ESAR Lab

Characteristics of chemical composition for ultrafine particle collected at Narita International Airport

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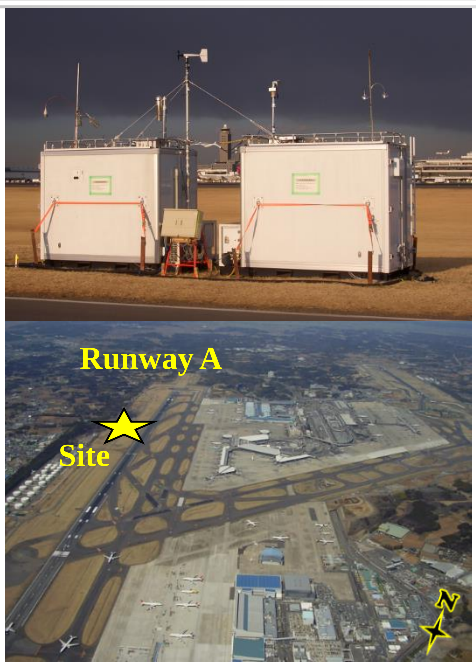

Figure 1. Aerial view of Narita International Airport and field measurements. Field measurement site is distance of 140 m west of 4,000 m runway A.

Introduction & Background

Jet engine aircraft are a significant source of atmospheric ultrafine particle (UFP, particles with aerodynamic diameter < 100 nm) and exist ubiquitously from ground level to the upper troposphere. Although countermeasures against exhaust particles from jet engines are already being implemented, at international airports, the number of flight departures and arrivals of aircrafts are increasing annually and the runway is also expanding; therefore, the influence on the atmospheric environment near airports is of great concern. Consequently, we collected particulate samples from an area near a runway at the Narita International Airport (Figure 1), Japan, during winter period (February) and summer period (July—August) in 2018, and performed a chemical analysis (Figure 2).

Sampling

Two NanoMoudi II impactors were used to collect size-resolved particles (Figure 2). To distinguish the effect of aircraft emissions, the samples were collected during the daytime (during aircrafts operation hours; 7:00–22:00) and nighttime (during non-operation hours; 0:00–6:00). We obtained three daytime (sample ID: #W1, #W2, #W3) and one nighttime (sample ID: #W4) samples in the winter period. In the summer period two daytime (sample ID: #S1, #S3) and two nighttime (sample ID: #S2, #S4) samples were obtained.

Particle mass

The particle masses of the size-resolved particles samples were determined using a micro-balance (readability 0.1 µg, UMX 2, Mettler-Toledo).

Chemical analysis

Analysis of the EC and OC were by using a thermal/optical carbon analyzer (DRI Model 2001 Carbon Analyzer). The ionic species (anion: F^-, Cl^-, NO_2^-, Br^-, NO_3^-, PO_4^{3-} and SO_4^{2-}; cation: Na^+, NH_4^+, K^+, Mg^{2+} and Ca^{2+}.) were analyzed using a ion chromatography (Metrohm, IC 850). The elemental composition was analyzed using PIXE system at the Nishina Memorial Cyclotron Center, Japan Radioisotope Association.

Results & Conclusions

The proportions of OC / EC, ions, and elemental constituents in the particles mass were different for daytime and nighttime collected samples (Figure 3). In the nighttime samples EC has not been detected almost. On the other hand, EC was detected from most daytime samples, and that proportion ranged in 5—24%. The proportion of ions constituents was ranged in 2—24%, and the main ions were NO_3^- and SO_4^{2-}. The proportion of the elemental components was 0.2—10%, except for 10—18 nm size particles of # W4 and # S3. The 10—18 nm size particles in # W4 and # S3 were mainly Al and Si in addition to S (insoluble sulfur). Insoluble sulfur in UFP accounts for about 50%, indicating the importance of insoluble sulfur as well as sulfate derived from fuel (Figure 4).

Acknowledgements

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Related publications

1) Fushimi A., Saitoh K., Fujitani Y., Takegawa N.: Identification of jet lubrication oil as a major component of aircraft exhaust nanoparticles, Atmos. Chem. Phys.19, 6389-6399, https://doi.org/10.5194/acp-19-6389-2019, 2019. 2) Saitoh K., Fushimi A., Sera K., Takegawa N. (Accepted, 2019) Elemental analysis of jet engine lubrication oil and jet fuel using in-air PIXE, International Journal of PIXE.

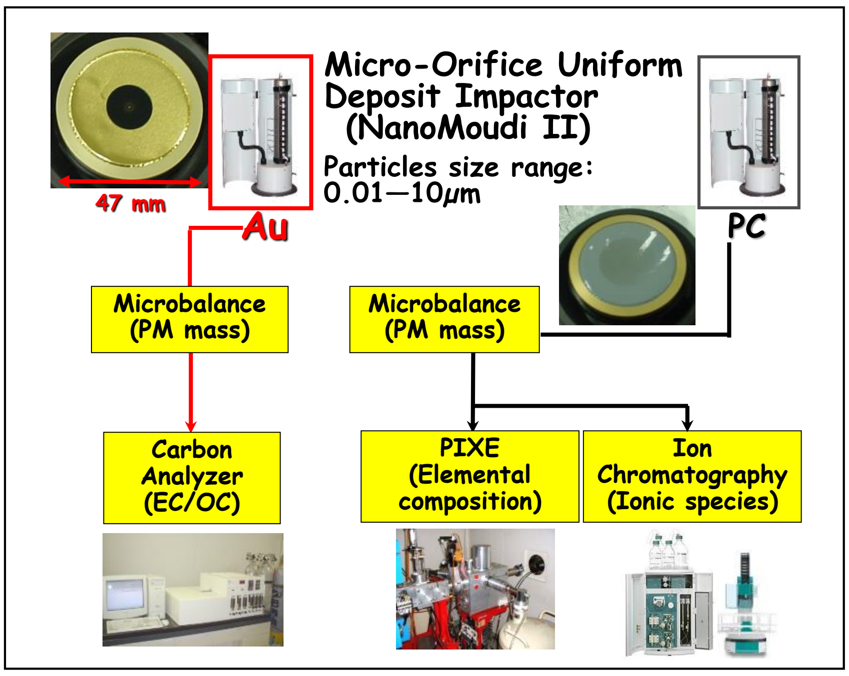

Figure 2. Instruments for sampling and chemical analysis.

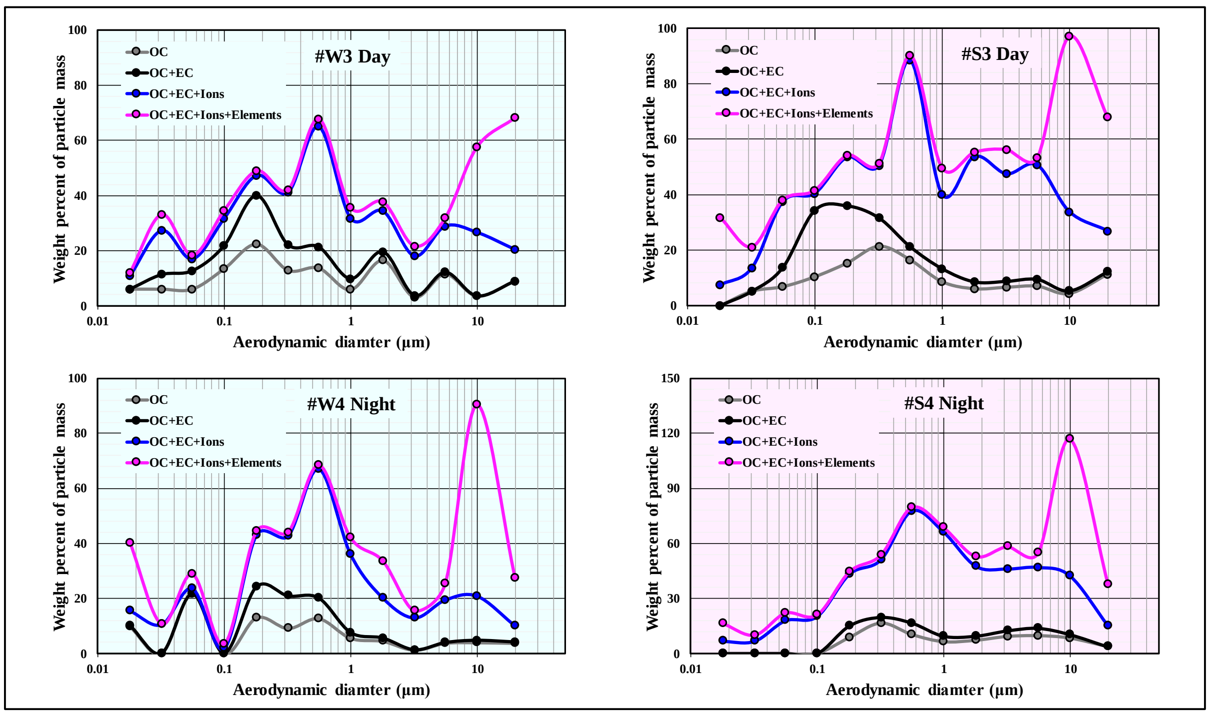

Figure 3. The OC, EC, ions and elements weight percent by particle size.

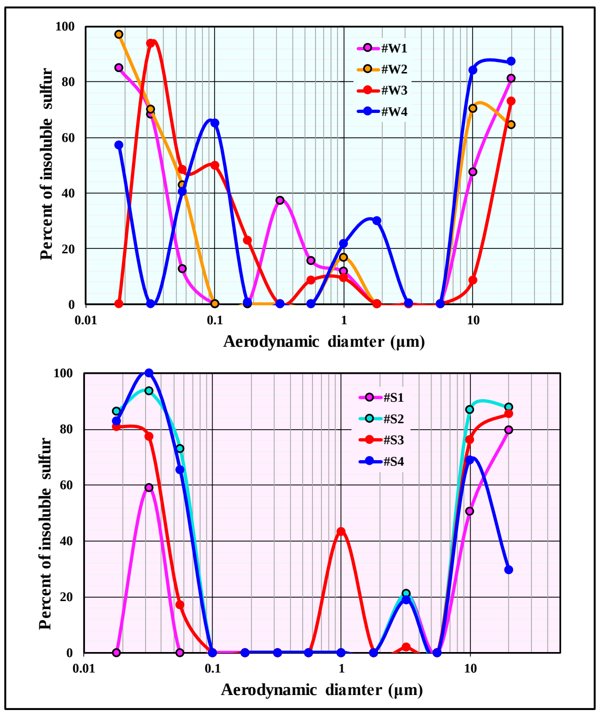

Figure 4. Percent of insoluble sulfur by particle size.