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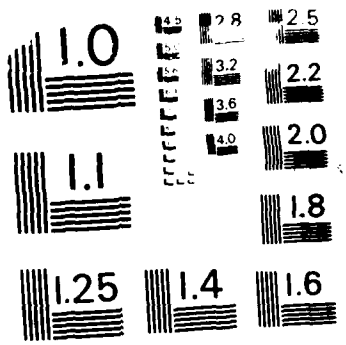

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CHARACTERIZATION OF THE BACKGROUND NATURAL AEROSOL IN THE WEST OF IRELAND

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2nd Interim Report

October 1986

1st Interim Report
June 1987

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1. INTRODUCTION

Western Ireland is strategically positioned for natural aerosol background work, being the most westerly geographical location in Europe. The nearest major anthropogenic or man-made aerosol sources lie some three thousand miles west, along the eastern coast of the United States and Canada. The prevailing wind flow across Ireland (and Britain) is south-westerly-westerly in direction from the Atlantic ocean. This ensures that the natural atmospheric aerosol reaching western Ireland is a natural background aerosol, devoid of man-made or local influences.

The main proposed measurement programme which has been initiated is at the Atmospheric Physics field research station geographically located at probably the cleanest aerosol research site in western Europe, at Mace Head, Carna (approximately $53^{o}.20'N$, $9^{o}50'W$) in the west of Ireland about 50 miles west of Galway City. The location of the field station is stratetically positioned and is exposed to a 130^{o} sector (between 170^{o} and 300^{o} from N) in the prevailing SW-W wind from the Atlantic ocean. The site is essentially unencroached by land mass, being positioned a few hundred metres from the ocean. There is no human habitation along the prevailing wind direction between the site and the Atlantic ocean. Thus the field research station site is ideally located to measure the clean natural background aerosol, unpolluted by manmade activity. Observations of size and concentration of Aitken nuclei have been made at the Mace Head site from 1958 to 1974 [O'Connor et al. (1958), O'Connor (1962), (1966)]. The site is distinctive in having very little change in its surroundings in over 25 years.

The second interim report provides data of particle size distribution, aerosol mass loading and Aitken nuclei concentration measurements. In addition, a description is given of instrumentation developed and currently being developed for use at the remote site at Mace Head.

2. Monitoring and Characterization of Physical properties of the background aerosol at Mace Head, Carna in the West of Ireland and at an urban site (Galway City).

(a) Aitken Nucleus Concentration Measurements

The total Aitken nucleus concentration, Z, is being measured with a photoelectric nucleus counter. The construction, calibration and performance of the counter has been described by Metnieks and Pollak (1959). The variation of Z with wind direction mainly based on weekly observations over a two month span to date is given in Table 1 below.

Table 1. Variation of Aitken Nucleus Concentration with Wind Direction at Mace Head

WIND DIRECTION	ESE	SE	S	SW	W	NW
AITKEN NUCLEUS CONCENTRATION cm^{-3}	3662	40373	585	285	412	2231
NUMBER OF OBSERVATIONS	14	10	16	39	18	24

Even though observations for wind directions N, NE and E have not yet been made, these results show clearly that the cleanest air is from the prevailing SW direction.

(b) Coarse Particle Sampling

Particles in the diameter range from 10 to 100 μm were sampled using a Rotorod intertial impactor (manufactured by Ted Brown Associates). The impactor consists of two rods 8.3 cm apart, mounted on a motor which rotates at a speed of 2400 rpm. The linear velocity of the rods is 10 ms^{-1}. The collector rod surface is coated with silicone grease to provide a better surface

for retention of the impacted particles. Particles larger than about 10 μm are efficiently (> 90%) collected by the impaction rods as verified both from theory (Emonds, 1972) and experiment (Vrins and Hofschreuder, 1983).

The Rotorod sampler was used to determine aerosol particle size distributions firstly at University College Galway. The exposed rods were examined using a Nikon microscope. Size analysis was facilitated through the use of a Porton Graticule (May 1965). For each size distribution a total number of about 300 particles was counted in order to obtain a representative sample (May 1945). A photograph of an aerosol sample (x 200 magnification), showing carbonaceous spherically shaped particles is shown below, in Fig.1.

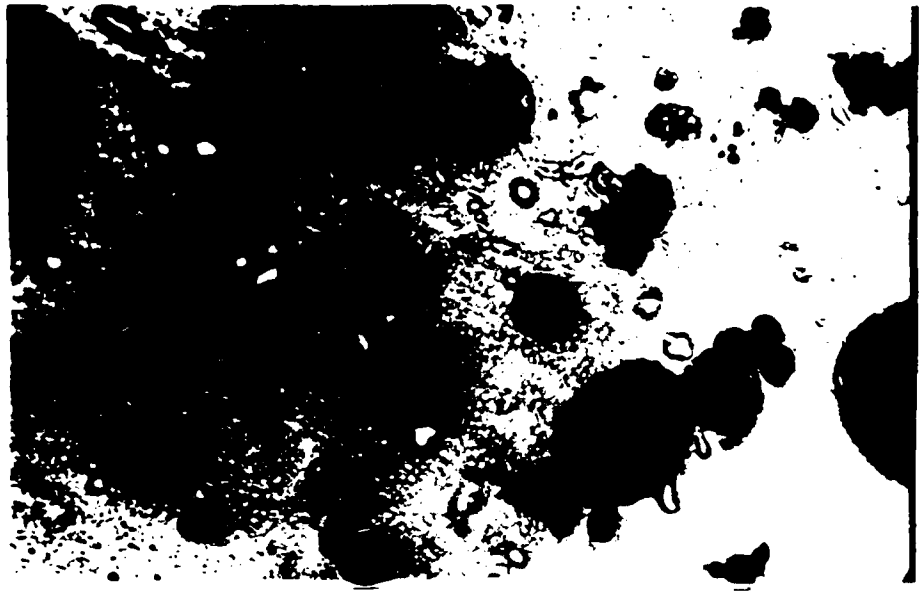
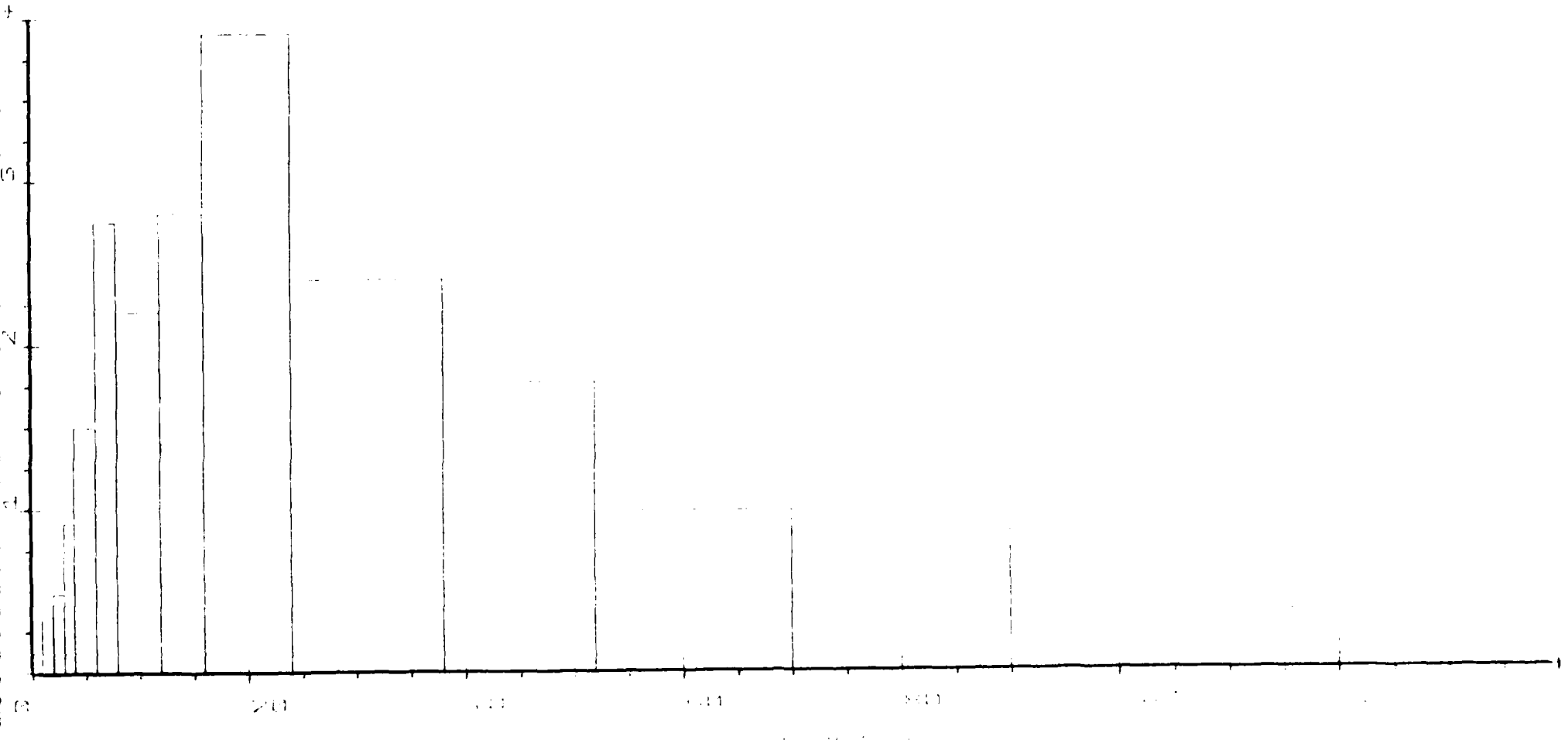


Fig. 1: Aerosol Particulate Matter sampled with a Rotarod Sampler, (magnification x 200).

A fairly typical particle size distribution at University College Galway site is shown in Fig.2. The next measurement phase will include coarse particle sampling at Mace Head Field Station having now shown that the sampling apparatus and size detection techniques have been satisfactorily tested.

FIG 2: GRAPH OF PARTICLE DIAMETER V'S PARTICLE CONCENTRATION OF

AMBIENT AEROSOL SAMPLE SAMPLED AT DELAWARE STATE COLLEGE



(c) Aerosol Mass Concentration

The aerosol mass concentration ($\mu g\ m^{-3}$) has been measured at Mace Head Field Station on a regular basis. A filtered air hood has been installed at the site to facilitate clean handling of the Whatman 41 filters used in the Hi-vol sampling. The sampling protocol involves preweighing the filter which is first placed in a desiccator until a constant mass is obtained. The filter is then loaded into the high volume sampler and sampling normally takes place over a 1-2 day period. The total volume of aerosol sampled is measured. The exposed filter is then removed and placed in the desiccator until it yields a steady mass reading. Some 20 high volume particulate samples have already been measured. An attempt to categorize the particulate mass according to wind direction sectors is shown in Table 2. This necessarily constitutes a smaller sample group since overlap in wind direction sectors may occur over a few days sampling period.

TABLE 2

High Volume Aerosol Particulate Mass Loadings

Wind Direction (Degrees)	Mass Concentration, $\mu g\ m^{-3}$		
0 - 90	26.0		
90 - 180	36.8	29.7	
180 - 270	17.0	36.1	32.0
270 - 360	10.5	29.7	23.0

More measurements are required to draw statistically significant conclusions from the particulate mass data. The initial high volume mass loading values range from 10 to about 40 $\mu g\ m^{-3}$.

3. Instrumentation

The high volume aerosol particulate sampler has been installed with its housings at the Mace Head site and has operated satisfactorily to date.

A rotorod coarse particle sampler which can collect particles over the diameter range 10 - 100 μm has been successfully tested in the laboratory (see Section 2). It is now planned to use this sampler at the Mace Head site.

A rotary intertial impactor which has the capability of size fractionating coarse aerosol particulate matter onto four stages from 6 to 100 μm diameter has been built and is about to undergo tests firstly in the laboratory and then at the Mace Head site.

A photoelectric condensation nucleus counter has been satisfactorily set up at the Mace Head site to routinely monitor Aitken nucleus concentration.

A 10 m mast equipped with anemometer cups and vane has been successfully installed at the Mace Head site to measure wind speed and direction. In addition the normal array of meteorological parameters are now measureable at the site.

4. Conclusions

(a) Measurements of aerosol mass have now begun to be routinely measured at the Mace Head site.

The next phase will include the measurement of particle size distribution as measured from segregated particulate samples from impactors (see Section 3) and through the use of a Knollenberg light scattering aerosol spectrometer probe.

(b) After having had discussions with Professor John Latham and Dr. T. Choularton from the Department of Pure and Applied Physics, UMIST, Manchester England it is planned to have an integrated and coordinated aerosol measurement programme with UMIST, Manchester in November. This should permit for the first

time a study of the evolution of the natural aerosol as it is transported across western Ireland over the Irish and British land masses on its progression towards mainland Europe.

(c) The described work provides the first characterization and monitoring of the physical properties of the cleanest background aerosol at the remote site at Mace Head, in western Ireland which possesses the distinctive advantage of being strategically located at probably the cleanest background field research site in the most westerly geographical locale in western Europe. Further anticipated results from the work should lead to the establishment of an unique data base of natural background aerosol for this strategic remote site at Mace Head. This data base should serve as an important reference baseline with which to compare influxes of aerosol other than background aerosol, as measured directly or remotely sensed with point type detectors or optically remote sensors.

The aerosol characterization work will provide an unique aerosol data set from which important optical parameters including optical depth and lidar backscatter to extinction ratios at laser and broad-band wavelengths from the visible to middle-IR can be calculated. This should provide baseline or reference values for lidar based E-O systems and sensors used in the remote sensing of the atmosphere specific to this clean background western European field research site.

5. REFERENCES

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Preparatory work is being carried out to calibrate measuring systems to be used in the characterization of the background natural aerosol in the west of Ireland.

An automated Aitken condensation nucleus counter, to be used for monitoring the variation in Aitken nucleus tested concentration is currently being tested. Calibration tests with a standard Pollak nucleus counter (Pollak and Metnieks, I960) are being carried out.

A high volume sampler has been assembled in a specially designed housing by our workshop technical personnel, under the direction of F.X. Gaffney. Preliminary measurements of aerosol mass loading have been made at site at University College, Galway City.

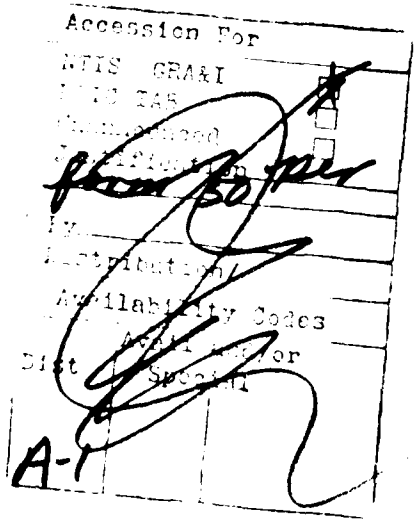
Calibration tests using Polystyrene Latex suspensions have been carried out for calibration of the Particle Measuring Systems (PMS) Classical Scattering Aerosol Spectrimeter Probe (CSASP-IOO) in order to determine correct size response for the instrument.

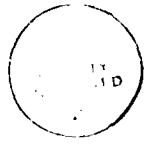
The important meteorological parameter of wind direction (and wind-speed) will be measured using a Munro model IM I46 velocity and direction transmitter. A digital output facility for digital display of wind-speed and direction at the Male Head site has been purchased. Work by our electronics workshop personnel (P.J. Walsh) has provided analogue signals (4-20 MA DC current) for the purpose of providing the facility of continuously recording the wind data. Calibration of wind direction and speed has also been accomplished.

It has been arranged to have a meeting with Professor John Lathan and his colleagues at the Department of Pure and Applied Physics, UMIST, Manchester in the near future in order to coordinate research efforts in

the characterization of the aerosol characteristics as the aerosol moves across Western Ireland over the Irish and British land masses.

Pollak L.W. and Metnieks A.L., 1960, "Intrinsic Calibration of the Photo-Electric Condensation Nucleus Counter Model 1957 with Convergent Light-Beam" Technical (Scientific) Note No. 9 Contract AF 61(052)-26.





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