Background and enhanced condensation nucleus observed by UAV around the edge of East Antarctica in summer

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Measurements of spatial aerosol distribution around the edge of East Antarctica were carried out using small Rogallo wing UAV (Unmanned Aerial Vehicle), named Kite Plane, during austral summer by the 58th and 60th Japanese Antarctic Research Expedition (JARE58 and JARE60), in January 2017 and 2019 respectively. Number concentrations of aerosols with diameter of D_P > 0.01 (Condensation Nuclei: CN), > 0.3, > 0.5, > 0.7, > 1.0, > 2.0, > 5.0 μm, Temperature, Relative Humidity, and GPS position were obtained around S17 ground station (69.02 S, 40.09 E, 600 m a.s.l.) and Tottuki cape, North East of 18 km form S17 of Antarctic coast. Two ways flight with 700 m a.s.l. of outgoing and 1200 m a.s.l. of incoming cruses were planned as a basic pattern by JARE58. Vertical observation up to 3000 m a.s.l. was also planned by JARE60. Measurements of ground-based Optical Particle Counter and Condensation Particle Counter were also carried out at S17 in January 2017 and 2019.

Spatial distribution by 14 flights (70 % of total flights) show uniform and low concentration, suggesting corresponding to background conditions around S17-Tottuki area in summer. 5-days backward trajectories for those air masses travel over Antarctic continent. High CN concentrations, of about 4000 – 7000 cm^{-3}, were observed for three flights, and classified using concentrations of Mei particles and water vapor. Hetero molecular homogeneous nucleation rate was numerically estimated considering a release of dimethyl sulfide from marine biological source, chemical reaction, condensation sink of gases on aerosol surface, temperature, and humidity.

CN concentrations in CN enhanced layer were much higher than those, sometimes show weak CN enhancement, observed at ice sheet level. Size distributions for CN and accumulation particles suggest that new particle formation occurred several days ago and remain as weak CN enhancement. Backward trajectories of three typical CN enhanced air layers go to ocean area, but show different patterns especially in altitude. On the other hand, the layers with the highest CN concentration adjoined dry layers, suggesting possibility of activation by mixing of different air masses. Based on numerical estimations, nucleation rate increase exponentially with increase of humidity and/or decrease of temperature. Estimation of nucleation rate based on active biological source for aerosol show high possibilities of new particle formation, beyond high preexisting aerosol in boundary aerosol in boundary layer over marine or sea ice. These results suggested that new particle formation occurs in boundary layer surrounding Antarctic sea ice region during January, austral summer.