Scientific Cruise Report

R.R.S. *John Murray*, Cruise No. 3/81, 30.3.81-9.4.81

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1. Introduction

The *John Murray* Cruise 3/81 was conceived with only about six months' notice to make use of a gap in the vessel's time-table. Its objective was to survey the thermal structure which occurs in the English Channel along the south coast of England, during the late winter/early spring, and to detect any associated structure in the biological productivity if it existed. The scientific purpose was threefold; to understand the physical structure of the "frontal" structure and to determine the mechanism whereby it is maintained; to determine the effect of the thermal structure on the productivity; and to compare the observed temperature structure with that deduced from thermal I.R. images from the Advanced Very High Resolution Radiometer on the TIROS/NOAA satellites.

2. The Cruise Plan

Figs. 1 and 2 show the cruise track for the two legs. Leg 1 sailed from Plymouth on 31 March 1981 and steamed a course generally eastward, but zigzagging the region of strong thermal gradients evident in the NOAA AVHRR Infra-Red satellite images for 26 and 28 March. Continuous sampling was performed under way, and at changes of course CTD casts were made. Once the regions of strongest thermal gradients had been detected south of the Isle of Wight two current meter moorings were laid, one on either side of the "frontal" region, on 2 April 1981, at Station 14 (50°18'N, 1°06'W) and 20 (50°21.8'N, 1°06.4'W). A more detailed CTD survey was made in this region (Stations 14-20). The continuous surface sampling survey was continued towards the east, as far as Station 29 (50°33'N, 0°17.4'W), continuing to zig-zag across the thermal gradients, and then westwards again into Poole Bay. The vessel then put into the Solent and anchored off Cowes to exchange the scientific personnel between leg 1 and leg 2 at 1030 GMT, 4.4.81.

Leg 2 returned to the current meter stations and attempted a twelve-hour anchor station for direct reading current meter measurements for comparison with the moored meters in a strong tidal stream. However it was not found possible to hold position and the anchor station was abandoned after four hours. After several hours of further surveying and CTD stations, the current meter rigs were recovered (5 April). Several hundred litres of water were obtained here for a Southampton University research project. The general survey then continued westwards, and the experiment to compare DRCM measurements with a moored current meter rig was repeated with a 12 hour mooring in Bigbury Bay, 50°17'N, 4°4'W, just off Plymouth (6-7 April). Following this the continuous sampling survey was continued with periodic CTD stations westwards, examining the thermohaline structure off the Lizard. Finally, a sample of several hundred litres of sea water was obtained off the Scilly Isles before returning to Barry.

3. Data Collected

Throughout the cruise continuous monitoring was carried out using the ship's non-toxic water supply as representative of the near-surface water conditions. This was fed to a thermosalinograph, a fluorimeter, a Partec transmissometer-type turbidity meter and a probe for measuring the dissolved oxygen concentration. The measurements from these instruments were continuously recorded on paper charts, but unfortunately a system designed to sample them every minute and record them on magnetic tape failed. The charts were time registered every 15 minutes when the decca position was noted in the scientific log, enabling spatial distributions of parameters to be plotted subsequently. The near-surface temperature distribution was plotted from the thermosalinograph record in real time, to enable the strong thermal gradients to be immediately located.

The ship hove-to at 87 stations, timed when underway at intervals between 1 and 6 hours apart, (10-40 km) principally at changes in the course direction, and more frequently in the frontal study zone south of the Isle of Wight. At 80 of these CTD casts were made. Careful comparison was made between the near-surface CTD temperature, the thermosalinograph temperature and the reversing thermometer temperature. The CTD was the most reliably and accurately calibrated of the available temperature measuring instruments and was taken as the standard. The thermosalinograph was found to register temperatures 0.28 ± 0.1°C higher than the CTD (see Cox, 1981), and much of this offset was probably due to the heating up of the non-toxic water supply as it passed through the ship to the T/S probe. The variability of the offset would be due in part to the variation of flow rate of the non-toxic supply.

When underway, water samples were taken from the non-toxic supply at nominally three-hour intervals, and fixed or stored in the appropriate way for later analysis for chlorophyll-a, dissolved oxygen, particulate organic carbon and dissolved organic carbon. The first two were used to calibrate the continuous traces of the fluorimeter and the oxygen probe (see Clancy 1981).

At 42 of the stations plankton hauls were made, and benthic fauna was sampled at 12 stations with a Van-Veen Grab.

The current meter moorings at stations 14 and 20 (see above) consisted of three Aanderaa recording current meters each. The purpose of the moorings was to compare the tidal currents on either side of the strong thermal gradient region in an attempt to detect any mean velocity shear which would indicate that the mass distribution was in geostrophic balance. With such a short span of data, the sampling interval was set at 1 min. Details of the current moorings are in table 1.

4. Scientific Results

During the cruise itself, it became apparent how valuable it was to have recent (i.e. two days old) infra-red satellite imagery to enable the ship's course to be planned so that the strong temperature gradients could be located easily without a blind general survey which would have been costly in time. Using the satellite image and ship survey together, it was possible to define the structure of the thermal gradient zone in three dimensions. This has been examined by Cox (1981), but work is still proceeding to understand the mechanisms which maintain the front in being, making use not only of the surface T/S records and CTD profiles at selected locations but also the current meter data. It appears so far that this is not strictly a front in dynamic geostrophic balance, but a region of active mixing between two water masses, apparently maintained by a convergent circulation similar to the turbulent convergent tidal fronts observed by Pingree *et al.* (1974). It is still not clear exactly why such a sharp gradient should be maintained off the headlands, but more diffuse elsewhere. be

The continuous traces of the oxygen and fluorimeter probes have been satisfactorily calibrated (Clancy 1981) but a full spatial distribution of O_2 and chlorophyll has not yet been produced for comparison with the thermal structure. However, it appears from a general inspection of the records that in some areas towards the centre of the Channel a warmer patch of water was identified with higher chlorophyll and oxygen levels, suggesting increased productivity, although this was clearly not always the case and the headland fronts thereby appeared to show little correlation with productivity. Work is continuing to clarify the relation between the chemical properties and the temperature.

During the cruise attempts were made with some limited success, to make continuous measurement of dissolved organic carbon using a continuous flow rig developed by Dr. P. J. Williams at the Department of Oceanography, Southampton University.

The biological sampling gave less satisfactory results. No significant difference could be detected between the trawl samples from the different temperature water masses. The benthic sampling was of little value because of the very rocky substrate in the region of interest around the steep thermal gradients, due no doubt to the scour of the strong tidal currents encountered there.

The record from the Partec meter served to indicate gross changes in turbidity, but as a precise measure of suspended material it is of little value due to its steady drift during the cruise. Thus whilst the fluorimeter data will be of value in calibrating the CZCS data, the particulate data will only permit a descriptive comparison. It is hoped to undertake these comparisons of water quality with satellite data in the near future.

What has been most successful is the comparison of the sea-surface temperature distribution measured by the T/S probe and the temperature calculated from the AVHRR image of 28.3.81, the clear-weather overpass closest to the cruise. Although absolute comparison cannot be accurately made, because of the difficulty of atmospheric correction of the satellite data and the offset of the ship data, comparison of temperature gradients shows very good agreement, and it is hoped to publish the results of this work shortly.

5. Conclusion

The objective of the cruise, to survey the thermal frontal structure, was successfully achieved, and the scientific aims have been put within reach once the data collected on the cruise has been fully analysed. We now have a much clearer idea of the three dimensional structure and chemical properties of a feature which previously was known only from its satellite I/R signature. We have also been able to perform the first direct comparison of sea-surface temperature gradients measured from ship and satellite, in U.K. coastal waters.

References

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Clancy, J. K., 1981. Chemical and biological parameters at presumed fronts in the English Channel. Unpublished M.Sc. thesis, University of Southampton, Department of Oceanography.

Pingree, R. D., Forster, G. R. and Morrison, G. K., 1974. Turbulent convergent tidal fronts. J. Mar. Biol. Assoc. U.K. 54, 469-479.

Appendix Scientific Personnel on RRS *John Murray* Cruise No. 3/81.

Leg 1 30.3.81-4.4.81
Plymouth→Cowes

B.J. Cox	NERC funded M.Sc. student, S.U.D.O.
J.K. Clancy	NERC funded M.Sc. student, S.U.D.O.
K. MacFarlane	SERC funded Ph.D. student, S.U.D.O.
J.S. Robinson	Lecturer S.U.D.O. - Principal Scientist, Leg 1
P. Taylor	Research Vessel Base, Barry
J.A. Williams	Lecturer, S.U.D.O.
P.J. Williams	Lecturer, S.U.D.O.

Leg 2 4.4.81-9.4.81
Cowes→Barry

J. Cross	Technician, S.U.D.O.
B. Dickie	M.Sc. student, S.U.D.O.
Q. Espey	Ph.D. student, S.U.D.O.
C. Griffiths	NERC funded Ph.D. student, S.U.D.O.
G. Pennie	M.Sc. student, S.U.D.O.
P. Statham	NERC research fellow, S.U.D.O.
P. Taylor	Research Vessel Base, Barry
N.C. Wells	Lecturer, S.U.D.O. - Principal Scientist, Leg 2

Table 1

Details of current meter moorings

Station	Sea Depth	Meter Depth	Sampling interval	Start time GMT	End time GMT	Timing error	Notes
"14" 50°17.8'N 1°06.6' W	50	15	1min	10.00 2/4/81	16.20 5/4/81	-3secs	
		20	1min	10.00 2/4/81	16.20 5/4/81	+1min	
		25	1min	10.00 2/4/81	16.20 5/4/81	-1min	possible compass error
"20" 50°21.8'N 1°08.6' W	40	15	1min	15.10 2/4/81	11.00 5/4/81	no infor -mation	clock stopped on retrieval
		20	1min	15.10 2/4/81	11.00 5/4/81	+ 2secs	
		25	1min	15.10 2/4/81	11.00 5/4/81	+ 3secs	

Cruise Track John Murray 3/31