preliminary data report
may 5, 1995
A.   Cruise Narrative

A.1. Highlights

A.1.a WOCE Designation ISS1

A.1.b EXPOCODE   35MF68SUZIL

A.1.c Chief Scientist   Young-Hyang Park

A.1.d   Ship   M/V Marion Dufresne

A.1.e   Port of Call   Le Port, La Reunion

A.1.f   Cruise Date   April 12 to May 20, 1991

A.2   Cruise Summary

A.2.a Geographic boundaries

The cruise track followed four near-meridional sections cutting across the
ACC core and a zonal section along 38 S, within the area bounded by 37 – 51 S
and 50 – 80 E.

A.2.b Total number of stations

During the cruise, a total of 73 CTD/rosette stations were occupied using a
12 bottle rosette equipped with 12 l Niskin water sampling bottles.

A.2.c Floats and drifters deployed

A.2.d Moorings deployed or recovered

A.3   List of Principal Investigators

Name   Responsibility   Affiliation

Y. H. Park   CTD, S, 02   Museum National d'Histoire
                                                 Naturelle (MNHN)
                                                 Paris, France
----

A.4   Scientific Programme and Methods

The cruise was carried out in the Crozet Basin area which has recently
been included within the WOCE special study area in the Southwest Indian Ocean
(ISS1).

Our primary goal was to give a detailed description of the frontal structure
and transport associated with the Antarctic Circumpolar Current in the area
where the bottom topography of the Crozet and Kerguelen Plateaux together with
the eastward extension of the Agulhas Return Current exert a particularly
crucial influence on the regional circulation.

A secondary, but still very important, goal was to improve knowledge of
the water characteristics and circulation at all depths related to the water
mass exchanges between the Southern Ocean and the Indian Ocean. Specifically,
this includes the formation and modification of the thermocline water masses
north of the ACC, the injection of modified waters into the subtropical

anticyclonic gyre in the South Indian, and the circulation of deep and bottom waters within the Crozet Basin.

Water sampling during the cruise included measurements of temperature, salinity, and oxygen by CTD, and water bottle samples for analysis of salinity and oxygen to calibrate the CTD sensors.

The ship departed Le Port, La Reunion on April 12, 1991, and made on April 13 a test station near 26 09'S, 55 20'E to test the CTD and its rosette water sampling equipment. The first station (Sta. 1) was occupied on April 15 at 37 S, 55 E, and the last station (Sta. 73) on May 17 at 38 S, 58 30'E. The CTD used is Neil Brown Mark III B No 01-1116 equipped with a dissolved oxygen sensor. The CTD temperature and pressure sensors were calibrated at the IFREMER calibration facility both before and after the cruise. The conductivity and oxygen sensors were calibrated using data from the on-board analyses of the salinity and oxygen samples which were collected at each station from PVC Niskin bottles mounted on a General Oceanic rosette sampler.

Detailed analysis and interpretation of the cruise data set have been given in Park et al. (1992). Selected plots showing property vs property relationships within the cruise area and the property sections at 53 E.

A.5   Major Problems and Goals not Achieved

During the early stage of the cruise a problem developed with the General Oceanics rosette tripping mechanism which resulted in mis-firings and double-tripping of the water sampling bottles. This problem was resolved simply by replacing the problematic rosette sampler by a spare one.

A.6   Other Incidents of Note
A.7   List of Cruise Participants

Name	Responsibility	Institution
Young-Hyang Park	Chief Scientist	MNHN, Paris
Lucien Gamberoni	Salts/Oxygens	MNHN, Paris
Edwige Charriaud	CTD Software	MNHN, Paris
Annie Kartavtseff	CTD Hard & Softwares	LODYC, Paris
Catherine Rouault	CTD Soft ware	LODYC, Paris
Mathilde Nithart	Watch Stander	Univ. Luminy, Marseille
Henri Orengo	Watch Stander	Univ. Luminy, Marseille
Frederic Rigaud	Watch Stander	Lab. Arago, Banyuls s/mer
Jean-Louis Turon	Watch Stander	Univ. Bordeaux
Jean-Jacques Pichon	Watch Stander	Univ. Bordeaux
Fabienne Maret	Watch Stander	Univ. Bordeaux

C.Measurement Techniques and Calibrations

C.1 CTD Calibration (L. Gamberoni and E. Charriaud)

Temperature

The calibrations at the IFREMER calibration facility before and after the cruise showed a temperature change (in a interval of 15 months) of 0.003 C at 0 C and 0.001 C at 25 C. Post-cruise temperature calibration consisted of a fifth order polynomial curve fit to seven temperature points sampled between -2 and 25 C. The polynomial fitting shows a 0.0002 C standard deviation, while the accuracy of the thermometer standard as claimed by the IFREMER calibration facility is 0.002 C. Corrections determined from this polynomial fitting were applied to the CTD data.

Pressure

Pre- and post-cruise calibrations showed a pressure drift of 10 dbar. During
the post-cruise calibration, data were sampled at 400 db intervals with both
increasing and decreasing pressure between 0 and 6000 dbar. Corrections were
determined from a fifth order polynomial curve fit to sixteen pressure points.
The standard deviation from the polynomial fitting is 0.25 dbar for the
downcast calibration and 0.14 dbar for the upcast calibration, while the
accuracy of the pressure tester as claimed by the IFREMER calibration facility
is ± 1.2 dbar at 6000 dbar. The corrections determined from this polynomial
fitting were applied to the CTD data from the cruise, with the pressure bias
term being set equal to the pre-lowering deck unit pressure reading made
during each CTD cast.

Conductivity

The conductivity sensor was calibrated with shipboard salinity measurements
on the maximum 12 water samples collected at each station. The conversion of
water sample salinities into the corresponding conductivities was made using
the algorithms of Fofonoff and Millard (1983), with
$C(35, 15, 0) = 42.914$ mS/cm.

The raw conductivities from the CTD were first corrected for temperature and
pressure effects on the conductivity sensor, using the following algorithm
proposed by the CTD constructor:
$$Cc = Cr [1- a (T-15) + b P]$$
where Cc and Cr are the corrected and raw conductivities, a is the temperature
correction coefficient (7×10^{-6} C^{-1}), b is the pressure correction
coefficient (1.48×10^{-8} $dbar^{-1}$),and T and P are the calibrated temperature and
pressure.

The calibration consisted in least-square regression fit of the CTD
conductivities to their respective water sample data. The data were subdivided
into two homogeneous groups (Stas. 1-12 and Stas. 13-73) in which the
differences between water sample and CTD conductivities appeared to have
homogeneous calibration characteristics. An iterative regression procedure was
used, discarding successively the outlying observations in excess of 2.8 times
the standard deviation of the conductivity differences in the station group
under consideration.The following regression equations were determined from
the retained data points (about 90 % of the initial data points for each
homogeneous group), which were used to correct the CTD conductivities:

Stas.	Retained Data Points	Regression Eq.	St. Dev. (mS/cm)
1-12	72 (91.1 %)	C = 0.00494042 + 1.000110 Cc	0.0032
13-73	552 (90.0 %)	C = 0.01278070 + 0.999841 Cc	0.0026

Finally, the calibrated CTD conductivities were converted into the
corresponding salinities using the algorithms of Fofonoff and Millard (1983).

Oxygen

The calibration of the CTD oxygen sensor was made against in situ water sample
oxygen data. The calibration algorithm used here is that of Millard (1982):

$$OX = Soc*Oc*OXSAT(T, S)*exp\{tcor [T + wt (T0 - T)] + pcor*P\}$$

where OX is the CTD oxygen in ml/l, Oc is the CTD oxygen current, Soc is the
oxygen current slope, OXSAT is the oxygen saturation value after Benson and
Krause (1984), T, S, and P are the calibrated CTD temperature, salinity, and
pressure, tcor and pcor represent the temperature and pressure corrections,
T0 is the CTD oxygen prove internal temperature, and wt is the weighting

fraction of oxygen prove internal temperature.

The parameters Soc, tcor, wt, and pcor were determined from water sample oxygen values
by performing a linear least-square regression. The calibration procedure was analogue to that used
for the conductivity; stations were subdivided into four homogeneous groups (Stas. 1-12, Stas. 13-43,
Stas. 44-58, and Stas. 59-73), and the outlying observations in excess of 2.0 times the standard
deviation of the oxygen differences in the station group under consideration were discarded
successively from the iterative least-square fits. The resulting parameter values and the standard
deviation of oxygen differences for each group are shown below.

Stas.	Retained Data Points	Soc	tcor	wt	pcor	St. Dev. (ml/l)
1-12	55 (83.3 %)	2.6354	− 0.0354	0.818	0.000150	0.046
13-43	202 (70.4 %)	2.6632	− 0.0351	0.680	0.000151	0.038
44-58	101 (78.3 %)	2.6663	− 0.0363	0.844	0.000144	0.046
59-73	78 (63.4 %)	2.6421	− 0.0336	0.817	0.000150	0.034

The conversion of oxygen content in ml/l into that in micromol/kg (as reported in Data Files) was made using the following equation from Culberson (1991):

$$O2\ (micromol/kg) = 44.660 \times O2(ml/l) / rsw$$

where rsw is the density of seawater at the temperature at which the oxygen sample was pickled.

C.2.2 Salinity and Oxygen Measurements during the MD 68-SUZIL Cruise

by: L. Gamberoni

Salinity

The water sample salinities were measured with a Guildline Portasal Model 8410 salinometer that was standardized daily with IAPSO Standard Sea Water Batch P-110. The salinity measurements during this cruise were made within a temperature controlled (1 C) portable laboratory, generally maintained about 1-2 C below that of the salinometer water bath.

Oxygen

The dissolved oxygen samples measured during this cruise were analyzed with the Winkler titration method described by Carritt and Carpenter (1966), with two exceptions. The thiosulfate normality was reduced from 0.14 to 0.01, and the microburette was replaced by a 20 ml Metrohm Dosimat digital piston buret. Potassium hydrogen iodate standard solutions (KH(IO3)2) were previously prepared in the laboratory.

D.   Acknowledgments
E.   References

Benson, B., and D. Krause Jr. (1984) The concentration and isotopic fractionation of oxygen
dissolved in fresh and seawater in equilibrium with the atmosphere.

Limnol. Oceanogr., 29,   (3), 620-632.

Carritt, D. E., and J. H. Carpenter. (1966) Comparison and evaluation of currently employed
modifications of the Winkler method for determining dissolved oxygen in seawater;
a NASCD report. J. Mar. Res., 24, 286-318.

Culberson, C. H. (1991) Dissolved oxygen. WHP Operations and Methods, WHPO 91-1,
WHP Office, WHOI, Woods Hole.

Fofonoff, N. P., and R. C., Millard. (1983) Algorithms for computation of fundamental properties
of seawater. Unesco technical papers in marine science No. 44, 53 pp.

Millard, R. C. (1982) CTD calibration and data processing techniques at WHOI using the 1978
practical salinity scale.
Proc. Int. STD Conference and Workshop, La Jolla, Mar. Tech.   Soc., 19 pp.

Park, Y. H., L. Gamberoni, and E. Charriaud. Frontal structure, water masses and circulation in
the Crozet Basin. J. Geophys. Res. (accepted).

Unesco, 1983. International Oceanographic tables. Unesco Technical Papers in Marine Science, No. 44.

Unesco, 1991. Processing of Oceanographic Station Data, 1991. By JPOTS editorial panel.

F.   WHPO Summary

Several data files are associated with this report. They are the mf68.sum, mf68.hyd, mf68.csl and *.wct files. The mf68.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The mf68.hyd file contains the bottle data. The *.wct files are the ctd data for each station. The *.wct files are zipped into one file called mf68wct.zip. The mf68.csl file is a listing
of ctd and calculated values at standard levels.

The *.csl files are not aviliable at this time due to the CTD data files being given in non-uniform levels.

G.   Data Quality Evalutation