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New particle formation and growth observed at a forest site in Wakayama, Japan

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The oxidation products of biogenic volatile organic compounds (VOCs) from terrestrial vegetation contribute to both the mass and number concentrations of atmospheric aerosol particles. These aerosol particles may affect the Earth's climate through acting as cloud condensation nuclei (CCN) and modifying cloud droplet properties. Characterization of biogenic aerosols remains as an important research subject, especially in the regions where they are rarely investigated. We report the aerosol properties, including those during the new particle formation (NPF) events, observed at a forest site in Wakayama, Japan. The potential significance and the influence of NPF over the studied area are discussed.

The number size distributions of aerosol particles (from 14 to 710 nm) were measured using a scanning mobility particle sizer (SMPS) at the forest site in Wakayama, Japan (34.07 degrees N, 135.52 degrees E), in summer 2010. Aerosol particles with diameters no large than 0.95 micron were collected on quartz fiber filters, and were subjected to the chemical analysis of ionic species, organic carbon (OC), and elemental carbon (EC). The maritime air mass condition days in the years from 2006 to 2010 were identified from the daily backward air mass trajectories, which were computed using the Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT4) Model. The precipitation rates around the forest area were calculated for the maritime air mass condition days in August of 2006 to 2010.

NPF was observed in four days during the studied period. The NPF events were characterized by large increases in the number concentrations of sub-30 nm particles and their growth for several hours. These events occurred preferentially under the conditions of low vapor condensation sink and less pre-existing particles. The calculated growth rates of 14 to 30 nm particles on the four NPF event days were from 5.0 to 15.7 nm/h. The mass fraction of OC on the NPF event days (on average 43.4% of the sum of ionic species, OC, and EC) was relatively high, which is in contrast to that on non-event days (on average 24.6%). The biogenic aerosol originated from forest vegetation presumably contributed to the relatively high OC fraction. The trajectory analysis shows that the clean maritime air masses arrived at the studied area on the NPF event days. According to the classification of trajectories, the maritime air mass conditions occurred on 10% to 16% of days for the individual year of 2006 to 2010. If new aerosol particles formed under the maritime air mass conditions as observed during this intensive campaign, the NPF may not be a rare phenomenon around the studied forest area. The large increases in the number concentrations of >90 nm particles and the enhanced precipitation rates in the afternoons of NPF event days further suggest that newly-formed particles grow up to involve in the convective cloud formation and precipitation over the region.

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