weiss [1988]. The CFCs were separated on a packed stainless steel column filled with Porasil C and detected with an Electron Capture Detector (ECD). The carrier gas was ECD pure Nitrogen, which was additionally cleaned by molsieves (13X mesh 80/100). The calibration was done using a standard gas with near air concentrations to convert the ECD signal in concentrations. The CFC values are reported in pmol kg^{-1} on the SIO93 scale (R. Weiss, SIO).

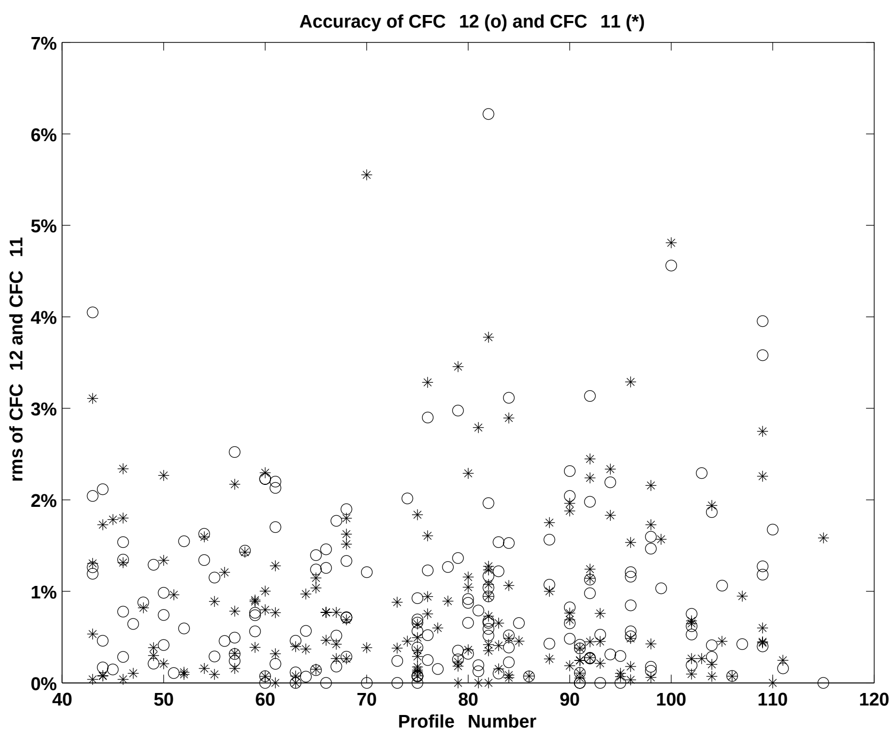

Figure 1: Accuracy of CFC-11 (*) and CFC-12 (o); replicate samples plotted vs profile number.

Performance

During the cruise M32/6 the Kiel CFC system worked continuously. Both freon components CFC-11 and CFC-12 had been sampled on 70 CTD Stations and 960 water were analyzed successful. The accuracy was checked by measuring about 190 water samples twice or more (Figure 1). It was found to be for CFC-12 1.1% or 0.0055 pmol kg^{-1} and 1.2% or 0.006 pmol kg^{-1} for CFC-11.

The mean blank of the sample transfer and the measurement procedure was determined by degasing 1 - 2 mL of CFC free deep water. During the cruise it was in the order of 0.003 pmol kg^{-1} for CFC-12 and 0.006 pmol kg^{-1} for CFC-11. Furthermore, CFC free water was created by degasing 5 L of seawater with ECD-pure nitrogen gas, to determine blanks of the measurement system and the syringes. Analysis of 25 mL of blankwater resulted in concentrations of 0.006 pmol kg^{-1} for both components.

The effciency of the ECD was stable in time for both components (Figure 2). The temporal variations were only 15%. While CFC-12 showed a decrease of the effciency during the cruise to about 85%, the CFC-11 component did not show a signficant trend, but varied between 95% to 115%. To correct the temporal drift of the ECD, a calibra- tion curve with seven different gas volumes was taken before and after each station. The temporal change between two calibration curves was assumed to be linear in time. CFC concentrations were calculated by using the two neighboured points, supposing that the calibration curve is linear between these points.

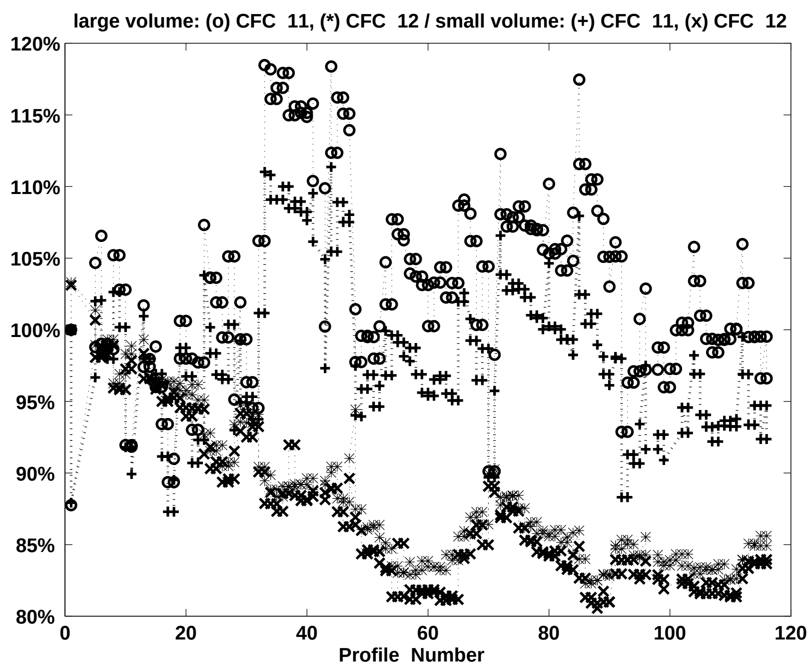

Figure 2: Temporal evolution of the ECD-effciency during the cruise for the 0.5 mL volume (small) and the 2 mL volume (large).

Contamination

During the cruise CFC-11 and CFC-12 could not be analyzed for the first 42 stations (No. 463-504), because of a combination of leakage in the ship's air-conditioning system and a small leakage between the stripper and a valve in the freon purge and trap unit. On some stations, the CFC-12 peak was disturbed by the high N_2O levels of the samples, these data were removed. Comments The CFC concentrations decreased exponentially from the surface to about 1000 m depth (Figure 3). At larger depths, CFC concentrations were below detection limit. At the surface the mean saturation was 103% for CFC-11 and 97% for CFC-12 (Figure 4) [Rhein et al., 1997]. As observed during the cruise Meteor 32/4 in June/July 1995, the CFC-11 saturation was about 5-6% higher than the values of CFC-12. At 400 m depth this difference could not be observed, the saturation of both components were equal (15.9%). Low surface-saturation were observed at the northern edge of the 'Southern Gyre' (Stat. 521) and at the northern edge of the 'Great Whirl' (Stat.545). Due to the decreasing wind at the end of the cruise, the upwelling at the coast of Oman stopped and the freon concentration were nearly in equilibrium to the atmosphere [Plähn, 1999].

The maximum of the mean CFC-11/CFC-12 ratio (Figure 5) is at about 150 m depth (σ_θ~ 26) ~ 1.95, downward this ratio decreases (<1.8 at 800 m, σ_θ = 27). The accuracy of the ratio is less than 0.1 if the CFC-11 concentration it larger than 0.15 pmol kg^{-1}. The concentrations at 700 m depth are less than 10% of the surface-values, within this depth-range the error of the ratio increases rapidly.

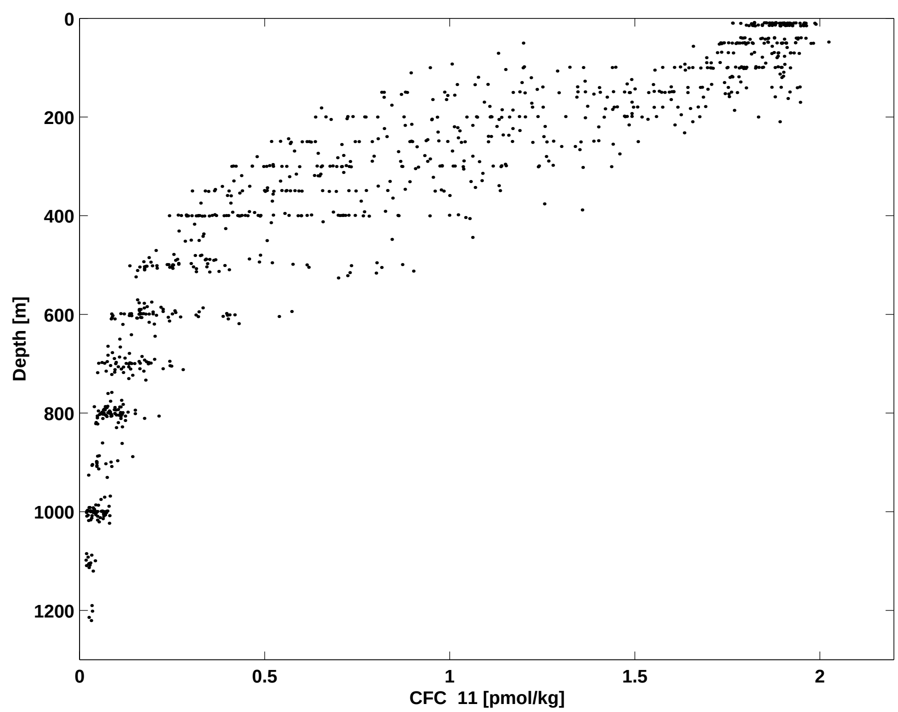

Figure 3: All CFC-11 concentrations measured during the cruise M32/6 versus depth.

References

Bullister, J.L. and R.F. Weiss (1988). Determination of CCl3 F and CCl2 F2 in seawater and air. Deep-Sea Res., 35, S. 839{853.

Plähn, O. (1999). Ventilation und Zirkulation in der Arabischen See: Ergebnisse aus Beobachtungen und Modellanalysen. Dissertation, Universit• at Kiel.

Rhein, M., O. Plähn, andL. Stramma (1997). Tracer distribution in the Arabian Sea, 1995. WOCE Newsletter, 27, S. 12{14.

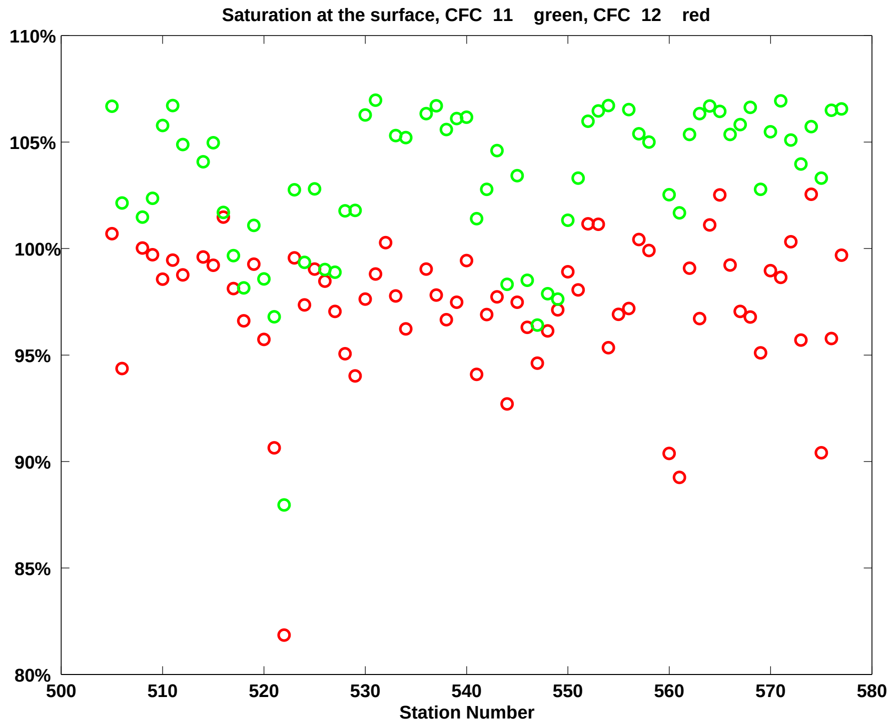

Figure 4: CFC-11 (green) and CFC-12 (red) saturation at the surface

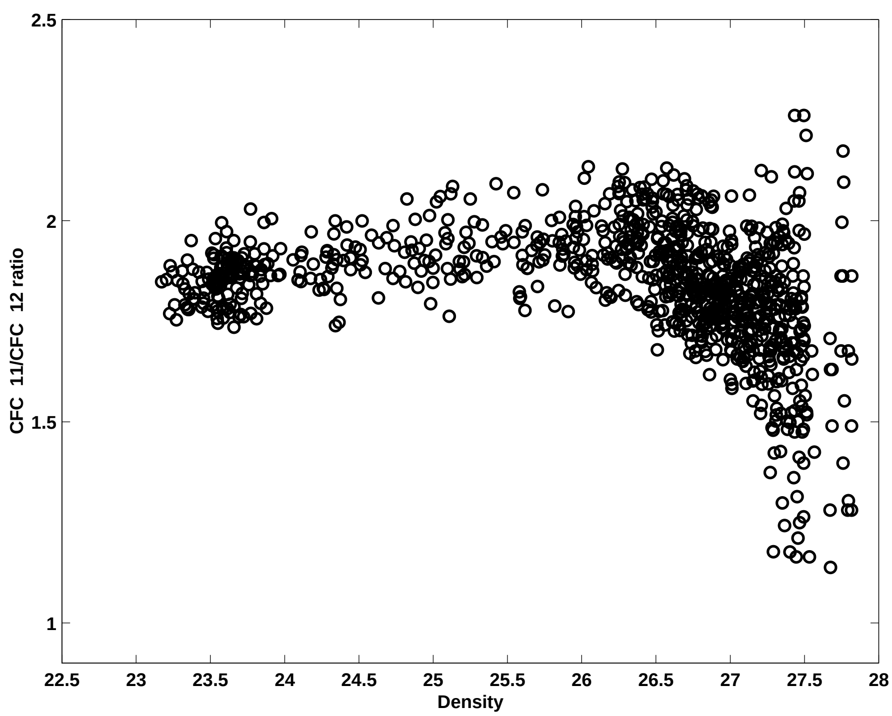

Figure 5: CFC-11/CFC-12 ratio versus density

Appendix

- Leg 6 is part of the 1995 Kiel CFC data set including the M32 legs 1 and 4 in the Arabian Sea.

- The station file 'meteor326.sum' includes:
  1 station number
  2 year
  3 month
  4 day
  5 hour: minutes in decimal system
  6 latitude: minutes in decimals
  7 longitude: minutes in decimals
  8 water depth (m)
  9 depth of CTD profile (m)

- The bottle file 'meteor326.sea' includes:
  1 station number
  2 bottle number
  3 depth (dbar)
  4 in-situ temperature (-C)
  5 salinity (psu)
  6 CFC-12 (pmol kg^{-1})
  7 CFC-11 (pmol kg^{-1})
  8 WOCE quality ag for CFC-12 and CFC-11

Technical information

Gas	chromatograph Shimadzu GC 14
GC column	stainless steel, packed with Porasil C
Cooling trap	with Porapak T and Porasil C
Trap temperatures	-30-CC, 100-C
Column temperature	70-CC, isothermal
ECD temperature	300-C
Electron capture detector	Shimadzu
Software for chromatogram analysis	Shimadzu CLASS C-R4A
Standard gas	ALM 83959, R. Weiss, SIO
Accuracy	CFC-11: 1.2% , CFC-12: 1.1%
Blanks	CFC-11: 0.006 pmol kg^{-1}, CFC-12: 0.003 pmol kg^{-1}

WHPO Data Processing Notes

Date	Contact	Data Type	Data Status Summary
05/08/00	Rhein	CFCs	Data are Public
	the CFC data 06MT32_1 06MT32_6 can be made public and included in the CD_ROM		
03/20/03	Stramma	CTD/BTL	Website Updated;Data are public
	I saw that there are three references with CTD and bottle data listed as non-public. These are: IR01W 06MT32_1 IR03N 06MT32_1 IR03N 06MT32_6 We like to ask you to make these data public.		
03/27/03	Bartolacci	CTD/BTL	Website Updated; Data are public
	I have unencrypted both bottle and CTD files for this cruise. The bottle file contains incorrect number of quality bytes for the number of asterisked columns in the file. Dr.s Schott and Strama have been emailed for course of action with this file. The file is linked, however the data history should reflect the incorrect QUALT1 word. No further action was taken at this time. CTD files have been edited so all casts for all station files are 1 instead of the previous increasing cast numbering. No stations contained more than one cast as per sumfile. Exchange, netCDF and inventory files were generated for CTD files and linked online. All files are public.		
04/02/03	Bartolacci	BTL	Website Updated; BTL file edited/replaced
	A new updated bottle file was received from Dr.Stramma to replace previous bottle file (which contained too many asterisked columns for number of quality bytes). New file had columns realigned, name/date stamp added. Format checked new file with no errors after editing. Created exchange netCDF and inventory files. Updated web pages and responded to Dr. Sramma's submission email. All data for this cruise are now public.		
07/02/03	Kappa	DOC	PDF and Text versions of cruise report assembled
	Both PDF and Text docs contain: Cruise summary information CFC Report These WHPO Data Processing Notes PDF report also contains: Figures for CFC report Cruise Track Links to Figures from text references		