Number-size distribution and cloud condensation nuclei (CCN) activity of marine aerosol over the northern North Pacific in spring

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Aerosol particles in the atmosphere affect the climate directly by absorbing/scattering solar radiation and indirectly by acting as cloud condensation nuclei (CCN) and affecting cloud formation. Because the estimate of the radiative effect by aerosol via cloud formation are highly uncertain, to clarify the CCN activity of atmospheric aerosol and the characteristics of CCN is important for the assessment of global climate. The sources of aerosols in the marine atmosphere are primary emission as sea spray and secondary formation from volatile compounds. In spring, emission/formation of primary/secondary particles containing biogenic organic components in association with the enhancement of the biogenic activity in the ocean would affect the characteristics of the number concentrations of aerosol particles and CCN. In this study, the number concentration and number-size distribution of aerosol particles and the number concentration and activity of CCN were investigated, based on a shipboard measurement of atmospheric aerosols over the northern North Pacific.

The atmospheric observation on R/V *Hakuho-maru* was performed from 6 to 26 March, 2015. Aerosol particles passed through a cyclone (50% cut-off diameter: 2.5 micrometer) were introduced to the instruments in the laboratory, and the number-size distribution of the aerosol was measured every 5 min using a scanning mobility particle sizer. Further, the CCN efficiency spectra (the ratios of CCN to aerosol particles at respective diameters) at 0.1%, 0.2%, and 0.6% supersaturations were also measured every 1 h using a scanning mobility CCN analysis system, by switching the supersaturation conditions every 20 min.

The number-size distribution was bimodal on the average. Based on the characteristics, the observed aerosols are categorized to 3 types: (a) the number concentration was low and the peak of the size distribution was in the accumulation mode (diameter: >100 nm); (b) the number concentration was high and the peak of the size distribution was in the Aitken mode (diameter: <100 nm); (c) peaks were both in the Aitken and accumulation modes. Based on the backward trajectory analysis of the studied air masses, it is inferred that the transport of terrestrial aerosols in addition to clean maritime aerosols affected the number-size distributions. The hygroscopicity parameter calculated from the CCN efficiency spectra were lower than literature values for clean marine aerosols enriched in inorganic salts. This result suggests that the presence of organic components of terrestrial origin or those from the sea surface resulted in the decrease of the CCN activity of aerosol particles. The CCN number concentrations tended to be high, as compared to literature values for the clean marine atmosphere. The obtained data would be useful to assess the contributions of marine biota to the CCN number concentrations and those of physical factors (the number concentration and number-size distribution) and chemical factors (the chemical composition and hygroscopicity) to the CCN concentrations.

