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Behavior of Heavy Metal-containing PM2.5 Transported from the Asian Continent :Single-particle MS and Chemical Analysis

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The Asian continent is an important source region of atmospheric aerosols with different origins and metals including combustion, dust storms and industrial and residential emissions. Some studies were reported polluted aerosols are transported from the Asian continent over from winter to spring by the outflow of the Asian air masses. In order to better understand characteristics of these aerosols, we investigated the chemical characteristics of individual aerosol particles by using a laser ionization single-particle mass spectrometer (LISPA-MS) along with other aerosol and gas measurements in the spring and winter of 2010 in Fukue Island, Nagasaki. Trace gas concentrations, total mass concentration of atmospheric aerosols (TEOM), mass concentrations of sulfate, nitrate, organics, and ammonium (AMS), and organics, trace metals (HVI2.5) were utilized to get quantitative information during the field campaign. We focused on the fine particle with lead (Pb) -containing aerosols as lead is considered a criteria air pollutant with wide range of health effects.

Over the measurement period, the LISPA-MS obtained ca. 90,000 (spring) and ca. 30,000 (winter) positive single-particle mass spectra. Pb-containing particles accounted for 2-4% of all the measured particles. Pb-containing aerosols were classified four major particle types from the obtained mass spectral patterns. The K-Fe-Zn type is characterized by the presence of an intense K ion peak with Fe, sodium Na, and zinc Zn and it makes up 40-60% of the total Pb-containing particles. The aerosol type with intense K, Fe , Zn without Al, Sn, and V is attributed coal combustion from the previous laboratory experiment. The Al-Ca type is characterized by the specific presence of aluminum (Al) ion peak and calcium (Ca). Since Al and Ca is a marker of mineral dust, the Al-Ca type is assigned dust aerosols. The V type is characterized the specific presence of vanadium ion peaks (V and VO) which is a maker of fuel oil combustion and refining. The Sn type is characterized by the specific presence of a tin (Sn) which is a marker of industrial waste incineration. While air mass reached to Fukue Island from China continent for back trajectory, the number of Pb-containing particles showed a significant increase. The temporal variation of Pb-containing particles except from V-type shows well-correlated with that of the fraction of dust particles which is SiO_3 containing particles analyzed from the negative mass spectra. In conclusion, the LISPA-MS measurements indicated that Pb-containing particles originated from the anthropogenic source such as coal combustion and industrial waste incineration accounted for 40-70% and were mainly transported from China continent.

Keywords: PM2.5, long-range transport, single-particle laser ionization mass spectrometer, Heavy metal-containing aerosols