Eastern Atlantic Experiment 1997

RRS Challenger 09/05/97 - 02/06/97

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ATMOSPHERIC CHEMISTRY STUDIES IN THE OCEANIC ENVIRONMENT

MARINE AEROSOL AND GAS EXCHANGE

EASTERN ATLANTIC EXPERIMENT 1997

RRS CHALLENGER 09/05/97 - 02/06/97

UEA
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Acknowledgements

I would like to express my thanks to everyone involved in the organisation and operation of Challenger Cruise 133, the second of the ACSOE/MAGE Eastern Atlantic Cruises.

Much was learnt from the very successful first Eastern Atlantic cruise in June 1996 and I believe that we built on our experiences then, achieved a wider range of objectives and had a similarly successful cruise. So my thanks go to everyone who was part of 'UEA Girlies on Tour', all the scientists, Robin Powell, Gareth Knight and Martin Bridger from RVS-Scientific and the Master Geoff Long and his Officers and Crew.

Additionally I would like to thank Andy Louch and Sue Scrowston in the RVS-OPS office and Kev Smith for his help during mobilisation and demobilisation.

My hugest thanks go to my boss Tim Jickells for both co-ordinating the ship operation from the Land Station at Mace Head and also for keeping us all entertained with stories of his attempts to find tinned custard on the west coast of Ireland.

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Martin Wyness	Seaman
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Keith Pringle	Motorman
Chris Elliott	Catering Manager
John Haughton	Chef
Graham Mingay	Steward
Mick Stephen	Steward

Atmospheric Chemistry Studies in the Oceanic Environment

Atmospheric Chemistry Studies in the Oceanic Environment (ACSOE) is a five year NERC Research Programme. It aims to improve understanding of natural processes in the remote marine atmosphere and how these processes are modified by the presence of continental emissions, particularly those of anthropogenic origin. The project concentrates on the chemistry of ozone and on the evolution and modification of aerosols and cloud condensation nuclei in the atmosphere. Both these have a major influence on global climate.

ACSOE consists of three consortia. This work forms part of the **M**arine **A**erosol and **G**as **E**xchange (MAGE) subproject.

The Eastern Atlantic Experiment 1997

This experiment was the second in the series of ACSOE/MAGE cruises in the Eastern Atlantic. As for 1996, the rationale behind the experiment was:

SULPHUR COMPOUNDS

- Gas phase dimethyl sulphide (DMS), derived from marine phytoplankton, is emitted from the oceans to the atmosphere in amounts comparable to the emission of sulphur dioxide from fossil fuel combustion.
- Once in the atmosphere, DMS is converted to sulphate aerosol particles through sulphur dioxide, methane sulphonic acid and sulphuric acid.
- DMS therefore contributes to the acidity of rain and aerosols.
- In addition, sulphate particles are very important cloud condensation nuclei (CCN) influencing the amount of cloud over the ocean which governs the amount of solar radiation which is reflected back into space.

NITROGEN COMPOUNDS

- The ocean is probably a net source of ammonia which partially neutralises some of the acidity formed from DMS transformations. It therefore affects the acid/base balance of rain and aerosols and the amount of CCN formed.
- Nitrogen oxides (from high temperature hydrocarbon combustion) are oxidised to nitric acid providing a source of acidity in polluted air.
- Reaction of nitric acid with seasalt as an air mass moves from land to sea increases the particle size with which the nitrogen is associated and increases the speed with which the particles are deposited to the oceans.

Atmospheric deposition of biologically essential elements such as nitrogen and iron may stimulate the phytoplankton which produce DMS. Once in the atmosphere, metals such as iron and copper may influence the rate of

sulphate aerosol production. Thus the cycles of sulphur, nitrogen and metals are thought to be linked and important in climate control.

Aims of the EAE '97 Experiment

1. Quantify the input of DMS and a range of other important biogenic gases into a parcel of air by measuring their concentrations in air and surface seawater and calculating their flux to the atmosphere using meteorological data from the ship.
2. Measure the speciation of sulphur, nitrogen and metals in the gas phase, in size fractionated aerosols and in precipitation.
3. Examine the oxidation of DMS and its reaction with nitrogen species as a function of time.
4. Investigate the "bursts" of new particle formation as a results of these gas-to-particle transformations through a detailed study of the physics and chemical composition of fine particles.
5. Discriminate between natural and anthropogenic fractions of sulphur and nitrogen using isotopic measurements and use this information to try to identify the branching ratio of MSA to SO_2 in the atmospheric oxidation of DMS.
6. Model the data via a zero-dimensional time-dependent photochemical box model of an air mass in the marine boundary layer.

Measurements were made:

1. At The Mace Head Atmospheric Research Station which is located on the west coast of Ireland at 53^o 19.34´ N, 009^o 54.14´ W and operated by University College, Galway.
2. Aboard RRS Challenger which operated in a 200 by 200 nautical mile box between 51^o and 55^o N and 010^o and 015^o W.
3. In the air using The Cranfield Jetstream Research Aircraft to link measurements made on land and at sea and provide profiles of aerosol size and distribution throughout the marine boundary layer.

Both the MAGE and OXICOA (**OXI**dsing **C**apacity of the **O**ceanic **A**tmosphere) consortia were working at Mace Head during this period.

Information on the measurements made at Mace Head by both groups can be obtained from the ACSOE Project Manager, Dr. Bill Sturges at UEA or on the ACSOE home page (http://www.uea.ac.uk/~e011/acsoe/acsoe.html).

The Role of RRS Challenger

1. To quantify the input of biogenically produced gases (including DMS, isoprene and methyl iodide) into a parcel of air, it is first necessary to determine their surface water concentrations on both spatial and temporal scales. Measurements of surface water biogenic gases were, therefore, made onboard RRS Challenger throughout the cruise. Initially a systematic survey of the surface waters between Mace Head and the Porcupine Bank was carried out to broadly define the emission field of these gases.

After the initial survey, Challenger operated in a series of modules, depending on the weather.

2. In 1996, highest concentrations of DMS were seen about 100 miles offshore, possibly related to upwelling along the shelf break. This year a survey of the surface waters in this region was conducted to determine if this region is a consistent source of biogenic gases to the atmosphere.

3. To examine changes in concentration over a daily time period, water and atmospheric samples were taken over a 24 hour period with the ship head to wind. This mode was conducted both offshore and in the coastal zone.

4. Processes controlling the production and emission of gases from seawater can be determined more easily if the vertical profile of the species is known. A series of water bottle casts were, therefore, conducted at varying locations within the sampling area.

5. Under warm calm conditions seabreezes can develop with resulting short term mixing of marine and continental air. Under likely meteorological conditions the ship was positioned between 10 and 20 miles offshore and atmospheric sampling was conducted.

The default module was the 'Lagrangian' mode, as in 1996.

6. The LAGRANGIAN MODULE - In order to examine the oxidation of DMS and its reaction with nitrogen species, measurements have to be made within the same air mass but separated by time. Unfortunately it is not possible to add a deliberate tracer to the air to ensure that the same body of air is measured each time. Use was therefore made of forecast five day air parcel back trajectories provided by The British Atmospheric Data Centre (BADC). In the event of connected air flow the ship was positioned approximately 12 hours air transit time from the land station at Mace Head, either downwind or upwind of the site depending on the wind direction.

The sampling delay allows changes in composition as a function of time within the same air mass to be determined. The very limited aircraft time was used to take measurements between the ship and Mace Head. During operation in this module, the ship functioned in two modes. Each day was split into two 12 hour periods. Half the time head to wind for atmospheric measurements, to prevent contamination of samples from the ship's stack, and the remaining time in survey mode to assess the spatial and temporal variability of DMS. In the event of rain, the ship was stopped and positioned head to wind. Surveying recommenced once the rain ceased.

In addition to these modules, it was also planned to take samples in the coastal waters around Mace Head using an inflatable boat to try to determine the importance of the seaweed beds there. As a result of a number of difficulties it proved impossible to achieve this aim. The reasons for this and ways hopefully to avoid this happening again are outlined in the Section 'Comments regarding ship operation.'

Measurements Made and Samples Collected

Measurements Made Onboard:

- Continuous measurement of latitude, longitude, bathymetric depth and continuous Acoustic Doppler Current Profiler (ADCP) measurements to 500 m.
- Underway measurements of surface water salinity, temperature, optical attenuance and fluorescence using the ships non-toxic supply.
- Continuous meteorological measurements (wind speed, wind direction, air temperature, relative humidity, barometric pressure, solar radiation, photosynthetically available irradiance and photosynthetically available radiance).
- Atmospheric and surface water DMS measurements with onboard analysis by gas chromatography.
- Particulate phase DMSP determination by alkaline hydrolysis and subsequent measurement of the resulting DMS by gas chromatography.

DMSP = dimethyl sulponiopropionate the precursor of DMS

- Atmospheric and surface water measurements of non-methane hydrocarbons (including isoprene) using gas chromatography.
- Atmospheric and surface water measurement of methyl halides with onboard analysis by gas chromatography.
- Surface water measurements of CO.

- Continuous measurements of atmospheric NO, NO_2, O_3 and aerosol particle size.
- Survey of seabirds and cetaceans.

Samples Taken for Analysis on Land.

- Aerosol samples for the determination of major ions (including the stable isotope composition of nitrogen and sulphur) and trace metals.
- Gas phase samples using impregnated filters for SO_2 and NH_3 determination.
- Precipitation samples for the determination of major ions and trace metals.
- Surface water samples for chlorophyll determination, phytoplankton identification and nutrient analysis.

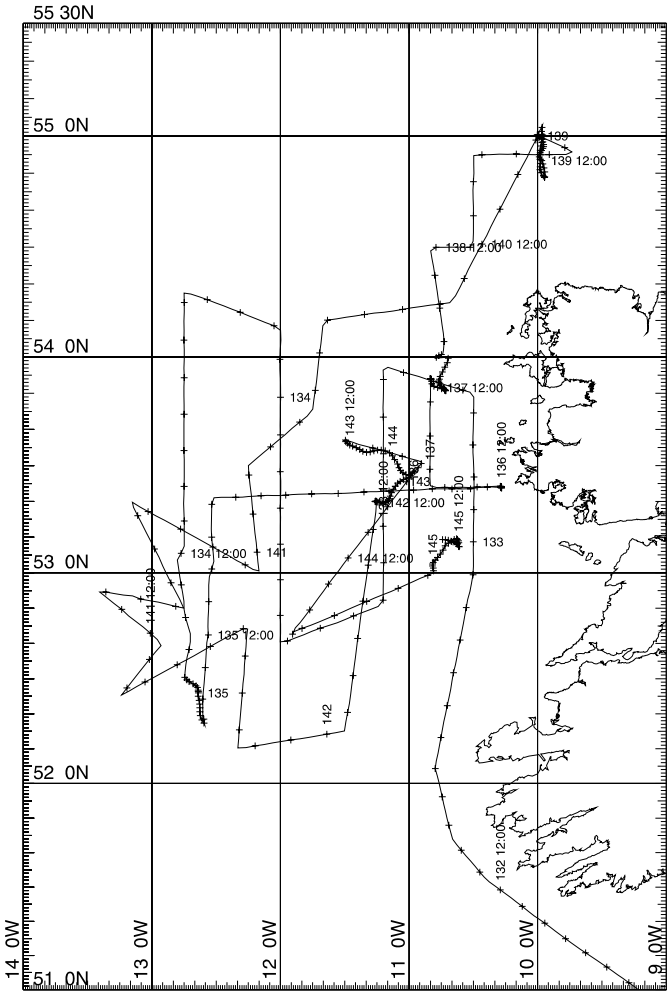
Overview of Cruise Activities.

Gas phase DMS, Non-Methane Hydrocarbons, Halocarbons and CO were analysed for in both surface seawater and at depth. Air concentrations of these species, NO_x and O_3 were also measured and atmospheric samples for subsequent determination of SO_2, NH_3, aerosols and rainwater were collected whilst the ship was head to wind to prevent contamination from the ships stack.

Leg Name	Start Date and Time	End Date and Time	Comments
Survey 01	12/05/97 18:09	14/05/97 16:36	map spatial variability through the sampling area opportunistic aerosol sampling while surveying, westerly winds rain commenced 14/05/97 at 19:40
Transect to Slyne Head	15/05/97 08:01	16/05/97 04:01	intermittent rain through day and night winds swinging round to easterlies
Nearshore Diurnal Study, Slyne Head*	16/05/97 05:07	17/05/97 07:04	
Water Profile, Slyne Head	16/05/97		strong smell of seaweed
Profile 54° N 010.7° W*	17/05/97		very calm
Transect to NE	18/05/97 08:31	18/05/97 20:00	absolutely huge rain event from 16:23 until 20:40
NE Deep Water Profile^	19/05/97		profile on shelf break, sunny during day, fog developed at night
Shelf Edge Survey	20/05/97 08:30	21/05/97 23:00	survey shelf break region where DMS was high in 1996 opportunistic aerosol sampling during period of northerly winds
Jetstream Overpass No. 1 (W of Mace Head)	22/05/97		water column, air and aerosol sampling
Jetstream Overpass No. 2 (W of Mace Head)	23/05/97		low wind speed easterlies recommence
Dog Leg	24/05/97 10:00	24/05/97 19:01	very sunny and hot
Water Profiles, Close to Mace Head*	25/05/97		strong seabreezes
Coastal Water Transect Near Aran Isles	26/05/97 08:32	26/05/97 20:02	increased winds in afternoon
Transect to Fluorescence Maximum	27/05/97 10:05	27/05/97 19:01	
Transect to Deep Water Maximum	28/05/97 10:35	28/05/97 19:31	winds change to southerly, very sunny and hot
Deep Water Profile No. 1^	29/05/97		including offshore diurnal studies
Deep Water Profile No. 2	30/05/97		very sunny, moderate winds

* Beware tide and oil/sewage from ship
^ Surface fluorescence increase during profile

Full and Intermediate Cruise Tracks



MERCATOR PROJECTION

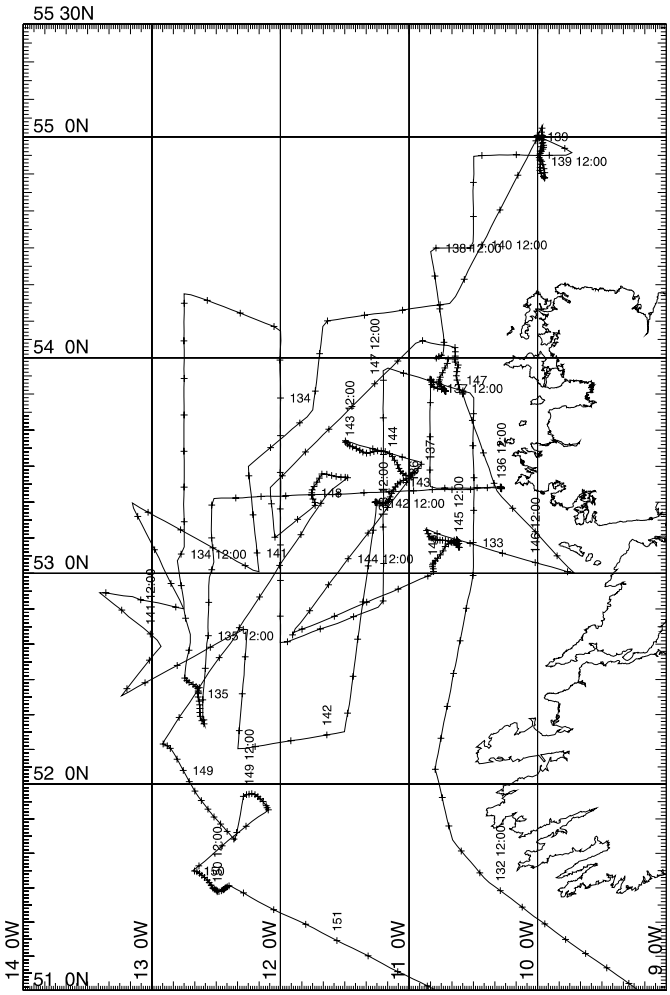
SCALE 1 TO 2250000 (NATURAL SCALE AT LAT. 55)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 51

GRID NO. 1

— Track plotted from bestnav

Challenger 133 Cruise Track (Week 2)



MERCATOR PROJECTION

SCALE 1 TO 2250000 (NATURAL SCALE AT LAT. 55)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 51

GRID NO. 1

— Track plotted from bestnav

Challenger 133 Cruise Track (Week 3)

Comments Regarding Ship Operation.

Huge thanks go to RVS-Scientific - Robin Powell, Gareth Knight and the new boy Martin Bridger - for yet again being complete stars and making sure everything operated successfully. Also to Polly Machin at BODC for making sure all occurrences (well scientific ones!) were logged and for sorting out all the subsequent underway data. Thanks also to RVS-Marine for all their help at sea and to Kev Smith for help during mobilisation and demobilisation.

One individual small event that made life much easier was moving the computer logging the meteorological data from the old plot into the main laboratory. We would like to thank those involved for doing this. Perhaps additional comments (units/offset on wind vane etc.) could be incorporated into the display to make this facility even more useful.

Attempts to use Inflatables in Coastal Waters.

Before I explain the major problem experienced during CH133, I would like to repeat my thanks to the Master, Geoff Long and his Officers and Crew for all their help during this cruise. We successfully achieved all but one of our objectives.

One of the major objectives of this work was to determine if the macroalgal beds in the coastal waters off Ireland are a significant source of the important biogenic gases Dimethyl Sulphide, Isoprene and Methyl Iodide. It was therefore proposed, at the Cruise Planning Meeting, to take samples within the seaweed beds using an inflatable boat launched from Challenger.

This was accepted and, since the seaweed beds occur in shallow rocky waters extending several miles from the coast, it was suggested that UEA's inflatable was used in addition to the inflatable on Challenger. This allowed two boats to be out together, each acting as a safety boat. It was made clear at the cruise planning meeting that the UEA inflatable could only be used if a Ships Officer was aboard and in charge. We suggested that UEA personnel would be trained to operate the UEA inflatable, this was agreed with but not deemed essential since it was likely that one of the ships crew would actually operate the boat.

With regard to Diplomatic Clearance, we were told we would only need additional clearance to that already applied for on the notification form, if we actually wanted to land. Since exchange of samples between ship and the

land site for intercomparison purposes would have been scientifically advantageous, additional clearance to land was applied for in February 1997.

Once however at sea, the Master informed me that we could not operate in the coastal waters of Ireland unless we had full Diplomatic Clearance to land and that, although the UEA inflatable was more than adequate, the ships inflatable was unsuitable and could not be used as a safety boat. The additional complication was that there was no Officer aboard except himself who had a small boat licence.

Although having major problems trying to obtain Diplomatic Clearance, the Master was still not happy about the use of the inflatable boat. He was uninformed as to the objectives of the cruise until just before sailing and, as outlined above, his worries were safety-based. I agreed absolutely with him that safety was paramount. Since we could not use the ships inflatable as a safety boat we decided that it was not possible to operate a single inflatable in the shallow waters around Ireland and this objective was abandoned.

If small boat work is to be allowed aboard NERC vessels there must be suitably trained personnel within the ships company and problems obtaining necessary clearance for work in coastal regions must be cleared up. Most importantly the Master must be informed in advance of the cruise objectives, if possible by being present at the cruise planning meeting or, if not, through a meeting with RVS-OPS in advance of the cruise. Any ship operating problems could then be made clear to the PSO and any potential problems sorted out prior to sailing.

Cruise Reports from Individual Participants

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METHYL IODIDE AND HALOCARBONS

Methyl iodide was measured in seawater taken from the ship's non-toxic supply and Niskin bottles for deeper waters. Detection was by ECD gas chromatography after purging a 100 ml sample with pure nitrogen and trapping the evolved gases at -150 ^{o}C. The system was calibrated by injections of methyl iodide dissolved in heptane on a daily basis.

Initially the chromatograph was found to be contaminated by a substance which interfered with the latter stages of the chromatographic run. However, the peak for methyl iodide was not affected and was well resolved throughout the cruise. The contamination was steadily removed and information on the occurrence of other organo-iodine and organo-halogen compounds should be accessible for the later stages of the cruise.

There are some clear trends in methyl iodide levels in the surface waters studied. Concentrations in the near-shore waters of the eastern Atlantic were much higher than those in off-shore waters. The initial survey of the area was carried out after a period of relatively high wind speeds. When these waters were re-visited after several days of calmer weather there had been a significant increase in methyl iodide concentration, which is consistent with a lower rate of sea to air gas transfer.

Depth profiles of methyl iodide showed the majority of the gas to be present in the upper 100m of the water column, although it was detectable at 900m. Vertical distributions within the upper 100m varied from station to station and the profile on some occasions followed that of DMS and on others was more similar to isoprene.

Thanks to PSO Lucy for a jolly cruise and the non-toxic team for being gassy in their own special ways.

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NON-METHANE HYDROCARBONS IN AIR AND SEAWATER

Non-methane hydrocarbons (NMHCs) are important reactive gases in the atmosphere, which provide a sink for the hydroxyl radical (OH) and are key players in the production and destruction of ozone in the troposphere. The importance of anthropogenic emissions of NMHCs and biogenic emissions of monoterpenes and isoprene (2-methyl 1,3-butadiene) from the terrestrial biosphere has long been recognised and extensively studied. However, the ocean as a source of reactive species such as isoprene has only recently been identified. The emission of isoprene and other NMHCs from the ocean may provide a significant source of reactive organics to the atmosphere over the remote oceans. The mechanism of production of these gases in seawater is poorly understood. It is believed to be a combination of both photochemistry and emission of NMHCs or their precursors from phytoplankton.

Seawater and air samples were collected throughout the cruise and analysed *in situ* by Gas Chromatography and Flame Ionisation Detection (GC-FID). A 1.4 litre sample of seawater was purged with CP nitrogen at 60 ml min^{-1} for 30 min. to remove the trace gases. These volatile trace gases in the nitrogen stream were passed through a water droplet trap and a Nafion dryer before being cryogenically concentrated in a 1/8" stainless steel trap containing 80 mesh glass beads held at -185°C by a headspace of liquid nitrogen. This temperature trapped all trace gases of interest whilst allowing the free passage of nitrogen and oxygen. The sample loop was heated to 95°C to inject the sample into the GC where the components were separated on an Al_2O_3 PLOT column. The method is described fully in Broadgate (1995). Air samples were preconcentrated in the same way. Approx. 30 aliphatic C_2 - C_7 NMHCs were separated and quantitatively analysed for each sample. DMS was also observed, but the analytical conditions were not optimised for this compounds so it was not quantified.

Air samples were collected via 8 m of 1/4" stainless steel tubing mounted forward of the bridge on the raft deck. A battery operated metal bellows pump was used to fill a 3.2 l stainless steel canister to ca. 30 psi. Seawater samples were collected from both the Niskin bottle on the hydrowire and the ship's underway seawater supply. The underway samples were collected simultaneously with those for DMS, halocarbon and chlorophyll/phytoplankton analysis via 4 Teflon tubes which split the flow of water from the underway seawater supply in the fish lab. In addition a sample was taken using a bucket to confirm that the underway supply was not contaminating or degassing the NMHC samples.
Sampling of all the trace gases was co-ordinated with that of the following biological parameters. 100 - 200 ml of water was filtered onto 25 mm Whatman GF/F filters and flash-frozen in liquid nitrogen for fluorometric analysis of chlorophyll at UEA using methods in Parsons *et al.*, 1989. 150 ml water was treated with Lugol's iodine and 150 ml was treated with formalin for the preservation of phytoplankton and zooplankton.

Hydrocarbon samples were collected routinely between ca. 0800 and 2000 for seawater analysis. Air samples were also collected at least once daily and with higher frequency on days of atmospheric sampling. The table below shows the frequency of sampling and the different modes of operation throughout the cruise for trace gas analysis in water. In all, 142 seawater samples were collected and analysed for NMHCs. 25 air samples were collected.

The isoprene data showed very little variation in surface waters throughout the cruise, although slightly higher levels were observed near to the coast and in region of the fluorescence max. Very little change was observed in isoprene concentration throughout the day. Depth profiles consistently

showed a sub-surface maximum at ca. 10 or 30 m. The surface isoprene concentrations ranged from 13.9 to 62.1 pmol l^{-1}.

Surface Water Sampling - Number of samples collected for DMS, Hydrocarbon (HC) and Halocarbon (Hal) analysis during each leg of the cruise

Name of Leg	From	To	DMS	HC	Hal	Comments
Survey 01	12/05/97 18:09	14/05/97 16:36	54	21	26	
Transect to Slyne	15/05/97 08:01	16/05/97 04:01	30	3	0	
Diurnal (Slyne) #	16/05/97 05:07	16/05/97 21:04	5	10	9	
Slyne profile	16/05/97		-	2	2	smells of seaweed
Profile 54N, 10.7W #	17/05/97		-	4	-	Very calm, sunny/misty
Transect to NE	18/05/97 08:31	18/05/97 20:00	20	12	11	
NE Deep Profile $	19/05/97		-	5	3	Sunny in day, foggy in evening
Shelf Edge Survey	20/05/97 08:30	21/05/97 23:00	64	29	21	Sunny, hot on 21/5
Jetstream 1 (W of MH)	22/05/97					Sunny, E winds
Jetstream 2 (W of MH)	23/05/97					E winds
Dog Leg	24/05/97 10:00	24/05/97 19:01	0	10	10	Very sunny, hot
Profiles close to MH #	25/05/97		-	6	7	Sunny, E wind
Aaron Isles Transect	26/05/97 08:32	26/05/97 20:02	12	10	10	wind picking up p.m.
Transect to Fluor. Max.	27/05/97 10:05	27/05/97 19:01	7	10	9	Sunny and overcast, F3-4
Transect to Deep Max.	28/05/97 10:35	28/05/97 19:31	10	9	9	Sunny, hot, S wind
Deep Profile 1$	29/05/97		6	7	8	
Deep Profile 2	30/05/97		-	7	7	sunny, F4

Beware tide and oil/sewage from ship
$ Surface fluorescence increase during profile

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AEROSOL AND GAS PHASE MEASUREMENTS

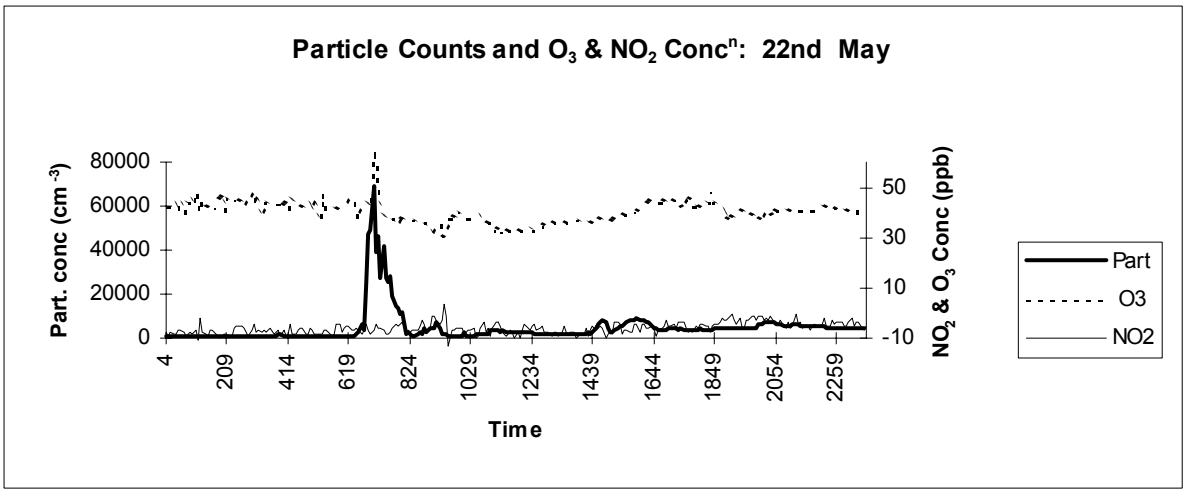
The following measurements were taken on Challenger cruise 133 between Monday 12th May and Friday 30th May:

- **Continuous detection of nitric oxide (NO), nitrogen dioxide (NO_2) and ozone (O_3) -** NO and NO_2 were measured using a chemiluminescent analyser (API 200) with a detection limit of ≈ 1 ppb. NO_2 concentrations were also measured using a Scintrex (theoretical detection limit 5 ppt). O_3 was measured using a Monitor labs. instrument (UV absorption @ 254 nm). Values were recorded as 5 minute averages using a datalogger.
- **Particle Counter -** A TSI 3022 instrument was deployed which measures condensation particle concentrations in the 8 nm - 5 μm diameter range. The results were recorded as 1 minute averages.
- **Measurement of aerosol and gases using filters** - Filter packs each containing 4 filters were run over 3 hourly periods:

1) Nucleopore: Polycarbonate filters with 12 μm pore size. Particulate material > 2.5 μm will be collected by this stage and will be analysed for: MSA, NO_3^-, SO_4^{2-}, Cl^- and Na^+
2) Teflon filters: These have a 1 μm pore size and collect the > 2.5 μm aerosol fraction. These will be analysed for the same species as above.
3) Cellulose filters - K_2CO_3 impregnated: These filters collect 'acid' gases i.e. sulphur dioxide and nitric acid.
4) Cellulose filters - Ascorbic acid impregnated: These filters are treated to make them active sinks with respect to ammonia gas.

Emissions from the ships stack severely contaminate filters and alter continuous measurements, therefore results are only valid for the periods where we were stationary and maintaining a head-to-wind position. These periods greatly varied throughout the cruise (- see record of cruise track)

All filters were frozen and taken back to Birmingham for analysis.
Some results for the 22nd May are shown in the graph below - note that the NO_2 data are below limit of detection and serve only to indicate stack interference.



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SHIPBOARD DATA MANAGEMENT

Shipboard data management worked very well, with over 500 separate events recorded (see daily log). Thanks very much to everyone who took the time to fill in the sampling logs and yellow book and to RVS for 5 star service - but not for fragrance abuse generated by motorbike engines in the plot !!

Daily checks were also made of many of the underway instruments, which generally performed very well throughout the cruise :

- the thermosalinograph was noisy for the first week of the cruise, but settled down thereafter. Calibrations against reversing thermometers attached to 5 metre water bottles and salinity samples analysed on board by Robin Powell indicate that the thermosalinograph temperature was 0.0279 degrees high (standard deviation 0.0718) with no evidence of drift. Initially problems were encountered with large temperature discrepancies, but these were all associated with flat calm days and considerable variation between the two reversing thermometer temperatures, indicating the presence of shallow diurnal thermoclines. The thermosalinograph salinity was 0.021 PSU low (standard deviation 0.03 PSU) and also showed no evidence of drift. It is concluded that the thermosalinograph was stable throughout the cruise and most of the noise seen is actually real, due to the development of shallow diurnal thermoclines.

- the barometer read 2.293 millibar lower than the bridge barometer (standard deviation 0.35 mbar), but 1.9 of this is accounted for by the corrections added to the bridge barometer to bring it to sea level. Thus, the two barometers were almost always within 0.5 mbars and both appeared to be stable and working well.

- the two PAR meters were also stable and appeared to be working well - obviously benefiting from Robin's ministrations with a rag ! The port PAR meter was generally between 2 and 8 % higher than the starboard meter, but this was probably because it was less prone to shading.

- the air temperature sensor read 0.126 degrees higher than the bridge dry bulb air temperature (standard deviation 0.31 degrees) and appeared to be working well.

- the anemometer also worked well. Checks against the 6-hourly estimates of absolute wind speed and direction made by the officers on the bridge showed the anemometer as 1.5 knots high and 5.7 degrees low (standard deviations 3.22 knots and 25.3 degrees respectively) but this is largely due to the difficulty of estimating wind speed and direction, especially at near-zero wind speeds. The help of Captain Geoff Long and his officers in assisting with persistent and bizarre requests to look at logbooks is gratefully acknowledged.

- the new transmissometer and fluorometer seemed to be working well, although the transmissometer suffered from noise due to trapped bubbles and will need to be looked at carefully. The old transmissometer in the red tank was more stable and will be used as a backup if necessary. The fluorometers need to be calibrated; this will be done as soon as the chlorophyll samples have been analysed at UEA.

- the clock on the ADCP was running approximately 9 minutes faster than the ship's master clock. No provision was made for calibration of the ADCP; Pete Bowyer from Galway may be able to do this if necessary. The vertical resolution was 4 metres throughout the cruise, but temporal resolution was changed from 10 minutes to 5 minutes on 21/05/97 after a request from Pete.

Please note that calibrated underway data - hydrographic, meteorological or navigation-related will be available from BODC in the near future and you are strongly encouraged to make use of this facility. Please contact either Roy or myself (email P.Machin@pol.ac.uk) with any requests.

Claire Pollock - JOINT NATURE CONSERVATION COMMITTEE

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REPORT ON SEABIRD AND CETACEAN OBSERVATIONS

INTRODUCTION

Line transects surveys of seabirds and cetaceans were carried out during an ACSOE cruise onboard RRS Challenger off the west coast of Ireland. Transect counts using 10 minute recording intervals, were carried out from the bridge wings (height 10 m) when the ship was steaming. A total of 7110 minutes (118.5 hours) data was collected over an area of 632 km^2 while travelling a distance of 2075 km. Coverage of 69 15' N x 30' W squares was obtained, of which 51 squares had not been previously surveyed in May.

As well as looking at seabird distribution, the cruise presented opportunities for explaining these distributions. Dimethylsulphide (DMS) is given off by phytoplankton when grazed on by zooplankton and is a major source of atmospheric sulphur. Members of the Petrel family (fulmars, shearwaters and storm petrels), feed on zooplankton and apparently can smell DMS. In collaboration with UEA, it is hoped to investigate the use of smell as a foraging technique by the petrels. Based on 10 minute bird samples, there are 335 samples which can be compared to DMS samples.

Weather conditions during the cruise were generally favourable for surveying in. Wind direction was variable. Although occasionally reaching gale force, wind speed was usually less than Beaufort 5. Seastate ranged from 1-6 but most surveying was carried out at seastates less than 5. Luckily the swell was less than 5. Visibility was mostly greater than 10 km. Lighting conditions occasionally made surveying difficult due to either strong glare or very dull overcast conditions.

SEABIRD DISTRIBUTION

Fulmar

Fulmars were the most abundant species with a total of 1966 birds recorded in transect counts. Highest densities were recorded in shelf waters (<200 m) west of Ireland on 13 May. Lowest numbers (8) were recorded in the North Sea and the English Channel.

Sooty Shearwater

A single sooty shearwater was recorded 12 miles west of the Beara Peninsula, Co. Cork on 12 June.

Manx Shearwater
Manx shearwaters were the third most abundant species overall with a total of 927 birds recorded. Highest numbers (623 birds) were recorded in inshore waters off Galway and Mayo on 26 May. Many were feeding in mixed flocks of kittiwakes and terns.

Storm Petrel
A total of 240 birds were recorded. Highest numbers were observed along the shelf break north west of Ireland on 20 May.

Gannet
This was the second most abundant species, with a total of 1363 birds recorded. Gannets were commonly observed in all areas except the North Sea and the Channel. Highest densities were present in shelf waters particularly off south west Ireland in the vicinity of the Little Skellig colony.

Phalarope
A single bird which was either a red-necked or grey phalarope was observed east of the Porcupine Bank on 21 May.

Pomarine Skua
All but one of a total of 8 adult pomarine skuas were recorded west of Ireland. There was a single bird seen in the English Channel. All birds were flying north or north east and were in summer plumage, except for the Channel bird.

Arctic Skua
Two adult dark phase arctic skuas were recorded north west of Mayo on 20 May.

Great Skua (Bonxie)
This was the most commonly observed skua and 36 birds were counted.

Skua Species
Four skuas were not identified to species.

Lesser Black-backed Gull
This was the most common gull with a total of 267 birds. Highest numbers were observed in the Celtic Sea where 43% of the total birds seen were recorded on 31 May.

Herring Gull
Herring gulls were scarce with only 7 birds recorded. Of these, 5 were in the North Sea, 1 in the English Channel and 1 off south west Ireland.

Great Black-backed Gull

This gull was uncommon (total 49 birds) and was observed mostly in shelf waters.

Kittiwake
This was the most numerous gull species (total 562) and was observed in all areas. Highest numbers were recorded in coastal waters off Co. Galway on 26 May. Some birds were feeding among flocks of Manx shearwaters and terns.

Gull Species
Some gull species were not identified to species. This included 3 gull species, 4 large gull species, 2 herring/lesser black-backed gulls and 44 black-backed gulls.

Common Tern
Seven common terns were recorded in coastal waters off Galway on 26 May. All but one were feeding.

Arctic Tern
Five arctic terns were observed of which 4 were close to the coast of Galway on 26 May.

Tern Species
Of 79 terns which were not identified to species, 45 were 'commic' terns.

Guillemot
This was the most common auk species with 87 birds recorded. Over 67% of guillemots were in the coastal waters off west (41 birds) and south west (17 birds) Ireland.

Razorbill
Razorbills similarly were mostly found in coastal waters with highest numbers off Co. Galway on 26 May. A total of 28 birds were observed.

Puffin
Puffins were thinly distributed and a total of 32 birds were recorded.

Auk Species
There were 37 unidentified auks of which 34 were either guillemots or razorbills.

Shore Bird Species
Shore bird species observed from the ship included 1 whimbrel, 1 dunlin, 1 turnstone, 11 racing pigeons, 1 collared dove, 3 turtle doves, 13 swallows and 3 house martins.

CETACEANS

Not all the dolphins observed could be identified to species. Of 30 unidentified dolphins, 12 were patterned.

Risso's Dolphin
Three groups of Risso's dolphins were recorded in shelf waters. Two sightings (3 and 12 animals) were off SW Ireland on 12 May and the third sighting of 7 animals was off the NW coast of Ireland on 19 May (not during transect counts).

White beaked Dolphin
A school of 50 white beaked dolphins was recorded in slope waters west of Ireland on 21 May. The dolphins appeared to be feeding as there were gannets circling and diving over the group. In addition, two dolphins were recorded in shelf waters on 24 May.

Common Dolphin
This was the most numerous cetacean observed with a total of 154 animals recorded. All 11 sightings were in shelf waters west of Ireland. A minimum of three dolphins were calves.

SUMMARY
A total of 5771 seabirds of 18 species were recorded during the cruise. The most abundant were fulmars, gannets and Manx shearwaters. Three species of dolphin (256 animals) were observed of which common dolphins were the most numerous.

ACKNOWLEDGEMENTS
I thank Dr. Lucinda Spokes for once again facilitating the survey on RRS Challenger and to Captain Geoff Long, and all the crew and scientists for their hospitality and helpfulness onboard. Also thanks to Adrian Thompson and Sue Turner for partaking in the seabird-DMS interaction study.

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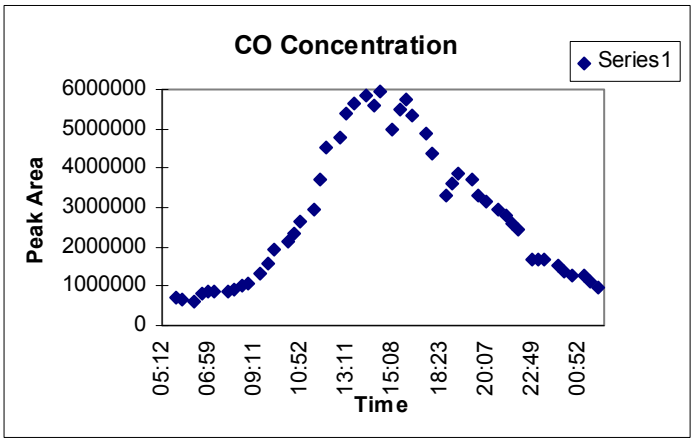
CARBON MONOXIDE IN THE SURFACE OCEAN AND ATMOSPHERE.

Underway measurements were taken continuously from the non-toxic supply and analysed directly by gas chromatography/atomic absorption. Seawater was pumped in at a rate of 0.7 l/min to an equillibrator with a 4:1 proportion of water to gas. A Martin Bellows pump was used to recirculate the air through the water column. Hopcalite was used to clean up the carrier gas (zero grade air). Equilibrium was reached in 15 minutes. A 0.14 ml gas

sample was then injected through a precolumn (Unibead, 60-80 mesh) and a 1m Molecular-sieve 13X (80-100 mesh) column to a Reduction Gas Detector. In the detector CO is carried over a mercuric-oxide bed which reacts on a mole-to-mole basis to produce carbon dioxide and elemental mercury. An ultraviolet lamp subsequently detects elemental mercury which is recorded on a Spectra-Physics integrator. A water sample is analysed in 19 minutes and an air sample 3 minutes. The whole run is automated and is controlled via a laptop computer. Atmospheric samples were taken every 60 minutes from the bow to avoid possible contamination from the ships exhausts.

During stationary sampling, CO exhibited a diurnal trend with the highest concentrations ca 3-5 hours after noon (GMT) followed by a steady decline reaching predawn levels a couple of hours after midnight. During surveying (steaming) more variability was evident, although the general diurnal trend were still discernible. Preliminary analysis of the data seem to suggest the existence of 'hot-spots' along the shelf break, often coinciding with elevated DMS concentrations. Photolysis of dissolved organic carbon (DOC) has been identified as the main area of production of CO. Export to the atmosphere is the largest loss mechanism of oceanic CO, though further research is needed to quantify the sea-air fluxes as well as the microbial consumption of CO.

Atmospheric levels showed little variability during the cruise. Carbon monoxide levels remained very low throughout the study period. As expected northerly winds had the lowest concentrations whereas elevated levels were associated with easterly winds.



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AEROSOL AND RAIN COLLECTION

The following samples were collected onboard RRS Challenger as part of the Eastern Atlantic Experiment 1997. At all stages of collection and analysis, techniques designed to minimise contamination were employed. Samples were double bagged on collection and frozen until analysis back in the home laboratory.

1. Aerosol samples

Three aerosol collectors were deployed on the foredeck of RRS Challenger and operated whilst the ship was head to wind. Two of the samplers collected bulk aerosols whereas the third sampler collected size segregated aerosols using a cascade impactor. This sampler operated at a flow rate of around 1.2 m^3 min^{-1}, separating the aerosol population into the following fractions:

1. a first impactor stage, preconditioning the air and collecting aerosols greater than 1.4 μm in diameter
2. a second impactor stage collecting aerosols between 0.9 and 1.4 μm in diameter
3. a backup filter collecting aerosols less than 0.9 μm in diameter

In addition to these, an impregnated filter was placed behind the backup filter to collect gas phase SO_2 for Adrian Thompson.

Deployments were generally for up to 12 hours in duration although a series of six hour size segregated samples were taken during periods of connected easterly flow in order to assess whether the size distribution of aerosol nitrate changes as continental air mixes with marine air. In total 67 samples were collected.

2. Rain Samples

Rain samples were collected on an event basis using two manually deployed collectors on the monkey island (one for subsequent analysis of trace metals, the other for major ions). For large rain events, sequential samples were taken to assess the changes in composition as a function of time and volume. In total 12 rain samples were collected, including those from a particularly marvellous period when it bucketed down all day!

Samples will be analysed for the following species:

1. Cl^-, NO_3^-, NO_2^-, SO_4^{2-}, CH_3COO^-, $HCOO^-$, MSA, Br^-, F^- by Ion Chromatography
2. Na, K, Mg, Ca by Flame Atomic Absorption Spectroscopy and ICP-AES
3. Fe, Mn, Cd, Pb, Cu, Zn by Atomic Absorption Spectroscopy with Electrothermal Atomisation
4. NH_4^+ and Fe(II) by Colorimetry
5. Nitrogen stable isotope ratios by Stable Isotope Mass Spectrometry

In addition, sulphur isotope ratios will be determined by colleagues at UEA.

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DMS AND DMSP MEASUREMENTS

Concentrations of dimethyl sulphide (DMS) and its algal precursor, dimethylsulphoniopropionate (DMSP) were determined in surface water samples, one depth profile and two onboard incubation studies, conducted by Olivier Vesperini. A separate analytical system was used to determine air concentrations of DMS.

(NB. interconversion of DMS concentration units: nmol = ng/32)

1. Water samples

Surface samples were collected from the ship's non-toxic pumped supply when the ship was in survey or transit mode within the experimental area. The aim was to determine the spatial and temporal variation in DMS concentrations and hence calculate sea-to-air fluxes.

In order to ensure, as far as possible, that the same water was sampled for all analyses (halocarbons, hydrocarbons, sulphur species and chlorophyll + nutrients), the laboratory supply was split into four outlets, using a tubing array known as the 'quadrupus'. Thus, four bottles could be filled simultaneously.

The water was analysed immediately for DMS, by filtered injection into a solid-sorber purge and trap system, followed by flame photometric, gas chromatographic detection. The filter was stored in strong alkali (to decompose the particulate DMSP to DMS) for subsequent onboard analysis.

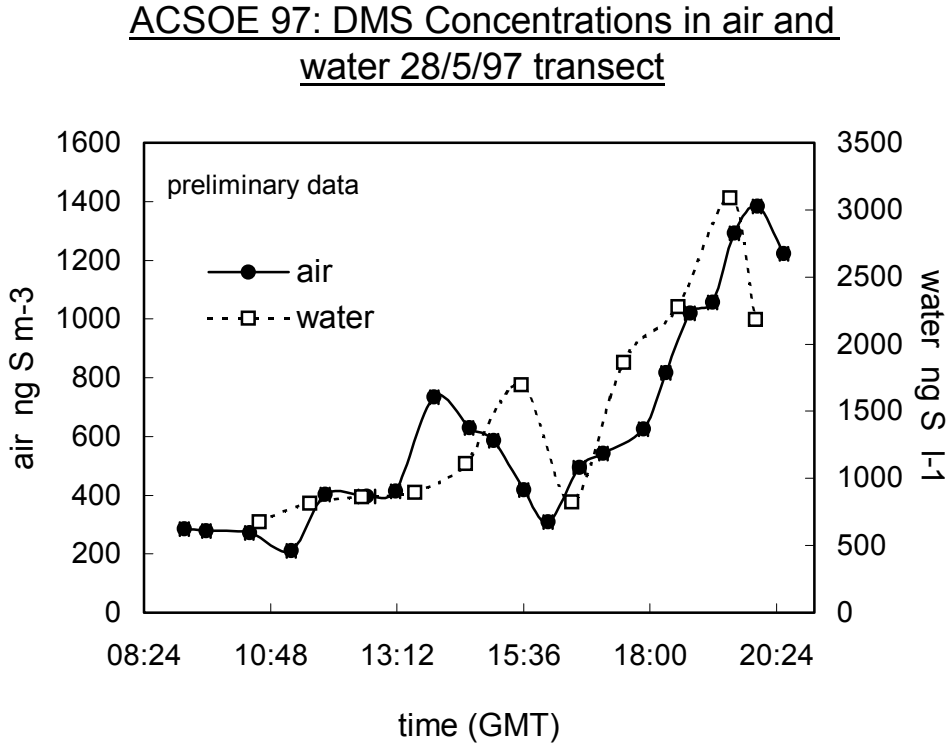
Results from the initial survey showed that there was a maximum in DMS concentration (approx. 3 nmol l^{-1}) over the shelf edge, in the same area recorded on the ACSOE cruise in June 1996. Subsequent visits to this region showed marked increases with time and the overall maximum was over 90 nmol l^{-1}, 3 times higher than the previous year. A DMS maximum was also observed at about 55° N. The range of concentrations was 0.26 - 97 nmol l^{-1}. Data for DMSP and DMS fluxes have not yet been worked up

2. Air Samples

Our first analytical system for determination of atmospheric DMS concentrations was field-tested during this experiment. Although there were problems early on, requiring some method development and improvement, air samples were analysed successfully during the second half of the cruise.

Air was drawn through the laboratory sample preparation line *via* 45m of FEP tubing, with the inlet positioned at the ship's bow, approximately level with the intakes for particulate and SO_2 filters. Thus, given concentrations are integrals over time and space. Sample flow rates and trapping times (initially 200 cm^3 min^{-1} and 30 min. respectively) had to be decreased as DMS levels increased considerably with time.

The figure below shows how concentrations of DMS in surface water and air varied along the transect on 28th May. This plot, constructed piecemeal during the transect and known as the 'race to the top of the graph paper' ($Thompson_{water}$ vs. $Turner_{air}$), shows the highest concentrations (air and water) observed during the cruise.



3. Comments

This was a very successful cruise in terms of gathering information on the distributions of DMS and only minor instrument problems were encountered. However, weather and bureaucracy denied fulfilment of two objectives of the cruise. Firstly, we were not able to work in Westerly air flow, connected with the sampling station at Mace Head. Secondly, since the ship was not given permission to deploy small boats at the coast, there was no exchange of samples and intercalibration of the land- and ship-based DMS systems was not achieved.

We thank the crew, officers, RVS, fellow scientists and Marm for their support and in making 'UEA Girlies on Tour' such an enjoyable campaign.

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CHLOROPHYLL, PHYTOPLANKTON AND NUTRIENT SAMPLING

I joined the Challenger Cruise number 133 as a part of my M.Sc. project research. I had to collect chlorophyll, phytoplankton and nutrient samples. Phytoplankton samples were preserved in Lugol's Iodine and neutralised in formalin. For chlorophyll, a known volume of water was filtered through GF/F filters. The filters were immediately dipped in liquid nitrogen and then kept in the freezer. From the filtered water, a subsample was taken and frozen for subsequent nutrient analysis. All the analyses will be carried out once back at the School of Environmental Sciences, University of East Anglia.

These biological parameters were sampled many times during the cruise, in order to realise three different aspects:

The first, and most important, was to increase our knowledge of the study area trying to map the surface seawater using these parameters and see their evolution, both in time and space.

The second was to know what their vertical distribution was in certain places.

The third was to understand what the evolution of a 7-day incubation would be using both nearshore and offshore water. This work was more restricted to my own project.

The atmosphere on board was very friendly but I have to complain about the questions of the Trivial Pursuit which were too hard to answer especially for a French frog who has absolutely no idea about who won the Cricket final in 1967 or what Beano did in the 138th episode of the comic. Actually, who is Beano??

Daily Log (all times in GMT)

09/05/97	06:10	Departed from Great Yarmouth
	13:00	Non-toxic supply switched on
10/05/97	08:48	non-toxic sample PG901, sal 35.3330
11/05/97	00:00	ship's clocks turned back one hour to GMT
	08:48	non-toxic sample PG902, sal 35.4194
12/05/97	00:01	non-toxic sample PG007 taken for chl, nuts, phyto, DMS, NMHC, halos
	09:26	non-toxic sample PG903, sal 35.4542
	16:06	air sample AS2, NMHC
	17:00	edge of survey box reached
	17:06	air sample AS3, carbon monoxide
	18:09	SURVEY 01 COMMENCED
		Way-point -1
		non-toxic sample PG001 taken for chl, nuts, phyto, DMS, halos
	19:05	non-toxic sample PG002 taken for chl, nuts, phyto, DMS, NMHC, halos
	19:30 - 13/05/97 11:19	UEA HiVol aerosol samples HV1
	19:45 - 13/05/97 11:30	Birmingham filter samples J1
	20:00	non-toxic sample PG003 taken for chl, nuts, phyto, DMS, NMHC, halos
	21:04	non-toxic sample PG004 taken for chl, nuts, phyto, DMS, halos
	21:41	air sample AS4, NMHC
	22:02	non-toxic sample PG005 taken for chl, nuts, phyto, DMS, halos
	23:01	way-point 0
	23:05	non-toxic sample PG006 taken for chl, nuts, phyto, DMS, NMHC, halos
13/05/97	01:01	non-toxic sample PG008 taken for chl, nuts, phyto, DMS, NMHC, halos
	02:01	non-toxic sample PG009 taken for chl, nuts, phyto, DMS, NMHC, halos
	03:01	non-toxic sample PG010 taken for chl, nuts, phyto, DMS
	04:00	non-toxic sample PG011 taken for chl, nuts, phyto, DMS
	04:31	way-point 1
	05:00	non-toxic sample PG012 taken for chl, nuts, phyto, DMS
	06:01	non-toxic sample PG013 taken for chl, nuts, phyto, DMS
	07:00	non-toxic sample PG014 taken for chl, nuts, phyto, DMS
	07:40	way-point 2
	08:00	air sample AS5, NMHC
	08:00	non-toxic sample PG015 taken for chl, nuts, phyto, DMS
	08:40	air sample AS6, carbon monoxide
	09:00	non-toxic sample PG016 taken for chl, nuts, phyto, DMS
	09:15	non-toxic sample PG904, sal 35.4864
	09:45	air sample AS7, carbon monoxide
	10:00	non-toxic sample PG017 taken for chl, nuts, phyto, DMS
	10:47	air sample AS8, carbon monoxide
	11:01	non-toxic sample PG018 taken for chl, nuts, phyto, DMS
	11:25 - 20:09	UEA HiVol aerosol samples HV2
	11:35 - 20:15	Birmingham filter samples J2
	12:00	air sample AS9, carbon monoxide
	12:00	non-toxic sample PG019 taken for chl, nuts, phyto, DMS, halos
	13:04	non-toxic sample PG020 taken for chl, nuts, phyto, DMS, halos
	13:11	air sample AS10, carbon monoxide
	14:03	non-toxic sample PG021 taken for chl, nuts, phyto, DMS, NMHC, halos
	14:04	way-point 3
	14:17	air sample AS11, carbon monoxide
	15:00	cleaned red tank

	15:00	air sample AS12 taken for carbon monoxide, halos
	15:03	non-toxic sample PG022 taken for chl, nuts, phyto, DMS
	15:18	air sample AS13
	15:30	air sample AS14, NMHC
13/05/97	16:00	air sample AS15, carbon monoxide
	16:01	non-toxic sample PG023 taken for chl, nuts, phyto, DMS, halos
	17:03	non-toxic sample PG024 taken for chl, nuts, phyto, DMS, NMHC
	17:12	air sample AS16, carbon monoxide - way-point 4
	18:01	non-toxic sample PG025 taken for chl, nuts, phyto, DMS
	19:00	air sample AS17, carbon monoxide
	19:03	non-toxic sample PG026 taken for chl, nuts, phyto, DMS, NMHC, halos
	20:01	non-toxic sample PG027 taken for chl, nuts, phyto, DMS, NMHC, halos
	20:05	air sample AS18, carbon monoxide
	20:10	light meters cleaned
	21:00	non-toxic sample PG028 taken for chl, nuts, phyto, DMS, halos
	21:20	air sample AS19, carbon monoxide
	22:03	non-toxic sample PG029 taken for chl, nuts, phyto, DMS, NMHC, halos
	23:02	non-toxic sample PG030 taken for chl, nuts, phyto, DMS, NMHC, halos
14/05/97	00:02	non-toxic sample PG031 taken for chl, nuts, phyto, DMS, NMHC
	01:06	non-toxic sample PG032 taken for chl, nuts, phyto, DMS, NMHC
	01:48	way-point 5
	02:01	non-toxic sample PG033 taken for chl, nuts, phyto, DMS
	03:01	non-toxic sample PG034 taken for chl, nuts, phyto, DMS
	04:00	non-toxic sample PG035 taken for chl, nuts, phyto, DMS
	04:43	way-point 6
	05:03	non-toxic sample PG036 taken for chl, nuts, phyto, DMS
	06:00	non-toxic sample PG037 taken for chl, nuts, phyto, DMS
	07:01	non-toxic sample PG038 taken for chl, nuts, phyto, DMS
	08:00	non-toxic sample PG039 taken for chl, nuts, phyto, DMS, halos
	09:00	non-toxic sample PG040 taken for chl, nuts, phyto, DMS, halos
	09:30	non-toxic sample PG905, sal 35.4672
	09:33	non-toxic sample PG041 taken for chl, nuts, phyto, DMS
	09:40	air sample AS20, carbon monoxide
	10:03	non-toxic sample PG42 taken for chl, nuts, phyto, DMS, NMHC, halos
	10:16	air sample AS21, carbon monoxide
	10:31	non-toxic sample PG043 taken for chl, nuts, phyto, DMS
	11:02	non-toxic sample PG044 taken for chl, nuts, phyto, DMS, NMHC, halos
	12:00	non-toxic sample PG045 taken for chl, nuts, phyto, DMS, halos
	12:15	air sample AS22, carbon monoxide
	12:33	non-toxic sample PG046 taken for chl, nuts, phyto, DMS
	13:01	non-toxic sample PG047 taken for chl, nuts, phyto, DMS, NMHC, halos
	13:30	non-toxic sample PG048 taken for chl, nuts, phyto, DMS
	13:35	air sample AS23, carbon monoxide
	14:03	non-toxic sample PG049 taken for chl, nuts, phyto, DMS, NMHC, halos
	14:33	non-toxic sample PG050 taken for chl, nuts, phyto, DMS
	14:35	air sample AS24, carbon monoxide
	15:03	non-toxic sample PG051 taken for chl, nuts, phyto, DMS, NMHC, halos
	15:31	non-toxic sample PG052 taken for chl, nuts, phyto, DMS
	15:35	air sample AS25, carbon monoxide
	15:51	non-toxic sample PG053 taken for chl, nuts, phyto, DMS
	15:53	air sample AS26, halos
	16:00	hove to on station, head to wind, way-point 7
	16:12 - 15/05/97 08:54	Birmingham filter samples J3
	16:15 - 15/05/97 08:55	UEA HiVol aerosol samples HV3
	16:27 - 16:35	water bottle sample BOT1, sal 35.4672

16:30 stainless steel hydrocarbon receptacle stylishly deployed by Wendy !
16:36 non-toxic sample PG054 taken for chl, nuts, phyto, DMS, NMHC
END OF SURVEY 01.
16:40 air sample AS27, carbon monoxide
17:20 air sample AS28, carbon monoxide
18:35 air sample AS29, NMHC
19:39 - 15/05/97 08:33 UEA rain water sample RAIN1 : approx. 300 ml

14/05/97 19:45 air sample AS30, carbon monoxide
20:50 air sample AS31, carbon monoxide
21:50 air sample AS32, carbon monoxide

15/05/97 07:55 air sample AS33, carbon monoxide
08:01 START TRANSECT TO SLYNE HEAD
non-toxic sample PG055 taken for chl, nuts, phyto, DMS
08:32 non-toxic sample PG056 taken for chl, nuts, phyto, DMS
08:35 - 16:05 UEA rain water sample RAIN2 : 15 ml
09:00 non-toxic sample PG057 taken for chl, nuts, DMS
09:15 moving off from WP7
09:19 air sample AS34, carbon monoxide
09:30 non-toxic sample PG058 taken for chl, nuts, DMS
09:48 non-toxic sample PG906, sal 35.5494
10:00 non-toxic sample PG059 taken for chl, nuts, DMS
10:22 air sample AS35, carbon monoxide
10:30 non-toxic sample PG060 taken for chl, nuts, DMS
11:00 non-toxic sample PG061 taken for chl, nuts, DMS
11:31 non-toxic sample PG062 taken for chl, nuts, DMS
12:00 non-toxic sample PG063 taken for chl , nuts, DMS
12:05 air sample AS36, carbon monoxide
12:30 non-toxic sample PG064 taken for chl, nuts, DMS
13:00 non-toxic sample PG065 taken for chl, nuts, DMS
13:08 air sample AS37, carbon monoxide
13:31 non-toxic sample PG066 taken for chl, nuts, DMS
14:00 red tank and monkey island light meters cleaned
14:00 non-toxic sample PG067 taken for chl, nuts, DMS
14:30 non-toxic sample PG068 taken for chl, nuts, DMS
14:37 air sample AS38, carbon monoxide
15:00 non-toxic sample PG069 taken for chl, nuts, phyto, DMS
15:32 non-toxic sample PG070 taken for chl, nuts, DMS
15:35 air sample AS39, carbon monoxide
16:04 non-toxic sample PG071 taken for chl, nuts, DMS, NMHC
16:07- 16/05/97 07:58 UEA rain water sample RAIN3 : 10 ml
16:33 non-toxic sample PG072 taken for chl, nuts, DMS
16:45 air sample AS40, carbon monoxide
17:00 non-toxic sample PG073 taken for chl, nuts, phyto, DMS
18:01 non-toxic sample PG074 taken for chl, nuts, DMS, NMHC
19:00 non-toxic sample PG075 taken for chl, nuts, DMS
19:05 air sample AS41, carbon monoxide
20:04 non-toxic sample PG076 taken for chl, nuts, phyto, DMS, NMHC
21:01 non-toxic sample PG077 taken for chl, nuts, DMS
22:00 non-toxic sample PG078 taken for chl, nuts, DMS
22:59 non-toxic sample PG079 taken for chl, nuts, phyto, DMS

16/05/97 00:00 non-toxic sample PG080 taken for chl, nuts, DMS
01:00 non-toxic sample PG081 taken for chl, nuts, DMS
02:00 non-toxic sample PG082 taken for chl, nuts, phyto, DMS
03:00 non-toxic sample PG083 taken for chl, nuts, DMS

04:01 non-toxic sample PG084 taken for chl, nuts, DMS
04:55 END OF TRANSECT TO SLYNE HEAD
hove to on station
COMMENCE INSHORE DIURNAL STUDY AT SLYNE HEAD
INCLUDING DEPTH PROFILE
05:15 air sample AS42, carbon monoxide
06:20 air sample AS43, carbon monoxide
07:47 air sample AS44, carbon monoxide
08:00 - 09:00 UEA rain water sample RAIN4 : 10 ml
08:15 - 20:35 UEA HIVOL filter samples HV4
16/05/97 08:30- 20:35 Birmingham filter samples J4
09:12 non-toxic sample PG907, sal 34.9053
09:22 air sample AS45, carbon monoxide
09:31 air sample AS46, NMHC
09:44 air sample AS47, NMHC
10:24 air sample AS48, carbon monoxide
11:24 air sample AS49, carbon monoxide
12:16 air sample AS50, carbon monoxide
13:20 air sample AS51, carbon monoxide
13:30 monkey island light meters cleaned
13:30 air sample AS52, NMHC
14:20 air sample AS53, carbon monoxide
14:44 - 14:48 water bottle sample BOT2, 5 m
14:57- 15:02 water bottle sample BOT3, 25 m chl, nuts, phyto, NMHC, halos
15:32 air sample AS54, carbon monoxide
16:34 - 16:47 water bottle sample BOT4, 80 m
16:39 air sample AS55, carbon monoxide
16:57- 17:00 water bottle sample BOT5, 5 m
18:08 air sample AS56, carbon monoxide
19:52 air sample AS57, carbon monoxide
19:57 air sample AS58, NMHC
20:54 air sample AS59, carbon monoxide
21:14 END INSHORE DIURNAL STUDY AT SLYNE HEAD
moving off from station
21:36 air sample AS60, carbon monoxide
23:20 air sample AS61, carbon monoxide
23:45 - 17/05/97 08:15 UEA rain water sample RAIN5 : 5 ml

17/05/97 02:45 hove to, head to wind, on station
08:17 - 18/05/97 08:13 UEA rain sample RAIN6 : 20 ml, bulk sample
10:04 - 22:05 UEA HIVOL aerosol samples HV5
10:10 - 22:10 Birmingham filter samples J5
13:04 air sample AS62, carbon monoxide
13:45 air sample AS63, carbon monoxide
14:00 COMMENCE DEPTH PROFILING AT SLYNE HEAD
14:36- 14:43 water bottle sample BOT6, 10 m, NMHC, sal, chl, nuts
14:50 air sample AS64, carbon monoxide
14:59- 15:03 water bottle sample BOT7, 15 m, chl, nuts
15:08 - 15:10 water bottle sample BOT8, 5 m
15:11 non-toxic sample PG908, sal 35.0577
15:30 - 15:35 water bottle sample BOT9, 20 m , NMHC, sal, chl, nuts
15:43 - 15:47 water bottle sample BOT10, 25 m chl, nuts
15:53 - 15:56 water bottle sample BOT11, 5m
16:06 air sample AS65, carbon monoxide
16:28- 16:34 water bottle sample BOT12, 30 m, NMHC, sal, chl, nuts

16:41 -16:49 water bottle sample BOT13, 35 m chl, nuts
16:54- 16:56 water bottle sample BOT14, 5 m
18:32 air sample AS66, carbon monoxide
19:30 air sample AS67, NMHC
20:00 air sample AS68, carbon monoxide
22:23 - 18/05/97 08:03 UEA HIVOL aerosol samples HV6

18/05/97 05:15 reposition on station
08:20 -16:20 UEA rain water sample RAIN7 : 70 ml, started 15:00
08:32 COMMENCE SURVEY - TRANSECT TO NE
08:36 non-toxic sample PG909, sal 35.2322
10:02 non-toxic sample PG099 taken for chl, nuts, phyto, DMS, NMHC, halos
10:13 air sample AS69, carbon monoxide
11:00 non-toxic sample PG100 taken for chl, nuts, phyto, DMS, NMHC, halos
18/05/97 11:15 air sample AS70, carbon monoxide
12:04 non-toxic sample PG101 taken for chl, nuts, phyto, DMS, NMHC, halos
12:17 air sample AS71, carbon monoxide
12:34 non-toxic sample PG102 taken for chl, nuts, DMS
13:05 non-toxic sample PG103 taken for chl, nuts, phyto, DMS, NMHC
13:12 air sample AS72, halos
13:19 air sample AS73, carbon monoxide
13:37 non-toxic sample PG104 taken for chl, nuts, DMS
14:03 non-toxic sample PG105 taken for chl, nuts, phyto, DMS, NMHC, halos
14:22 air sample AS74, carbon monoxide
14:30 non-toxic sample PG106 taken for chl, nuts, DMS
15:02 non-toxic sample PG107 taken for chl, nuts, phyto, DMS, NMHC, halos
15:24 air sample AS75, carbon monoxide
15:31 non-toxic sample PG108 taken for chl, nuts, DMS
16:00 non-toxic sample PG109 taken for chl, nuts, phyto, DMS, NMHC, halos
16:23 - 17:38 UEA rain water sample RAIN8 : 300 ml !
16:28 air sample AS76, carbon monoxide
16:30 non-toxic sample PG110 taken for chl, nuts, DMS
17:01 non-toxic sample PG111 taken for chl, nuts, phyto, DMS, NMHC, halos
17:10 air sample AS77, carbon monoxide
17:28 non-toxic sample PG112 taken for chl, nuts, DMS
17:40 - 18:50 UEA rain water sample RAIN9 : 150 ml
18:03 non-toxic sample PG113 taken for chl, nuts, phyto, DMS, NMHC, halos
18:30 non-toxic sample PG114 taken for chl, nuts, DMS
18:55 - 20:40 UEA rain water sample RAIN10 : 15 ml
19:01 non-toxic sample PG115 taken for chl, nuts, phyto, DMS, NMHC, halos
19:14 air sample AS78, carbon monoxide
19:30 air sample AS79, NMHC
19:31 non-toxic sample PG116 taken for chl, nuts, DMS
19:55 END OF SURVEY - TRANSECT TO NE
on station; head to wind
20:00 non-toxic sample PG117 taken for chl, nuts, phyto, DMS, NMHC, halos
20:10 - 19/05/97 08:12 UEA HIVOL filter samples HV7
20:10 - 19/05/97 20:30 Birmingham filter samples J6 , 24 hours
20:35 air sample AS80, carbon monoxide
20:42 - 19/05/97 19:30 UEA rain sample RAIN11 : 20 ml, bulk sample

19/05/97 08:17 - 20:00 UEA HIVOL filter samples HV8
09:01 air sample AS81, carbon monoxide
09:28 non-toxic sample PG910, sal 35.2526
09:31 non-toxic sample PG911, sal 35.2524
09:33 non-toxic sample PG912, sal 35.2496

09:36 non-toxic sample PG913, sal 35.2448
09:45 cleaned red tank; new transmissometer air reading
10:22 air sample AS82, carbon monoxide
11:25 air sample AS83, carbon monoxide
12:27 air sample AS84, carbon monoxide
12:30 COMMENCE NE DEEP WATER PROFILE
12:32- 12:36 water bottle sample BOT15, 15 m, NMHC, chl, nuts
12:42 - 12:45 water bottle sample BOT16, 5 m
13:25 air sample AS85, carbon monoxide
13:27 -13:31 water bottle sample BOT17, 20 m, NMHC, chl, nuts
13:38 - 13:43 water bottle sample BOT18, 25 m, chl, nuts
13:46 - 13:49 water bottle sample BOT19, 5 m
14:03 old transmissometer air reading 4.65V (blank = 0.00V)
14:35 air sample AS86, carbon monoxide
15:00 - 15:05 water bottle sample BOT20, 30 m, NMHC, halos, chl, nuts
15:15 - 15:20 water bottle sample BOT21, 35 m, chl, nuts
15:24 - 15:27 water bottle sample BOT22, 5 m

19/05/97 16:13 - 16:17 water bottle sample BOT23, 10 m, NMHC, halos, chl, nuts
16:24 - 16:27 water bottle sample BOT24, 5 m
16:37 air sample AS87, carbon monoxide
18:03 non-toxic sample PG118 taken for chl, nuts, phyto, NMHC, halos
18:55 air sample AS88, carbon monoxide
19:18 air sample AS89, NMHC
19:35 UEA rain water sample RAIN12 : no rain
20:30 - 20/05/97 08:10 UEA HIVOL aerosol samples HV9
20:30 - 20/05/97 08:10 Birmingham filter samples J7

20/05/97 08:30 START OF SHELF EDGE SURVEY
non-toxic sample PG119 taken for chl, nuts, DMS
09:00 non-toxic sample PG120 taken for chl, nuts, phyto, DMS, NMHC, halos
09:26 non-toxic sample PG914, sal 35.4147
10:00 non-toxic sample PG121 taken for chl, nuts, phyto, DMS, NMHC
11:02 non-toxic sample PG122 taken for chl, nuts, phyto, DMS, NMHC, halos
12:00 non-toxic sample PG123 taken for chl, nuts, phyto, DMS
13:01 non-toxic sample PG124 taken for chl, nuts, phyto, DMS, NMHC, halos
14:01 non-toxic sample PG125 taken for chl, nuts, phyto, DMS, NMHC, halos
15:00 non-toxic sample PG126 taken for chl, nuts, phyto, DMS, NMHC, halos
15:55 air sample AS90, halos
16:01 non-toxic sample PG127 taken for chl, nuts, phyto, DMS, NMHC, halos
17:01 non-toxic sample PG128 taken for chl, nuts, phyto, DMS, NMHC, halos
18:01 non-toxic sample PG129 taken for chl, nuts, phyto, DMS, halos
19:02 non-toxic sample PG130 taken for chl, nuts, phyto, DMS, NMHC, halos
19:31 non-toxic sample PG131 taken for chl, nuts, DMS
20:01 non-toxic sample PG132 taken for chl, nuts, phyto, DMS, NMHC, halos
20:31 non-toxic sample PG133 taken for chl, nuts, DMS
21:03 non-toxic sample PG134 taken for chl, nuts, phyto, DMS, NMHC, halos
21:33 non-toxic sample PG135 taken for chl, nuts, DMS
22:03 non-toxic sample PG136 taken for chl, nuts, phyto, DMS, NMHC, halos
22:30 non-toxic sample PG137 taken for chl, nuts, DMS
23:00 non-toxic sample PG138 taken for chl, nuts, phyto, DMS
23:30 non-toxic sample PG139 taken for chl, nuts, DMS

21/05/97 00:00 non-toxic sample PG140 taken for chl, nuts, phyto, DMS
00:30 non-toxic sample PG141 taken for chl, nuts, DMS
01:00 non-toxic sample PG142 taken for chl, nuts, phyto, DMS
01:30 non-toxic sample PG143 taken for chl, nuts, DMS

02:00 non-toxic sample PG144 taken for chl, nuts, phyto, DMS
02:30 non-toxic sample PG145 taken for chl, nuts, DMS
03:03 non-toxic sample PG146 taken for chl, nuts, phyto, DMS
03:30 non-toxic sample PG147 taken for chl, nuts, DMS
04:00 non-toxic sample PG148 taken for chl, nuts, phyto, DMS
04:30 non-toxic sample PG149 taken for chl, nuts, DMS
05:00 non-toxic sample PG150 taken for chl, nuts, phyto, DMS
05:30 non-toxic sample PG151 taken for chl, nuts, DMS
06:00 non-toxic sample PG152 taken for chl, nuts, phyto, DMS
06:30 non-toxic sample PG153 taken for chl, nuts, DMS
07:01 non-toxic sample PG154 taken for chl, nuts, phyto, DMS
07:30 non-toxic sample PG155 taken for chl, nuts, DMS
08:03 non-toxic sample PG156 taken for chl, nuts, phyto, DMS, NMHC, halos
08:30 non-toxic sample PG157 taken for chl, nuts, DMS
09:02 non-toxic sample PG158 taken for chl, nuts, phyto, DMS, NMHC
09:30 non-toxic sample PG159 taken for chl, nuts, DMS
09:35 air sample AS91, NMHC
10:00 non-toxic sample PG160 taken for chl, nuts, phyto, DMS, NMHC, halos
10:02 non-toxic sample PG915, sal 35.4627

21/05/97 10:29 ADCP resolution changed from 10 min to 5 min
(request from Pete Bowyer)
10:29 non-toxic sample PG161 taken for chl, nuts, DMS
11:00 non-toxic sample PG162 taken for chl, nuts, phyto, DMS, NMHC
12:00 non-toxic sample PG163 taken for chl, nuts, phyto, DMS, NMHC, halos
12:28 non-toxic sample PG164 taken for chl, nuts, DMS
13 :01 non-toxic sample PG165 taken for chl, nuts, phyto, DMS, NMHC
13:08 air sample AS93, halos
13:32 non-toxic sample PG166 taken for chl, nuts, DMS
13:35 air sample AS92, NMHC
14:02 non-toxic sample PG167 taken for chl, nuts, phyto, DMS, NMHC, halos
14:31 non-toxic sample PG168 taken for chl, nuts, DMS
15:01 non-toxic sample PG169 taken for chl, nuts, phyto, DMS, NMHC, halos
15:31 non-toxic sample PG170 taken for chl, nuts, DMS
16:02 non-toxic sample PG171 taken for chl, nuts, phyto, DMS, NMHC
16:30 non-toxic sample PG172 taken for chl, nuts, DMS
17:04 non-toxic sample PG173 taken for chl, nuts, phyto, DMS, NMHC, halos
18:01 non-toxic sample PG174 taken for chl, nuts, phyto, DMS, NMHC
18:56 non-toxic sample PG175 taken for chl, nuts, phyto, DMS, NMHC, halos
19:30 air sample AS94, NMHC
20:01 non-toxic sample PG176 taken for chl, nuts, phyto, DMS, NMHC, halos
21:04 non-toxic sample PG177 taken for chl, nuts, phyto, DMS, NMHC
21:35 non-toxic sample PG178 taken for chl, nuts, DMS
22:03 non-toxic sample PG179 taken for chl, nuts, phyto, DMS, NMHC, halos
22:30 non-toxic sample PG181 taken for chl, nuts, phyto, DMS
23:00 CONCLUDE SHELF EDGE SURVEY

22/05/97 07:00 ON STATION, HEAD TO WIND, FOR JETSTREAM OVERPASS No. 1
09:45 non-toxic sample PG916, sal 35.1469
10:10 cleaned red tank
10:30 cleaned light meters
11:10 - 23:00 UEA HIVOL aerosol samples HV10
11:20 - 23/05/97 15:30 Birmingham filter samples J8, stopped 06:05 -10:00
13:38 Jetstream overflight
14:03 Jetstream overflight, approx. altitude 400M
15:37 - 15:41 water bottle sample BOT25, 5 m

17:29- 17:32 water bottle sample BOT26, 5 m
19:36 - 19:38 water bottle sample BOT27, 5 m
23:20 - 23/05/97 06:05 UEA HIVOL aerosol samples HV11

23/05/97 06:20 moving off station
09:06 ON STATION, HEAD TO WIND FOR JETSTREAM OVERPASS No. 2
09:49 non-toxic sample PG917, sal 35.4985
10:00 - 22:00 UEA HIVOL aerosol samples HV12
10:17 air sample AS96, carbon monoxide
10:36 air sample AS95, NMHC
11:22 air sample AS97, carbon monoxide
12:06 air sample AS98, carbon monoxide
12:23 air sample AS99, NMHC
13:08 air sample AS100, carbon monoxide
14:10 air sample AS101, carbon monoxide
14:13 air sample AS102, NMHC
15:17 air sample AS103, carbon monoxide
15:45 - 24/05/97 08:05 Birmingham filter samples J9
16:35 air sample AS104, NMHC
16:37 air sample AS105, carbon monoxide
18:02 air sample AS106, carbon monoxide

23/05/97 18:13 air sample AS107, NMHC
20:15 air sample AS108, NMHC
22:10 - 24/05/97 08:15 UEA HIVOL aerosol samples HV13

24/05/97 08:30 COMMENCE DOG LEG SURVEY
09:38 non-toxic sample PG918, sal 35.2296
10:00 non-toxic sample PG182 taken for chl, nuts, phyto, DMS, NMHC, halos
10:15 air sample AS121, carbon monoxide
11:00 non-toxic sample PG183 taken for chl, nuts, phyto, NMHC, halos
11:54 air sample AS122, carbon monoxide
12:03 non-toxic sample PG184 taken for chl, nuts, phyto, NMHC
13:00 air sample AS123, carbon monoxide
13:01 non-toxic sample PG185 taken for chl, nuts, phyto, NMHC, halos
13:30 cleaned red tank and thermosalinograph
14:00 light meters cleaned
14:00 air sample AS124, carbon monoxide
14:02 non-toxic sample PG186 taken for chl, nuts, phyto, NMHC, halos
15:02 non-toxic sample PG187 taken for chl, nuts, phyto, NMHC, halos
15:11 air sample AS125, carbon monoxide
16:01 non-toxic sample PG188 taken for chl, nuts, phyto, NMHC, halos
18:03 non-toxic sample PG189 taken for chl, nuts, phyto, NMHC, halos
18:44 air sample AS109, NMHC
19:01 non-toxic sample PG190 taken for chl, nuts, phyto, NMHC, halos
20:14 END OF DOG LEG SURVEY, ON STATION HEAD TO WIND
20:20 - 25/05/97 08:10 UEA HIVOL aerosol samples HV14
20:30 - 25/05/97 20:20 Birmingham filter samples J10

25/05/97 05:12 air sample AS126, carbon monoxide
06:18 air sample AS127, carbon monoxide
07:49 air sample AS128, carbon monoxide
08:10 - 20:15 UEA HIVOL aerosol samples HV15
09:11 air sample AS129, carbon monoxide
09:26 non-toxic sample PG919, sal 34.9667

10:11 air sample AS130, carbon monoxide
10:15 cleaned red tank - fluorometer/transmissometer
11:12 air sample AS131, carbon monoxide
11:32 non-toxic sample PG191 taken for chl, nuts, phyto, NMHC, halos
12:30 COMMENCE WATER BOTTLE SAMPLING CLOSE TO MACE HEAD
12:33 - 12:35 water bottle sample BOT29, 10 m, NMHC, halos , chl, nuts, sal 34.9516
12:45- 12:47 water bottle sample BOT30, 15 m, chl, nuts, sal 34.9682
12:50 air sample AS132, carbon monoxide
12:53 - 12:55 water bottle sample BOT31, 5 m, sal 34.9555
13:29 - 13:32 water bottle sample BOT32, 20 m, NMHC, halos, chl, nuts, sal 34.9617
13:43-13:47 water bottle sample BOT33, 25 m, chl, nuts, sal 35.032
13:52 -13:55 water bottle sample BOT34, 5 m, sal 34.9664
13:54 air sample AS133, carbon monoxide
14:32 - 14:35 water bottle sample BOT35, 30m, NMHC, halos, chl, nuts, sal 35.2464
14:45 14:50 water bottle sample BOT36, 35 m, chl, nuts, sal 35.347
14:55 - 14:58 water bottle sample BOT37, 5 m, sal 34.9757
14:56 air sample AS134, carbon monoxide
15:30 - 15:35 water bottle sample BOT38, 40 m, NMHC, halos, chl, nuts, sal 35.3993
15:47 - 15:53 water bottle sample BOT39, 45 m, chl, nuts, sal 35.4545
16:00 - 16:02 water bottle sample BOT40, 5 m, sal 35.0168
16:29 -16:37 water bottle sample BOT41, 50 m, NMHC, halos, chl, nuts, sal 35.4744

25/05/97 16:29 air sample AS135, carbon monoxide
16:48 - 16:50 water bottle sample BOT42, 5 m, sal 35.0535
18:18 non-toxic sample PG192 taken for chl, nuts, phyto, NMHC, halos
18:23 air sample AS136, carbon monoxide
19:25 air sample AS137, carbon monoxide
20:20 air sample AS138, carbon monoxide
20:23 , 26/05/97 08:15 UEA HIVOL aerosol samples HV16
20:35 , 26/05/97 08:15 Birmingham filter samples J11

26/05/97 08:25 air sample AS110, NMHC
08:32 non-toxic sample PG193, DMS
08:36 COMMENCE COASTAL SURVEY NEAR ARAN ISLES
09:02 non-toxic sample PG194 taken for chl, nuts, phyto, NMHC, halos
10:00 non-toxic sample PG195 taken for chl, nuts, phyto, NMHC, halos
10:05 non-toxic sample PG920, sal 34.8603
12:01 non-toxic sample PG197 taken for chl, nuts, phyto, DMS, halos
13:02 non-toxic sample PG198 taken for chl, nuts, phyto, DMS, NMHC, halos
14:03 non-toxic sample PG199 taken for chl, nuts, phyto, DMS, NMHC, halos
15:02 non-toxic sample PG200 taken for chl, nuts, phyto, DMS, NMHC, halos
16:04 non-toxic sample PG201 taken for chl, nuts, phyto, DMS, NMHC, halos
16:58 air sample AS139, halos
17:02 non-toxic sample PG202 taken for chl, nuts, phyto, DMS, NMHC, halos
18:02 non-toxic sample PG203 taken for chl, nuts, phyto, DMS, NMHC, halos
18:58 non-toxic sample PG204 taken for chl, nuts, phyto, DMS, NMHC, halos
19:55 CONCLUDE ARAN ISLES SURVEY
20:02 non-toxic sample PG205 taken for chl, nuts, phyto, DMS, NMHC, halos
20:10 - 27/05/97 08:05 Birmingham filter samples J12
20:10 - 27/05/97 08:06 UEA HIVOL aerosol samples BHV17
20:30 - 27/05/97 08:14 UEA rain water sample RAIN13 : 10 ml, mist !

27/05/97 04:10 ship repositioning
04:25 head to wind, 1 knot
08:20 UEA rain water sample RAIN14 : misty but nothing collected
09:00 START TRANSECT TO FLUORESCENCE MAXIMUM
09:19 non-toxic sample PG921, sal 35.084
10:05 non-toxic sample PG206 taken for chl, nuts, phyto, NMHC, halos
10:59 non-toxic sample PG207 taken for chl, nuts, phyto, NMHC, halos
12:00 non-toxic sample PG208 taken for chl, nuts, phyto, NMHC, halos
12:52 air sample AS140, halos
13:01 non-toxic sample PG209 taken for chl, nuts, phyto, DMS, halos
13:50 air sample AS141, halos
14:01 non-toxic sample PG210 taken for chl, nuts, phyto, DMS, NMHC, halos
15:01 non-toxic sample PG211 taken for chl, nuts, phyto, DMS, NMHC, halos
16:00 non-toxic sample PG212 taken for chl, nuts, phyto, DMS, NMHC, halos
17:02 non-toxic sample PG213 taken for chl, nuts, phyto, DMS, NMHC, halos
18:02 non-toxic sample PG214 taken for chl, nuts, phyto, DMS, NMHC, halos
18:06 - 28/05/97 19:40 UEA HIVOL aerosol samples HV18
19:01 non-toxic sample PG215 taken for chl, nuts, phyto, DMS, NMHC, halos
19:45 TRANSECT CONCLUDED, ON STATION HEAD TO WIND
19:53 air sample AS142, NMHC
20:20 - 28/05/97 10:40 Birmingham filter samples J13

28/05/97 09:39 non-toxic sample PG922, sal 35.526
09:39 cleaned red tank
10:35 non-toxic sample PG216 taken for chl, nuts, phyto, DMS, NMHC, halos
10:54 START SURVEY TO DEEP WATER MAXIMUM
11:08 air sample AS143 , carbon monoxide
11:33 non-toxic sample PG217 taken for chl, nuts, phyto, DMS, NMHC, halos
12:32 non-toxic sample PG218 taken for chl, nuts, phyto, DMS, NMHC, halos
28/05/97 13:32 non-toxic sample PG219 taken for chl, nuts, phyto, DMS, NMHC, halos
14:00 - 20:00 Birmingham filter samples J14
14:30 non-toxic sample PG220 taken for chl, nuts, phyto, DMS, NMHC, halos
15:32 air sample AS144, halos
15:33 non-toxic sample PG221 taken for chl, nuts, phyto, DMS, NMHC
16:31 non-toxic sample PG222 taken for chl, nuts, phyto, DMS, NMHC, halos
17:01 air sample AS145, NMHC
17:30 non-toxic sample PG223 taken for chl, nuts, phyto, DMS, halos
18:32 non-toxic sample PG224 taken for chl, nuts, phyto, DMS, NMHC, halos
19:31 non-toxic sample PG225 taken for chl, nuts, phyto, DMS, NMHC, halos
20:00 FINISH SURVEY TO DEEP WATER, HEAD TO WIND ON STATION
20:00 - 29/05/97 08:15 UEA HIVOL aerosol samples HV19
20:00 - 29/05/97 08:15 Birmingham filter samples J15

29/05/97 08:36 moving off from station, repositioning
10:00 hove to on station, head to wind
10:02 air sample AS146, halos
10:10 - 19:37 UEA HIVOL aerosol samples HV20
10:12 air sample AS147, NMHC
10:13 COMMENCE DEEP WATER PROFILE No. 1
10:14 - 11:15 water bottle BOT43, 900 m, gases, nuts, sal 35.518, temp 9.244
10:22 - 11:07 water bottle BOT44, 700 m, nuts, sal 35.451
10:29 -11:01 water bottle BOT45, 500 m, nuts, sal 35.486
10:36-10:54 water bottle BOT46, 300 m, nuts, sal 35.451
11:15 - 19:55 Birmingham filter samples J16
12:15 air sample AS148, halos

12:22 air sample AS149, NMHC
13:01 - 13:06 water bottle BOT47, 50 m, gases, nuts, chl, sal 35.554, temp 11.918
13:15 -13:19 water bottle BOT48, 45 m, nuts, chl, sal 35.571, temp 12.136
13:26 - 13:28 water bottle BOT49, 5 m, temp 13.538
14:01 - 14:05 water bottle BOT50, 40 m, gases, nuts, chl, sal 35.559, temp 11.932
14:15 - 14:21 water bottle BOT51, 35 m, nuts, chl, sal 35.579, temp 12.674
14:57- 15:01 water bottle BOT52, 30 m, gases, nuts, chl, sal 35.578, temp 12.862
15:12 - 15:16 water bottle BOT53, 25 m, nuts, chl, sal 35.583, temp 13.367
15:21 - 15:23 water bottle sample BOT54, 5 m, temp 13.609
15:43-15:46 water bottle BOT55, 20 m, gases, nuts, chl, sal 35.585, temp 13.574
15:58 - 16:02 water bottle BOT56, 15 m, nuts, chl, sal 35.585, temp 13.598
16:44 - 16:48 water bottle BOT57, 10 m, gases, nuts, chl, sal 35.58, temp 13.555
16:49- 17:01 water bottle BOT58, 5 m, nuts, chl, sal 35.577, temp 13.565
18:31 - 19:23 water bottle BOT59, 200 m, nuts, chl, sal 35.522
18:36 - 19:17 water bottle BOT60, 160 m, nuts, chl, sal 35.527
18:40 - 19:11 water bottle BOT61, 120 m, nuts, chl, sal 35.539
18:48 - 18:59 water bottle BOT62, 80 m, gases, nuts, chl, sal, temp 11.578
20:00 non-toxic sample PG227 taken for chl, nuts, phyto, NMHC, halos
20:04 moving off from station, reposition
20:57 air sample AS150, halos
23:15 hove to on station, head to wind
23:25 - 30/05/97 08:20 UEA HIVOL aerosol samples HV21
23:35 - 30/05/97 20:00 Birmingham filter samples J17

30/05/97 08:20 -20:04 UEA HIVOL aerosol samples HV22
08:00 START DEEP WATER PROFILE No. 2
08:34 - 08:40 water bottle BOT63, 100 m, gases, nuts, chl, sal 35.539, temp 11.55
30/05/97 08:49 - 08:55 water bottle BOT64, 80 m, nuts, chl, sal 35.545, temp 11.598
09:29 - 09:34 water bottle BOT65, 60 m, gases, nuts, chl, sal 35.6, temp 12.054
09:43 - 09:47 water bottle BOT66, 45 m, nuts, chl, sal 35.599, temp 12.148
10:29 - 10:31 water bottle BOT67, 30 m, gases, nuts, chl, sal 35.596, temp 12.766
10:42 - 10:44 water bottle BOT68, 25 m, nuts, chl, sal 35.589, temp 13.062
10:49 - 10:51 water bottle BOT69, 5 m, temp 13.565
12:20 air sample AS151, NMHC
12:59 - 13:02 water bottle BOT70, 20 m, gases, nuts, chl, sal 35.588, temp 13.503
13:11- 13:14 water bottle BOT71, 15 m, nuts, chl, sal 35.589, temp 13.546
13:59 - 14:01 water bottle BOT72, 10 m, gases, nuts, chl, sal 35.590, temp 13.545
14:11 - 14:13 water bottle BOT73, 5 m, nuts, chl, sal, temp 13.664
14:29 - 16:36 water bottle BOT74, 1390 m, FAILED !!!
14:37 - 16:24 water bottle BOT75, 1190 m, nuts, sal 35.457
14:43 - 16:15 water bottle BOT76, 990 m, nuts, sal 35.518
14:49 - 16:03 water bottle BOT77, 790 m, nuts, sal (suspect) 35.518
15:00 air sample AS152, halos
15:56 non-toxic sample PG228 taken for chl, nuts, phyto, NMHC, halos
16:47 - 16:58 water bottle BOT78, 200 m, gases, nuts, chl, sal 35.565, temp 11.255

	17:57 - 18:44	water bottle BOT79, 600 m, nuts, sal 35.539
	18:05 - 18:35	water bottle BOT80, 400 m, nuts, sal 35.516
	18:09 - 18:27	water bottle BOT81, 300M, nuts, sal 35.484
	20:33	*Challenger* breaks the world record for 9.5 knots from a standing start. Transit to Portland commences.
31/05/97		In transit to Portland.
01/06/97	10:44	Computer logging of underway data stopped.