Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

AAS21-P03 Room:Convention Hall Time:May 27 18:15-19:30

Single-particle measurement of iron-containing dust particles using a laser-induced incandescence technique

YOSHIDA, Atsushi[1*] ; MOTEKI, Nobuhiro[1]

[1]Graduate School of Science, The University of Tokyo

1. Introduction

Two major light-absorbing ubiquitous in earth atmosphere, black carbon (BC) and mineral dust, contribute positive climate forcing by absorbing solar radiation in atmosphere and by reducing albedo of snowpack. Light-absorption efficiency of mineral dust has shown to be strongly correlated with iron-content [Moosmueller 2012]. Reliable data for concentration and microphysical properties (size distribution, mixing state, complex refractive index, etc.) of BC and iron-containing dust particles are important to provide a physical basis in climate simulations.

For statistical sampling and continual observations, we need a fast and real-time technique to measure concentrations and the microphysical properties of these light-absorbing particles. In this study, we experimentally show that the laser-induced incandescence (LII) technique, which has been used only for BC measurement so far, is also effective for identifying and measuring iron-containing dust particles.

2. Laser-induced incandescence (LII)

We use the single-particle soot photometer (SP2, Droplet measurement technology) to measure laser-induced incandescence and light-scattering signals for individual particles. In SP2, sample air containing aerosols are continually introduced into an intra-cavity Nd:YAG laser beam with 1064 wavelength. Refractory light-absorbing particles with boiling higher than $\sim$3000K emit thermal radiation detectable in visible wavelength. In SP2, thermal radiation is measured at two distinct wavelength bands, the blue-band (300-500 nm) and the red-band (580-710 nm), to infer the spectra of incandescent light. As the spectra of thermal radiation shifts shorter wavelength as temperature increases, the blue-band to red-band signal ratio (color ratio) is a proxy of boiling point of the incandescing particle.

3. Identification of incandescing particles

The probability distribution of measured color ratio for various laboratory samples and field dust samples are shown in Figure. For laboratory sample, there are three distinct modes in color ratio distribution: iron and iron oxides ($\sim$1.5), titanium ($\sim$2.0), and fullerene soot ($\sim$2.6) (standard material of BC). Therefore, we can distinguish incandescent materials (iron, iron oxides, titanium, BC) in a particle using the value of color ratio.

Figure also shows the result for two field samples: Iceland particle (provided by Dr. P. Dagsson-Waldhauserova, University of Iceland) and Taklimakan desert particle (provided by Dr. R. Tada (The University of Tokyo)). The color ratio distributions of these samples have two distinct modes with peaks around 1.5 and 2.6, corresponding to iron (and iron oxides) and fullerene soot, respectively. From the observed color ratio, the incandescing particles observed in the two field samples were identified as BC and iron-containing particles.

4. Calibration for iron measurement by LII

We have experimentally determined the relationships between blue-band signal intensity and mass of pure iron particle. This relationship was used as a calibration curve for estimating iron-content in field samples.

Keywords: aerosol, atmospheric chemistry

AAS21-P03 Room:Convention Hall Time:May 27 18:15-19:30