Foreword

It is no exaggeration to claim that mass spectrometry has revolutionized the analysis of tropospheric aerosols. Before the development of real time aerosol particle analysis, aerosol particles had to be trapped and collected on a filter, their contents extracted by various methods, and the results analyzed by GC, GC–MS or more recently LC–MS. While useful, this approach is not only time consuming and often flawed because of unwanted reactions in the extraction and/or analysis steps, it is very difficult to obtain time resolved data that permit modeling an urban atmosphere during 24 h cycles. Preferably, one would like to achieve at least 1 h time resolution as there is a clear break in the wind power spectrum around 1 h—shorter time scales are due to turbulence and longer ones are due to oscillations, i.e. diurnal variations. In addition, because the filter collects all particles, irrespective of their chemical composition, this approach could only give the chemical composition of an ensemble of particles, providing no information about the differences among classes of particles, such as sea salt, soot, dust, etc.

The development of the real time aerosol mass spectrometer by Murphy and Johnston [1] in 1991 and later by the Prather and Nordmeyer [2] not only permitted the complete analysis of single aerosol particles, but it could do so on a time scale of a second. The results provided the first look at the range of particle types that exist in our atmosphere and could clearly distinguish between biogenic (naturally produced) and anthropogenic (man made) particles. Since each particle is analyzed within a second after entering the mass spectrometer inlet, these types of instruments allow detailed correlations to be drawn between particle size/composition and wind speed/direction. The introduction of particles into the mass spectrometer was greatly aided by the development of the aerodynamic lens by McMurry and co-workers in 1995 [3], which permitted atmospheric sampling of particles with near unit efficiency. The high efficiency enables many experiments, for example measurements of pristine air where the particle number concentration is low or rapid measurements on an aircraft where the plane quickly flies in and out of plumes.

Since the mid 1990s, the number of workers entering this field has increased substantially, and two commercial instruments are now available from TSI and the Aerodyne Corporation. The impact of both commercial and custom built instruments has been substantial. A quick review of the literature between 2000 and 2006 shows over 300 publications on the use of real time aerosol mass spectrometers, which accounts for about a third of all publications that use mass spectrometry for aerosol characterization. The 1/3–2/3 split occurs despite the fact that off-line instruments (e.g. GC–MS, LC–MS) outnumber real time instruments by orders of magnitude. Today, research in real time aerosol mass spectrometry encompasses three main areas—instrument and method development, laboratory work (e.g. the study of gas-surface reactions) and field measurements. This special issue touches on all three areas, providing an introduction to and snapshot in time of the field. We hope the reader will share our excitement for this emerging field of aerosol mass spectrometry and its potential for solving important atmospheric problems.

References

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