# University of Essex Aerosol Sampling

## Bulk Aerosol Sampling

Two types of sample were collected: PTFE filters for trace metal analysis and filter packs for particulate and gaseous anion determinations. The filter holders were installed on an outrigger on the forward mast, some 6m from the bow of the ship and 10m above sea level (4m above the deck). The vacuum pump and associated equipment were installed in a waterproof housing located behind the sampling equipment to prevent contamination. The pump exhausts were located 10m astern of the sampling inlets.

The overriding concern of the operational procedures was the elimination of contamination from the ship. Samples were only taken when the ship was sailing into the wind. No sampling was undertaken at low relative windspeeds or, for safety reasons, at windspeeds in excess of 15 m/s. All equipment and filter handling employed standard clean techniques within a class 100 laminar flow hood. Filters were always enclosed in clean polythene containers when moved about the ship.

Exposed filters were transferred to airtight polypropylene bottles and kept refrigerated prior to analysis which was completed within a week of the ship docking.

Trace metal samples were collected using a Sartorius 16509B filter holder capable of accepting 1 µm pore size 47mm Whatman PTFE membrane filters installed facing downwards inside a rain shelter. The system maintained a nominal flow rate of 15 litres per minute and the total volume sampled was recorded using a gas meter. The face sampling velocity of the filter was 20 cm/s.

Anion samples were collected using a filter pack comprising three filters in series in a Teflon filter holder. These were a 47mm diameter 1 µm pore size Whatman PTFE membrane filter (particulate material), a 47mm diameter 0.45 µm Sartorius nylon filter (gaseous acids) and a 5% phosphoric acid impregnated 55mm diameter Whatman 41 cellulose paper (ammonia). The pack was designed with minimal path length and internal volume to reduce sample loss to the holder. During operation, the pack was installed in a rain shelter. A nominal flow rate of 8 litres per minute was maintained and the face sampling velocity was 8 cm/s.

## Cascade Impactor Sampling

A May "Ultimate" cascade impactor (May 1975) was operated isokinetically inside a wind tunnel constructed of epoxy painted, zinc plated steel 1.2m long and 0.25m in diameter. This was mounted on a pivot with a wind vane which aligned the mouth into the wind. The fan and cascade impactor were mounted on pedestals within the duct. A honeycomb structure was placed immediately in front of the cascade impactor to reduce the effects of swirl caused by the fan. A sampling inlet of high grade stainless steel protruded forward through the honeycomb to sample beyond the disturbed region. An operational flow rate of 20 litres per minute was maintained.

The operating set up gave $d_{50}$ cutoffs at 20, 8, 4, 2, 1 and 0.5 µm with a 0.5 µm Whatman PTFE filter paper used as a back up. The impaction media were Whatman 541 filter papers thoroughly prewashed in deionised water.

This system was mounted on a pedestal 1.3m high on the port side of the forecastle some 6m from the bow of the ship and 8m above sea level. Included in the mounting was a microswitch operated system which automatically ensured that samples were only taken from sectors free from sources of contamination. Periods of operation were recorded by a data logger.

At high windspeeds the equipment was deactivated and covered to prevent contamination from spray. It was also closed down during rain or fog to avoid overloading the impaction substrate with water droplets. Due to the low abundance of large particles and the limited availability of suitable sampling conditions, only one, or at most two, samples could be obtained per cruise.

At the end of the cruise, the impactor was taken to the laminar flow hood and the impaction slides transferred to a microscope slide box. The sampler nozzle was washed with 1% nitric acid and made up to 50 ml to obtain a quantitative measure of the larger aerosol depositing within the sample inlet.

**Analytical Techniques**

Trace metals from the PTFE filters were determined by atomic absorption spectroscopy using a Perkin-Elmer 103.

The anions Cl, $NO_3$ and $SO_4$ were analysed by ion chromatography (Dionex 2000i/SP). This technique was used for both the particulate material and gaseous acids, immediately after desorption (with agitation on a mechanical shaker) from the Teflon and nylon filters into deionised water and carbonate buffer respectively.

The system was operated using an AG4A guard column preceding an HPLC AS4A analytical column. Samples were injected via a 500-µl loop into the carbonate buffer (0.75 mM $NaHCO_3$/ 2.2 mM $Na_2CO_3$) maintained at 2 ml/min. Analytes were detected conductimetrically with micromembrane background conductivity suppression using 0.0025N $H_2SO_4$.

Particulate ammonium and ammonia collected on the acid impregnated filters was desorbed into deionised water with mechanical agitation and determined (as ammonium) using a flow injection fluorescence technique based on reaction with o-phthalaldehyde (Rapsomanikis et. al. 1988).

Data quality is discussed in Ottley and Harrison (1992).

**References**

Ottley, C.J. and Harrison, R.M. (1992). The spatial distribution and particle size of some inorganic nitrogen, sulphur and chlorine species over the North Sea. Atmospheric Environment 26A(9), 1689-1699.

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Rapsomanikis, S., Wake, M., Kitto, A.-M.N. and Harrison, R.M. (1988). Analysis of atmospheric ammonia and particulate ammonium by a sensitive fluorescence method. Envir. Sci. Technol. 22, 948-952.