Linking urban field measurements to their chemical analysis and their effects on health

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Introduction
Epidemiological research has highlighted the detrimental effects of airborne particulate matter (PM) on human health. However there is still a wide debate over which characteristics of PM are responsible for the adverse health effects. The sources of PM are fairly well understood but their trace element composition and mechanism by which they exert their toxic effects still remains unclear. To a first approximation, the smaller the particle the further it will penetrate the lung so the greater the toxicity.

PM is generally classified by two factors: SIZE and (more recently) CHEMICAL COMPOSITION.

The size classification is as follows: PM10 (particulate matter with a diameter less than 10 μm) and PM2.5 (that less than 2.5 μm). Chemical analysis shows PM to comprise many inorganic, organic and elemental materials, several of which are toxic. For example, solubilized metal ions such as zinc have been found to be linked to lung injury and polyaromatic hydrocarbons (PAHs) exhibit carcinogenic or mutagenic properties, which cause marked stress on lung tissue. Hence the necessity for integrated collection/analysis/toxicology projects of the type described here.

Aims
- Collection of PM10 and PM2.5 in Cork (Roussial, Urban Background and Rural sites)
- “Total” physico-chemical analysis method development to determine composition
- Characterisation of ambient particulate matter and related species for the determination of source receptor relationships and also atmospheric processing pathways.
- Data retrieval from the total chemical analysis to develop a Computer Model for determining the origin & distribution of PM in Cork.
- Determination of biochemical/toxicological effects for airborne particle components.

Experimental

Field Measurement:
Samples are collected using two types of sampler, the high volume cascade impactor (Fig 1) and the dichotomous Particulate sampler (Fig 2). Both can monitor for the PM (PM2.5 and fine PM1.0) fraction.

Conclusions

- Concluding on the quality of Cork air from an inorganic point of view, it could be said that Cork is a low to moderately polluted city.
- For Pb metal concentrations none of the monthly analyses exceed 10ng m⁻³. No monthly value was found to be less than 2 ng m⁻³.
- Analysis of the seasonal trends at Cork indicates that a greater Pb concentration is found in the fine fraction (by a factor of some 50%) except in Summer when the coarse and fine fractions appear to be similarly loaded. This latter observation is driven by a comparatively high Pb particle measurement made in July 2004 for the Cork PM2.5 fraction.
- The seasonal trends also indicate a greater Pb concentration in the Autumn/Winter pair compared to the Spring/Summer pair for the OSR PM2.5 fraction.
- The levels of Pb detected in the above campaign are comparable to measurements previously reported for OSR Cork.
- The measurements represent the first analyses comparing Pb (and the other metals listed above) content in coarse and fine PM fractions in Cork.
- The annual average concentration of Pb for the urban background site was found to be well below the EU limit threshold values over the twelve-month period (PM10, twelve month average for Pb = 16.45μg/m³).

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