

Long-term observation of CCN characteristics at Suzu, Noto peninsula, Japan

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Atmospheric aerosols can play a significant role in regulating radiative properties and lifetimes of clouds by acting as cloud condensation nuclei (CCN). The atmospheric concentrations of CCN are perturbed by major anthropogenic emission sources. This is particularly true in East Asia and its downwind regions which can be considered by far as one of the global hotspots of anthropogenic aerosols. Despite the regional relevance, there are still few reports on the variations of CCN properties in relation to the distinct monsoon and seasonal climate in the region.

In this study, we performed long-term monitoring of CCN activity at the remote coastal site along the Sea of Japan, namely at the tip of Noto peninsula. Such a remote geographical setting is considered ideal for characterizing CCN over extended periods with particular emphasis on the effects of typical seasonal atmospheric transport patterns and occasional outflow of atmospheric pollutants.

The measurement was conducted at the NOTOGRO (acronym for NOTO Ground-based Research Observatory) station in Suzu city (37.45 oN, 137.36 oE) at the tip of a peninsula. The PM10 inlet (14.7 m a.g.l.) provided sample air into the building for the aerosol in-situ measurements. The ambient aerosol was dried by silica-gel before entering into a differential mobility analyzer (DMA, Model 3081, TSI) for size selection. The mono-dispersed aerosol was then guided to a condensation particle counter (CPC, Model 3785, TSI) and a continuous flow thermal gradient CCN counter (CCNC, CCN-100, DMT). The CCNC was operated at four different supersaturation conditions ($SS=0.1\%$, 0.2% , 0.5% , 0.8%). We employed SMCA (Scanning mobility CCN analysis) method for obtaining the activation diameter d_{act} for each SS (Moore et al., Aerosol Sci. Tech., 2010) from which the hygroscopicity parameter κ can be derived (Peters and Kreidenweis, Atmos. Chem. Phys., 2007). The bulk chemical composition of non-refractory submicrometer-sized aerosols was also measured simultaneously by an aerosol chemical speciation monitor (ACSM, Aerodyne Inc.).

The spring and autumn months were characterized by large variation in mass and composition of CCN relevant particles. This was caused by the subsequent arrival of extra-tropical cyclone and anti-cyclone often accompanying transport of polluted continental air-mass. However, unexpectedly high concentrations of fine particles persisted even in summer period, characterized by relatively large contribution of organics. There was a rather good correlation between the abundance of organics (relative to sulfate) in the aerosol bulk chemical composition and the hygroscopicity κ , such that κ values were particularly low during the summer period.

There was a further evidence that the temporal variation in κ value was not in phase with org/inorg mass ratios alone, but also weakly correlated with the organic composition. Analysis of mass spectra from ACSM revealed that the oxidative state of organics also influenced the κ_{org} . These findings highlight the importance of the temporal variations in particle chemistry as well as their aging states for conducting CCN closure in the region.

Keywords: aerosol, CCN, Organics, Long-range transport