Eastern Atlantic Experiment 1996

RRS Challenger 06/06/96 - 05/07/96

Principal Scientist Dr. Lucinda Spokes
School of Environmental Sciences
University of East Anglia
Norwich
NR4 7TJ
United Kingdom.

ATMOSPHERIC CHEMISTRY STUDIES IN THE OCEANIC ENVIRONMENT

MARINE AEROSOL AND GAS EXCHANGE

EASTERN ATLANTIC EXPERIMENT 1996

RRS CHALLENGER 06/06/96 - 05/07/96

UEA
NORWICH

UEA CRUISE REPORT SERIES NO. 2
AUGUST 1997

TABLE OF CONTENTS

1. ACKNOWLEDGEMENTS

I would like to thank everybody involved in the preparation and the execution of this Natural Environment Research Council funded cruise. As it was my first 'attempt' at PSO I was just a touch nervous at the start (people tell you horrible things!). Everyone, however, was so incredibly helpful and kind that it turned out to be, all in all, a really marvellous experience.

As the ships position was governed entirely by the wind speed and direction (which varied from Force 0 to Force 8 and did come from just about every possible direction), the Master Richard Bourne, the bridge crew and the engineers all coped admirably with me changing the position of the ship, the number of engines I required (thankfully there were only two, just imagine Martin what I would be like if I had more to choose from!) and my mind many times a day. All I can say is that's weather (and perhaps women) for you. Thanks also to all the crew, for beers and laughs and to Wolfie and George for extra mashed potato on a particularly stressful day. Special thanks also to Joe, without who's agility up and down the foremast twice a day in all conditions, would have resulted in many lost samples.

I'd also like to thank everyone in the scientific party for making this cruise both scientifically successful and very enjoyable, for their hard work under some pretty horrible conditions and for getting their paper work in on time (with only a little nagging). A special mention should go to Claire (the bird woman) for teaching us how to drink Boddingtons and that fulmers go 'flap, flap, glide'.

I would also like to thank Andy Louch at SOC in the RVS-OPS office who answered my many queries cheerfully and helpfully, Tim Jickells and Peter Liss for having the confidence in me that I could do the job (perhaps something to do with neither of them wanting to go to sea?) and especially to Wendy Broadgate my partner in crime at the land station at Mace Head, Ireland. She made it all really rather straightforward, sending us all over our patch of ocean in what was really a significantly more logical way than the cruise track makes out.

2. ***CRUISE PARTICIPANTS***

School of Environmental Sciences, University of East Anglia, Norwich, U.K.

Lucinda Spokes
Sally Jo Palmer Locarnini

Environmental Health, School of Chemistry, The University of Birmingham, Birmingham, U.K.

Jonathan James
Laura Yun Wang

British Oceanographic Data Centre, Bidston Observatory, Birkenhead, Merseyside, U.K.

Roy Lowry

Research Vessel Services, Southampton Oceanography Centre, Southampton, U.K.

Robin Powell
Gareth Knight
Simon Watts

Joint Nature Conservation Committee, Seabirds at Sea Team, Department of Zoology, University College, Cork, Ireland.

Claire Pollock

Department of Oceanography, Dalhousie University, Halifax, Canada

Bob Moore
Stewart Niven
Walter Judge
Huiziang Xie

Ships Officers and Crew

Richard Bourne	Master
Ceri Leather	Chief Officer
Paul Burridge	2nd Officer
Peter Reynolds	3rd Officer
Martin Holt	Chief Engineer
Anne James	2nd Engineer
Clive Phillips	3rd Engineer
Keith Connor	3rd Engineer
M. 'Trev' Trevaskis	Bosun
Christos Vrettos	Bosun's Mate
Joe Perkins	Seaman
Bob Johnson	Seaman
Tim Edwards	Seaman
Kevin Shelton	Seaman
Keith Pringle	Motorman
Chris Elliott	Catering Manager
George Welch	Chef
Mick Stephen	Steward
Peter Robinson	Steward

3. *ATMOSPHERIC CHEMISTRY STUDIES IN THE OCEANIC ENVIRONMENT*

3.1 A BRIEF INTRODUCTION

Atmospheric Chemistry Studies in the Oceanic Environment (ACSOE) is a five year Community Research Programme of The Natural Environment Research Council which aims to investigate the physico-chemical processes occurring in the atmosphere (the boundary layer and the free troposphere) over the oceans.

The studies aim to both bring about a clearer understanding of natural processes in the remote marine atmosphere and the modification of these processes by the presence of anthropogenic emissions. Such studies are vital in understanding regional and global-scale changes in atmospheric chemistry and climate. Particular emphasis will be placed on studies of the complex photochemistry of ozone and other oxidants in the marine atmosphere, and on the evolution and modification of aerosols and cloud condensation nuclei. Both of these aspects have a major influence on the Earth's atmospheric radiation balance; both directly in the case of clouds, aerosols and ozone, and indirectly in the case of atmospheric oxidation processes. These latter processes control the lifetimes of many greenhouse gases.

ACSOE activities will provide a wealth of accessible data on the chemical state of the Atlantic and North Sea atmosphere, together with new insights into the processes therein. This will be of vital importance to regulatory and policy-making bodies who must manage and maintain atmospheric air quality and the impacts of climate change in this region.

ACSOE consists of three consortia:

1. **OXICOA** (**OXI**dising **C**apacity of the **O**cean **A**tmosphere), a study of oxidant, radical and related gas chemistry within the clean and moderately polluted marine atmosphere.
2. **MAGE** (**M**arine **A**erosol and **G**as **E**xchange), a study of aspects of air-sea exchange relevant to atmospheric chemistry and aerosol production.
3. **ACE** (**A**erosol **C**haracterisation **E**xperiment), a study of gas and aerosol processing through hill cap clouds and subtropical marine stratocumulus.

From The ACSOE Implementation Plan March 1996 (ed. W. T. Sturges et al).

The EASTERN ATLANTIC EXPERIMENT 1996 was the first field experiment conducted as part of the MAGE component of ACSOE.

3.2 MAGE: MARINE AEROSOL AND GAS EXCHANGE

Exchange of chemicals across the air-sea interface has important implications for both atmospheric and oceanic chemistry. Trace gases produced naturally in seawater and through anthropogenic activity can, once in the air, affect:

1. the oxidising capacity of the atmosphere (through the breakdown of non-methane hydrocarbons and natural halocarbons)
2. the atmospheric radiation balance (uptake/release of CO_2, N_2O, CH_4 and the formation of cloud condensation nuclei from DMS oxidation)
3. the acidity of rain and aerosols (a balance between acids produced from fossil fuel combustion and from DMS oxidation and bases from natural and anthropogenic ammonia and methylamine sources).

In addition, deposition of aerosols and rain to the surface ocean provides a source of trace substances (such as iron and fixed nitrogen) to marine biota.

4. THE EASTERN ATLANTIC EXPERIMENT 1996

4.1 BACKGROUND

The rationale behind the experiment is:

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 species such as 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 influencing the amount of cloud over the ocean. The number of condensation nuclei governs the amount of water within a cloud. This 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, affecting the acid/base balance of rain and aerosols and reducing the amount of cloud condensation nuclei formed.
- Nitrogen oxides (from high temperature hydrocarbon combustion) are oxidised to nitric acid and are therefore important sources 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.

4.2 DETAILS AND AIMS OF THE EXPERIMENT AS A WHOLE

THE AIMS OF THIS EXPERIMENT WERE TO:

1. Quantify the input of DMS into a parcel of air by measuring its concentration in air and surface seawater and calculating its flux to the atmosphere.
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. The ship is operated by NERC Research Vessel Services and the cruise was designated CH127.
3. In the air using The Cranfield Jetstream Research Aircraft and the Meteorological Research Flight C-130 Hercules Research Aircraft to link measurements made on land and at sea and provide profiles of aerosol size and distribution throughout the marine boundary layer.

5. THE ROLE OF RRS CHALLENGER IN THE EXPERIMENT

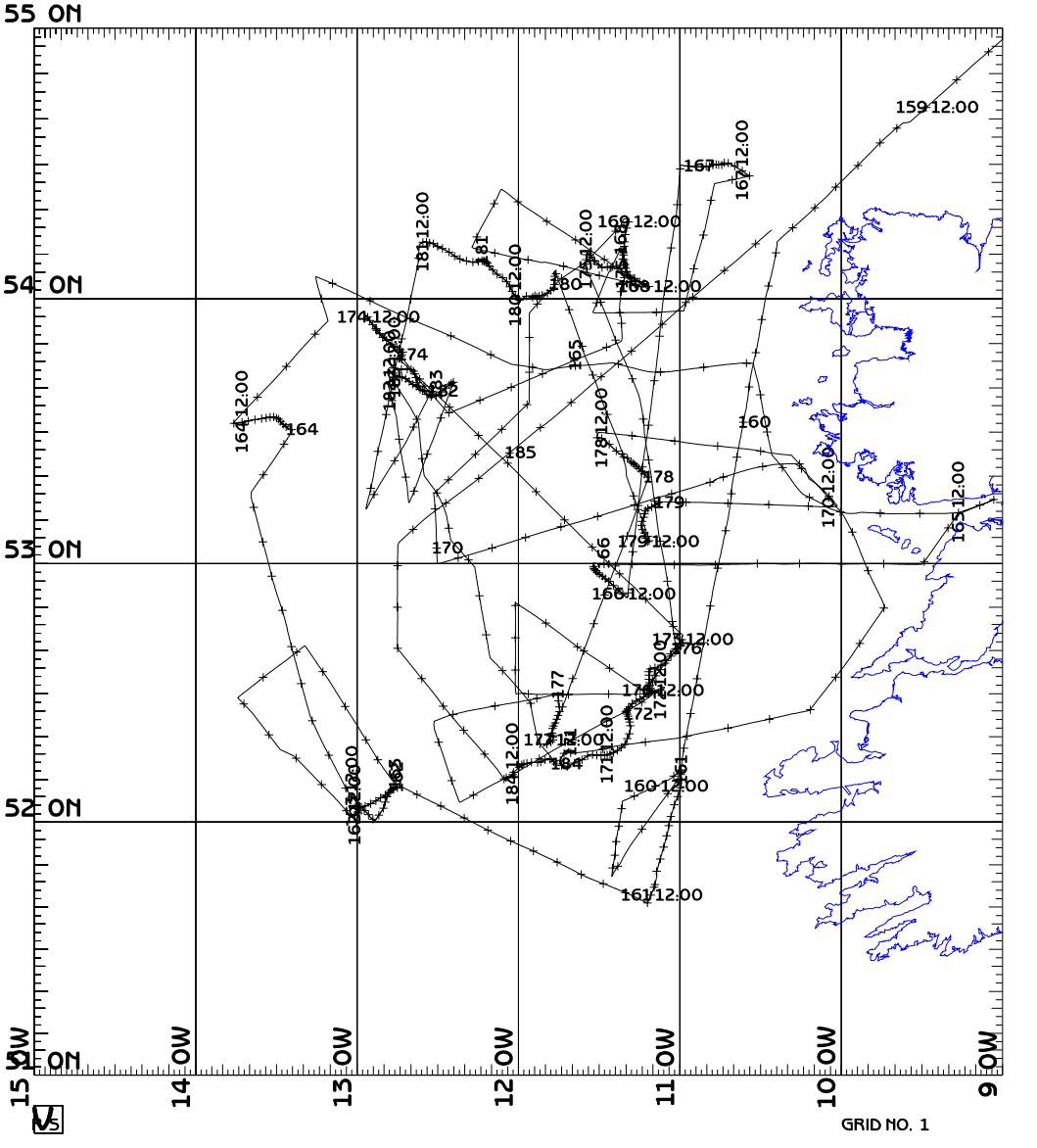
To quantify the input of DMS into a parcel of air, it is first necessary to determine its concentration, on both a spatial and temporal scale, in surface seawater. Measurements of surface water DMS were, therefore, made onboard RRS Challenger throughout the cruise. Once this and the wind speed data are processed, the flux of DMS into the atmosphere will be determined using wind speeds from the newly installed meteorological package on the foremast, the known transfer velocity and published wind speed parameterisations.

In order to examine the oxidation of DMS and its reaction with nitrogen species in the atmosphere, measurements have to be made within the same air mass but separated by time. Unfortunately it was not possible to add a deliberate tracer to the air to ensure that the same body of air was measured each time. Use was therefore made of forecast five day air parcel back trajectories provided by The British Atmospheric Data Centre (BADC), an example of which is shown in Fig. 1, and meteorological data from the U.K. and Irish Meteorological Offices. In the event of connected air flow, the experiment switched into a 'Lagrangian' mode and its multi-platform nature was employed. The ship was positioned approximately 8-9 hours air transit time from the land station at Mace Head, either downwind or upwind of the site depending on the wind direction. Sampling times were altered at the land station to enable samples to be matched. The sampling delay allowed 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 and to quantify, to some extent, the loss of species through mixing of air across the marine boundary layer into the free troposphere.

As atmospheric sampling and surface water surveying are incompatible, RRS Challenger was operated in two modes throughout the experiment. Each

day was split into two 12 hour periods. Half the time (generally between 00:00 and 12:00) the ship operated 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, again to prevent sample contamination from the ship's stack. Surveying recommenced once the rain ceased. The general plan of how the ship was operated on a daily basis is given in Table 1, accurate timings and positions at which samples were taken are given in Section 8, the daily log.

5.1 CRUISE TRACK



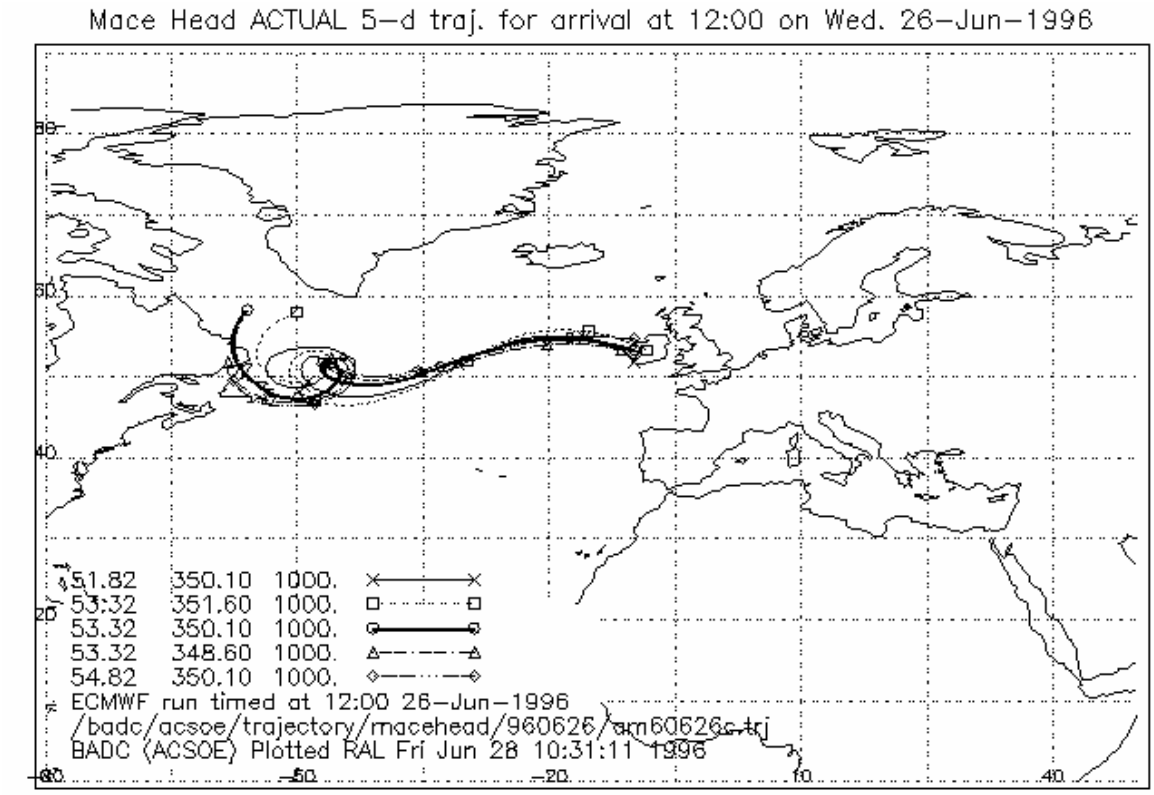
MERCATOR PROJECTION

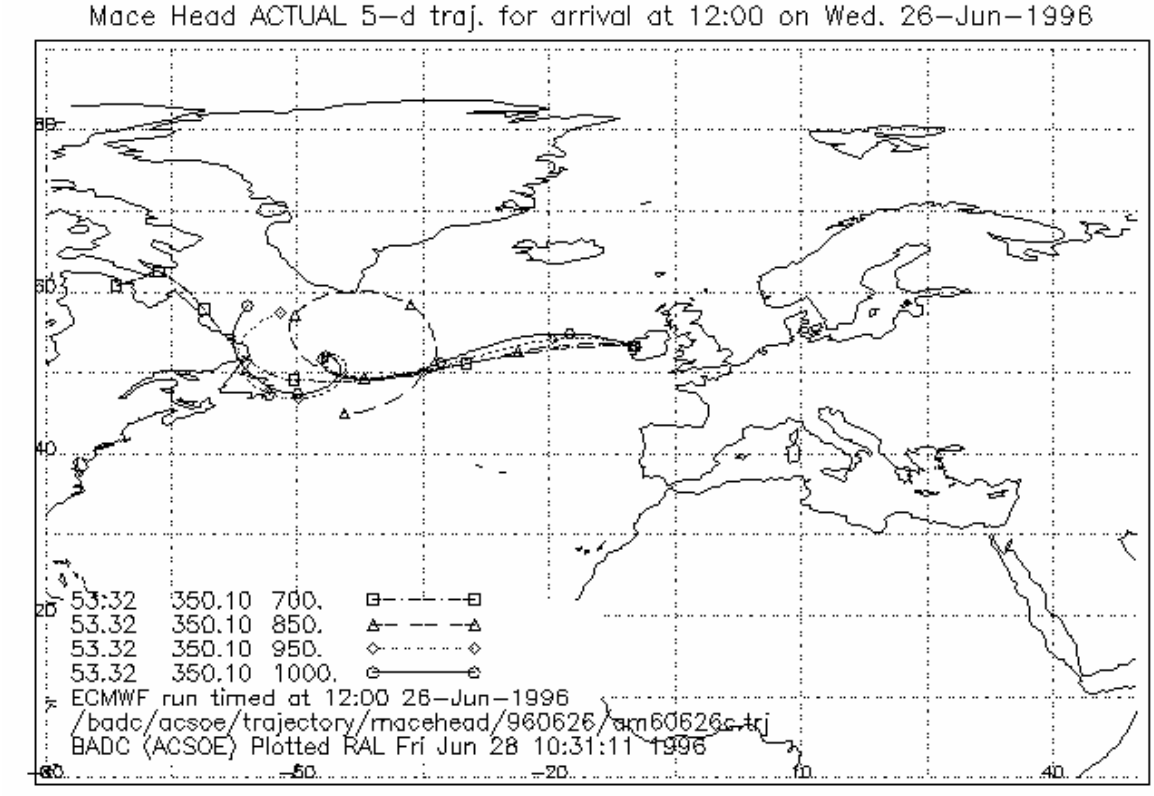
SCALE 1 TO 2250000 (NATURAL SCALE AT LAT. 55)

INTERNATIONAL SPHEROID PROJECTED AT LATITUDE 51

Challenger 127__Cruise Track

FIGURE 1. Example five day air parcel back trajectories for 26 June 1996. Trajectories are calculated at different pressures (1000 mbar is ≈ surface). Winds arriving at Mace Head and RRS Challenger at all heights are westerly in direction and the air has a North American component.





5.2 MEASUREMENTS AND SAMPLES TAKEN

5.2.1 ACSOE MEASUREMENTS MADE ONBOARD:

- Underway measurements (3262 nautical miles) of surface water salinity, temperature, transmission and fluorescence using the ships non-toxic supply.

- Continuous meteorological measurements (wind speed, direction, air temperature, irradiance) using the newly installed package on the foremast.

- 24 Discrete CTD profiles (including fluorescence and transmission) to depths between 5 and 400 m.

- Surface water bottle samples (from the non-toxic supply) for DMS (403 samples), with onboard analysis by gas chromatography.

- Continuous measurement of NO, NO_2 and O_3.

5.2.2 ACSOE SAMPLES TAKEN FOR ANALYSIS BACK 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.

- Air samples for hydrocarbon analysis.

- Particulate and dissolved phase surface seawater samples for DMSP (dimethyl sulponiopropionate - the precursor of DMS) determination.

- Surface water samples (from the non-toxic supply) for chlorophyll.

5.2.3 NON-ACSOE MEASUREMENTS MADE/SAMPLES TAKEN:

- Gas phase samples for the subsequent analysis of tetra and ionic alkyl lead.

- Continuous measurement of bathymetry and continuous Acoustic Doppler Current Profiler (ADCP) measurements to 500 m.

- Vertical profiles of dissolved methyl halides and carbonyl sulphide down to ≈ 100 m using bottles on the hydrowire and onboard analysis by GC-MS.

- Survey of seabirds and cetaceans.

TABLE 1. Daily plan of operation.

DATE	00:00 - 12:00	12:00 - 00:00
06/06/96	mobilisation	passage
07/06/96	passage	passage
08/06/96	passage	surface water survey
09/06/96	atmospheric sampling	surface water survey and atmospheric sampling
10/06/96	atmospheric sampling	surface water survey and atmospheric sampling
11/06/96	atmospheric sampling	surface water survey and atmospheric sampling
12/06/96	atmospheric sampling	surface water survey
13/06/96	surface water survey	surface water survey
14/06/96	atmospheric sampling	surface water survey and atmospheric sampling
15/06/96	atmospheric sampling	surface water survey
16/06/96	atmospheric sampling	surface water survey
17/06/96	atmospheric sampling	surface water survey
18/06/96	surface water survey	surface water survey
19/06/96	atmospheric sampling	atmospheric sampling
20/06/96	atmospheric sampling	surface water survey
21/06/96	atmospheric sampling	surface water survey
22/06/96	atmospheric sampling	surface water survey
23/06/96	atmospheric sampling	surface water survey
24/06/96	atmospheric sampling	surface water survey
25/06/96	atmospheric sampling	surface water survey
26/06/96	atmospheric sampling	surface water survey
27/06/96	atmospheric sampling	surface water survey and atmospheric sampling
28/06/96	atmospheric sampling	atmospheric sampling
29/06/96	atmospheric sampling	surface water survey
30/06/96	atmospheric sampling	surface water survey
01/07/96	atmospheric sampling	surface water survey
02/07/96	atmospheric sampling	surface water survey and passage
03/07/96	passage	passage
04/07/96	passage	arrival p.m. Fairlie Nato Pier
05/07/96	demobilisation	

6. CRUISE REPORTS FROM INDIVIDUAL GROUPS

6.1 JONATHAN JAMES - UNIVERSITY OF BIRMINGHAM

Institute of Public and Environmental Health
School of Chemistry
The University of Birmingham
Birmingham B15 2TT, U. K.

The following measurements were taken on the cruise between Monday 10th June and Tuesday 2nd July:

Continuous detection of NO/NO_2 and ozone. Two separate instruments were both measuring the NO/NO_2 concentrations (Scintrex and API 200 series Chemiluminescent analyser) so this data will be available in duplicate. Values were recorded as 5 minute averages using a Campbell 21X datalogger. The instruments were generally calibrated every 3 days.

Filter packs, each containing 4 filters were run over 3 hourly periods.
The filters were:

1) Nucleopore: Nylon filters with 12 μm pore size. Particulate material >12 μm will be collected by this stage and will be analysed for MSA, NO_3^-, SO_4^{2-}, Cl^- and potentially acetate and formate.
2) Teflon Filters: These have a 1 μm pore size and hence collect the 12 to 1 μm aerosol fraction. These will be analysed for the same particulate anions as above.
3) SO_2 filters: These impregnated filters measure gaseous sulphur dioxide concentrations.
4) NH_3 filters: Again these are treated but are used to find ammonia gas concentrations.

Because emissions from the ships stack would severely contaminate filters and alter continuous measurements, results are only valid for the periods where we were stationary and maintaining a head-to-wind position. On most days this was from midnight to midday - although there are a few exceptions to this.

All filters were frozen and will be taken back to Birmingham for analysis.

The cruise was very successful from my perspective - all the equipment appears to have run properly and filters 'runs' were not disrupted by the bad weather.

6.2 SALLY JO PALMER LOCARNINI - UNIVERSITY OF EAST ANGLIA

School of Environmental Sciences
University of East Anglia
Norwich, NR4 7TJ, U. K.

Dimethyl sulphide, DMS, is a volatile biogenic sulphur compound generated from the breakdown of dimethyl sulphoniopropionate, DMSP, an osmoregulatory compound found in phytoplankton. Once in the atmosphere, DMS is oxidised to form SO_2, sulphuric acid and methane sulphonic acid. These oxidant by-products of DMS contribute to the acidity of rainwater and are a source of cloud-condensation nuclei over the oceans and could thus act as a feedback mechanism in climate regulation. The objectives of this cruise were to determine the concentration of DMS in the surface waters of the North Atlantic and to estimate the sea to air flux of DMS.

Water samples were routinely taken from the ship's non toxic pump by rinsing a 500 ml bottle several times, allowing the water to fill the bottle and to flush the bottle for several minutes before being sealed with a ground glass stopper. A volume (20-200 ml) of this sample was then gently filtered to be measured for DMS. Samples were preconcentrated cryogenically before analysis using a Varian gas chromatograph fitted with a flame photometric detector. Samples of DMSP (both dissolved and particulate) were taken back for approximately one quarter of the stations sampled and will be analysed back in the laboratory. Additionally, 100 ml of the sample water was filtered and frozen for chlorophyll analysis, which will be completed back in the laboratory.

Approximately 400 samples were measured for DMS. Preliminary data analysis shows that the concentrations ranged from <0.5 nM to 40.0 nM.

6.3 ROY LOWRY - BRITISH OCEANOGRAPHIC DATA CENTRE

British Oceanographic Data Centre
Bidston Observatory
Birkenhead
Merseyside L43 7RA, U. K.

Data Management

There were two primary objectives for shipboard data management on this cruise. The first was to ensure that a complete, detailed, centralised inventory of samples taken and measurement made was constructed. This will be supplied to BADC to form the basis for their cruise data tracking. This was achieved through maintenance of a detailed scientific log which was transposed into a series of spreadsheets detailing the data events. My thanks go to all the scientific

party for diligently keeping the log up to date with only the occasional reminder required!

The second objective was to finalise the data management policy for the cruise data set, particularly clarifying the roles of BODC and BADC. A detailed document has been prepared, the main points of which are summarised here:

Data logged by ship's system
The underway data (navigation, transmissometer, thermosalinograph, fluorometer, bathymetry and meteorological package) will be worked through BODC's standard quality assurance procedures. The fully processed data will then be reformatted into AMES and submitted to BADC.

In addition to the above, a shipboard acoustic doppler current profiler (ADCP) was run continuously during the cruise, including a calibration transect. This will be processed through the BODC system and loaded into our on-line data base. This is a high volume data set which is currently not considered to be highly relevant to ACSOE. Therefore, unless a requirement emerges to the contrary, these data will be held at BODC and not lodged with BADC.

ACSOE measurements
The DMS, DMSP and chlorophyll data set will be submitted to BODC as soon as the analyses are completed. The chlorophyll data set will be used in conjunction with the Dalhousie data to calibrate the underway and CTD fluorometers. The entire data set will then be merged with the final version of the navigation, reformatted into AMES and submitted to BADC.

All other ACSOE measurements on the cruise (UEA aerosol, rainwater and air samples: Birmingham NO_X, ozone and filter pack data) will be reformatted into AMES by the scientists responsible and submitted directly to BADC.

Non-ACSOE measurements
The group on board from Dalhousie were responsible for the CTD data and a set of chlorophyll determinations on sub-surface water samples in addition to their primary interest in methyl halides and carbon disulphide. They have kindly agreed to make the CTD and chlorophyll data public domain immediately. The CTD data will be worked through BODC's standard quality assurance procedures, reformatted into AMES and submitted to BADC. The chlorophyll data will be merged with the UEA bottle data and submitted to BADC. The remaining data will be submitted to BODC's National Oceanographic Database after a two year originator's priority period has elapsed.

Non-ACSOE measurements of alkylated lead species and aerosol chemistry were made by the Birmingham group. The management of these data has not yet been settled and is an issue that needs to be clarified between the ACSOE project, BADC and the principal investigator (Prof. R. Harrison).

UNDERWAY INSTRUMENTATION AND CTD

Thermosalinograph

The thermosalinograph was fully operational throughout the cruise. However, considerable post-cruise processing will be required for two reasons.

First, calibration checks showed significant instrumental drift. Temperature (calibrated against the Dalhousie CTD) drifted from 0.08°C low at the start of the cruise to 0.13°C low by the end. Salinity (calibrated against salinity bottle samples) drifted steadily from 0.05 PSU low at the start of the cruise to 0.12 PSU low by the evening of July 2nd. Between 20:00 on July 2nd and 00:00 on July 3rd the calibration error leapt dramatically to 0.39 low. The cause of this is not known for certain but the event seems to correlate with the time some of the scientific equipment was powered down.

Secondly, an incorrectly wired plug on a piece of scientific equipment caused the thermosalinograh temperature to read approximately 0.2°C low each time the equipment was switched on.

Transmissometer and Fluorometer

Both instruments worked well throughout the cruise. The only problem encountered was a number of spikes in the transmissometer record caused by bubble formation in the tank during rough weather.

Meteorological Instrumentation

The newly installed meteorological package on the foremast worked well throughout the cruise. A number of checks were made against bridge meteorological reports and the monkey island light meters which gave good agreement.

There were two small problems encountered with the monkey island light meters. First, a faulty level A analogue board caused corruption of the starboard 2-pi PAR meter until the problem was identified and rectified on June 18th. It is not yet known whether the data can be recovered but even if this does not prove possible good 2-pi PAR data were obtained from the port sensor which is the least prone to shading.

Secondly, it was discovered that the Kipp and Zonen solar irradiance meters had incorrect calibrations applied. This problem was rectified at 14:12 on June 22nd. Prior to this, data from the port sensor need to be multiplied by 0.9763033 and data from the starboard sensor by 1.037398.

CTD

The Sea Bird SBE25 package, including a 10cm SeaTech transmissometer and a Sea Tech fluorometer, worked extremely well throughout the cruise. Calibration checks against water bottle samples and a calibrated digital reversing thermometer showed temperature and salinity to be accurate. The only problem

encountered was that the fluorometer read full scale during most of the first two casts due to the internal sensitivity jumpers being set to the wrong range.

6.4 LUCINDA SPOKES - UNIVERSITY OF EAST ANGLIA

School of Environmental Sciences
University of East Anglia
Norwich, NR4 7TJ, U. K.

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

1. Aerosol samples

Two aerosol collectors were deployed on the foredeck and operated whilst the ship was head to wind. For safety reasons and to reduce motor wear, samplers were run at 110 V resulting in an average flow rate of 0.6 m^3 min^{-1}. Bulk aerosol samples were collected onto Whatman 41 cellulose filters which will be digested either in strong acid (for metal determination) or using water and ultrasonification (for major ion determination). Deployments were generally 12 hours although a series of 6 hourly samples were taken in the middle of the experiment to assess the shorter time scale variability of some species. In total 57 samples were collected. Two samples from one of the instruments were lost at the beginning of the cruise due to a faulty transformer but this was rectified on day 3. Thereafter the samplers operated well throughout the cruise.

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 17 rain samples were collected, more than we have ever managed over this time period, perhaps our rain collecting curse is over!

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 or ICP-MS.
4. NH_4^+ and Fe(II) by Colorimetry.
5. Nitrogen stable isotope ratios by Stable Isotope Mass Spectrometry. In addition sulphur stable isotope ratios will be determined by colleagues at UEA.

6.5 LAURA YUN WANG - UNIVERSITY OF BIRMINGHAM

Institute of Public and Environmental Health
School of Biological Sciences
The University of Birmingham
Birmingham B15 2TT, U. K.

1. To determine trace metals in aerosols

Marine atmospheric aerosols were sampled at 1.25 m^3 min^{-1} onto quartz filter papers using a PM10 HiVol sampler. Each filter was exposed twice from 00:00 to 12:00 PM on the day and following day (total 24 hours sampling). After sample collection, the filter paper was folded, placed in a plastic bag and then stored in a freezer. Twelve aerosol samples have been collected.

2. To determine tetra alkyl lead and ionic alkyl lead in the gas phase

Gas phase tetra alkyl lead (R_4Pb) were sampled with three stainless steel tubes (3.25 in. long x 0.2 in. id) in series packed with Tenax in the first tube and with poropak Q in the second and third. A filter (0.45 μm) for removing atmospheric aerosols was attached to the upstream end of the first sampling tube. Eleven R_4Pb samples, based on 24 hours sampling for each sample, were collected and stored frozen. Gas phase ionic alkyl lead were sampled (24 hours sampling) by bubbling filtered (0.45 μm) air into two bubblers in series, each containing 120 ml of Milli-Q purified water. After sampling completed, the contents of the two bubblers were combined, transferred into a 1L brown glass bottle, and stored at 4°C. Ten of these samples were collected.

6.6 CLAIRE POLLOCK - UNIVERSITY COLLEGE, CORK, IRELAND

Seabirds and Cetaceans Branch
Joint Nature Conservation Committee
University College
Cork, Ireland.

Report on Seabird and Cetacean Observations from R. R. S. Challenger.

Cruise Dates: 6 June - 4 July 1996
Observer: Claire Pollock
Regions Visited: Clyde, Atlantic (North, West and Southwest of Ireland)

Introduction

Line transect surveys of seabirds and cetaceans were carried out from R. R. S. Challenger during 'ACSOE' (Atmospheric Chemistry Studies in the Oceanic Environment) sea-trials off the west coast of Ireland. Transect counts using ten minute recording intervals were carried out from the bridge wings (height 10 m) when the ship was steaming. A total of 8190 minutes (136.5 hours) date was

collected over an area of 684 km² while travelling a distance of 2641 km. Coverage of 80 15´N x 30´W squares was obtained.

Weather conditions while extremely variable, were generally favourable for surveying in, and it was possible to collect data on 24 out of 29 days. The wind was predominantly from the south-west, but was also from the west, north-west and north-east at times. Although occasionally reaching gale force, wind speed was usually less than Beaufort 5. Seastate ranged from 0-6 but generally less than 5. There was swell present on all days but two. Luckily the swell was mostly low but at times it increased, and was the main reason that surveying could not be carried out. Visibility was mostly excellent but on 2 days, foggy conditions prevented surveying for a while.

Seabird Distribution

Fulmar - Fulmars were the second most abundant species with a total of 1866 birds recorded in transect counts. Highest numbers (393) were recorded on 17 May off the west coast of Ireland where 200 were associated with a fishing vessel.

Manx Shearwater - Manx shearwaters were the most abundant species overall with a total of 2884 birds recorded. Distribution was patchy with peaks on the shelf in waters less than 200 m deep. Highest numbers (1105 birds) were recorded south-west of Loop Head on 8 June.

Storm Petrel - Storm petrels were common with a total of 750 birds observed. A concentration of over 200 birds was recorded in the mouth of the Shannon over the Kerry Head Shoal on 18 June.

Storm Petrel Species - Four unidentified storm petrel species were observed.

Gannet - This was the third most abundant species, with a total of 1199 birds recorded. Highest numbers of 174 birds were recorded on 9 June on waters over the slope, west of Great Skellig.

Eider - A flock of 10 eider ducks was observed in the Clyde in 6 June.

Cormorant and Shag - On 13 June, 1 cormorant, 1 shag and 1 cormorant/shag were recorded in inner Galway Bay.

Bonxie - This was the only skua recorded and 22 birds were counted. Most of these birds were on waters over the slope.

Sabine's Gull - Three adult birds were observed on 9,11 and 12 June, all in waters over the slope west of Ireland. Two were flying north-west, and the other south-east.

Black-headed Gull - Two adult birds were recorded in Galway Bay on 13 June.

Common Gull - Seven birds were observed in the Clyde.

Lesser Black-backed Gull - This was the most common gull with a total of 149 birds. It's distribution was patchy and a maximum of 38 birds was recorded on 18 June in inshore waters.

Herring Gull - Herring gulls were observed in inshore waters only (total 87 birds) and 62 of these were in the Clyde.

Great Black-backed Gull - This species was generally sparse with only 31 birds recorded. Over half were west of Galway/Mayo.

Kittiwake - This was the most numerous gull species (total 777) and was observed in all areas. Highest concentrations (over 50%) were seen off the coast of Galway, particularly in Galway Bay.
Gull Species - Some Gull species were not identified to species. This included 12 gull species, 16 large gull species and 48 black-backed gulls.
Sandwich Tern - Six sandwich terns were observed in Galway Bay on 13 June.
Common Tern - Four single common terns were recorded in inshore waters.
Arctic Tern - Seven arctic terns were observed of which five were west of Mayo on 7 June.
Tern Species - Off 33 terns which were not identified to species, 23 were 'commic' terns.
Guillemot - This was the most abundant auk species with 609 birds recorded. There were two main concentrations; 275 birds in Galway Bay on the Claire side mainly under the cliffs by the south sound, and there were 244 birds around the Clyde.
Razorbill - There were fewer razorbills than guillemots (total 102), but they were concentrated in the same areas; Clyde (42) and Galway Bay (33).
Puffin - A total of 66 puffins were recorded with a maximum of 25 in Galway Bay.
Tystie (Black Guillemot) - Although not recorded in transect counts, approximately 5 birds were observed feeding in the vicinity of the jetty at Fairlie and there was at least one nest in a crevice in the jetty itself.
Auk Species - There were 152 unidentified auks of which 135 were guillemot/razorbill.
Shore Bird Species - On 12 June, whilst 95 miles west of Achill Island, a ringed plover landed on the ship and remained until the following day. A turnstone flew around the ship several times in 17 June, 58 miles west of Achill Head. During the cruise, several racing pigeons landed onboard for a rest. Two of them enjoyed their stay so much that they decided to move in but unfortunately it is feared that they were claimed by the sea one night during stormy weather.

Cetaceans

Not all cetaceans could be identified to species. These included 1 cetacean species, l whale and 31 dolphins.
Possible Bottle Nosed Whales - On 29 June, on the slope west of Mayo, three whales were observed travelling North. Although viewing conditions weren't great, due to a moderate swell. It is thought that the animals were northern bottlenosed whales.
Minke Whales - A single minke whale was spotted by the third mate Peter Reynolds on 26 June, 40 miles west of Slyne Head. The animal was allegedly travelling on a south-east course.
Killer Whale - There were five sightings of killer whales yielding a total of 17 animals. On 9 June, a pod of 3 whales were observed 50 miles west of Great Skellig and pods of sizes 4,2,3 and 5 were recorded in 22 and 23 June approximately 80 miles west of Galway.

Harbour Porpoise - A single animal was observed in the south sound of Galway Bay on 13 June.
Bottlenosed Dolphin - Two schools of 3 and 5 dolphins were recorded on 13 and 14 June respectively, approximately 50 miles west of County Claire at a water depth of 120 m.
White-Beaked Dolphin - A group of three white beaked dolphins were travelling north-east on 23 June, 48 miles north west of Inishmore.
Common Dolphin - This was the most numerous cetacean with a total of 114 animals recorded. Sixty percent of sightings were concentrated west of the Aran Islands. Four of the dolphins were calves.

Bits'n'Bobs

During the cruise several other creatures of interest were spotted. These included one sunfish, 2 seals (one of which was a grey) and 1 basking shark and 7 other sharks (probably blues).

Summary

A total of 8249 seabirds of 22 species were recorded during the cruise. The most abundant were manx shearwaters, fulmers and gannets. Seven species of cetaceans were observed of which common dolphins were the most numerous.

Acknowledgements
I thank Dr. Lucy Spokes for facilitating the survey on R.R.S. Challenger and to Captain Richard Bourne and all the crew and scientists for their hospitality and helpfulness onboard.

6.7 R. M. MOORE - DALHOUSIE UNIVERSITY, CANADA

Department of Oceanography
Dalhousie University
Halifax
CANADA B3H 4JI

Personnel: Bob Moore, Walter Judge, Stewart Niven, Huiziang Xie.

Vertical profiles were collected at 21 stations for the measurement of methyl chloride, bromide and iodide, carbon disulphide and isoprene by GC-MS. Calibrations were done by means of microlitre-volume injections of these gases in nitrogen. Uncalibrated data were also obtained for carbonyl sulphide and methylene chloride. Metal bottles fitted with Teflon seals were used in order to avoid the contamination with carbon disulphide. The non-toxic pumped seawater supply was found to be significantly contaminated with this gas.

The analytical system functioned well except for a period during which a poor electrical connection within the source caused fluctuations in sensitivity. After replacement of the source, this problem did not recur.

In addition to providing temperature, salinity and fluorescence data for the selection of water sampling depths, the CTD was also used to check the calibration of the thermosalinograph.

In ca. 10 cases comparisons were made with water samples that had been irradiated with full spectrum sunlight, typically for 30 minutes, Production rates of carbon disulphide were measured as a function of wavelength in surface water samples at 12 locations. These experiments were done using a Heraeus sun lamp and a set of 6 cut-off filters. The experiments were repeated with subsurface waters at 2 locations.

Trace gas production rates under irradiation were determined both using full solar spectrum and a function of wavelength.

Experiments were done to determine whether the sampling handling procedures had any significant effects on trace gas concentrations.

Reproducibility of the analytical method was checked by repeated analysis of a single 100 m sample. Checks were made on changes in gas concentration on storage.

Seven days into the cruise it was found that one liquid nitrogen container had been only partially filled; sufficient remained for a further 11 days, after which work continued intermittently with liquid nitrogen provided by the UEA group.

7. PROBLEMS

7.1 ELECTRICAL EQUIPMENT ON DECK

All of the last minute panic concerning scientific equipment prior to sailing were the responsibility of the scientific party and not RVS. I would like to thank Stan Smith for successfully solving our problems with the minimum of fuss. In order to prevent a repercussion, I believe a clear protocol concerning the use of electrical equipment on deck must be established. Under much less severe conditions on land, all electrical equipment must have suitable armoured cabling, waterproofed connections and plugs. This should have been known by the scientists concerned. I would suggest that it is a requirement that all electrically run deck equipment is operated at 110 V unless it is proved to the qualified RVS electrical personnel prior to sailing (ideally during the cruise planning stage) that the equipment is safe to use at 240 V.

7.2 EMAIL

It was made very clear in the cruise planning meeting that a high level of communication was required between the ship and the land station. We were therefore very disappointed that, although promised, Email was not available at any time during the cruise. As the 'problem' was known about prior to sailing we should have been made aware of it earlier, we could have then made alternative arrangements for contacting, in particular, our home universities. Communication with the land station was achieved satisfactorily by fax and telephone.

8. DAILY LOG

Roy Lowry BODC, Richard Bourne Master RRS Challenger, Lucinda Spokes UEA.

All times in GMT (1 hour ahead of local)

06/06/96	14:12	Depart Fairlie NATO Pier.
	14:23	Non-toxic supply turned on.
		Reversing thermometer T264 set up for TSG calibration. Initially using red tank. Calibration is T = t*1.000006016 + 0.015800567
	14:54	Full away on passage.
07/06/96	07:19	Lat: 55 08.6 N. Long: 08 38.5 W. CTD1 off deck. Cast to 50m.
	07:30	Messenger released firing bottles at 15m and 40m.
	07:31	Surface bucket sample taken.
	07:36	CTD1 onboard. 15m bottle suffered terminal leakage.
	09:20	Thermosalinograph cleaning commenced.
	09:34	Thermosalinograph cleaning completed.
	12:00	Lat: 54 48.7 N. Long: 09 17.0 W.
08/06/96	09:40	Hove to for setting up atmospheric gear in calm conditions
	09:45	Bucket sample taken for halocarbons.
	11:20	Commencing SW transect across shelf break.
	12:00	Lat: 52 08.4 N. Long: 11 09.2 W.
	13:50	Rain collector deployed (RS1). Intermittent rain.
	14:10	Surface transmissometer and fluorometer windows cleaned.
	16:00	Turning into southerly swell. Virtually hove to.
	18:35	Rainwater sample recovered. About 100ml collected.
	18:42	UEA dimethyl sulphide (DMS) samples taken.
	19:15	UEA DMS sampling complete.
	19:30	Making way to aerosol sampling position to SW of Mace Head.
	21:50	Lat: 52 12.4 N. Long: 10 59.5 W. Hove to on station, head to wind.
09/06/96	00:15	UEA aerosol filters deployed (EAHV1). Heavy rain, high winds and lots of spray.
	10:05	Lat: 51 45.3 N. Long: 11 09.3W. CTD2 in the water. Wire out 3m.
	10:08	First bottle attached. Wire out 10m. Firing depth 100m.
	10:12	Second bottle attached. Wire out 35m. Firing depth 75m.
	10:19	Third bottle attached. Wire out 60m. Firing depth 50m.

	10:22	Fourth bottle attached. Wire out 115m. Firing depth 20m.
	10:25	UEA underway DMS sampling commenced.
	10:26	Fifth bottle attached. Wire out 105m. Firing depth 5m.
	10:30	Messenger released. Wire out 113m.
	10:38	CTD2 onboard.
	10:45	Bucket sample taken for halocarbons.
	11:55	UEA aerosol sample collected (EAHV1). One (of 2) samplers failed.
	11:59	UEA aerosol sample started (EAHV2).
	12:00	Lat: 51 42.8 N. Long: 11 10.8 W.
	13:00	Steaming to arrive at 52° 8′ N, 12° 45′W at midnight for aerosol sampling.
	16:38	Transmissometer and fluorometer cleaned.
	16:50	Rain water samplers deployed in anticipation of rain (RS2). Rain started at 16:56. Michael Fish beware!
	19:53	Rain samplers brought in. Very small volume. New bottles deployed in case of overnight rain (it didn't rain!).
	20:56	UEA DMS sampling ceased.
	23:55	Lat: 52 08.1 N. Long: 12 44.9 W. Hove to on station, head to wind.
10/06/96	00:06	UEA aerosol sample collected (EAHV2). One sampler failed.
	00:09	UEA aerosol samples started (EAHV3).
	08:30	Lat: 52 03.2 N. Long: 12 59.5 W. CTD3 to 400m. CTD in the water.
	08:58	CTD 3 onboard.
	09:28	Lat: 52 02.6 N. Long: 12 59.4 W. Bottle sample B3A. Bottle attached. Wire out zero. Depth 100m.
	09:29	Bottle attached. Wire out 25m. Firing depth 75m.
	09:31	Bottle attached. Wire out 50m. Firing depth 50m.
	09:33	Bottle attached. Wire out 80m. Firing depth 20m.
	09:35	Bottle attached. Wire out 95m. Firing depth 5m.
	09:36	Messenger released. Wire out 105m.
	09:44	Bottle cast complete.
	10:19	Lat: 52 02.0 N. Long. 12 59.7 W. Bottle cast B3B. Bottle attached. Wire out 1m. Firing depth 500m.
	10:20	Surface transmissometer and fluorometer cleaned.
	10:23	Bottle attached. Wire out 100m. Firing depth 400m.
	10:28	Bottle attached. Wire out 300m. Firing depth 300m. Failed to close.
	10:31	Bottle attached. Wire out 300m. Firing depth 200m.
	10:35	Bottle attached. Wire out 350m. Firing depth 150m.
	10:40	Messenger released. Wire out 503m.
	11:03	Bottle station completed. All bottles onboard.
	12:00	Lat: 52 01.5 N. Long: 13 01.1 W.
	12:16	UEA aerosol samples (EAHV3) collected.
	12:20	UEA aerosol samples (EAHV4) deployed.
	12:30	Lat: 52 01.3 N. Long: 13 01.9 W. Moving off station to commence triangle survey.
	15:30	Birmingham particle and impregnated filters (BFP1) deployed.
	16:39	Rain samplers deployed (RS3).
	18:15	UEA DMS sampling ceased.
	18:36	Rain samplers recovered. About 25 ml of sample.
11/06/96	00:07	Lat: 52 08.4 N. Long: 12 45.2 W. Hove to on station, head to wind.
	00:25	UEA aerosol samples (EAHV4) collected. Birmingham HiVol sample (BHV1) started. First of two exposures.
	00:27	UEA aerosol samples (EAHV5) deployed.
	00:30	Birmingham particle/impregnated filter samples (BFP1) recovered.
	00:31	Birmingham particle/impregnated filter samples (BFP2) deployed.

	08:31	Lat: 52 01.4 N. long: 12 55.3 W. CTD cast CTD4. CTD in the water.
	08:42	CTD onboard.
	08:59	Lat: 52 01.8 N. long: 12 55.7 W. Bottle cast B4 commenced.
	09:00	Bottle attached. Wire out 0m. Firing depth 100m.
	09:02	Bottle attached. Wire out 25m. Firing depth 75m.
	09:03	Bottle attached. Wire out 50m. Firing depth 50m.
	09:05	Bottle attached. Wire out 70m. Firing depth 30m.
	09:06	Bottle attached. Wire out 95m. Firing depth 5m.
	09:08	Messenger released. Wire out 103m.
	09:15	Bottle station completed.
	10:00	Surface transmissometer and fluorometer cleaned. Tank rinsed.
	11:46	UEA DMS sampling commenced.
	12:00	Lat: 52 06.0 N. Long: 13 01.9 W.
	12:14	UEA aerosol samples (EAHV5) collected.
	12:20	UEA aerosol samples (EAHV6) deployed.
	12:30	Birmingham HiVol pump switched off to terminate filters' first exposure.
	12:45	Birmingham particle/impregnated filter samples (BFP2) recovered.
	12:46	Birmingham particle/impregnated filter samples (BFP3) deployed.
	13:00	Lat: 52 08.0 N. Long: 13 04.3 W. Surface water survey started to arrive at aerosol sampling site on the Porcupine Bank at ≈ midnight.
11/06/96 cont.	17:00	Continuous measurement of NO_x and O_3 commenced.
	22:40	UEA DMS sampling ceased.
	23:50	Lat: 53 30.5 N. Long. 13 24.2 W. Hove to on station, head to wind.
12/06/96	00:03	UEA aerosol samples (EAHV6) collected.
	00:06	UEA aerosol samples (EAHV7) deployed.
	00:15	Birmingham HiVol pump switched on. Second exposure commenced.
	00:25	Birmingham tetra-alkyl lead (TAL) sample (TAL1) started.
	00:30	Birmingham particle/impregnated filter samples (BFP3) recovered.
	00:31	Birmingham particle/impregnated filter samples (BFP4) deployed.
	08:28	Lat: 53 33.1 N. Long: 13 34.6 W. Bottle station (BA) commenced.
	08:31	Bottle attached with wire out zero. Firing depth 5m.
	08:32	Messenger released with wire out at 8m.
	08:33	Bottle recovered and second bottle attached with wire out zero. Firing depth 5m.
	08:34	Messenger released with wire out at 8m.
	08:35	Bottle station completed.
	10:24	UEA air sample for hydrocarbons (AS1) taken.
	12:00	Lat: 53 32.3 N. Long: 13 42.8 W. Birmingham TAL sample (TAL1) collected.
	12:10	UEA DMS sampling commenced.
	12:18	UEA aerosol samples (EAHV7) collected.
	12:30	Birmingham HiVol sample (BHV1) collected after two exposures. Birmingham particle/impregnated filter samples (BFP4) recovered.
	13:00	Lat: 53 32.4 N. Long: 13 45.6 W. Underway survey over shelf break then across the shelf to Galway for boat transfer.
	14:40	Underway fluorometer and transmissometer cleaned.
	17:00	Underway transmissometer calibration. Air reading 4.700 V. Blocked 0.000 V. SN125. Manufacturer's reading 4.789 V.
13/06/96	08:28	Bucket sample taken for halocarbons.
	09:31	UEA DMS sampling ceased.
	11:44	Bucket sample taken for halocarbons.
	12:27	Non-toxic supply switched off to facilitate boat transfer.

	13:02	Vessel hove to, head to sea at Galway Pilot Station.
	13:20	Boat alongside.
	13:34	Boat transfer completed (Simon Watts departing, Christos Vrettos arriving).
	13:40	Non-toxic supply switched back on.
	15:48	Underway transmissometer and fluorometer cleaned.
	16:16	Light meters on the monkey island cleaned.
	16:58	UEA DMS sampling commenced.
	23.20	UEA DMS sampling ceased.
14/06/96	00:01	Lat: 53 00.0 N. Long: 11 28.9 W. Hove to on station, head to wind.
	00:04	UEA aerosol sample (EAHV8) commenced.
	00:05	Birmingham HiVol sample (BHV2) commenced.
	00:15	Birmingham particle/impregnated filter samples (BFP5) deployed.
	00:30	Birmingham TAL and ionic alkyl lead (IAL) samples (TAL2) commenced.
	08:17	Lat: 52 56.3 N. Long: 11 27.3 W. CTD5 in the water.
	08:25	CTD5 onboard.
	08:35	Lat: 52 56.3 N. Long: 11 27.0 W. Bottle station B5 commenced.
	08:37	Bottle attached. Wire out zero. Firing depth 100m.
	08:40	Bottle attached. Wire out 25m. Firing depth 75m.
	08:43	Bottle attached. Wire out 60m. Firing depth 40m.
	08:46	Bottle attached. Wire out 88m. Firing depth 12m.
	08:48	Bottle attached. Wire out 95m. Firing depth 5m.
	08:49	Messenger released. Wire out 103m.
14/06/96 cont.	08:56	Bottle station completed.
	09:35	CTD calibration exercise in the transmissometer tank commenced.
	10:34	CTD calibration exercise complete.
	10:43	UEA DMS sampling commenced.
	12:00	Lat: 52 53.0 N. Long: 11 21.1 W. Birmingham TAL/IAL pump switched off.
	12:14	UEA aerosol sample (EAHV8) retrieved.
	12:17	Birmingham HiVol sample (BHV2) retrieved.
	12:30	Birmingham particle/impregnated filter samples (BFP5) retrieved. Birmingham particle/impregnated filter samples (BFP6) deployed.
	12:51	Lat: 52 52.3 N. Long: 11 19.5 W. Surface water survey commenced.
	14:00	Buzzed by French maritime patrol aircraft.
	15:58	Underway transmissometer and fluorometer cleaned.
	16:00	Light meters cleaned.
	22:29	UEA DMS sampling ceased.
	23:12	Lat: 54 29.8 N. Long: 10 59.5 W. Hove to on station, head to wind.
15/06/96	00:07	Birmingham HiVol sample (BHV3) commenced.
	00:09	UEA aerosol sample (EAHV9) commenced.
	00:20	Birmingham TAL/IAL pump switched back on.
	00:30	Birmingham particle/impregnated filter samples (BFP6) retrieved.
	00:31	Birmingham particle/impregnated filter samples (BFP7) deployed.
	08:15	Lat: 54 29.9 N. Long: 10 44.0 W. CTD6 in the water.
	08:24	CTD6 onboard.
	08:35	Lat: 54 30.2 N. Long: 10 43.8 W. Bottle station B6 commenced.
	08:36	Bottle attached. Wire out zero. Firing depth 100m.
	08:38	Bottle attached. Wire out 25m. Firing depth 75m.
	08:39	Bottle attached. Wire out 50m. Firing depth 50m.
	08:42	Bottle attached. Wire out 75m. Firing depth 25m.
	08:43	Bottle attached. Wire out 95m. Firing depth 5m.
	08:44	Messenger released. Wire out 103m.

	08:50	Bottle station completed.
	09:30	Lat: 54 30.1 N. Long: 10 42.2 W. CTD7 in the water.
	09:52	CTD7 completed.
	12:00	Lat: 54 28.5 N. Long: 10 36.8 W.
		Birmingham IAL/TAL sample (TAL2) collected.
	12:05	Birmingham particle/impregnated filter samples (BFP7) retrieved.
	12:18	UEA aerosol sample (EAHV9) collected.
	12:22	UEA DMS sampling commenced.
	12:35	Birmingham HiVol switched off.
	12:57	Lat: 54 27.4 N. Long: 10 34.1 W. CTD8 in the water.
	13:08	CTD8 onboard.
	13:09	Lat: 54 27.4 N. Long: 10 34.0 W. Bottle station B8 commenced.
	13:10	Bottle attached. Wire out zero. Firing depth 100m.
	13:12	Bottle attached. Wire out 25m. Firing depth 75m.
	13:14	Bottle attached. Wire out 50m. Firing depth 50m.
	13:15	Bottle attached. Wire out 75m. Firing depth 25m.
	13:16	Bottle attached. Wire out 95m. Firing depth 5m.
	13:17	Messenger released. Wire out 103m.
	13:23	Bottle station completed.
	13:25	Lat: 54 27.4 N. Long: 10 34.0 W. Surface water survey commenced.
	13:30	Underway fluorometer and transmissometer cleaned.
	14:05	Light meters on the monkey island cleaned.
	22:35	Lat: 54 10.8 N. Long: 11 22.3 W. Hove to on station, head to wind.
	22:49	UEA DMS sampling ceased.
16/06/96	00:00	Birmingham HiVol switched back on.
	00:05	Birmingham particle/impregnated filter samples (BFP8) deployed.
		UEA aerosol sample (EAHV10) deployed.
		Birmingham TAL/IAL sample (TAL3) deployed.
16/06/96 cont.	08:30	Lat: 54 04.6 N. Long: 11 17.4 W. CTD9 in the water
	08:38	CTD9 onboard.
	08:49	Lat: 54 04.6 N. Long: 11 16.9 W. Bottle station B9 commenced.
	08:50	Bottle attached. Wire out zero. Firing depth 100m.
	08:52	Bottle attached. Wire out 25m. Firing depth 75m.
	08:54	Bottle attached. Wire out 50m. Firing depth 50m.
	08:56	Bottle attached. Wire out 80m. Firing depth 20m.
	08:57	Bottle attached. Wire out 95m. Firing depth 5m.
	08:58	Messenger released. Wire out 103m.
	09:04	Bottle station completed.
	10:39	Bucket sample taken for halocarbons.
	10:54	UEA DMS sampling commenced.
	12:00	Lat: 54 02.8 N. Long: 11 11.5 W.
		Birmingham TAL/IAL sampling pump turned off.
		Birmingham particle/impregnated filter samples (BFP8) retrieved.
	12:03	UEA aerosol sample (EAHV10) retrieved.
	12:14	Birmingham HiVol sample (BHV3) retrieved.
	12:20	Lat: 54 02.5N. Long: 11 11.2 W. Survey commenced.
	13:48	Underway transmissometer and fluorometer cleaned. Tank flushed.
	14:20	Light meters on the monkey island cleaned.
	23:19	UEA DMS sampling ceased.
17/06/96	00:02	Lat: 54 03.2 N. Long: 11 16.0 W. Hove to on station, head to wind.
	00:03	Birmingham HiVol sample (BHV4) started.
	00:05	Birmingham particle/impregnated filter samples (BFP9) deployed.
	00:10	UEA aerosol sample (EAHV11) started.
		Birmimgham TAL/IAL pump switched back on.

	08:18	Lat: 54 12.2 N. Long: 11 20.6 W. CTD10 in the water.
	08:27	CTD10 onboard.
	08:37	Lat: 54 12.5 N. Long: 11 20.6 W. Bottle station B10 commenced.
	08:38	Bottle attached. Wire out zero. Firing depth 100m.
	08:39	Bottle attached. Wire out 25m. Firing depth 75m.
	08:41	Bottle attached. Wire out 50m. Firing depth 50m.
	08:42	Bottle attached. Wire out 25m. Firing depth 25m.
	08:44	Bottle attached. Wire out 95m. Firing depth 5m.
	08:45	Messenger released. Wire out 103m.
	08:50	Bottle station completed.
	10:23	Bucket sample for halocarbons.
	12:00	Lat: 54 17.3 N. Long: 11 19.1 W. Birmingham TAL/IAL sample (TAL3) collected. Birmingham particle/impregnated filter samples (BFP9) retrieved.
	12:12	Birmingham HiVol pump switched off.
	12:18	UEA aerosol sample (EAHV11) retrieved. UEA DMS sampling commenced.
	12:23	Lat: 54 17.8 N. Long: 11 18.9 W. Coastal water survey.
	13:23	Underway transmissometer and fluorometer cleaned. Tank flushed.
	14:05	Monkey island light meters cleaned.
	14:20	Bucket sample for halocarbons taken.
18/06/96	08:31	Lat: 53 19.2 N. Long: 10 46.6 W. CTD11 in the water. Bottles attached. Wire out zero. Firing depth 100m.
	08:33	Bottle attached. Wire out 25m. Firing depth 75m.
	08:34	Bottle attached. Wire out 50m. Firing depth 50m.
	08:36	Bottle attached. Wire out 75m. Firing depth 25m.
	08:37	Bottle attached. Wire out 95m. Firing depth 5m.
	08:38	Messenger released. Wire out 103m.
	08:45	CTD11 onboard. Bucket sample taken for halocarbons.
	12:00	Lat: 53 15.0 N. Long: 10 04.8 W.
	13:18	Underway transmissometer and fluorometer cleaned. Tank flushed.
18/06/96 cont.	13:40	Monkey island light sensors cleaned. Investigation of unusual looking data from the starboard 2-pi PAR meter. Problem identified in the analogue board of the lumen Level A. Now this has been fixed starboard 2-pi PAR data since the beginning of the cruise are revealed as total rubbish.
	23:45	UEA DMS sampling ceased.
19/06/96	00:20	Lat: 52 16.9 N. Long: 11 41.8 W. Hove to on station, head to wind.
	00:24	UEA aerosol samples (EAHV12 and EAHV12A) deployed.
	00:25	Birmingham HiVol sample (BHV5) deployed. Birmingham TAL/IAL sample (TAL4) started. Birmingham particle/impregnated filter samples (BFP10) deployed.
	06:11	UEA aerosol sample (EAHV12A) taken off.
	06:13	UEA aerosol sample (EAHV12B) deployed.
	08:00	Lat: 52 15.8 N. Long: 11 32.3 W. CTD12 in the water.
	08:09	CTD12 onboard.
	08:21	Lat: 52 15.7 N. Long: 11 31.9 W. Bottle station B12 commenced.
	08:22	Bottle attached. Wire out zero. Firing depth 75m.
	08:25	Bottle attached. Wire out 25m. Firing depth 50m.
	08:26	Bottle attached. Wire out 50m. Firing depth 25m.
	08:27	Bottle attached. Wire out 65m. Firing depth 10m.
	08:29	Bottle attached. Wire out 70m. Firing depth 5m.
	08:30	Messenger released. Wire out 78m.
	08:34	Bottle station completed.

	10:17	Bucket sample taken for halocarbons.
	12:00	Lat: 52 15.8 N. Long: 11 27.0 W.
	12:15	Birmingham particle/impregnated filter samples (BFP10) retrieved. Birmingham particle/impregnated filter samples (BFP11) deployed. UEA aerosol samples (EAHV12 and EAHV12B) taken off.
	12:17	UEA aerosol samples (EAHV13 and EAHV13A) deployed.
	16:30	ADCP logging switched from binary Transect files to old system logging on the Level C.
	17:55	UEA aerosol sample (EAHV13A) taken off.
	17:57	UEA aerosol sample (EAHV13B) deployed.
	18:14	Birmingham HiVol sample (BHV5) collected and sample BHV6 started.
	18:30	Birmingham TAL/IAL sample (TAL4) collected and sample TAL5 started.
20/06/96	00:00	Lat: 52 30.7 N. Long: 11 12.3 W.
	00:05	Birmingham particle/impregnated filters (BFP11) collected and samples (BFP12) deployed.
	00:07	UEA aerosol samples (EAHV13 and EAHV13B) taken off.
	00:09	UEA aerosol samples (EAHV14 and EAHV14A) deployed.
	06:02	UEA aerosol sample (EAHV14A) taken off.
	06:03	UEA aerosol sample (EAHV14B) deployed.
	08:05	Lat: 52 28.8 N. Long: 11 14.7 W. CTD13 in the water.
	08:13	CTD13 onboard.
	08:24	Lat: 52 28.9 N. Long: 11 14.2 W. Bottle station B13 commenced.
	08:25	Bottle attached. Wire out zero. Firing depth 100m.
	08:26	Bottle attached. Wire out 25m. Firing depth 75m.
	08:28	Bottle attached. Wire out 50m. Firing depth 50m.
	08:30	Bottle attached. Wire out 75m. Firing depth 25m.
	08:31	Bottle attached. Wire out 95m. Firing depth 5m.
	08:32	Messenger released. Wire out 103m.
	08:38	Bottle station completed.
	11:52	Bucket sample taken for halocarbons.
	12:00	Lat: 52 30.8 N. Long: 11 07.2 W. Birmingham TAL/IAL sample (TAL5) collected.
	12:06	UEA aerosol samples (EAHV14 and EAHV14B) collected.
20/06/96 cont.	12:10	Birmingham particle/impregnated filter samples (BFP12) retrieved.
	12:17	UEA DMS sampling commenced.
	12:20	Birmingham HiVol sample (BHV6) collected.
	12:35	Lat: 52 31.4 N. Long: 11 06.6 W. Underway on triangular survey. First leg due east and second leg due north for ADCP heading calibration.
	14:04	Underway transmissometer and fluorometer cleaned. Tank flushed. Wave over starboard side caught Robin.
	22:13	UEA DMS survey ceased.
	23:18	Lat: 52 30.1 N. Long: 11 12.1 W. Hove to on station, head to wind.
21/06/96	00:05	UEA aerosol samples (EAHV15) deployed. Birmingham particle/impregnated filters samples (BFP13) deployed.
	00:06	Birminham HiVol sample (BHV7) started.
	00:10	Birmingham TAL/IAL sample (TAL6) started.
	08:05	Lat: 52 39.9 N. Long: 11 01.3 W. CTD14 in the water.
	08:14	CTD14 onboard.
	08:27	Lat: 52 40.1 N. Long: 10 59.2 W. Bottle station B14 commenced.
	08:28	Bottle attached. Wire out zero. Firing depth 100m.
	08:30	Bottle attached. Wire out 25m. Firing depth 75m.

	08:31	Bottle attached. Wire out 50m. Firing depth 50m.
	08:32	Bottle attached. Wire out 70m. Firing depth 30m.
	08:34	Bottle attached. Wire out 95m. Firing depth 5m.
	08:35	Messenger released. Wire out 103m.
	08:41	Bottle station completed.
	10:36	Bucket sample taken for halocarbons.
	11:49	UEA DMS sampling commenced.
	12:00	Lat: 52 42.5 N. Long: 10 59.2 W.
		Birmingham TAL/IAL sampler pump switched off.
	12:05	Birmingham particle/impregnated filter samples (BFP13) retrieved.
	12:06	UEA aerosol samples (EAHV15) collected.
	12:10	Birmingham HiVol pump switched off.
	12:30	Lat: 52 42.9 N. Long: 10 59.3 W. Survey commenced.
	13:29	Underway fluorometer and transmissometer windows cleaned.
	14:19	Bucket sample taken for halocarbons.
	22:50	Lat: 53 46.2 N. Long: 12 43.4 W. Hove to on station, head to wind.
	23:34	UEA DMS sampling ceased.
22/06/96	00:00	Birmingham HiVol pump switched back on.
	00:05	Birmingham TAL/IAL sampler pump switched back on.
		UEA aerosol sample (EAHV16) deployed.
		Birmingham particle/impregnated filters samples (BFP14) deployed.
	08:05	Lat: 53 53.1 N. Long: 12 52.8 W. CTD15 in the water.
	08:24	CTD15 onboard.
	08:39	Lat: 53 53.2 N. Long: 12 53.0 W. Bottle station B15 commenced.
	08:40	Bottle attached. Wire out zero. Firing depth 100m.
	08:41	Bottle attached. Wire out 25m. Firing depth 75m.
	08:43	Bottle attached. Wire out 50m. Firing depth 50m.
	08:44	Bottle attached. Wire out 80m. Firing depth 20m.
	08:45	Bottle attached. Wire out 95m. Firing depth 5m.
	08:46	Messenger released. Wire out 103m.
	08:51	Bottle station completed.
	08:55	Bucket sample taken for halocarbons.
	12:00	Lat: 53 56.0 N. Long: 12 56.1 W.
		Birmingham TAL/IAL sample (TAL6) collected.
	12:06	UEA aerosol sample (EAHV16) collected.
		Birmingham particle/impregnated filter samples (BFP14) retrieved.
	12:20	Birmingham HiVol sample (BHV7) collected.
	12:27	UEA DMS sampling commenced.
	12:28	Lat: 53 56.3 N. Long: 12 56.5 W. Survey commenced.
22/06/96 cont.	14:12	Kipp and Zonen light meter calibrations swapped. For unknown time, port calibration has been applied to starboard and vice versa. Correction required - x starboard by 1.02927 and port by 0.97156.
	15:05	Underway transmissometer and fluorometer cleaned. Tank flushed.
	15:20	Monkey island light meters cleaned.
	22:50	UEA DMS sampling ceased.
	23:10	Lat: 54 01.9 N. long: 11 22.0 W. Hove to on station, head to wind.
23/06/96	00:05	UEA aerosol sample (EAHV17) deployed.
	00:06	Birmingham HiVol sample (BHV8) deployed.
	00:10	Birmingham TAL/IAL sample (TAL7) deployed.
		Birmingham particle/impregnated filters samples (BFP15) deployed.
	08:07	Lat: 54 08.6 N. Long: 11 31.8 W. CTD16 in the water.
	08:22	CTD16 onboard.
	08:25	4 mackerel caught much to the amazement of all on board. (Well caught Roy and thanks Wolfie, they tasted wonderful)

	08:41	Lat: 54 08.6 N. Long: 11 32.0 W. Bottle station B16 commenced. Bottle attached. Wire out zero. Firing depth 100m.
	08:42	Bottle attached. Wire out 25m. Firing depth 75m.
	08:43	Bottle attached. Wire out 50m. Firing depth 50m.
	08:44	Bottle attached. Wire out 75m. Firing depth 25m. Bottle attached. Wire out 85m. Firing depth 15m.
	08:45	Messenger released. Wire out 103m.
	08:51	Bottle station completed.
	08:56	Bucket sample taken for halocarbons.
	11:06	UEA DMS sampling commenced.
	12:00	Lat: 52 30.7 N. Long: 11 10.3 W.
	12:45	Bucket sample taken for halocarbons.
	13:55	Birmingham HiVol and TAL/IAL pumps switched off.
	14:00	Birmingham particle/impregnated filter samples (BFP15) retrieved. UEA aerosol sample (EAHV17) collected. Underway transmissometer tank cleaned out with Decon. Note that Decon is fluorescent so chlorophyll 'high' for next 15 minutes is an artifact.
	14:06	Lat: 54 06.4 N. Long: 11 34.5 N. Survey commenced.
	14:15	Underway fluorometer and transmissometer windows cleaned.
	14:53	Light meters on the monkey island cleaned.
	22:39	UEA DMS sampling ceased.
	23:55	Lat: 52 40.5 N. Long: 11 01.5 W. Hove to on station, head to wind.
24/06/96	00:00	Birmingham HiVol pump switched back on.
	00:05	Birmingham TAL/IAL sampler pump switched back on. Birmingham particle/impregnated filters samples (BFP16) deployed. UEA aerosol sample (EAHV18) deployed.
	08:15	Lat: 52 33.1 N. Long: 11 11.4 W. CTD17 in the water.
	08:24	CTD17 onboard.
	11:39	Lat: 52 30.8 N. Long: 11 1.5 N. CTD18 in the water.
	11:40	Bottle attached. Wire out zero. Firing depth 100m.
	11:41	Bottle attached. Wire out 25m. Firing depth 75m.
	11:43	Bottle attached. Wire out 50m. Firing depth 50m.
	11:45	Bottle attached. Wire out 75m. Firing depth 25m.
	11:46	Bottle attached. Wire out 95m. Firing depth 5m.
	11:47	Messenger released. Wire out 103m.
	11:52	CTD18 onboard.
	12:00	Lat: 52 30.7 N. Long: 11 10.3 W. Birmingham TAL/IAL sample (TAL7) collected.
	12:05	UEA aerosol sample (EAHV18) collected. Birmingham particle/impregnated filter samples (BFP16) retrieved.
	12:06	Birmingham HiVol sample (BHV8) collected.
	12:30	UEA DMS sampling commenced.
24/06/96 cont.	12:40	Lat: 52 30.1 N. Long: 11 10.1 W. Survey commenced.
	13:37	Tests on detergent fluorescence commenced. Disregard flute data.
	13:44	Tests completed. Transmissometer/fluorometer windows cleaned.
	13:55	Monkey island light meters cleaned.
	23:28	UEA DMS sampling ceased.
	23:40	Lat: 52 29.8 N. Long: 11 45.5 N. Hove to on station, head to wind.
	23:50	Rain sample (RS4) deployed.
25/06/96	00:04	UEA aerosol sample (EAHV19) deployed.
	00:10	Birmingham particle/impregnated filters samples (BFP17) deployed. Birmingham HiVol sample (BHV9) deployed. Birmingham TAL/IAL sample (TAL8) deployed.

	07:50	Bucket sample for halocarbons taken.
	08:17	Lat: 52 21.8 N. long: 11 47.2 W. CTD19 in the water.
	08:31	CTD19 onboard.
	09:12	Rain sample (RS4) recovered. About 300 ml. Rain sample (RS5) deployed.
	10:17	Transmissometer and fluorometer windows cleaned.
	12:00	Lat: 52 19.2 N. Long: 11 47.2 W.
	12:05	Birmingham particle/ impregnated filter samples (BFP17) retrieved. TAL/IAL sampling pump switched off.
	12:37	Rain sample (RS5) recovered. About 250 ml. Rain sample (RS6) deployed.
	13:00	Problem with the thermosalinograph observed. Intermittent depressed temperatures from 09:25. Housing temperature noisy from 10:50.
	13:58	UEA aerosol sample (EAHV19) recovered.
	14:00	Birmingham HiVol pump switched off.
	14:01	UEA DMS sampling commenced.
	14:27	Rain sample (RS7) deployed.
	14:35	Lat: 52 17.9 N. Long: 11 50.5 W. Survey commenced.
	15:55	Noise on thermosalinograph housing temperature seems improved. Steps are still there.
	20:04	Rains sample (RS7) recovered. 10 ml approx. sample.
	20:34	UEA DMS sampling ceased.
	23:55	Lat: 53 19.7 N. Long: 11 11.8 W. Hove to on station, head to wind.
26/06/96	00:00	Birmingham HiVol pump turned on.
	00:07	UEA aerosol sample (EAHV20) deployed.
	00:08	Birmingham particle/impregnated filters samples (BFP18) deployed.
	00:10	Birmingham TAL/IAL sampler turned on.
	08:16	Lat: 53 24.3 N. Long: 11 19.9 W. CTD20 in the water.
	08:24	CTD20 onboard.
	08:40	Lat: 53 24.3 N. Long: 11 20.5 W. UEA DMS sampling commenced. Bottle station B20 commenced.
	08:42	Bottle attached. Wire out zero. Firing depth 100m.
	08:43	Bottle attached. Wire out 25m. Firing depth 75m.
	08:44	Bottle attached. Wire out 50m. Firing depth 50m.
	08:45	Bottle attached. Wire out 75m. Firing depth 25m.
	08:47	Bottle attached. Wire out 95m. Firing depth 5m. UEA air bottle sample for hydrocarbons (AS2) taken.
	08:48	Messenger released. Wire out 103m.
	08:53	Bottle station B20 completed.
	10:22	Bucket sample for halocarbons taken.
	12:00	Lat: 53 28.6 N. Long: 11 29.2 W. Problem with temperature steps in the thermosalinograph proved to be cured. Turned out to be a UV irradiator with earth and neutral wired the wrong way round.
	12:15	Birmingham TAL/IAL sample (TAL8) collected.
	12:19	Lat: 53 28.6 N. Long: 11 29.7 W. Bottle station BB commenced.
26/06/96 cont.	12:20	Bottle attached. Wire out zero. Firing depth 33m. Birmingham particle/impregnated filter samples (BFP18) retrieved.
	12:21	Bottle attached. Wire out 3m. Firing depth 30m.
	12:22	Messenger released. Wire out 36m.
	12:24	Bottle station BB completed.
	12:25	Birmingham HiVol sample (BHV9) collected.
	12:33	UEA aerosol sample (EAHV20) collected.
	12:45	UEA air bottle sample for hydrocarbons (AS3) taken.

	13:00	Lat: 53 29.9 N. Long: 11 30.2 W. Survey commenced.
	13:24	Underway transmissometer and fluorometer windows cleaned. Tank flushed out.
	13:50	Monkey island light meters cleaned.
	22:34	UEA DMS sampling ceased.
	23:55	Lat: 53 14.0 N. long: 11 07.8 W. Hove to on station, head to wind.
27/06/96	00:05	Birmingham HiVol sample (BHV10) commenced.
	00:06	Birmingham TAL/IAL sample (TAL9) commenced. UEA aerosol sample (EAHV21) deployed.
	00:10	Birmingham particle/impregnated filters samples (BFP19) deployed.
	00:40	UEA rain samplers (RS8) deployed (starts 00:53).
	08:15	Bucket sample for halocarbons taken.
	08:43	Lat: 53 08.0 N. Long: 11 14.0 W. Bottle station BC commenced.
	08:45	Bottle attached. Wire out zero. Firing depth 100m.
	08:49	Messenger released. Wire out 103m.
	08:53	Bottle station completed.
	09:45	UEA rain sample (RS8) collected.
	09:46	UEA rain sample (RS9) deployed (rain started 10:30).
	11:45	Lat: 53 05.0 N. long: 11 12.1W. CTD21 in the water.
	11:54	CTD21 onboard.
	12:00	Lat: 53 05.0 N. Long: 11 12.0 W.
	12:11	Lat: 53 05.1 N. Long: 11 11.8 W. Bottle station B21 started. Bottle attached. Wire out zero. Firing depth 100m.
	12:12	UEA aerosol sample (EAHV21) collected.
	12:13	UEA aerosol sample (EAHV22) deployed. Bottle attached. Wire out 25m. Firing depth 75m.
	12:14	Bottle attached. Wire out 50m. Firing depth 50m.
	12:15	Birmingham HiVol pump turned off.
	12:16	Bottle attached. Wire out 75m. Firing depth 25m.
	12:18	Bottle attached. Wire out 95m. Firing depth 5m.
	12:19	Messenger released. Wire out 103m.
	12:20	Birmingham TAL/IAL sampler turned off.
	12:24	Bottle station completed.
	12:30	Birmingham particle/impregnated filter samples (BFP19) retrieved.
	12:31	UEA DMS sampling commenced.
	12:37	Birmingham particle/impregnated filters samples (BFP20) deployed.
	12:48	UEA rain sample (RS9) collected. 50 ml approx.
	12:50	UEA rain sample (RS10) deployed.
	13:30	Transmissometer and fluorometer windows cleaned.
	13:42	UEA rain sample (RS10) collected. 15 ml approx.
	13:44	UEA rain sample (RS11) deployed.
	13:50	Lat: 53 05.4 N. Long: 11 11.5 W. Survey commenced.
	20:57	UEA DMS sampling ceased.
	21:00	Lat: 54 05.8 N. Long: 11 46.1 W. Hove to on station, head to wind.
	21:42	UEA rain sample (RS11) collected. 20 ml approx.
	21:43	UEA rain sample (RS12) deployed.
28/06/96	00:00	Birmingham particle/impregnated filter samples (BFP20) retrieved.
	00:02	Birmingham HiVol pump switched back on.
	00:03	UEA aerosol sample (EAHV22) collected.
	00:04	UEA aerosol sample (EAHV23) deployed.
28/06/96 cont.	00:05	Birmingham TAL/IAL sampler switched back on.
	00:10	Birmingham particle/impregnated filters samples (BFP21) deployed.
	09:25	UEA air sample for hydrocarbons (AS4) taken.
	09:42	UEA rain sample (RS12) collected. 200 ml approx.

	09:43	UEA rain sample (RS13) deployed.
	12:00	Lat: 54 00.7 N. Long: 12 01.1W.
	12:14	UEA DMS sampling commenced.
	12:40	Birmingham HiVol sample (BHV10) collected.
		Birmingham TAL/IAL sample (TAL9) collected.
	13:20	Imperial College Jetstream pass just below cloudbase.
	13:26	UEA DMS sampling ceased.
	13:28	UEA air sample for hydrocarbons (AS5) taken.
	13:38	Imperial College Jetstream departed after 3 low passes.
	13:40	Transmissometer and fluorometer windows cleaned.
	14:58	UEA aerosol sample (EAHV23) collected.
	15:00	Birmingham particle/impregnated filter samples (BFP21) retrieved.
		Birmingham particle/impregnated filters samples (BFP22) deployed.
	15:03	UEA aerosol sample (EAHV24) deployed.
	21:35	UEA rain sample (RS13) recovered. No rain.
29/06/96	00:00	Lat: 54 08.5 N. Long: 12 13.6 W.
		Birmingham HiVol filter (BHV11) deployed.
		Birmingham particle/impregnated filter samples (BFP22) retrieved.
	00:03	UEA aerosol sample (EAHV24) collected.
	00:05	UEA aerosol sample (EAHV25) deployed.
		Birmingham TAL/IAL sample (TAL10) started.
	00:10	Birmingham particle/impregnated filters samples (BFP23) deployed.
	08:58	Lat: 54 12.4 N. Long: 12 31.6 W. CTD22 in the water.
	09:04	CTD22 onboard
	10:10	UEA DMS sampling commenced.
	10:30	Transmissometer/fluorometer tank cleaned out with Decon.
	10:40	Fluorometer and transmissometer windows cleaned
	11:05	UEA rain sample (RS14) deployed.
	12:00	Lat: 54 12.7 N. Long: 12 35.6 W.
		Birmingham particle/impregnated filter samples (BFP23) retrieved.
	12:05	Birmingham TAL/IAL sampler pump switched off.
	12:06	UEA aerosol sample (EAHV25) recovered.
	12:10	Birmingham HiVol sampler pump switched off.
	12:40	Lat: 54 12.1 N. Long: 12 36.9 W. Survey commenced.
	23:07	UEA rain sample (RS14) collected.
	23:08	UEA rain sample (RS15) deployed.
	23:20	Lat: 53 39.5 N. Long: 12 32.1 W. Hove to on station, head to wind.
30/06/96	00:00	Birmingham HiVol pump turned back on.
	00:04	Birmingham particle/impregnated filters samples (BFP24) deployed.
		UEA aerosol sample (EAHV26) deployed.
	00:05	Birmingham TAL/IAL sampler turned back on.
	00:17	Air sample for hydrocarbons (AS6) taken.
	10:30	Lat: 53 42.5 N. Long: 12 46.0 W. CTD23 in the water. 250m cast.
	10:32	UEA rain sample (RS15) collected. 30 ml approx.
		UEA rain sample (RS16) deployed.
	10:45	CTD23 onboard.
	11:07	Air sample taken for hydrocarbons (AS7).
	11:14	Lat: 53 42.0 N. long: 12 46.9 W. Bottle station B23 commenced.
	11:15	Bottle attached. Wire out zero. Firing depth 100m.
	11:16	Bottle attached. Wire out 25m. Firing depth 75m.
	11:17	Bottle attached. Wire out 50m. Firing depth 50m.
	11:18	Bottle attached. Wire out 75m. Firing depth 25m.
	11:19	Bottle attached. Wire out 95m. Firing depth 5m.
	11:21	Messenger released. Wire out 103m.

30/06/96 cont.	11:26	Bottle station completed.
	12:00	Lat: 53 41.4 N. Long: 12 47.9 W.
		Birmingham particle/impregnated filter samples (BFP24) retrieved.
		Birmingham TAL/IAL sample (TAL10) collected.
	12:04	UEA aerosol sample (EAHV26) collected.
	12:10	Birmingham HiVol sample (BHV11) collected.
	12:23	UEA DMS sampling commenced.
	12:31	Lat: 53 41.1 N. Long: 12 48.5 W. Survey commenced.
	18:43	UEA DMS sampling ceased.
	19:00	Lat: 53 41.3 N. Long: 12 24.2 W. Hove to on station, head to wind.
	22:22	UEA rain sample (RS16) collected.
	22:23	UEA rain sample (RS17) deployed.
01/07/96	00:03	UEA aerosol sample (EAHV27) deployed
	00:05	Birmingham particle/impregnated filters samples (BFP25) deployed.
	00:06	Birmingham HiVol sample (BHV12) deployed.
		Birmingham TAL/IAL sample (TAL11) deployed.
	10:36	Air sample taken for hydrocarbons (AS8)
	10:48	Lat: 53 44.2 N. Long: 12 42.8 W. Jetstream overflight.
	10:59	UEA DMS sampling commenced.
	12:00	Lat: 53 44.5 N. Long: 12 46.0 W.
		Birmingham particle/impregnated filter samples (BFP25) retrieved.
	12:04	UEA aerosol sample (EAHV27) collected.
	12:05	Birmingham HiVol and TAL/IAL sampler pumps turned off.
	12:15	UEA rain sample (RS17) collected. 200 ml.
	12:16	UEA rain sample (RS18) deployed.
	12:26	Lat: 53 44.7 N. Long: 12 47.3 W. Survey commenced.
	13:15	Air sample taken for hydrocarbons (AS9)
	14:12	Transmissometer and fluorometer windows cleaned.
	14:30	Monkey island light meters cleaned.
	23:17	UEA DMS sampling ceased.
	23:54	Lat: 52 13.6 N. Long: 11 46.0 W. Hove to on station, head to wind
02/07/96	00:05	UEA aerosol sample (EAHV28) deployed.
		Birmingham TAL/IAL sampler pump switched back on.
	00:07	Birmingham HiVol pump switched back on.
	00:08	Birmingham particle/impregnated filters samples (BFP26) deployed.
	00:32	UEA air sample for hydrocarbons (AS10) taken
	07:58	UEA air sample for hydrocarbons (AS11) taken.
	08:14	Lat: 52 13.5 N. Long: 11 58.2 W. CTD 24 in the water (400m cast).
	08:35	CTD24 on deck.
	09:03	Lat: 52 13.4 N. Long: 11 58.8 W. Bottle station B24 commenced.
	09:05	Bottle attached. Wire out zero. Firing depth 100m.
	09:06	Bottle attached. Wire out 25m. Firing depth 75m.
	09:07	Bottle attached. Wire out 45m. Firing depth 55m.
	09:08	Bottle attached. Wire out 50m. Firing depth 50m.
	09:09	Bottle attached. Wire out 75m. Firing depth 25m.
	09:10	Bottle attached. Wire out 95m. Firing depth 5m.
	09:11	Messenger released. Wire out 103m.
	09:19	Bottle station B24 completed.
	09:45	Transmissometer/fluorometer tank flushed out.
	09:57	UEA air sample for hydrocarbons (AS12) taken.
	10:00	Transmissometer/fluorometer windows cleaned.
	10:29	UEA DMS sampling commenced.
	12:00	Lat: 52 11.2 N. Long: 12 02.2 W.
		Birmingham particle/impregnated filter samples (BFP26) retrieved.
	12:05	Birmingham TAL/IAL sample (TAL11) collected.

	12:07	UEA aerosol sample (EAHV28) collected.
	12:10	Birmingham HiVol sample (BHV12) collected.
	12:36	UEA air sample for hydrocarbons (AS13) taken.
02/07/96 cont.	12:40	UEA rain sample (RS18) collected. 20 ml approx.
	12:41	UEA rain sample (RS19) deployed.
	12:43	Lat: 52 10.5 N. Long: 12 03.0 W. Survey commenced.
	15:40	Monkey island light meters cleaned.
	20:18	DMS survey completed. En route to Fairlie.
03/07/96	12:00	Lat: 54 36.8 N. Long: 09 43.4 W.
	12:12	UEA rain sample (RS19) collected.
04/07/96	08:46	Ceased logging of temperature. salinity, transmission and fluorescence.
	08:50	Non-toxic supply switched off.
	13:19	Vessel Moored, Fairlie NATO Pier.
05/07/96	08:00	Commenced demobilisation
	11:00	Demobilisation complete.