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Gas and particle phase chemical characterization of photochemical smog in Beijing and Hong Kong

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Secondary chemistry transforming primary pollutants is of high relevance for Chinese photochemical smog. In particular, formation of ozone (O_3) and particulate matter (PM), including Secondary Organic Aerosols (SOA), are of major concern regarding impacts on health, climate and ecosystems. The atmospheric oxidation processes leading to SOA formation are complex and involves thousands of different compounds, both of biogenic and anthropogenic origin. Furthermore, for a thorough understanding both the gas and the particle phase need to be considered.

As part of an intercollaborative project to assess the photochemical smog in China, two major field campaigns were arranged in 2016; in Changping, Bejing during springtime and at HKUST, Hong Kong during the autumn. Alongside with other advanced instrumentations, a Time of Flight Chemical Ionisation Mass Spectrometer (ToF CIMS) utilising the Filiter Inlet for Gases and AEROsols (FIGAERO) was used to chemically characterize the gas and the particle phase. This specific instrument applies soft ionization limiting the fragmentation and one can usually identify molecular composition of hundreds of different parent molecules. In both Beijing and Hong Kong the iodide ionization scheme was utilised, making it possible to specifically detect oxygenated compounds such as carboxylic acids, organic nitrates and sulphates as well as some inorganic compounds e.g. N_2O_5, $ClNO_2$, and HONO. For numerous compounds significant levels were detected in both the gas and particle phase enabling evaluation of partitioning and gas-to-particle transformation and its relationship to atmospheric conditions and estimated vapour pressures. Furthermore, the detection of molecular markers such as levoglucosan, $C_6H_5NO_3$, $C_{10}H_{16}NSO_7$, $C_5H_8SO_7$, $C_5H_8O_4$ can support source apportionment and atmospheric process description. In order to further investigate atmospheric ageing/processing a portable laminar flow reactor (Go:PAM) was for selected periods utilized to oxidize the sampled air before characterisation with the ToF-CIMS-FIGAERO. These experiments were explorative but illustrated the potential of further formation of organic nitrates and sulfates in the observed air-masses.

The results of the measurements with the ToF-CIMS-FIGAERO are compared and evaluated in relation to data from other advanced instrumentations such as AMS, PTR-MS, GC-MS to further understand the complexity of SOA formation and the differences between the two measurement sites. The time resolution of all these measurements including the ToF-CIMS provided more insight into the diurnal variation and how that is linked to transport and source activities, such as traffic, biomass burning and emission from vegetation.