



Airborne measurements of the evolution of the organic aerosol component across Northern Europe

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The chemical composition of the atmospheric aerosol burden has significant implications for its climate impacts. Specifically, it determines the scattering or absorbing nature of the aerosol and has an important control upon its affinity for water uptake. Measurements of aerosol chemical composition are presented here from the UK Facility for Airborne Atmospheric Measurement (FAAM) BAe-146 research aircraft from flights conducted across Northern Europe. A primary goal of the studies was to examine the effects of atmospheric aging on aerosol chemical, physical and optical properties. A range of sampling conditions were evaluated, including relatively clean background conditions, polluted conditions in North-Western Europe and the near-field to far-field outflow from such conditions.

The aircraft employs a suite of aerosol instruments, which measure the chemical composition, microphysical, optical and hygroscopic properties of the in-situ aerosol population. An Aerodyne compact Time-of-Flight Aerosol Mass Spectrometer (cToF-AMS) measured the chemical composition of sub-micron non-refractory particulate matter, as a function of size. These components included organic matter, nitrate, sulphate and ammonium. The spatial distribution and chemical evolution of these components will be presented, with particular emphasis upon the organic component.

Ammonium nitrate and OA were found to be the dominant chemical components of the sub-micron aerosol burden, with mass fractions ranging from 20–50% each. Ammonium nitrate was found to dominate in North-Western Europe during episodes of high pollution, reflecting the enhanced NO_x and ammonia sources in this region. OA was ubiquitous across Europe and concentrations generally exceeded sulphate by 50–100%. A factor analysis of the OA burden was performed in order to probe the evolution across this large range of spatial and temporal scales. Two separate Oxygenated Organic Aerosol (OOA) components were identified; one representing an aged-OOA, termed Low Volatility-OOA (LV-OOA) and another representing fresher-OOA, termed Semi Volatile-OOA (SV-OOA) on the basis of their mass spectral similarity to previous studies. Significant chemical processing of the OA was observed downwind of major sources in North-Western Europe, with the LV-OOA component becoming increasingly dominant as the distance from source and photochemical processing increased. The measurements suggest that the aging of OA can be viewed as a continuum, with a progression from a less oxidised, semi-volatile component to a highly oxidised, less-volatile component. Substantial amounts of pollution were observed far downwind of continental Europe, with OA and ammonium nitrate being the major constituents of the sub-micron aerosol burden.