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Aerosol composition, climate and air quality, why molecular scale observations are important and what are the future challenges

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Atmospheric particulate plays an important role in air pollution and in the climate system. There is a strong relationship between concentrations of fine particulate matter and increased morbidity and mortality and no threshold has been determined below which no detrimental health impacts have been detected. This has led to World Health Organisation limit guidelines being revised to 5 $\mu g/m^3$ for PM2.5, representing a major challenge since reduction on the scales required are very large indeed. Aerosol particles scatter and absorb sunlight and influence cloud properties, and hence have an impact on climate through modification of regional radiation balance. Understanding the chemical and physical properties of particulate is essential if we are to be able to discriminate different sources, determine the processes driving the additional of particulate mass as a result of atmospheric processing, and constrain the optical properties and influence atmospheric pathways that control regional radiative properties and distribution.

Over the last 20 years there has been a transformation in the capability of instrumentation capable of determining the composition of atmospheric particulate matter. Offline analytical capability has enabled us to achieve a much more comprehensive molecular level description of aerosol composition. Over the same period there has been a transformation in the capability of online instrumentation for measurements of aerosol composition. Online mass spectrometric approaches now enable chemical characterisation of particulate at the molecular level in near-real time. Optical methods are also providing insight into fine particles, for example determining black carbon properties. Such measurements are providing an unprecedented insight into aerosol processes in the atmosphere on a wide range of scales and offer new observational constraints on many key atmospheric processes.

This presentation will examine the development of online aerosol measurement capability and its use in air quality and regional climate research, focussing on field observations, including observations from airborne platforms. The talk will consider the source contribution of vehicle, solid-fuel and cooking to primary aerosol in urban environments, and the contribution of secondary particulate matter and its sources, considering the role of both biogenic and anthropogenic precursors. Biomass-burning is a globally important source of both organic matter and black carbon and these sources are projected to increase as climate warms. Observations

have greatly advanced our knowledge of the relationship between biomass burning aerosol composition, optical properties and effect on radiation. Airborne observations focusing on subtropical smoke across South America and Africa and links to radiative properties and effects on climate will be discussed. The discussion will also cover secondary inorganic aerosol contributions from sulphur and nitrogen oxidation to aerosol and cloud properties. These observations have been used to provide constraint on global model estimates of aerosol budgets and lifecycles. The presentation will outline future challenges for observational aerosol science in the atmosphere and the role of large observation platforms given the need to reduce carbon footprint.