Composition and concentrations of organic aerosols over Mt. Tai in North China Plain

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Aerosol samples were collected on day/night basis in May 29 to June 28, 2006 at the summit (1534 m a.s.l.) of Mount Tai located in the North China Plain (36.25 N; 117.10 E) using a high-volume air sampler and pre-combusted quartz filters. Sampling was conducted during the season of biomass burning especially after the harvesting of wheat. The filter samples were analyzed for dicarboxylic acids, ketoacids and dicarbonyls employing butyl ester derivatization followed by capillary gas chromatography (GC) determination. The samples were also analyzed for total carbon (TC), total nitrogen (TN), and their stable isotopic compositions (d13C and d15N) using elemental analyzer (EA) and EA/isotope ratios mass spectrometer. Organic carbon (OC), elemental carbon (EC) were determined by Sunset Lab thermal optical carbon analyzer. Water-soluble organic carbon (WSOC) was measured by Shimadzu TOC 5000 after extraction with pure water.

TC concentrations ranged from 5 ugm-3 to 90 ugm-3 whereas WSOC ranged from 1 ugm-3 to 37 ugm-3. Their upper range concentrations are much higher than those reported in urban aerosols from Chinese mega cities (Wang et al., 2006). WSOC accounted for 20% to 55% of total aerosol carbon (TC). Homologous series of saturated diacids (C2-C11) were detected in the mountain aerosols with a predominance of oxalic (C2) acid followed by malonic (C3) and succinic (C4) acids. Unsaturated aliphatic diacids, including maleic (M), isomaleic (iM) and fumaric (F) acids, were also detected together with aromatic diacids (phthalic, tere-phthalic and iso-phthalic acids). C2-C9 w-oxocarboxylic acids were detected as the second most abundant compound class, followed by pyruvic acid and a-dicarbonyls (glyoxal and methylglyoxal). Concentrations of total diacids were found to be 200-6000 ngm-3. We found that the uppermost concentrations are much higher than those reported in the urban Chinese megacities. The concentrations increased from late May to early June showing a maximum on June 6 and then decreased significantly toward June 8. The decrease can be explained by wet scavenging of atmospheric aerosols and also by intrusion of clean air masses from the north. After the low concentration event, the concentrations started to increase showing the second maximum on June 12 and gradually decreased toward the end of June when the field burning declined. Similar temporal trends were found for ketocarboxylic acids and dicarbonyls, as well as TC and WSOC. Total diacids were found to account for 5% to 40% of WSOC. The concentration changes of carbonaceous components were found to positively correlate with the temporal variation of levoglucosan, a specific pyrolysis product of cellulose.

This study suggested that the enhanced field burning of agriculture residues in early summer strongly influenced the air quality of the mountain area over the North China Plain. The temporal variations of diacids demonstrated that their concentrations are several times higher than those reported in the urban atmosphere from China. This study demonstrated that direct production of diacids from biomass burning and photochemical production of diacids via the oxidation of volatile and semi-volatile organic precursors emitted from field burning largely control the air quality in East China. This study also indicates that the free troposphere where Mt. Tai often exists is strongly influenced by the biomass burning in the North China Plain in the early summer by the maximized agricultural activity.