(69)

CRUISE REPORT

CRUISE: RVS Cruise 69/90; PML Humber Plume Cruise III

VESSEL: RRS *Challenger*

PERIOD: July 26 to August 07, 1990

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ACKNOWLEDGEMENTS:
The excellent services provided by Capt. P Moore and his officers and crew are most gratefully acknowledged. Thanks are also due to Chris Adams for making arrangements for a transect of the Thames plume at very short notice.

OBJECTIVES:
(1) To define spatial and temporal characteristics of the plumes emanating from the estuaries of the Humber and Wash within an area off the east coast of England.
(2) To determine the principal mechanisms for transport of water borne conservative tracers away from estuary mouths in order to parameterise them in water quality models.
(3) To determine pathways for non-conservative tracers in plumes in relation to sediment/water interactions and biological processes in the water column.
(4) To reinforce the study of sediment/water exchanges and bioturbation effects on water column chemistry through further work at the SERE resuspension sites previously studied during cruises 44, 52, 60 and 65.

ITINERARY

Wed 25 July.
Scientific party muster at Barry, pm; load equipment and commence commissioning.

Thur 26 July.
Depart Barry 0800 (BST) en route for southern resuspension site in the North Sea. Complete commissioning of equipment.

Fri 27 July.
Continue towards resuspension site. Reconsider track in light of ETA at southern resuspension site (2100 on 28/7) relative to daylight working hours. Propose traverse into Thames plume zone with ETA at southern site delayed until am on 29/7. Proceed to pilot rendezvous off Margate.

Sat 28 July.
Pick up pilot at NE Spit off Margate 0830. Commence traverse into Thames Estuary. Continuous recording of nutrients (nitrate, nitrite, silicate, phosphate), transmissometer, fluorimeter, thermosalinograph. Sampling for dissolved and particulate metals along track with non-contaminating samppling system using towed fish. Proceed upestuary through Edinburgh Channel; complete upestuary transect and turn off Tilbury ca. 1315; proceed downestuary via Barrow Deep. Collect a series of six grab samples through sludge dumping zone for organic analysis 1710 to 1850. Drop pilot off Harwich (Sunk Buoy) at 1930 and proceed to southern resuspension experiment site.

Sun 29 July.
Commence box coring and Craib coring surveys for faunal quantification and chemical analysis at southern resuspension site 0800. Also take box cores for on-board incubation experiments. Survey at southern site completed 1510. Proceed to northern resuspension site.

Mon 30 July.
Commence box coring and Craib coring surveys for faunal quantification and chemical analysis at northern resuspension site 0600. Also take box cores for on-board incubation experiments. Take simultaneous test samples for TBT analysis using various devices: Go-Flo bottles on CTD, custom made scoop from shipside, hand sampling approx. 50m away from ship using ship's lifeboat 1330. Coring completed 1700, proceed immediately to NE corner of Humber plume grid zone.

Tues 31 July.
Commence first grid circuit 0800. Continuous sampling for nutrients, thermosalinograph, fluorometer, transmissometer. Pumped samples for particulate and soluble metal analysis and organic analysis at frequent intervals around grid. CTD profiles along outermost line of grid stations, with soluble and particulate metal samples from Go-Flo bottles. Day grab samples at intervals for pollutant organic analysis. Box cores at 5 selected sites for on-board incubation experiments and for organic pollutant analysis. Box core failure, buckled bucket and damaged spade 2235; hammer out box try with spare spade, which did not fit.

Wed 01 Aug.
Take CTD cast for primary production measurements 0412. AVHRR Satellite infra-red image of Humber plume zone for 0753, 29 July received; these indicate southward displacement of Flanborough Front into northernmost transect of plume grid zone. Continue first circuit.

Thur 02 Aug.
Continue first circuit. CTD cast for primary production at 0425. First

circuit completed. Proceed to anchor station off Spurn Point in mouth of Humber 0930. Take box core for on-board incubation experiments at 0945. Cmmence anchor station work at 1030. CTD casts at hourly intervals; occasional Day grabs; continuous recording of nutrients, thermosalinograph, fluorometer, transmissometer; soluble and particulate metal sampling from both non-contaminating pump and Go-Flo bottles on CTD.

Fri 03 Aug.

CTD cast at 0330 used for primary production measurements. Anchor station completed with CTD cast at 0930 followed by Day grab sample. Commence second circuit 1000; circuit shortened to concentrate on principal plume zone and associated regions of relatively high primary production, omitting stations along northern grid boundary and all stations south of 53^{O}N. Plume zone markedly limited in extent by very low river run-off conditions. Sampling planned as for first grid but with a single box core station in Silver Pit (abandoned on first circuit) and two Day grab stations required to complete grid coverage. Successful box core, 1300.

Sat 04 Aug.

Continue round second circuit. Adjust track to make dawn primary production cast at station selected according to coverage in hand and contoured fluorimeter data. Primary production CTD cast completed 0425. Second circuit completed 2115. Proceed directly into third circuit. This circuit to include the northern grid boundary and a N-S section of CTD casts at 2nm intervals starting at 54^{O} 02'N, 00^{O} 31'E in the thermally stratified region through to vertically homogeneous water. Again omit all stations south of 53^{O}N.

Sun 05 Aug.

CTD section commenced 0135, completed (12 casts) at 0640. CTD at 0425 used for primary production measurements. Continue third circuit.

Mon 06 Aug.

Third circuit completed 0800. Commence shortened fourth circuit designed to terminate in southern area of the grid appropriate for timely passage to Great Yarmouth. Terminate fourth circuit at 2300. Commence decommissioning and packing of scientific equipment. Two CTD stations on route to Great Yarmouth at 0500 and 0700.

Tues 07 Aug.

Stand off Great Yarmouth awaiting pilot 0900; pick up pilot 0930 and dock at 1000. Unload scientific equipment and depart for Plymouth 1400.

SUMMARY

This cruise was completed successfully according to plan. There were no major disruptions due either to instrument breakdown or to weather, which was clement throughout with only slight winds, except for the last day. Four circuits of the Humber plume grid were completed. Cruise logistics also allowed the inclusion of a transect into the Thames plume as far as Tilbury. In this we obtained results for the Thames plume which consolidate the information obtained in an earlier cruise specific to this region (Cruise No.

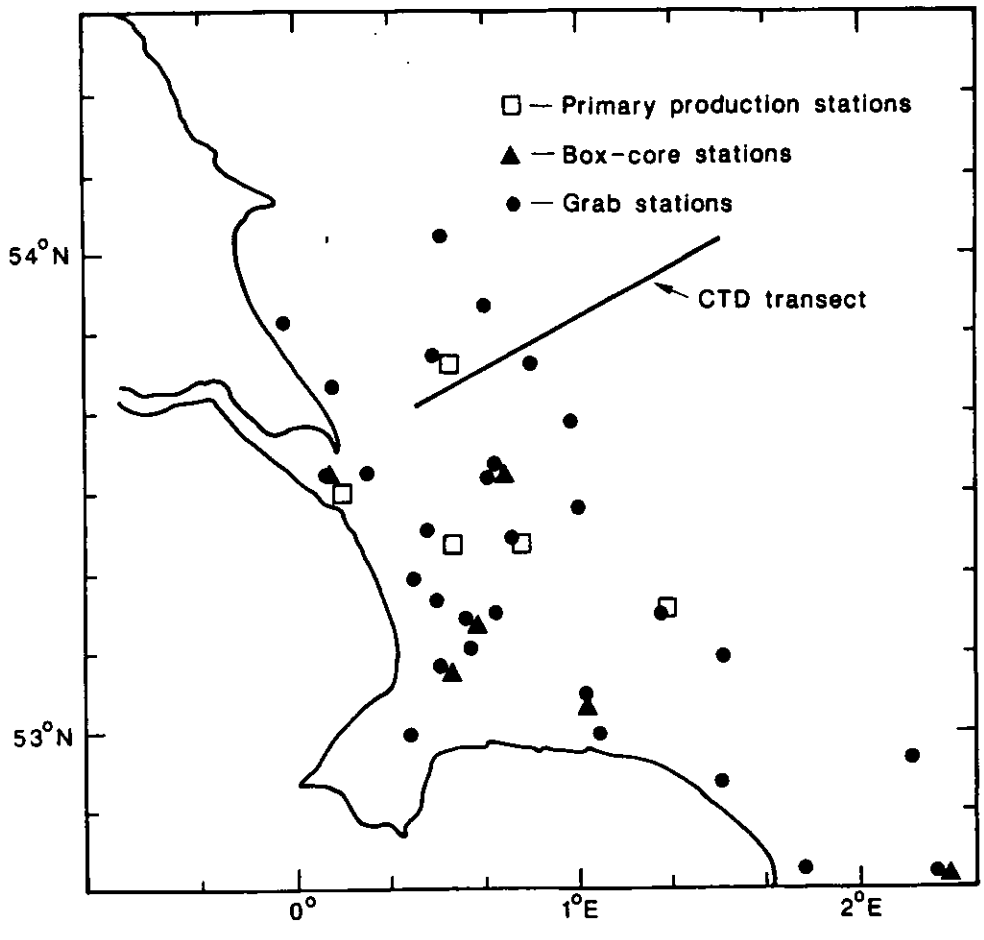

Figure 1. Stations worked in the Humber/Wash plume region.

46, February 1989). Work at the two sediment resuspension study sites was successfully incorporated, consolidating earlier visits during cruises 44, 52 and 60 in 1989 and 65 in 1990. One 24 hour anchor station in the mouth of the Humber was carried out; plans for a second were abandoned in view of the consistently very low river run-off encountered during the cruise period.

On-board incubation experiments were carried out throughout the cruise. These were: (1) radiochemical techniques applied to water samples for assessing the rates and equilibrium states of particle/water metal exchange, and (2) macrocosm techniques applied to box cores for measuring directly the rates of transfer of nutrients and metals across the sediment/water interface under undisturbed and disturbed (resuspension) conditions. In addition, pore water chemical profiles were measured for indirect estimation of diffusional fluxes across the interface.

Figure 1 shows the positions of grab, box core and primary production stations within the Humber/Wash plume zone; the transect line of CTD stations across the Flanborough Front is also marked.

The entire data set obtained during the cruise and through subsequent laboratory analyses of samples has been lodged at BODC.

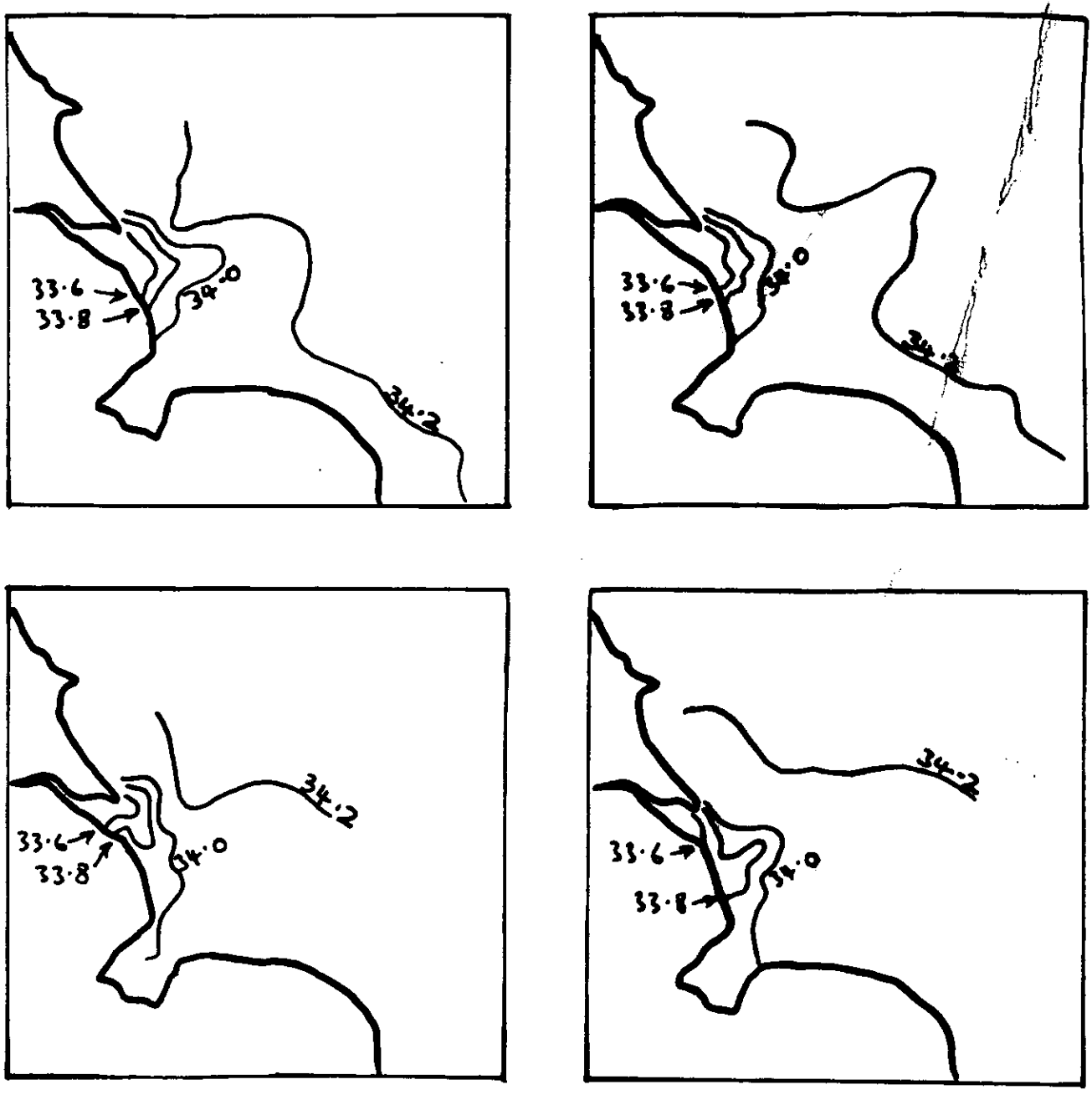

Figure 2. Near surface salinity distributions during each of the four circuits of the Humber/Wash plume zone.

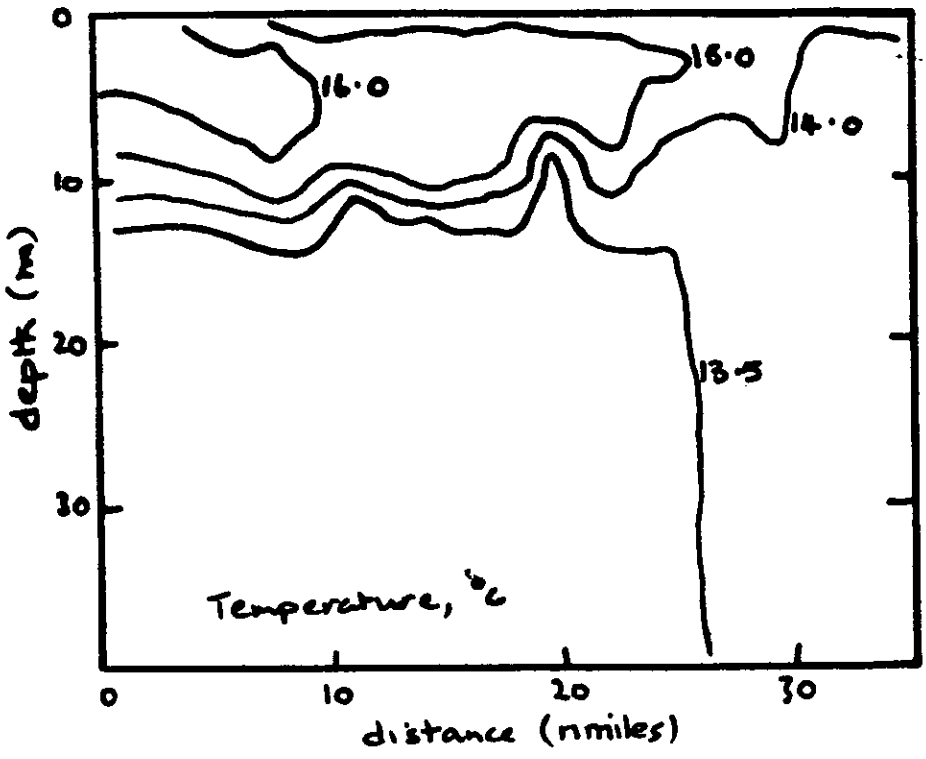

Figure 3. N-S section temperature section across the Flanborough Front.

RESULTS

Hydrography

Figure 2 shows the near surface salinity distribution recorded during each of the four circuits of the plume grid, traced without tidal correction from UNIRAS plots. The differences in the location of isohalines are predominantly due to differences in tidal displacement at the times of sampling. These plots show a very confined Humber plume without a strong signal emanating from the Wash. These distributions are in keeping with the very low river run-off occurring before and during the cruise period. The Humber plume tends to move southward, hugging the coastline, with some indications of easterly transport along the axis of Silver Pit. an E-W oriented deep channel ending south east of the mouth of the Humber. This form of distribution is similar to those recorded in December 1988 (Cruise 42) and earlier in the year (Cruise 65) and closely corresponds with our model predictions for windless conditions.

The water column was well-mixed over most of the grid, except for the northeasterly corner, where strong thermal stratification was encountered. It appears that this was due to the southward intrusion of the Flanborough Front, and this was confirmed by the satellite images recieved during the cruise. A line of CTD stations was included in order to improve our characterisation of the front. Figure 3, showing the temperature section recorded in this

investigation, highlights the sharpness of the front.

Water column chemistry

The chemical data has not yet been fully validated and only a descriptive summary is presently available. Nutrients and dissolved metal and suspended material distributions closely followed the salinity distribution, as expected. As in May (Cruise 65) the Humber nutrient signal predominated; the nutrient discharge from the Wash region was not strongly evident.

Water fluorescence and chlorophyll content indicated persistent pockets of enhanced primary production within the plume zone, and were most evident northeast of the Wash.

On board experiments

Metal particle/water distribution coefficients were determined in water samples collected from twentyfour stations dispersed around the plume grid. The values obtained were similar to those found in earlier cruises (42 in 1988; 65 in 1990), decreasing the uncertainty in applying these coefficients to the modelling of non-conservative metal behaviour in estuarine plumes.

On board mesocosm incubations were carried out on five box cores dispersed around the grid region, some repeating sites examined in earlier cruises. Measurements of nutrient exchange across the sediment/water interface were completed on board; samples for quantification of metal fluxes were returned to the laboratory for analysis. These data consolidate our information in both space and time on nutrient and metal fluxes required for non-conservative chemical modelling of estuarine plumes.

Report prepared by: A W Morris, 10 October, 1990

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