R. LOWRY

P.O.L.

RRS CHALLENGER

CRUISE 115A

4 OCTOBER 1994

17 OCTOBER 1994

The Humber-Wash Estuarine Plume System

The Holderness Coast

The Humber-Tweed Coastal Strip

CRUISE REPORT NO. 19

1994

Natural Environment Research Council

PROUDMAN OCEANOGRAPHIC LABORATORY

DOCUMENT DATA SHEET

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ABSTRACT

This report describes observations made on Challenger Cruise 115A, i.e. the first of three consecutive 15 days legs addressing the following overall objectives of the LOIS(RACS) programme.

The observations relate to three overlapping regions of the UK east coast between 52 30' to 56 00'N, a coastal strip 210km long and up to 40km offshore. The three regions concerned are: (i) the Humber-Wash estuarine plume system, (ii) the Holderness coast, (iii) the Humber-Tweed coastal strip. The ship's track within this area extended over 1000km and included approximately 60 monitoring stations. Parameters logged continuously along this track included: temperature, salinity, transmittance, fluorescence at 30 second intervals from a near-surface (-m) non-toxic pumped supply and irradiance at 10min intervals from an elevated position. Corresponding measurements at each monitoring station were made with a profiling CTD/rosette-sampler system.

The Holderness study involved the deployment of 8 standardised monitoring packages (PMP) on a sea-bed platform measuring water levels, currents, turbulence, temperature, salinity and suspended sediments. In addition 3 wave buoys (2 directional) and 1 meteorological buoy were deployed. Deployment of the shallowest PMP involved transfer to a shallow-draft trawler. Calibrations of the PMP measurements were made using hourly CTD profiles over a semi-diurnal tidal cycle at 4 of the PMP sites.

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RRS CHALLENGER

CRUISE 115A
4 - 17 OCTOBER 1994

The Humber-Wash estuarine plume system, The Holderness Coast The Humber-Tweed Coastal Strip

Principal Scientist

D. Prandle

1994

CRUISE REPORT CHALLENGER 115A 4/10/94 - 17/10/94

(D. Prandle, P.O.L., Principal Scientist)

SUMMARY

This report describes observations made on Challenger Cruise 115A, i.e. the first of three consecutive 15 days legs addressing the following overall objectives of the LOIS(RACS) programme:

1. To quantify hydrodynamical transports and the processes affecting transformations, interactions and fates of particles, biogeochemically important elements and representative contaminants from land sources to the coastal zone.

2. To provide the first integrated environmental database for a UK coastal region covering seasonal cycles and interannual variability and incorporating measurements of the fluxes of materials and rates of biological productivity.

3. To generate new quantitative understanding of estuarine and coastal zone processes controlling the fluxes and reactivities of both natural and anthropogenic materials.

4. To provide integratable models of these processes as building blocks for comprehensive coastal zone system models which will realistically predict the affects of future environmental change.

The observations relate to three overlapping regions of the UK east coast between 52 30' to 56 00'N, a coastal strip 210km long and up to 40km offshore. The three regions concerned are: (i) the Humber-Wash estuarine plume system, (ii) the Holderness coast, (iii) the Humber-Tweed coastal strip. The ship's track within this area extended over 1000km and included approximately 60 monitoring stations. Parameters logged continuously along this track included: temperature, salinity, transmittance, fluorescence at 30 second intervals from a near-surface (-m) non-toxic pumped supply and irradiance at 10min intervals from an elevated position. Corresponding measurements at each monitoring station were made with a profiling CTD/rosette-sampler system.

The Holderness study involved the deployment of 8 standardised monitoring packages (PMP) on a sea-bed platform measuring water levels, currents, turbulence, temperature, salinity and suspended sediments. In addition 3 wave buoys (2 directional) and 1 meteorological buoy were deployed. Deployment of the shallowest PMP involved transfer to a shallow-draft trawler. Calibrations of the

PMP measurements were made using hourly CTD profiles over a semi-diurnal tidal cycle at 4 of the PMP sites. (POL, Section 3).

Biological, Chemical and Sedimentological measurements were made over both the Humber-Wash and the Humber-Tweed tracks (twice). These comprised.

(i) Dissolved metals Cu, Zn, Co and Ni from a continuous independent clean supply particulate metals at -4m depth from each monitoring station

(LUDO, Section 4)

(ii) Daily estimates of primary production and nutrient uptake using incubated pre-dawn samples

Associated estimates of nutrients (phosphorous, ammonium, urea, phytoplankton and chlorophyll a)

Dissolved oxygen at 5 min intervals from the non-toxic supply

(SUDO, Section 5)

(iii) Gas chromatography of near-surface (1-5m) station samples with emphasis on the detection of dimethylsulphide.

(UEA, Section 6)

(iv) Nutrients NO_3, NO_2, PO_4 and S_i at 30s intervals from the non-toxic supply using an auto-analyser

(PML, Section 7)

(v) Particulate filtration of bottom station water

(UCNW, Section 11)

The above moored and ship-borne observations were complemented by air-borne remote sensing utilising ATM and RC-8 instruments

(PML, Section 8)

All direct measurements were logged by the on-board computing system.

(RVS, Section 9)

Guidance on data protocols was provided by BODC

(Section 10)

The exceptionally tranquil weather experienced throughout the cruise should provide a useful data set on autumnal parameter distributions under tidally-dominated dynamical conditions.

LIST OF CONTENTS

Personnel:

Master :	R.C. Plumley	
1st Officer	T.J. Boult	
2nd Officer	J.T. Morse	
3rd Officer	M.L. Crofts	
Chief Engineer	I.R. Bennett	
2nd Engineer	S.F. Dean	
3rd Engineer	R.J. Perriam	
Scientists:	D. Prandle	POL
	G. Ballard	POL
	B. Bellerby	PML
	E. Achterburg	LUDO
	C. Columbo	LUDO
	S. Jones	LUDO
	P. Shaw	SUDO
	R. Williams	SUDO
	R. Little	UEA
	R. Lowry	BODC
	P. Duncan	RVS
	R. Powell	RVS
	A.J. Harrison	POL }
	D. Flatt	POL } 4-10/10
	D. Braden	POL }
	C. Bull	UCNW 10-17/10
	R. Murphy	PML

2. DIARY

Tuesday 4/10/94

Sailed Barry 7.00 a.m. (BST)

Sunny, cold, no wind; sea calm

Wednesday 5/10/94

English Channel

fine, no wind; sea calm

Thursday 6/10/94

Overcast, no wind; sea calm

9.00 a.m. CTD test off Thames estuary

23.00 arrive at N3

CTD calibration of 4 transmissometers

23.30 ½-hourly CTD profiles, 1-hourly bottle samples

Friday 7/10/94 SPRING TIDES

Cloudy, cold, south wind; sea calm

07.00 start mooring deployments at N3

07.15 meteorological buoy

07.50 PMP

09.00 directional wave recorder. Proceed to S3

14.00 PMP deployed at S3. Proceed to N4

21.00 PMP deployed at N4. CTD profiles ½-hourly

Saturday 8/10/94

warm, misty, no wind, sea very calm

05.00 first SUDO samples, end CTD. Proceed to S2

08.45 PMP deployed at S2. Proceed to S1.

10.00 PMP deployed at S1. Proceed to N2.

11.00 CTD profiles at N2.

14.00 PMP and directional wave rider deployed at N2. Proceed to N3 (avoid shell fisheries in the dark). CTD profiles

Sunday 9/10/94

sunny, warm, no wind, calm

06.00 proceed to N2

07.00 rendezvous with the "*JANET M*" trawler

09.00 *JANET M* proceeds to N1. PMP deployed at N1. CTD at N2 hourly

Monday 10/10/94

sunny, no wind, calm

09.00 Rendezvous at Spurn Point with pilot

10.00 PMP deployed at S4

10.30 A. Harrison, D. Flatt, D. Braden transfer ashore

C. Bull, R. Murphy join *Challenger*

12.00 begin Humber-Wash grid at HW5

Tuesday 11/10/94

hazy, sun, no wind, flat calm

continue Humber-Wash grid. Fog slowed progress later in that day

Wednesday 12/10/94

low mist, no wind, calm

08.00 close to HW1

11.00 towed PMP UDR (reduced speed) until 16.00

01.30 1-hour rapid CTD at HW2 (slack tide). Commence Humber-Tweed Grid at station C3

Thursday 13/10/94 NEAP TIDES

hazy mist, no wind, calm

miss station C13

11.00 towed PML UDR from Station C14 to C15

miss Station C16 (wrong co-ordinates for C15)

13.00 rendezvous with NERC aircraft

Friday 14/10/94

sunny, mild, no wind flat calm

08.00 Station 25. 25-26 towed UDR

Saturday 15/10/94

low mist, no wind, calm

08.00 station 34

13.00 station 35, end Humber-Tweed grid

14.30 start shortened Humber-Wash grid

21.00 wind force 3-4 NE, sea rough

Sunday 16/10/94

low cloud, wind, sea rough

09.00 Wash

22.00 End Humber-Wash. CTD start hourly at position S2

Monday 17/10/94

12.00 end CTD

13.30 Pilot, Spurn Point

16.00 Dock Grimsby

3. HOLDERNESS DEPLOYMENTS (POL)

These observations are part of a study to measure the spatial and temporal variability in sediment fluxes originating (primarily) from the rapid erosion of glacial till from the Holderness Cliffs. The data will be used to develop numerical models to simulate this sediment transport over a range of tidal, storm and wave conditions. Such models will be used to hindcast historic erosion and compare with sedimentary recordings and ultimately to predict future trends.

The instruments mounted on each PMP are listed in Appendix 1, their positions in Appendix 2 and Figure 2 shows the latter. The moorings will record continuously from October '94 to January '95 with redeployments on Cruise 115C. Other simultaneous observations include: surface currents by H.F. Radar, waves by X-Band Radar and from (inter-tidal) pressure cells, beach bathymetry from land surveys, air-borne sensors and ship-borne side-scan sonar. Likewise near-bed sedimentary processes will be measured using STABLE (POL), MINIPOD, TETRAPOD & QUADRAPOD (MAFF, Lowestoft), BLISS (UP & UCNW). Modelling of beach processes will be carried out by HR Wallingford.

The two lines N1, N2 and N3 and S1, S2 and S3 provide data on both alongshore and cross-shore gradients associated with the sediment 'plume' from the Holderness Cliffs. The more off-shore PMP at N4 provides background open-sea conditions for specifying model boundary conditions. The PMP at S4 in the Humber mouth will be used both to specify boundary conditions for estuarine models and to provide data on coastal and estuarine exchanges.

4. CHEMISTRY (LUDO)

The investigations undertaken during *Challenger* 115 involved: (i) collecting particulate material for laboratory studies of their trace metal characteristics, and (ii) monitoring dissolved trace metals in the surface water of the Channel, North Sea and Humber and Wash coastal areas.

For both the particulate and trace metal monitoring, use was made of an independent (w.r.t. trace metal) clean sea water supply, consisting of a peristaltic pump and a 40m long hose connected to a fish deployed at about 4m depth. A total of some 20 particulate concentrates, and around 40 filtered and unfiltered samples were taken from the sea water supply at the collective CTD stations. The particulates in the sea water were concentrated (100-fold) using a tangential flow system. In addition,

the filtered and unfiltered samples were collected for subsequent analysis of the filtered material and for determinations of total, dissolved and particulate trace metals. Pre-weighed filters were utilized for all filtering operations, thus inter-laboratory calibration studies may be possible with gravimetric samples.

The clean sea water supply was continuously sub-sampled for real-time metal analysis (CU, Ni, Co, Zn). The sample flow was filtered and UV-digested on-line, and the dissolved trace metals were subsequently determined using 3 different automated voltammeters. The measuring frequency was every 30 min for Ni and Co, every 15 min for Cu and Zn, and the third machine determined Cu every 2-3 min.

An examination of Ni measurements along the cruise track showed the first large increase due to outflow of the river Thames, whereas the second increase was the result of Humber and Wash signals. Results for Zn, were comparable to these Ni data. Results for high resolution Cu monitoring indicate wave forms with decreasing baselines as the Challenger sails north from the Humber area towards the Tweed. The vessel was on a zig-zag course, and the tops of the waves correspond to a position close to land and the bottoms of the wave correspond with a position out to sea. The general decrease in baseline corresponds with positions of the ship away from the Humber-Wash plume, towards Atlantic waters with lower metal concentrations.

5. BIOLOGY/CHEMISTRY (SUDO)

Incubation Experiments

Samples were taken before dawn from 5m depth using CTD rosette from 8/10 to 15/10 1994, i.e. a total of 8 stations over both the Humber-Wash and Humber-Tweed grid. Sub-samples were transferred to polycarbonate bottles, spiked with isotopes of ^{15}N species (nitrate, ammonium and urea). $^{33}PO_4^{3-}$ and $^{14}CO_3^{2-}$. Spiked samples were then incubated in on-deck units at six different light levels. Bottles were then placed in darkness at dusk and filtered the following morning to determine transfer to plankton.

For all samples used for incubation experiments, filtered samples will be analysed for nutrients (or samples preserved for analysis). Samples were filtered for analysis of chlorophyll (spectrophotometric and HPLC) and whole samples preserved with Lugol's iodine for phytoplankton enumeration.

Phosphorus analyses

Samples were taken at CTD stations and preserved onboard with 3.5% w/u mercuric chloride for analysis on return to Southampton.

Ammonium analyses

Samples were taken from CTD samples used for incubation experiments and preserved in dark glass bottles with 3ml of phenol solution (10g phenol/100ml ethyl alcohol).

Urea analyses

Samples were taken from CTD samples used for incubation experiments and preserved in dark glass bottles (partly filled) by freezing.

Dissolved oxygen measurement

Continuous underway measurements of DO (at 5 min intervals) were made using an autonomous probe placed in an on-deck flow box fed by non-toxic supply. Calibration of the probe was carried out by sampling into BOD bottles and determination of [DO] using Winkler titration system. Approximately 100 DO measurements were made. DO was also measured continuously using an Endeco system at 5min intervals.

6. SURFACE SEAWATER MEASUREMENTS OF DIMETHYLSULPHIDE (UEA)

In order to produce sea-to-air flux estimates for Dimethyl sulphide, $(CH_3)_2S$, it is necessary to determine surface seawater concentrations of this volatile species. Seawater samples were taken at a depth of 1m from each CTD casts and whilst underway from the non-toxic supply which draws from a depth of approximately 5m.

Dimethyl sulphide is purged from a volume of seawater (typically 200mls) and trapped cryogenically in a sample loop pre-cooled to -150°C. The concentrated sample is carried onto a Chromosil 330 teflon column housed within a Varian 3300 Gas Chromatograph with Flame photometric detector.

Other measurements

Dimethyl sulphonioprionate, $(CH_3)_2S^+CH_2CH_2COO^-$, is the biogenic precursor of Dimethyl Sulphide and samples have been taken for later analysis to determine both the particulate and dissolved fractions of this species.

Samples have been prepared for chlorophyll analysis and correlations between dimethyl sulphide and its precursor with this indicator of primary production will be examined. This chlorophyll determination is in addition to the core chlorophyll measurements and may be used in an intercalibration exercise.

7. NUTRIENT ANALYSIS (PML)

Nutrient analyses were carried out using an Alpkem auto-analyser (4-12/10/94) and also a Technicon AA II system, developed at PML, both being set up to measure silicate, phosphate, nitrate

and nitrite. Nutrients were measured continuously over the Humber/Wash and coastal (Humber/Tweed) grids.

Continuous on-line analysis was employed throughout the cruise. Water, supplied to the laboratory, from the ships own non-toxic system was used. Initially the pressure of the flow was insufficient to supply the analyser and Southampton equipment (Section 4) simultaneously. This was attributed to a blockage of the non-toxic system in the web lab., which was cured by a temporary by-pass of the blocked portion of the system. Upon reaching the autoanalyser, water was on-line filtered by a continuous filter block, which contained a 0.45um Millipore filter.

Nutrient calibration was effected by running standards made up in low nutrient sea water (Ocean Science International - OSI). Daily standards were run for the on-line analysis. Milli-Q water was used as a reagent blank and low nutrient sea water as a standard zero. Working standards used for the CTD stations were as follows: phosphate 2, 4, 6, 8um, silicate and nitrate 5, 10, 15, 20um and nitrite 0.5, 1.0, 1.5, 2.0um.

This was the first time the new silicate method for the Alpkem analyser was used. Following lengthy, initial stabilisation, the method worked well, although a precipitate began to build up frequently. Repeated washing of the system and flushing of the flowcell with strong sodium hydroxide solution proved effective at removing this precipitate. However, after the first week, an increasing build up of precipitate in the flowcell (which could not be removed by flushing with acid or alkali) rendered the silicate data meaningless. Thus the Technicon analyser was brought on-line and the Alpkem shut down.

8. REMOTE SENSING (PML)

The remote sensing effort on Leg A of the Challenger 115A cruise was geared to collect data by the Compact Airborne Spectographer Imager (CASI), Airborne Thematic Mapper (ATM) and RC-8 camera along flight lines coincident with the ships track. In situ data on chlorophyll fluorescence, sediment concentration and conductivity collected by the Undulating Oceanographic Recorder (UOR) was to be registered to the remotely sensed airborne data to provide an integrated data set.

Technical problems with the sensor head of CASI meant that this sensor was operationally unavailable for the duration of Leg A. The ATM and RC-8 instruments were flown on 13/10/94 to test communications and operational aspects of the flight schedule, however, the weather conditions and visibility for this flight were sub-optimal. A replacement CASI sensor head will be made available for the start of Leg B. In spite of these problems the UDR was towed between the following points

	START TOW		END TOW	
Date	Lat	Long	Lat	Long
12/10/94	53° 54.1'N	0° 07.72'E	54° 01.88'N	0° 30.54'E
12/10/94	54°01.69'N	0° 29.41'E	54° 02.15'N	0° 19.52'E
13/10/94	54° 43.44'N	1° 04.94'W	55° 02.26'N	0° 54.64'W
14/10/94	55° 44.74'N	1° 16.63'W	55° 45.75'N	1° 54.57'W
15/10/94	54° 31.0'N	0° 02.79'E	54° 00.12'N	0°22.48'E
15/10/94	53° 59.82'N	0° 23.89'E	54° 01.78'N	0° 30.28'E
15/10/94	54° 01.29'N	0° 30.29'E	53° 54.84'N	0° 00.68'W

9. ON-BOARD COMPUTING (RVS)

The RVS ABC system on board *Challenger* was used to log the following packages.

LUMEN	2PI-PAR light meters (port and starboard) @ 30sec intervals
NUTRI2	Four channel autoanalyser, logging NO_2, NO_3, PO_4 and SI @ 30sec intervals
FLUTE	Deck fluorometer and transmissometer @ 30sec intervals
TSG103	Deck thermosalinograph @ 30sec intervals
SOLI	Kipp & Zonen solar integrator @ 10min intervals
RD200A	Bridge echo sounder (water below keel) @ 10sec intervals
GPS_TRIM	Trimble Navigation 4000AX GPS Surveyor @ <5sec intervals
BIN_GYRO	Ship's gyro-compass @ 1sec intervals
WINCH	Seametrix Cable Metering System @ 1sec intervals
RVS_CTDF	Neil Brown MkIII CTD @ 1sec intervals

Also logged directly to the Level C was the ship's ADCP system.

The Chernikeeff log was non-operational during this cruise, so there is no data on the ship's speed through the water.

The Magnavox MX-1107 satellite navigator is normally logged as a backup to GPS. Unfortunately, it could not be logged on this cruise due to a fault in either the setup of the navigator or the setup of the Level A.

The Simrad EA-500 dual channel echo sounder could in theory be logged by a MkII Level A, but despite the fact that data was arriving at the Level A, the Level A would not output SMP to the Level B.

In addition to data logged in real-time data from the Endeco dissolved oxygen was transferred via 5.25" floppy disk from the Amstrad PC to the level C via the translation PC. The data were then processed to take account of salinity.

Data logged from the CTD dips was processed from counts into real units using calibration data supplied by Robin Powell of the Sensors group.

Data logged from the thermosalinograph was also calibrated into real units.

The following plots were provided:

Proposed and actual track over both Humber/Wash and Humber/Tweed grids.

Contour plots of transmission during 3 CTD yoyos.

Contour plots of temperature, salinity, transmission, fluorescence and bathymetry during the 1st and 2nd Humber/Wash runs, and the Humber/Run.

A real-time plot of temperature, salinity, transmission and fluorescence against time was displayed on the M2250 graphics terminal in the main lab for the majority of the cruise.

10. DATA BANKING (BODC)

BODC personnel participate on research cruises to fulfil the following objectives:

- Ensure that a complete record is maintained of all data gathering activities on the cruise with particular reference to less formalised activities such as sampling from the non-toxic supply.
- Maintain a watch on the automatically logged data to be processed by BODC to ensure instrumental problems are noted as quickly as possible and that all information required for processing is available.
- Ensure that a complete record of all protocols used on board is maintained for subsequent incorporation into metadata.
- Contribute to the running of the cruise by fulfilling watchkeeping duties.

The data management objectives for CH115A were fully achieved. The sample logging strategy based on Excel spreadsheets developed on CH99 and CH108 was used and worked well. Thanks to the co-operation of all those who sampled on the cruise.

The monitoring of the underway data was greatly assisted by the provision of real-time graphical displays in the main laboratory. The system based on LabView was particularly useful because of the degree of user control over the format of information presentation. The variable x-axis time scale and the ability to temporarily hide channels were particularly useful. It would greatly benefit future cruises if thermosalinograph and autoanalyser data could be incorporated into graphical time series display.

A report was compiled of all sampling protocols used during the cruise. Calibration data, instrument serial numbers and operational information from RVS were completed and presented in a readily usable form.

11. GRAVIMETRIC SAMPLING (UCNW)

Filtration of bottom and surface water samples was carried out at each station using GF/C filters to establish the mass of SPM and allow calibration of transmissometers.

Simultaneous samples of 4m depth water using the CTD rosette and the Deck transmissometer were also taken in areas of distinctly different SPM load, to allow calibration between the continuous transmissometers reading provided by the deck unit and the discrete samples taken by the CTD mounted transmissometer.

Water samples were also collected for further on-shore analysis using a lazer sizer for determination of particle size distributions and a video microscope for particle shape analysis in preparation for the deployment of this equipment aboard *Challenger* on cruise CH115 Leg 3.

APPENDIX (1) Holderness Mooring Instrumentation

Mooring deployments and instrument set-ups for duration:

1) 8 October to 10 November ≈ 33 days

2) 10 November to 10 January ≈ 60 days

3) 10 January to 4 February ≈ 25 days

Station		Instrument/rig
N_1 - S_1	(1)	PMP system with buff marker buoys.
	a)	1 MHz ADCP sampling at 10 min with approx 600 pings.
	b)	S4 CM with 20 Mbyte, Obs, Pressure sampling for 20 min with one reading per sec at intervals of 1 hr.
	c)	Pressure wave recorder, PWR Sampling for 20 min with 2 readings per sec at intervals of 3 hrs. Plus 600 sec integration for 10 min.
	d)	Transmissometer TRB-2 (WSO). Sampling at 1 min intervals with 10 cm patch length and C/T.
	e)	ABS system
	f)	Benthos release
N_1 (2)		Wave recorder buoy
N_2 - S_2	(1)	PMP system with buff marker buoys.
	a)	1 MHz ADCP sampling at 10 min and ≈ 600 pings
	b)	S4 CM with 256 Kbytes Sampling for 64 sec with one reading per sec at intervals of ½ hr for 30 day deployments, and 1 hr for 60 day deployments
	c)	PWR Sampling for 20 min with 2 readings per sec at intervals of 3 hrs. Plus 600 sec integration for 10 min.
	d)	Transmissometer TRB-2 (WSO) Sampling at 1 min intervals with 10 cm path length and C/T.
	e)	EMP 2000, Obs (PML) Sampling at 10 min intervals for 30 day deployment, and 20 min intervals for 60 day deployment
	f)	Benthos release
N_2 (2)		Directional wave buoy with shallow mooring.

N_3 - S_3 (1) PMP system with toroid buoy

a) 1 MHz ADCP sampling at 10 min and ≈ 600 pings

b) S4 CM with 128 Kbytes

Sampling for 32 sec with one reading per sec at intervals of ½ hr for 30 day deployment, and 1 hr for 60 day deployment

c) PWR

Sampling for 20 min with 2 readings per sec at intervals of 3 hrs. Plus 600 sec integration for 10 min.

d) Transmissometer

i) TRB-2 (WSO) at site N_1

Sampling at 1 min interval with 10 cm path length and C/T.

ii) TRB-1 (UCNW) at site S_1

Sampling at 1 min interval with 25 cm path length.

e) Benthos release

N_3 (2) Directional wave buoy with deep mooring

N_3 (3) Met buoy

N_4 (1) Pop-up 'L' mooring with Spar buoy.

a) 1 MHz ADCP sampling at 10 min and ≈ 600 pings

b) PWR

Sampling for 20 min with 2 readings per sec at intervals of 3 hrs. Plus 600 sec integration for 10 min.

c) Transmissometer TRB-1 (UCNW)

Sampling at 1 min intervals with 25 cm path length.

d) Benthos release + 100m spooler.

S_4 (1) PMP system with toroid buoy.

a) 1 MHz ADCP sampling at 10 min and ≈ 600 pings.

b) S4 CM 128K memory

Sampling for 32 sec with one reading per sec at intervals of ½ hr for 30 day deployment, and 1 hr for 60 day deployment

c) PWR

Sampling for 20 min with 2 readings per sec at intervals of 3 hrs. Plus 600 sec integration for 10 min.

d) Transmissometer TRB-1 (UCNW)

Sampling at 1 min interval with 5 cm path length.

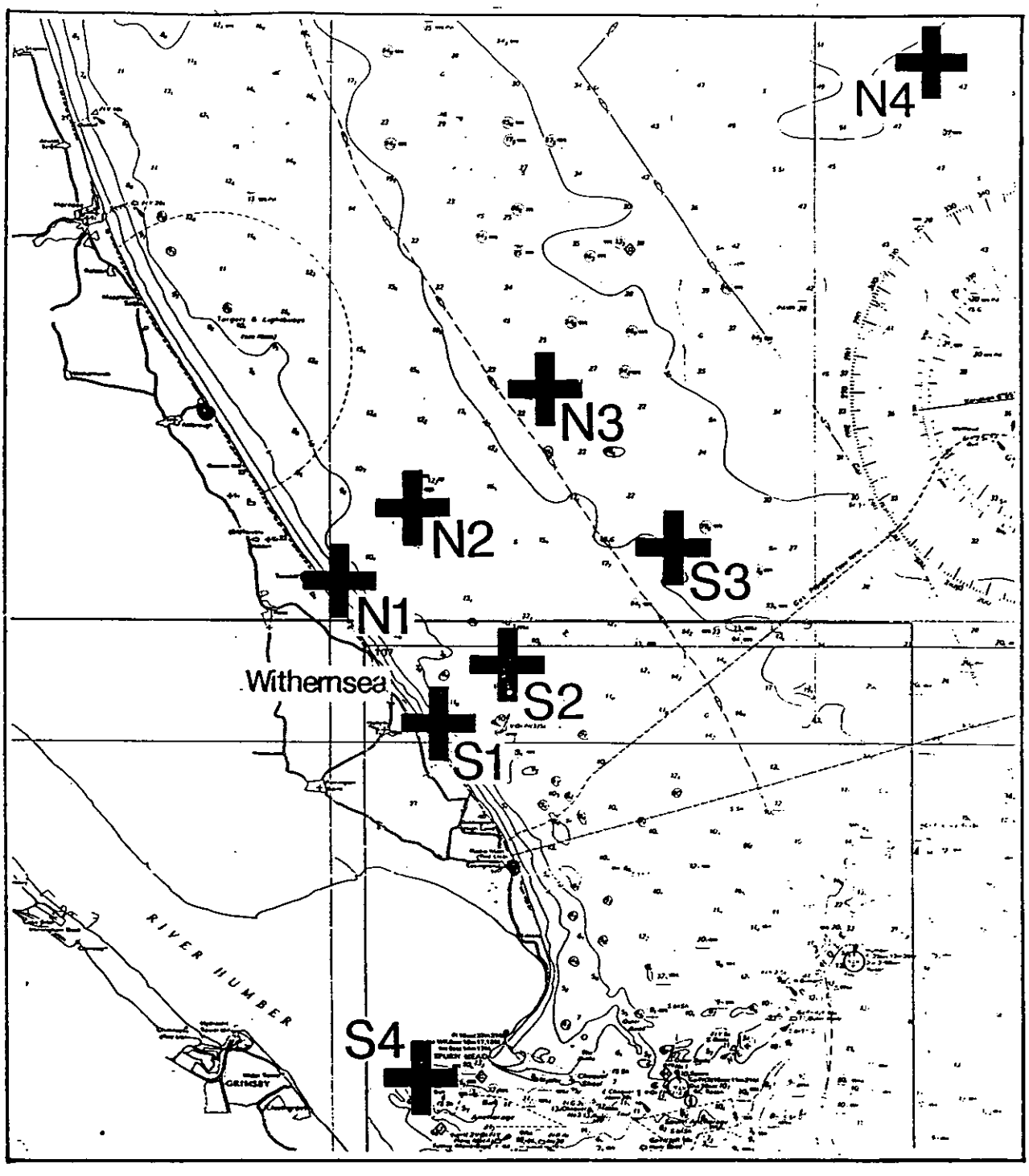
e) Benthos release.

APPENDIX 2 - Mooring Positions

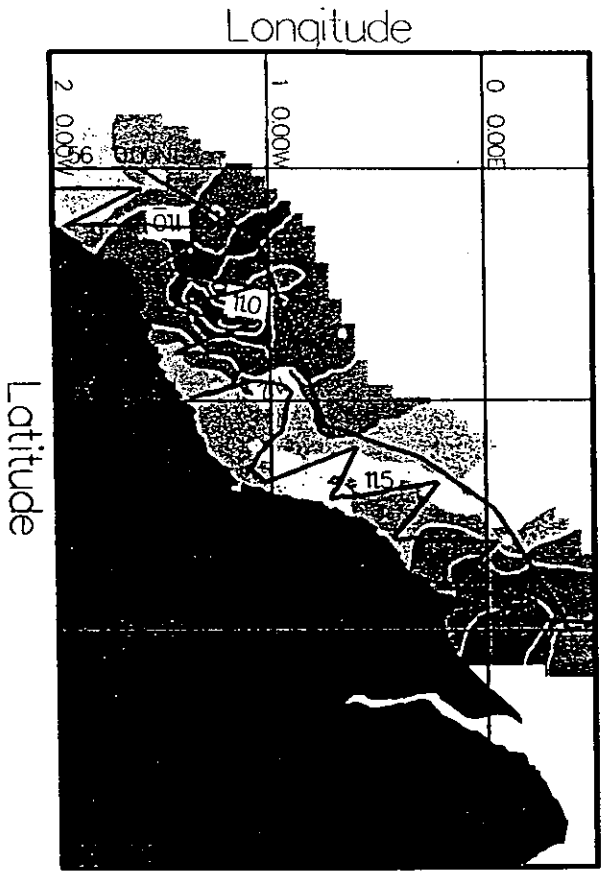
Station	Latitude	Longitude	Date/Time
S1	53 42.62 N	0 04.69 E	(8/10) PMP 09.20
S2	53 43.89 N	0 07.49 E	(8/10) PMP 08.38
S3	53 46.78 N	0 13.87 E	(7/10) PMP anchor
	53 46.75 N	0 13.79 E	PMP frame 13.26
S4	53 34.08 N	0 03.42 E	(10/10) PMP 10.15
N1	53 45.83 N	0 00.49 E	(9/10) PMP 09.00 (*JANET M*)
	53 45.84 N	0 00.77 E	Waverider
N2	53 47.51 N	0 03.34 E	(8/10) DWR 13.23
	53 47.53N	0 03.51 E	PMP 14.21
N3	53 50.58 N	0 09.6 E	(7/10) MET BUOY 07.15
	53 50.35 N	0 09.59 E	PMP 07.54
	53 50.57 N	0 09.11 E	DWR 09.05
N4	53 58.51 N	0 25.27 E	(7/10) PMP 20.36

CTD CASTS made on Humber-Wash Grid					
Cast		Lat	Lon	Water	Site
ID	Date & Time	deg N	deg E	depth (m)	Code
CP132	12/10/1994 08:40	53.8582	-00.0308	16.5	HW1
CP182	15/10/1994 15:28	53.8579	-00.0330	18.1	HW1
CP116	10/10/1994 20:57	53.4145	00.7668	23.1	HW10
CP191	16/10/1994 11:26	53.4179	00.7632	19.3	HW10
CP117	10/10/1994 22:11	53.2512	00.6509	27.2	HW12
CP119	11/10/1994 02:06	53.2554	00.6507	23.3	HW12
CP190	16/10/1994 10:06	53.2523	00.6489	22.0	HW12
CP118	11/10/1994 00:19	53.0017	00.4025	28.4	HW13
CP189	16/10/1994 08:13	53.0011	00.3998	31.7	HW13
CP188	16/10/1994 04:28	53.1496	00.8681	20.3	HW13A
CP121	11/10/1994 05:40	53.0013	01.0600	16.5	HW14
CP187	16/10/1994 02:36	52.9993	01.0701	20.5	HW14
CP122	11/10/1994 08:13	53.2917	01.3486	24.1	HW15
CP126	11/10/1994 18:12	53.2926	01.3479	22.7	HW15
CP186	16/10/1994 00:14	53.2932	01.3491	23.4	HW15
CP123	11/10/1994 10:39	52.9010	01.5196	20.3	HW16
CP124	11/10/1994 12:06	52.7114	01.8204	35.5	HW17
CP125	11/10/1994 13:49	52.7792	02.2026	45.8	HW18
CP133	12/10/1994 12:33	54.0321	00.5169	51.7	HW2
CP134	12/10/1994 12:37	54.0318	00.5164	51.7	HW2
CP135	12/10/1994 12:42	54.0313	00.5162	51.7	HW2
CP136	12/10/1994 12:46	54.0309	00.5154	51.8	HW2
CP137	12/10/1994 12:50	54.0306	00.5156	51.8	HW2
CP138	12/10/1994 12:54	54.0306	00.5155	51.8	HW2
CP139	12/10/1994 12:58	54.0301	00.5150	51.5	HW2
CP140	12/10/1994 13:02	54.0298	00.5146	51.6	HW2
CP141	12/10/1994 13:06	54.0297	00.5143	51.5	HW2
CP142	12/10/1994 13:10	54.0296	00.5142	51.3	HW2
CP143	12/10/1994 13:14	54.0295	00.5138	51.5	HW2
CP144	12/10/1994 13:18	54.0294	00.5136	51.4	HW2
CP145	12/10/1994 13:22	54.0293	00.5131	51.2	HW2
CP146	12/10/1994 13:26	54.0298	00.5121	50.9	HW2
CP147	12/10/1994 13:30	54.0298	00.5125	50.5	HW2
CP148	12/10/1994 13:34	54.0301	00.5120	51.0	HW2
CP181	15/10/1994 12:33	54.0315	00.5124	52.6	HW2
CP131	12/10/1994 06:25	53.7237	00.1330	17.9	HW3
CP183	15/10/1994 16:48	53.7257	00.1314	20.1	HW3
CP129	12/10/1994 01:49	53.8939	00.6802	42.9	HW4
CP111	10/10/1994 10:35	53.5515	00.1296	19.7	HW5
CP194	16/10/1994 16:23	53.5509	00.1329	20.1	HW5
CP112	10/10/1994 13:56	53.7718	00.8365	31.5	HW6
CP128	12/10/1994 00:08	53.7678	00.8295	32.5	HW6
CP184	15/10/1994 19:48	53.7714	00.8305	31.9	HW6
CP114	10/10/1994 17:54	53.4812	00.4004	14.8	HW7
CP193	16/10/1994 15:02	53.4807	00.3986	16.9	HW7
CP113	10/10/1994 15:21	53.6527	00.9651	23.8	HW8
CP127	11/10/1994 22:24	53.6494	00.9671	27.2	HW8
CP185	15/10/1994 21:15	53.6505	00.9652	24.4	HW8
CP115	10/10/1994 19:04	53.3095	00.3529	14.8	HW9
CP192	16/10/1994 13:15	53.3073	00.3520	14.4	HW9

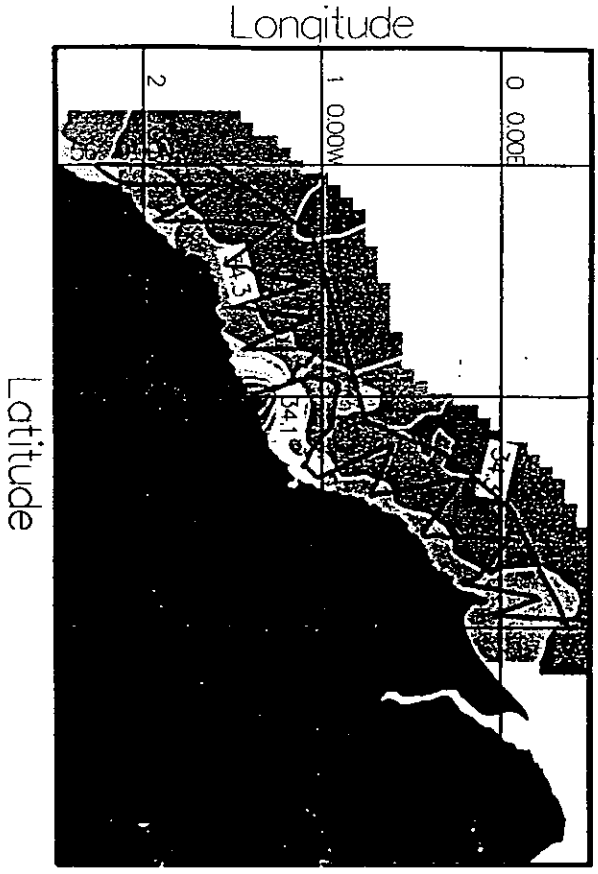
CTD CASTS made on Humber-Tweed Coastal Grid					
Cast		Lat	Lon	Water	Site
ID	Date & Time	deg N	deg E	depth (m)	Code
CP156	13/10/1994 04:34	54.5719	-00.7223	38.9	C10
CP157	13/10/1994 06:36	54.7997	-00.6006	62.4	C11
CP158	13/10/1994 09:25	54.6442	-01.0305	29.1	C12
CP159	13/10/1994 10:25	54.6904	-01.1171	28.6	C14
CP160	13/10/1994 14:44	55.0520	-00.9178	75.4	C15A
CP161	13/10/1994 15:48	55.0842	-01.0491	86.9	C17
CP162	13/10/1994 17:30	55.0126	-01.3653	24.4	C18
CP163	13/10/1994 19:30	55.2080	-01.0221	89.1	C19
CP164	13/10/1994 21:28	55.2056	-01.4452	44.8	C20
CP165	13/10/1994 23:12	55.3389	-01.0539	91.3	C21
CP166	14/10/1994 01:23	55.3901	-01.5027	40.5	C22
CP167	14/10/1994 03:10	55.4918	-01.0688	98.5	C23
CP169	14/10/1994 05:33	55.5676	-01.5502	37.6	C24
CP170	14/10/1994 07:15	55.7500	-01.2501	69.7	C25
CP171	14/10/1994 11:43	55.7605	-01.9363	32.6	C26
CP172	14/10/1994 13:30	55.9168	-01.5848	67.3	C27
CP173	14/10/1994 15:26	55.9170	-02.0817	68.9	C28
CP174	14/10/1994 16:33	55.9994	-02.2831	57.2	C29
CP149	12/10/1994 15:09	54.0373	00.3090	53.6	C3
CP175	14/10/1994 19:00	56.0011	-01.6024	76.5	C30
CP176	14/10/1994 21:47	55.7006	-01.0587	77.3	C31
CP177	15/10/1994 02:43	54.8892	-00.7466	67.5	C32
CP178	15/10/1994 04:41	54.7537	-00.3121	65.6	C33
CP179	15/10/1994 07:19	54.5240	00.0417	65.0	C34
CP180	15/10/1994 11:21	53.9989	00.3854	55.0	C35
CP150	12/10/1994 16:40	54.0493	-00.0483	23.1	C4
CP151	12/10/1994 17:54	54.1249	00.2319	55.8	C5
CP152	12/10/1994 19:53	54.1917	-00.2164	29.7	C6
CP153	12/10/1994 21:39	54.3842	00.0498	63.5	C7
CP154	12/10/1994 23:52	54.3976	-00.4383	39.4	C8
CP155	13/10/1994 01:48	54.6430	-00.2176	69.6	C9



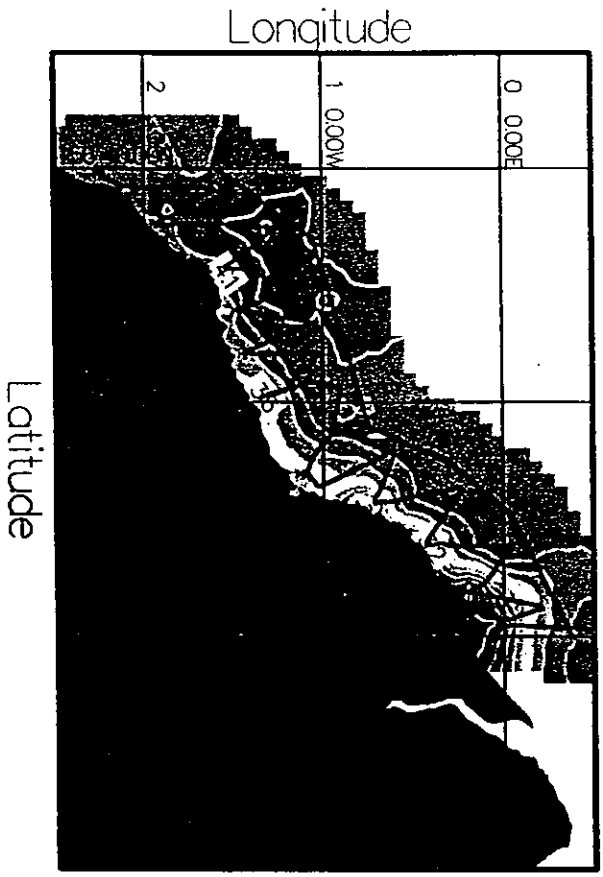
1. PMP Deployments



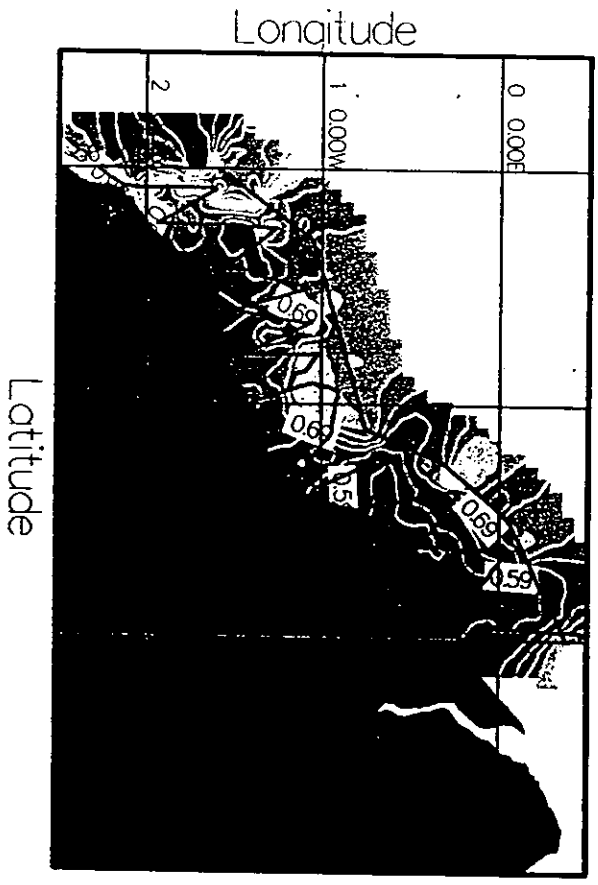
Temperature



Salinity

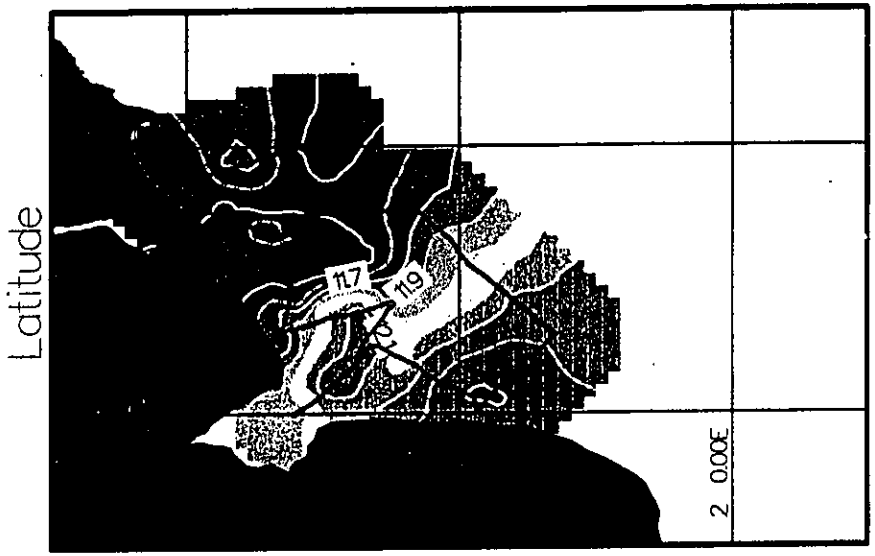


Transmission

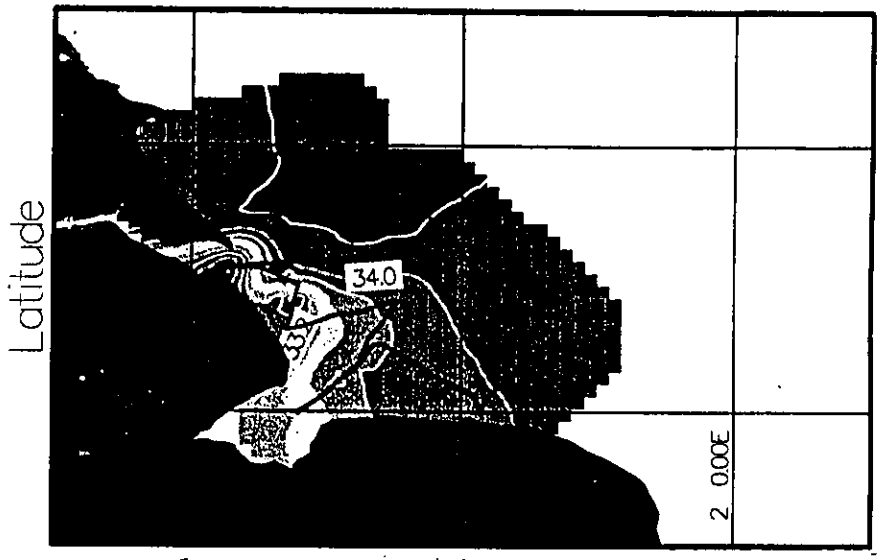


Fluoresence

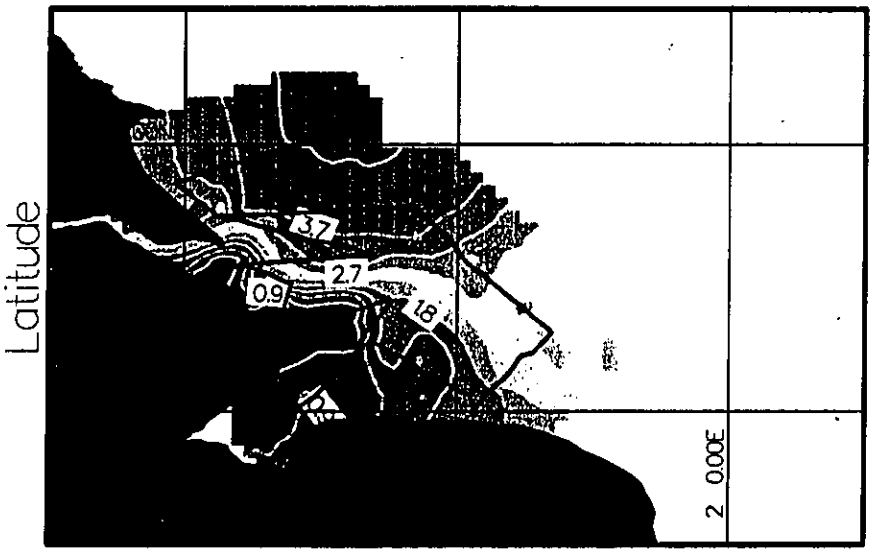
Humber/Tweed area



Temperature



Salinity



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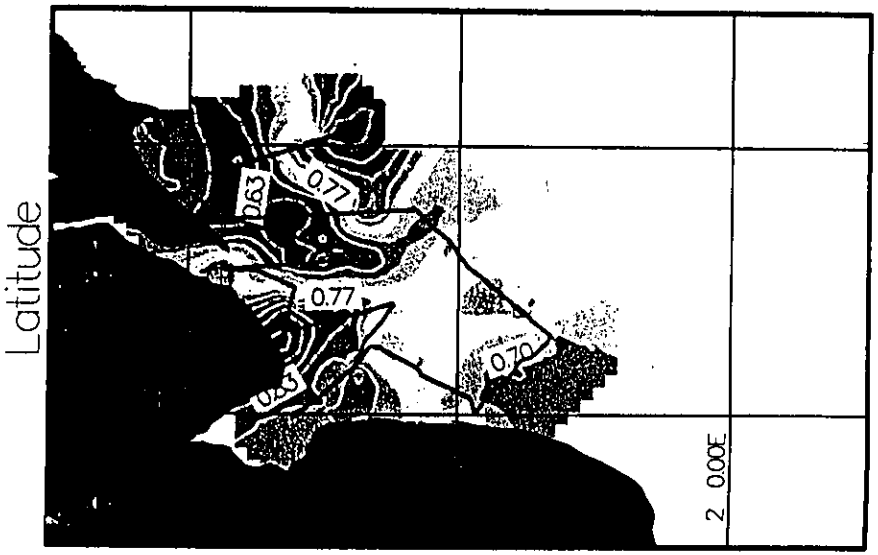
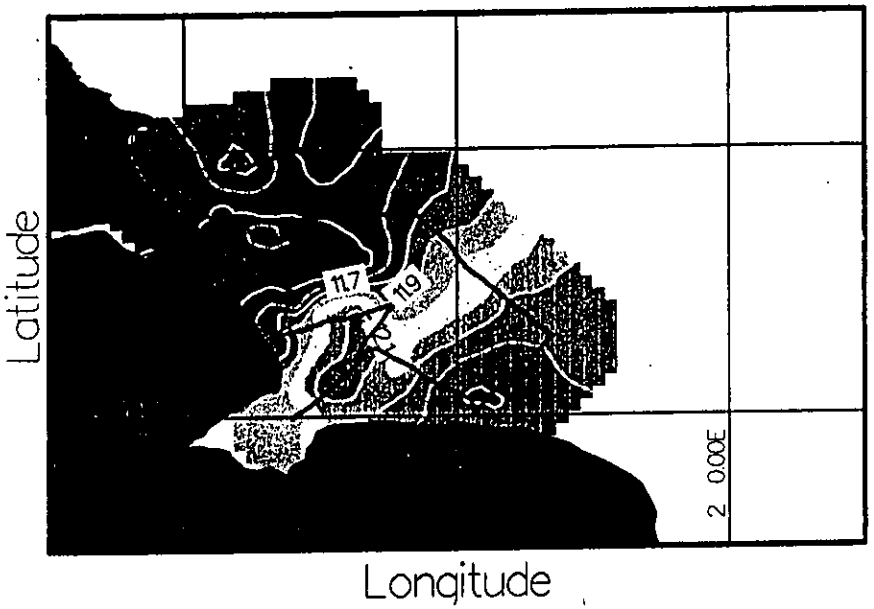
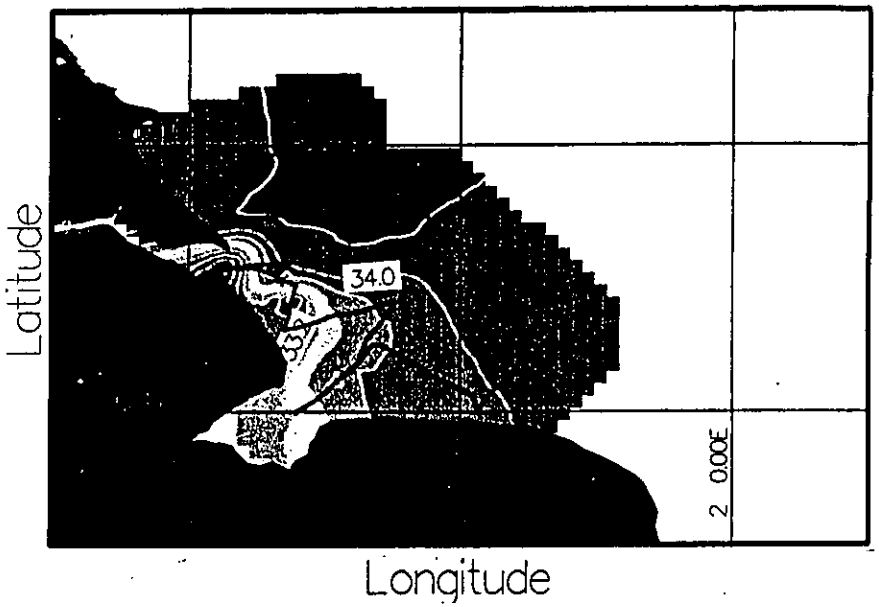


Fluoresence

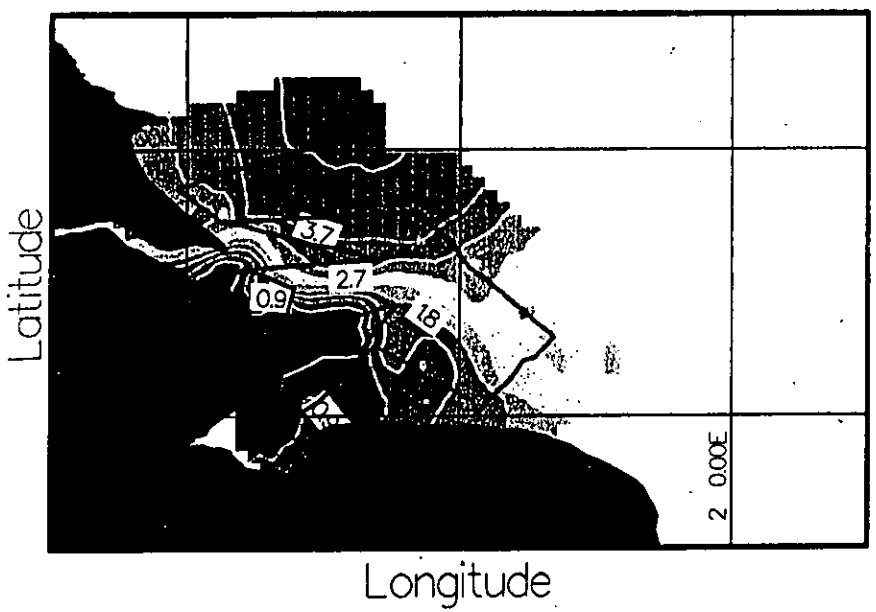
Humber / Wash area. (2nd run)



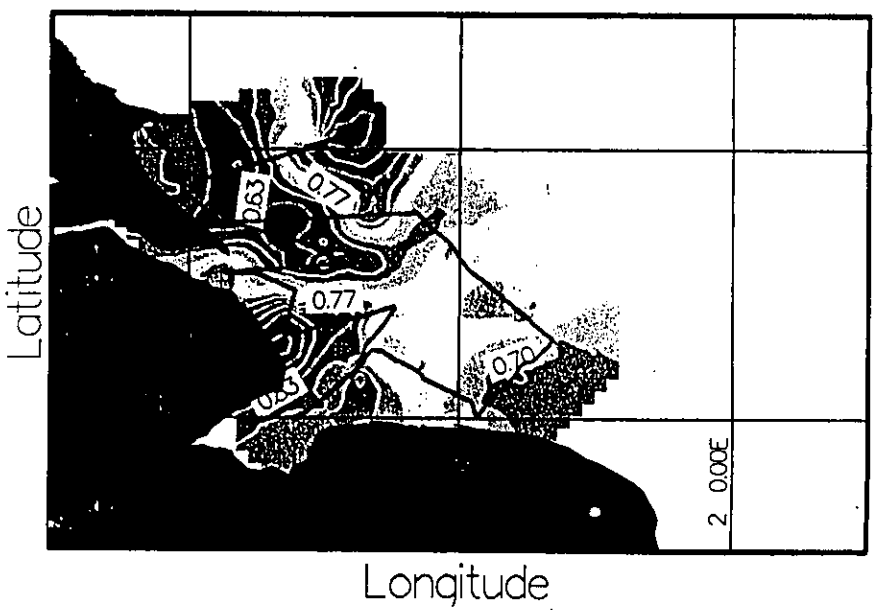
Temperature



Salinity



Transmission



Fluoresence