Insight into primary sources and secondary formation pathways of aminium salts in different sized atmospheric particles during nine marine and coastal campaigns

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Background: In this work, we analyzed the size-segregated particle chemical components measured during nine campaigns including measurements at a semi-urban site, one summer measurement at a beach site of the Yellow Sea, three cruise measurements over the marginal seas of China in summer and one measurement in fall, and one spring measurement from marginal seas of China to the northwest Pacific Ocean.

Results and discussion: In marine atmospheres, the average values of the measured dimethylaminium (DMA^+) and trimethylaminium (TMA^+) in $PM_{0.056\text{-}10}$ during different campaigns varied from 0.28 to 1.1 nnmol m^{-3} and 0.22-0.53 nnmol m^{-3}, respectively. The high averages were generally observed in summer over the marginal seas of China possibly because of strong marine biogenic emissions together with subsequent neutralization reactions. The average values of corresponding DMA^+ and TMA^+ were evidently smaller in the coastal atmospheres, i.e., ranging from 0.045 to 0.35 nmol m^{-3} for DMA^+ and ranging from 0.029 to 0.15 nmol m^{-3} for TMA^+ in different campaigns. Size distributions of DMA^+ and TMA^+ in atmospheric particles showed that primary combustion emissions featured by the mass median aerodynamic mode (MMAD) at 0.25±0.05 μm can yield a significant contribution to the observed concentrations and sometimes dominated. In-cloud formation of DMA^+ and TMA^+ featured by the MMAD at 0.7±0.2 μm was found to be the major contributor to the observed values during most of sampling periods. In some samples, the MMADs of DMA^+ and TMA+ evidently shifted to a smaller size relative to that of NH_4^+. The shift likely reflects the replacing reactions of ammonium by aminium because of the maxmimum surface, providing for heterogeneous reactions, occurring at the smaller size relative to mass concentrations. Fog-processing of DMA^+ and TMA^+ featured by the MMAD at 1-3 μm were observed only under fog weather conditions and the contribution can dominate others occasionally.