Measurement of atmospheric organic nitrate aerosols and its application in cloud events

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Boreal forests emit large amounts of biogenic volatile organic compounds (VOCs), primarily in the form of mono- and sesquiterpenes, which react with anthropogenic oxidant nitrate radical (NO_3) or undergo photochemical chemistry in the daytime to produce large, multifunctional organic nitrate with vapor pressures low enough to contribute new particle formation and growth. The organic nitrate aerosols, as a significant contribution to the global aerosol burden, can grow to cloud condensation nuclei (CCN) size and be activated into cloud droplets. However, the knowledge of organic nitrate aerosol-cloud interaction is poorly understood.

Observation of cloud events was carried out in a cloud observation station in Kuopio, Finland in 2010 (Hao et al., 2003, Leskinen et al., 2009). Samples from the cloud are introduced into the instruments through twin sampling lines. The first one is the total inlet line to collect the mixed information of cloud residual (RES) and interstitial particles (INT). The other is PM1.0 line to measure the cloud interstitial particles. The difference of both allows the estimation of composition of cloud residual. An Aerodyne high resolution aerosol time-of-flight mass spectrometer (TOF-AMS) was used to measure the chemical composition of cloud particles. We also applied positive matrix factorization (PMF) analysis to track the aerosol origin (Ulbrich et al., 2009). NO^+ and NO_2^+ ions were also integrated into the organic matrix for PMF analysis to separate the organic and inorganic nitrate components.

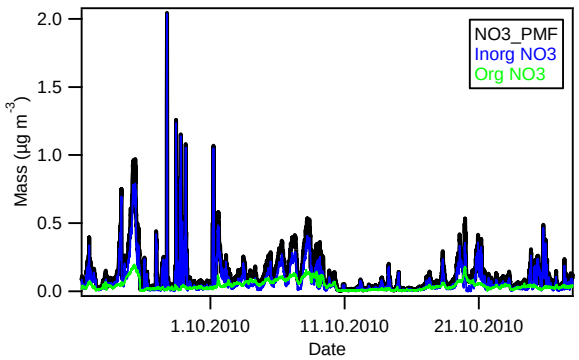

Figure 1. The time series of organic nitrate and inorganic nitrate mass concentrations from PMF fitting.

PMF analysis of the high resolution mass spectra of organics together with NO^+ and NO_2^+ ions allows for the separation of organic and inorganic species. Figure 1 shows the time series of organic nitrate and inorganic nitrate from PMF fitting results. Organic nitrates accounts for 34.7% of total nitrates and contributed to 1.9% of total aerosol masses, suggesting the significance as one of the global aerosol sources.

The investigation of chemical composition in cloud has showed in Table 1. The organic nitrates account for 51±7 % of total nitrate signals in the cloud interstitial particles, whereas its portion in the cloud residual particles was 26%. The difference between two can be explained by the cloud processing and particle size effects. However, the observations in this study highlight the potential important role of organic nitrates compounds playing in the cloud formation.

Table 1 Distribution of organic and inorganic nitrates compounds in cloud.

Mass conc. (µg m^{-3})	AMS measurements			PMF fitting		
	TOT	INT	RES	TOT	INT	RES
NO_3^-,org	-	-	-	0.11	0.050	0.060
NO_3^-,inorg	-	-	-	0.22	0.048	0.172
NO_3^- total	0.31	0.094	0.22	0.33	0.098	0.23
Fra. NO_3^-, org (%)	-	-	-	34	51	26
Fra. NO_3^-, inorg (%)	-	-	-	66	49	74

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