WORLD OCEAN CIRCULATION EXPERIMENT

DATA REPORT

WOCE AR7E

R/V TYRO Cruise 90/3
Leg from Galway, Ireland to Reykjavik, Iceland
WHP Office Report WHPO 93-X WOCE Report No. X/93

Research was carried out by Scientists and technicians from the Netherlands Institute for Sea Research (NIOZ) assisted by students from Utrecht and Wageningen.

1. OBJECTIVE

1.1. To contribute to the WOCE Hydrographic Program by carrying out surveys along the Atlantic repeat section AR7E.

1.2. To study the deep transport of overflow water from the Faroese regions through the Iceland Basin.

1.3. To study the circulation and heat budget of the Atlantic Current in the Northeastern Atlantic Basin.

2. CRUISE

2.1. Highlights

2.1.a. Expedition — Dutch-WARP 1990
R/V TYRO cruise 90/3
EXPOCODE - 64TR90/3

2.1.b. Chief Scientist — Dr. Hendrik M. van Aken
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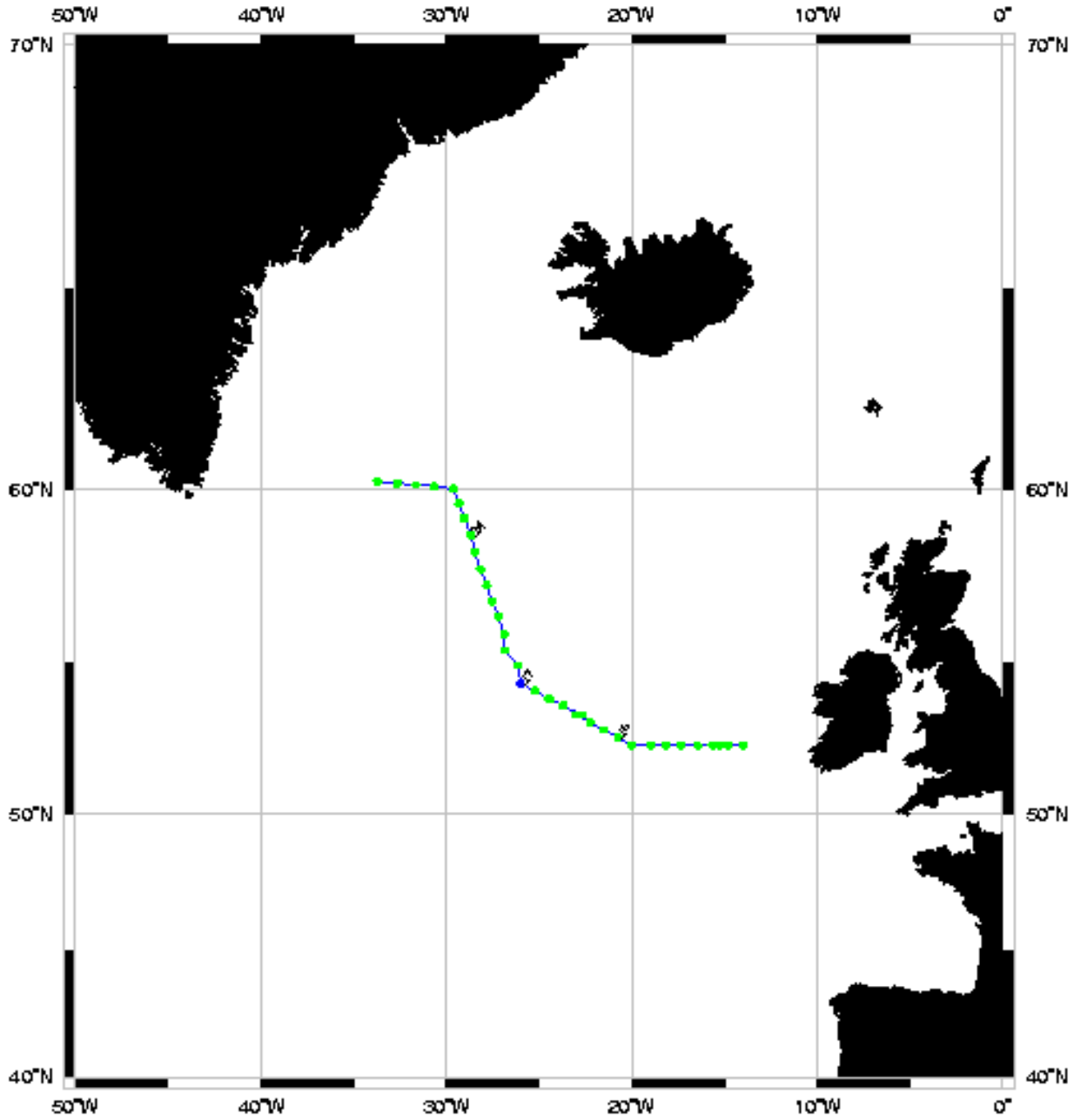
2.1.c. Ship — R/V TYRO

2.1.d. Ports of call — Galway, Ireland - Reykjavik, Iceland

2.1.e. Cruise Dates 1 July - 23 July, 1990

Station locations for AR07EA VANAKEN (NET)



2.2. Summary

2.2.a. Cruise Track

Geographic Bounds:

64 N
44 W 10 W
52 N

R/V TYRO departed Galway, Ireland on the morning of 1 July 1990, arriving at the Porcupine Bank the following morning. From there, on section AR7E, 33 CTD (Conductivity, Temperature, and Depth Instrument) stations were occupied, one every thirty miles (with an extra station over the steep slope of Porcupine Bank). Each CTD station also took water samples with a 24 bottle Rosette sampler using 12-liter bottles. Coordinates of station number 1 (rounded to the nearest minute) were 52 20N, 14 00W. Track from there was West to 52 20N, 20 00W, then WNW to 54 20N, 26 00W, then NNW to 60 00N, 29 38W, then slightly North of West to the last of the 33 stations at 60 13N, 33 43W. Having lost 98 hours due to bad weather, it was decided to terminate the AR7E section at station 33, about 260 miles from the Greenland coast. This resulted in the loss of the westernmost portion of the section, about 20% of the total length.

2.2.b. Underway Measurements

Ship's position, meteorological data, sea surface parameters, and echo sounder depths were recorded continuously during the cruise. The sampling rate of these measurements was once per minute. Parameters measured were:

Latitude	Wind Speed	Sea Surface Temperature
Longitude	Wind Direction	Sea Surface Salinity
Speed	Air Temperature	Sea Surface Flourescence
Heading	Relative Humidity	Water Depth
Insolation		

Four times per day, meteorological observations were sent as OBS messages to the GTS network.

After CTD Station No. 9, XBT Profiles were recorded between CTD Stations to increase the horizontal resolution of the temperature structure in the upper ocean.

2.2.c. Floats and Drifters

Three Argos Drifters were launched. Positions and dates were:

Date	Time(UTC)	Latitude	Longitude
6 Jul 90	1342	53 19.7 N.	22 57.8 W.
6 Jul 90	1855	53 37.0 N.	23 42.4 W.
7 Jul 90	0017	53 48.8 N.	24 26.4 W.

2.2.d. Current Meter Moorings

One current meter mooring (designated IB90/4) was deployed at 58 45N, 28 40W.

2.2.e. Other Activities

The remainder of this leg of the cruise was spent on non-WOCE activities. Two control volumes in the Iceland Basin were surveyed with 15-mile CTD station spacing. Three more current meter moorings were deployed and one recovered.

2.2.f. Principal Investigators/Affiliation

Table 1: Principal Investigators/Affliation

Name	**Affiliation**	**Measurement Responsibility**
H. M. van Aken	NIOZ	CTD analysis and interpretation, sample interpretation
L. Otto	NIOZ	Surface program, salinometry
M. Stoll	NIOZ	Carbon dioxide
T. de Bruin	NIOZ	Underway measurements

2.3. Cruise Personnel

Table 2: Cruise Personnel

Name	Measurement Responsibility	Affiliation
H. van Aken (PI)	CTD analysis, sample interpretation	NIOZ
L. Otto (PI)	Surface Program, Salinometry	NIOZ
C. de Boer	CTD operations, CTD & sample analysis	NWO/NIOZ
T. de Bruin	CTD operations, meteorology, remote sensing	BCRS/NIOZ
M. Stoll (PI)	Carbon dioxide	NWO/NIOZ
M. Manuels	Oxygen analysis	NIOZ
K. Bakker	Nutrients analysis	NIOZ
S. Ober	CTD operations, current meters	NIOZ
R. X. de Coster	CTD operations, data management	NIOZ
R. Groenwegen	CTD operations, electronics	NIOZ
L. Oost	CTD operations, electronics	NIOZ
H. de Porto	CTD winch, moorings	NIOZ
W. Polman	CTD winch, moorings	NIOZ
J. Blom	CTD winch, moorings	NIOZ
M. Bakker	CTD winch, moorings	NIOZ
M. Vosbeek	CTD operations, salinometry	RUU
M. Vellinga	CTD operations, salinometry	RUU
B. de Jong	CTD operations, salinometry	RUU
F-P. Lam	CTD operations, salinometry	RUU
J. Belgers	Oxygen analysis	IAHL

Abbreviations:
NIOZ Netherlands Institute for Sea Research
NWO Netherlands National Science Foundation
BCRS Netherlands Remote Sensing Board
RUU Student from Utrecht
IAHL Student from Wageningen
PI Principal Investigator

3. SAMPLING METHODOLOGY

3.1. CTD

The CTD used was a Neil Brown Mk3 with the following sensors: Temperature (fast and slow response sensors electronically combined), conductivity sensor, oxygen probe, flourometer, and transmissometer. The CTD was mounted in a Rossette sampler with 24 twelve-liter Niskin bottles. No calibration specifications were given for the flourometer or transmissometer, nor are the data reported.

3.2. Pressure

The CTD pressure is checked by comparison with unprotected reversing thermometers and SIS electronic pressure sensors. Since 1987, no systematic differences with the manufacturerís calibration have been found.

3.3. Temperature

For CTD temperature calibration, readings were compared with data from pairs of SIS electronic reversing thermometers (ERT) mounted on Niskin bottles. Bottles 1, 3, and 5 each had two ERTs mounted. They were calibrated the week before and the week after the cruise. The rms difference between a pair of ERTs averaged 1.8 mK. Data inspection revealed the shallower stations near the Reykjanes ridge, which have reletively high gradients in the bottom layer, contributed substantially to this value. Removal of all pairs obtained at less than 2500 dbar lowers the rms difference to 1.3 mK. The standard deviation of differences between CTD and ERTs shallower than 2500 dbars is 1.4 mK

3.4. Salinity

Salinity calibration was determined by comparing the salinity of bottle samples taken at specific depths on the upcast with corresponding CTD values. Samples were analyzed with a Guildline Autosal salinometer referenced to IAPSO standard water batch P112. Except for Stations 12 and 13, samples from even numbered bottles were analyzed. Stations 12 and 13 had no reliable CTD conductivity values because of sensor damage, so all 24 bottles were analyzed for salinity. 75 duplicates were analyzed. Of these, 58 showed no difference in the 3rd decimal place, 15 had differences of .001 psu, and 1 each of .002 and .003 psu.

3.5. Oxygen

Of the 33 AR7E stations, the first eight have no CTD oxygen data, because the oxygen sensor failed. Duplicate samples from odd-numbered Niskin bottles on all 33 casts were analyzed for oxygen concentration using a high precision photometric end point determination developed at NIOZ. Discounting outliers, (about 1 in every 150), the rms differences between duplicate bottles was 0.5 umol/kg.

3.6. Nutrients

Nutrient samples from all bottles were analyzed with a Technicon TRAACS autoanalyzer set at 60 samples per hour. Variables measured were Phosphate, Silicate, Nitrite, and Nitrate. Numerous duplicate samples were analyzed to ensure data consistency, resulting in the following rms differences: Phosphates - 0.07 umol/kg, Silicate - 0.09 umol/kg, Nitrate - 0.2 umol/kg. Nitrite rms differences were not stated.

3.7. Carbon Dioxide

At 13 stations total carbon (TCARBN) was measured using a high-precision coulometrics instrument.

3.8. Helium/Tritium

At a limited number of stations water samples were stored for later Tritium analysis. These do not appear in the data files. It is suggested that requests for these data go to the Chief Scientist.

4. WHPO SUMMARY

Because a calibration facility is not yet finished, the CTD has had no laboratory calibrations since its purchase in 1987. Calibrations are carried out in the field. Detailed comparisons with other WOCE data will follow once these become available. Comments from the data quality evaluators (DQEs) follow below.

4.1. Salinity, Oxygen, and Nutrients

- David Ellett, Dunstaffnage Marine Laboratory

The data exhibit a high standard of consistency, and salinity, oxygen, and silicate results are compatible with previous high quality observations from this region and with the perceived water mass structure. Few previous data are available in the literature for NE Atlantic nitrate, nitrite, and phosphate, and those which exist are not from modern methods of determination, so detailed comparison would be inappropriate, but there is good general agreement with earlier work in overlapping areas, and the replicate analyses quoted above demonstrate that good care has been taken in the determinations.

4.2. CTD Data

- James Crease, W.O.C.E. Data Information Unit (DIU)

Histograms of bottle-CTD differences indicate that the data is of high quality and meeting the WOCE requirements.... On many stations the Tyro stations went beyond the climatology (Levitus) bounds (but marginally), mostly in the upper 500m. This was always on the colder side of the bounds. The small size of the historical database is presumably only part of the reason for this and some effect can be ascribed to changes in the climatology.

4.3. Chief Scientist's Response to DQE Comments

From the other non-WOCE sections surveyed during the cruise it appears that the mode water, found in the upper 500 m shows some spatial variation in temperature and salinity in the Iceland Basin. Therefore I donít know whether the differences have to be ascribed to climatic changes or to under-sampling in the Levitus data set.

5. DATA LOCATION

Quality evaluated CTD and bottle data sets are available from the anonymous ftp server at the SAC and from WDC-A/NODC.

6. ACKNOWLEDGEMENTS

This research on board Tyro was carried out by scientists and technicians employed by the Netherlands Institute for Sea Research (NIOZ) in Texel assisted by students from Utrecht and Wageningen. Additional funding was obtained from the Netherlands Marine Research foundation (SOZ), the owner of the R/V Tyro, from the Netherlands National Science Foundation (NWO) and from the Netherlands Remote Sensing Board (BCRS).

7. REFERENCES

Joyce, T, C. Corry and M. Stalcup (1991) WHPO Publication 90-1 Revision 1 Requirements for WOCE Hydrographic Programme Data Reporting WOCE Report 67/91 Unpublished Manuscript

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