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Concentration of small ions measured at the center of Tokyo and at the summit of Mt. Fuji

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It has been proposed that climate could be affected by changes in cloudiness caused by variations in the intensity of galactic cosmic rays in the atmosphere. The cause of it is considered as a new particle formation with ion induced nucleation. The ion induced nucleation is occurred under the low concentration of particles and high concentration of ions, but there are a few reports. Then we observed small ions, aerosol size distributions, radon concentrations, and intensity of cosmic rays at the summit of Mt. Fuji simultaneously. We also observed the similar elements at Tarobo, the base of Mt. Fuji and Kagurazaka, the center of Tokyo.

Observation periods were from 29th July to 25th August 2010 and 5th to 23th August 2011 at the summit (3776m ASL) and from 9 to 23 August 2011 at Tarobo (1290m ASL) and from 30th October to 31st to 6th June 2011 at Kagurazaka. Small ions were measured with the Gerdien type meter (COM-3400). The critical mobility was set 0.7 cm2/V/s and we measured positive and negative ions alternately. Size distributions from 4.4 to 5000 nm in diameter were measured with a scanning mobility particle sizer (SMPS, TSI 3936N25 or 3936L22) and an optical particle counter (OPC, RION KR12 or KC01D). Radon concentration was calculated from concentration of radioactive aerosols collected on a filter.

Small ions are generated with ionization of air by cosmic rays or radiation from radioactive substances. Small ions are lost by various mechanisms such as ion-ion recombination and ion-aerosol attachment.
dn/dt=q-an2 -bnN
where n : small ion concentration, N : aerosol concentration, q : ion pair production rate (ionization rate), a : recombination coefficient, b : attachment coefficient. As the second term can be neglected because of small n compared with N in large city, dn/dt goes to q - bnN. Under the equilibrium conditions, the left-hand side is zero, q = bnN. If q is constant, n is inversely proportional to N. However, aerosol concentration is low and the ionization rate by cosmic ray is high in mountain atmosphere.

Hourly averaged concentration showed often the diurnal pattern of high in the early morning and low in the evening at Kagurazaka, Tarobo, and the summit in 2010. However, the different pattern of low in the early morning and high in the evening was often observed at the summit in 2011. This pattern had observed at the summit of Mt. Fuji by Sekikawa (1960) and Himaraya by Venzac et al. (2008). New particle formation with ion induced nucleation was observed once at night. There is a possibility of descending of stratosphere air mass and low concentration of particles during the period.

Ion concentration measured at Kagurazaka on mid-March showed high values. Its variation was well accorded with that of dose measured in the Tokyo Metropolitan Institute of Public Health 4km far from the observation site. Then we regarded this event was the transport of radioactive substances from the Fukushima Daiichi Nuclear Power Station. We estimated the scale of transported radioactive air mass and the deposition around the site.

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