Particulate Matter (PM2.5) Control Program Kawasaki Environment Research Institute

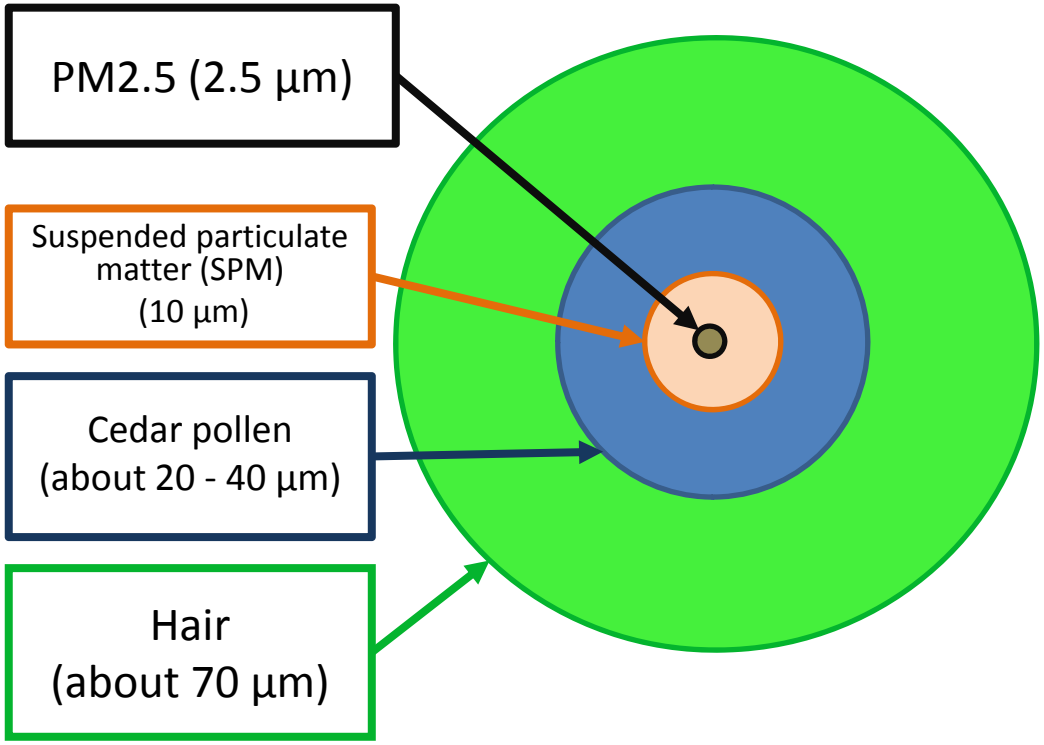
Yoshihiro Suzuki

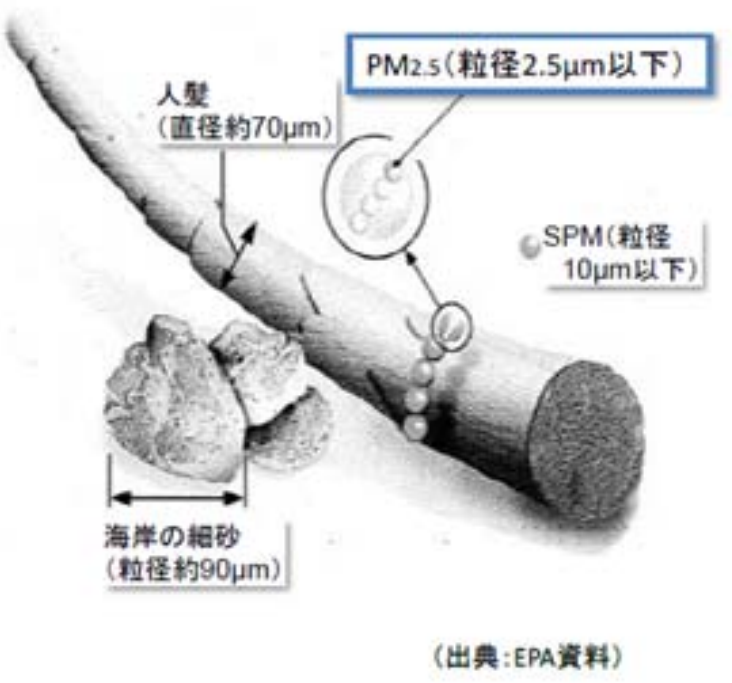
Local Environment/Pollution Monitoring Department,

Kawasaki Environment Research Institute

What Is Particulate Matter (PM 2.5)?

Small particle less than 2.5 µm in diameter suspended in the atmosphere

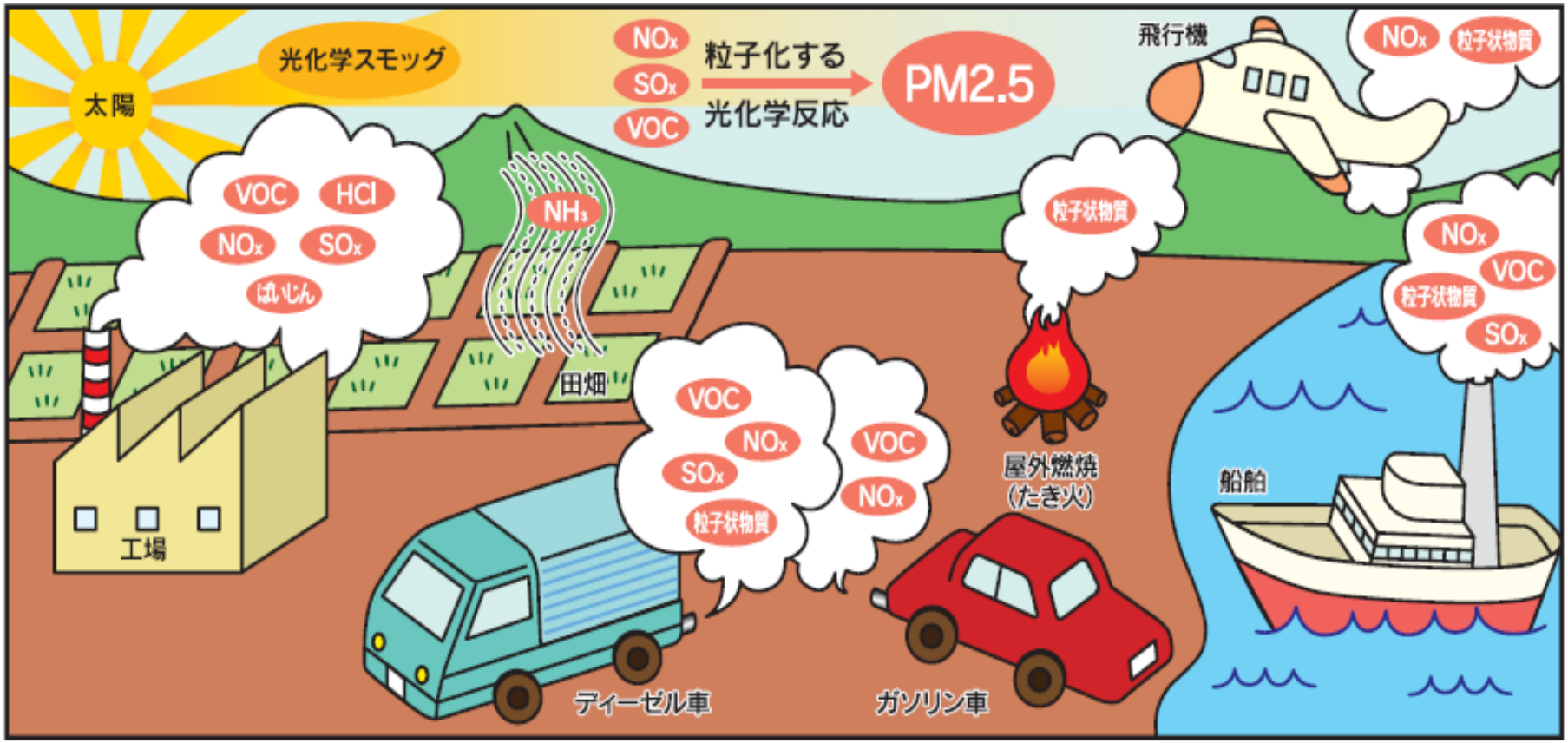




* 1 µm=1/1000 mm

Relative scale

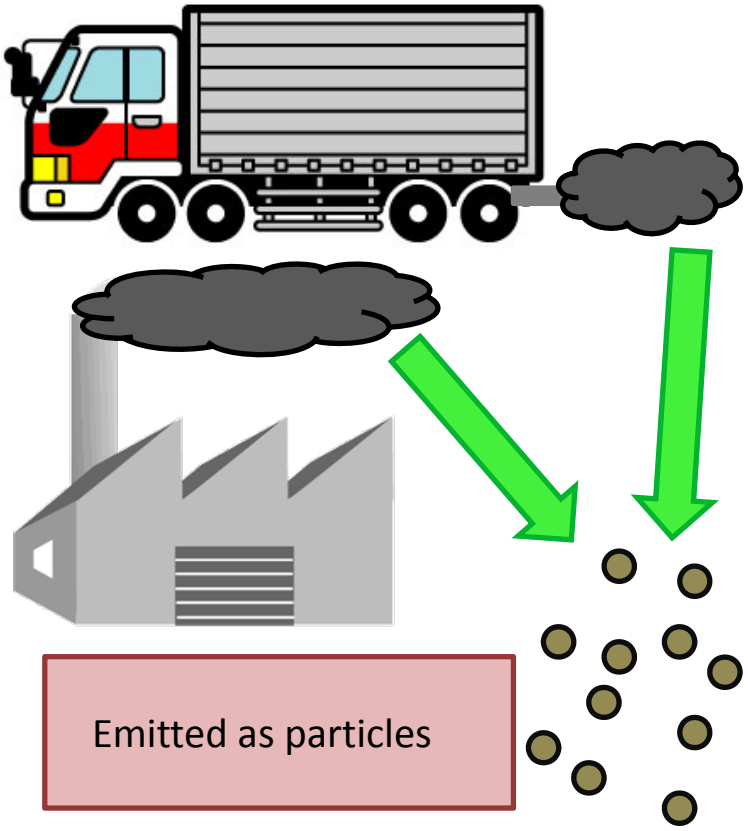
Major Sources of Particulate Matter (PM2.5)



Source: Leaflet prepared by Suspended Particulate Matter Control Subcommittee, Kanagawa Prefecture Pollution Prevention Promotion Council

Mechanism of Production of Particulate Matter (PM2.5)

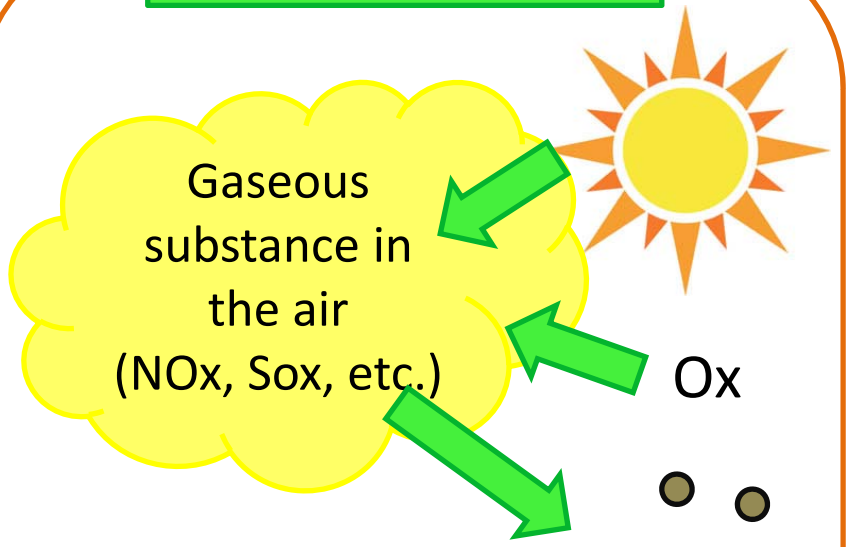
Primary particle



Emitted as particles

(Components: elemental carbon, etc.)

Secondary production particle



Particle production through photochemical reactions

(Components: sulfate ion, nitrate ion, etc.)

Environmental Standards for PM2.5

What are the environmental standards?

The standards that should be maintained to protect human health and preserve the living environment

Establishment of the environmental standards for PM2.5

Environmental standards were established and announced by the Ministry of the Environment on September 9, 2009

Contents of the environmental standards

Annual mean $\leqq$ 15 μg/m^3
Daily mean $\leqq$ 35 μg/m^3

Present Conditions of PM2.5 Monitoring in Japan

Establishment of measurement centers (2012)

General ambient air measurement centers
(General measurement centers) ・・・313
Automobile exhaust gas measurement centers
(Exhaust measurement centers) ・・・124

*Number of operating measurement centers

Conditions of adherence to environmental standards (2012)

General ambient air measurement centers
(general measurement centers) ・・・43.5%
Automobile exhaust gas measurement centers
(Exhaust measurement centers) ・・・33.9%

Source: Website of Ministry of the Environment (http://www.env.go.jp/press/press.php?serial=17553)

PM2.5 Monitoring/Investigation System
Kawasaki Environment Research Institute

○Constant monitoring/measurement

- ◇ Improvement/expansion of PM2.5 monitoring system
- ◇ Improvement/expansion of provision of PM2.5 related information
- ◇ Provision of warning information at the time of increased PM2.5 concentration

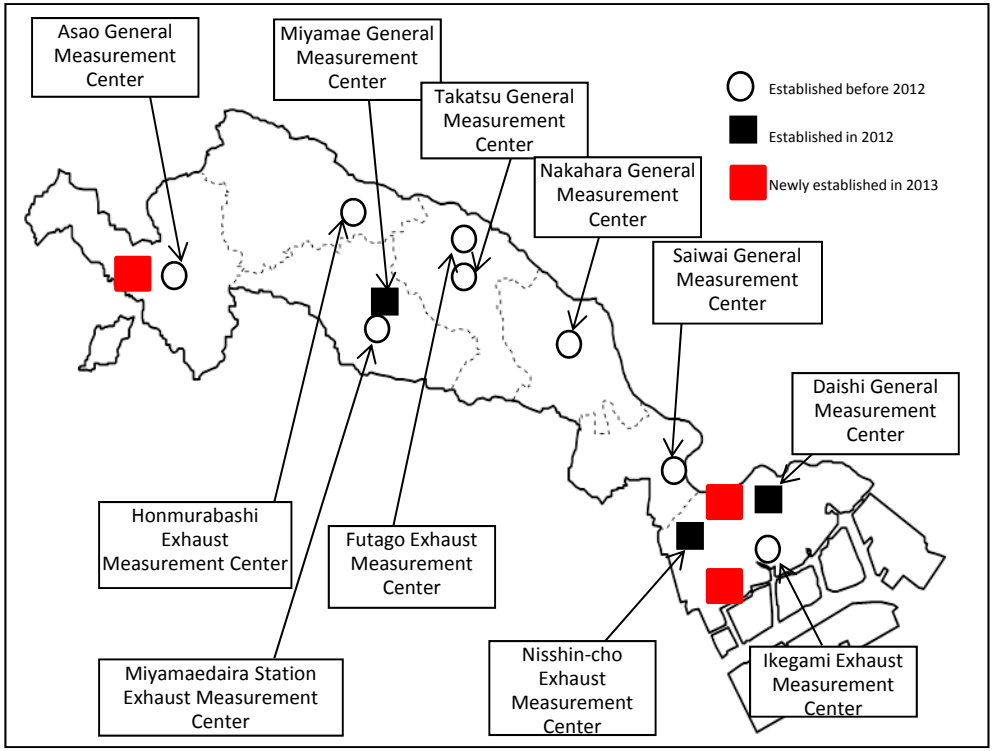
○Component analysis/investigation

Improvement/Expansion of PM2.5 Monitoring System

PM2.5 constant monitoring system in Kawasaki City

- Present system (11 centers in total)
  General ambient air measurement centers:
  6 centers (Daishi, Saiwai, Nakahara, Takatsu, Miyamae, Asao)
  Automobile exhaust gas measurement centers:
  5 centers
  (Ikegami, Nisshin-cho, Futago, Honmurabashi, Miyamaedaira Station)

- Measurement centers newly established in 2013
  General ambient air measurement centers:
  2 centers (including one national center)
  Automobile exhaust gas measurement center:
  one center
  [The system consisted of 14 centers in total in 2013]



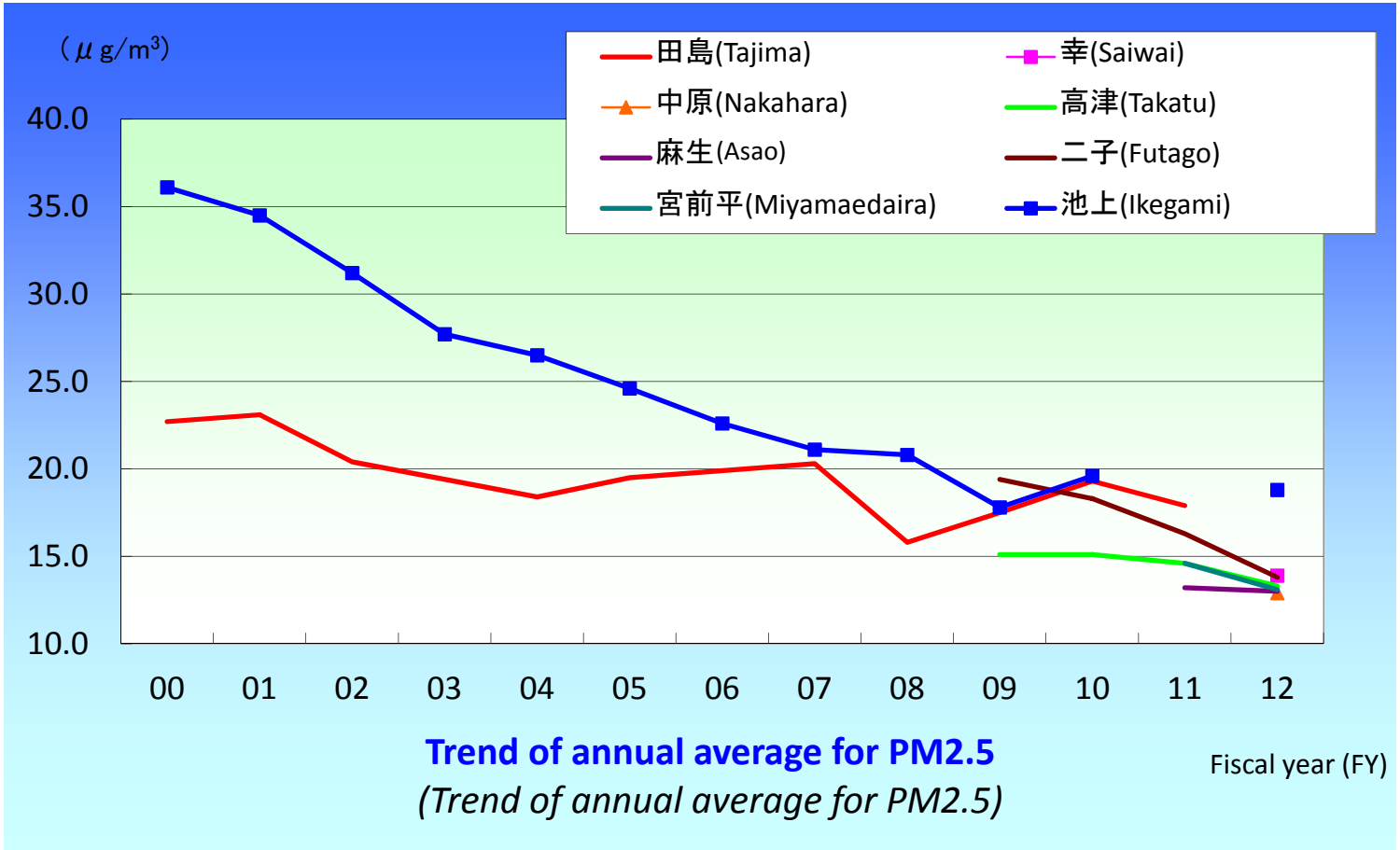
PM2.5 measurement centers in Kawasaki City
* General measurement center: general ambient air measurement center
Exhaust measurement center: automobile exhaust gas measurement center

Assessment of Constant Monitoring Data (2012)

The conditions of adherence to the environmental standards regarding particulate matter (PM2.5) in 2012 are presented in the table below. At the Ikegami Automobile Exhaust Gas Measurement Center, the measurements exceeded the environmental standards.

Measurement centers	General measurement centers				Exhaust measurement centers			
	Saiwai	Nakahara	Takatsu	Asao	Ikegami	Futago	Miyamaedaira Station	Honmurabashi
Assessment	○	○	○	○	×	○	○	○

Trend of Annual Average for PM2.5



* The monitor was switched from Series 1400a to Model 1405-DF on November 12, 2009 at the Tajima Center.
* Center (establishment): Tajima (Apr 2000); Saiwai (Mar 2012), Nakahara (Mar 2012), Takatsu (Mar 2009), Asao (Apr 2011), Ikegami (Jul 2000), Futago (Feb 2010), Miyamaedaira (Apr 2011)

Introduction of the Provision of Air Quality Data Using Data Broadcasting

Kawasaki City introduced a new system that enables citizens to view air quality data on their home TV screen in real time using Television KANAGAWA data broadcasting

TV screen

Measurement items displayed on the TV screen:
SO_2 (sulfur dioxide), NO_2 (nitrogen dioxide), O_X (photochemical oxidant), SPM (suspended particulate matter), PM2.5 (particulate matter 2.5)

Guide for viewing the data:
Press the “d” button on the remote control and select in the following order:
→「マイタウン情報　川崎市」(‘My Town Information Kawasaki City’)→「大気環境速報値」(‘Air Quality Preliminary Measurements’) (*)
(*) For TV sets in which the zip code of Kawasaki City has been entered.

Kawasaki City introduced an air quality data service using TV data broadcasting as the first case in Kanagawa Prefecture.

Provision of Warning Information in the Event of Increased PM2.5 Concentration

Information warning service

In the case of a predicted increase in PM2.5 concentration, warning information is provided through the following information media:

- Community disaster prevention wireless system
- Disaster prevention mailing list (For registration, send a blank e-mail to the following address.)
- Website of Kawasaki City
- Answering service (Kanagawa Prefecture): TEL 045-210-5980

Information calling attention to the PM2.5 situation

The following warning information is provided when PM2.5 concentration is expected to increase

- Don’t go out unless absolutely necessary
- Don’t exercise outside or keep such activities to a minimum
- Minimize the entrance of outside air into rooms by controlling ventilation or opening/shutting windows as little as possible
- Be extra careful if you suffer from respiratory or circulatory diseases. Small children and the elderly must act very carefully with due consideration for their health condition.

Component Analysis/Investigation

- By investigating/analyzing particle concentration and component composition of PM2.5, basic materials for the development of administrative measures for the achievement of environmental standards can be prepared

Objectives…

Clarification of the actual PM2.5 conditions	Analysis of source	Clarification of the actual conditions of advection

Details of Component Analysis

- PM2.5 concentration
- Ion components (8 ions)
  - Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}
- Carbon components
  - Elemental carbon (EC)
  - Organic carbon (OC)
  - Water-soluble organic carbon (WSOC)
- Metallic components (13 metals)
  - Mg, Al, K, Ca, V, Cr, Mn, Fe, Ni, Cu, Zn, Sb, Pb

Investigation Period (2012)

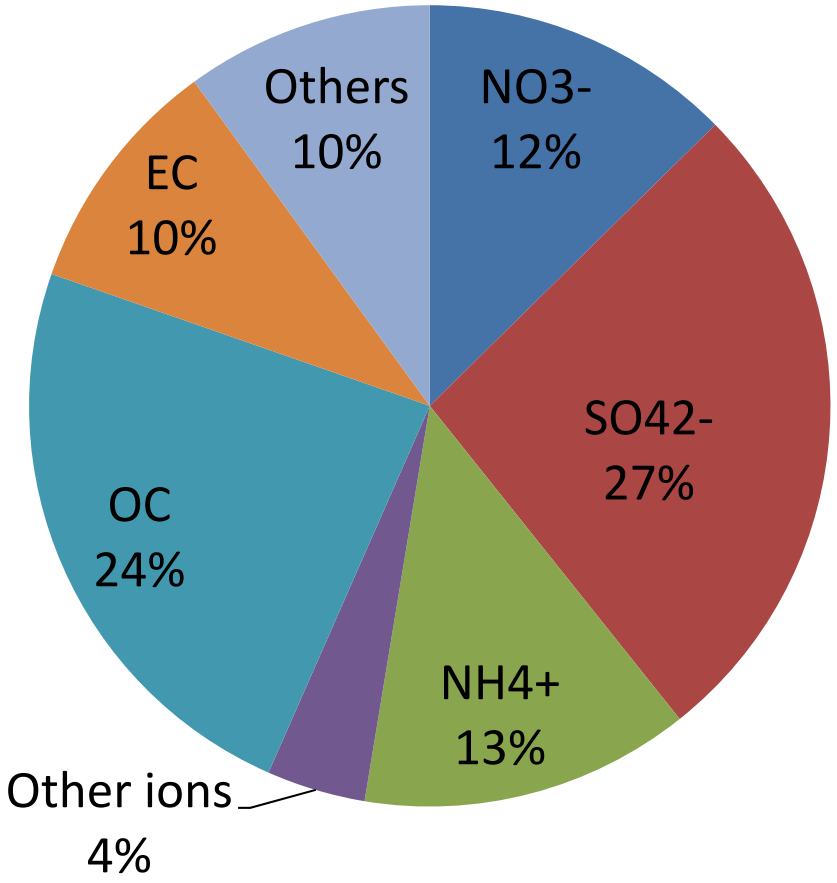
- 2 weeks each season (spring/summer/fall/winter)
- 23-hour sampling from 10:00 a.m. to 9:00 a.m. the following day

	Investigation period
Spring	May 9-May 22, 2012
Summer	Jul 25-Aug 7, 2012
Fall	Oct 23-Nov 5, 2012
Winter	Jan 22-Feb 4, 2013

Measurement Points for PM2.5 Component Analysis

- General environment areas: Tajima, Takatsu
- Roadside area: Ikegami

Component Composition of PM2.5



* Estimated from the annual mean of measurements taken at Tajima in 2012

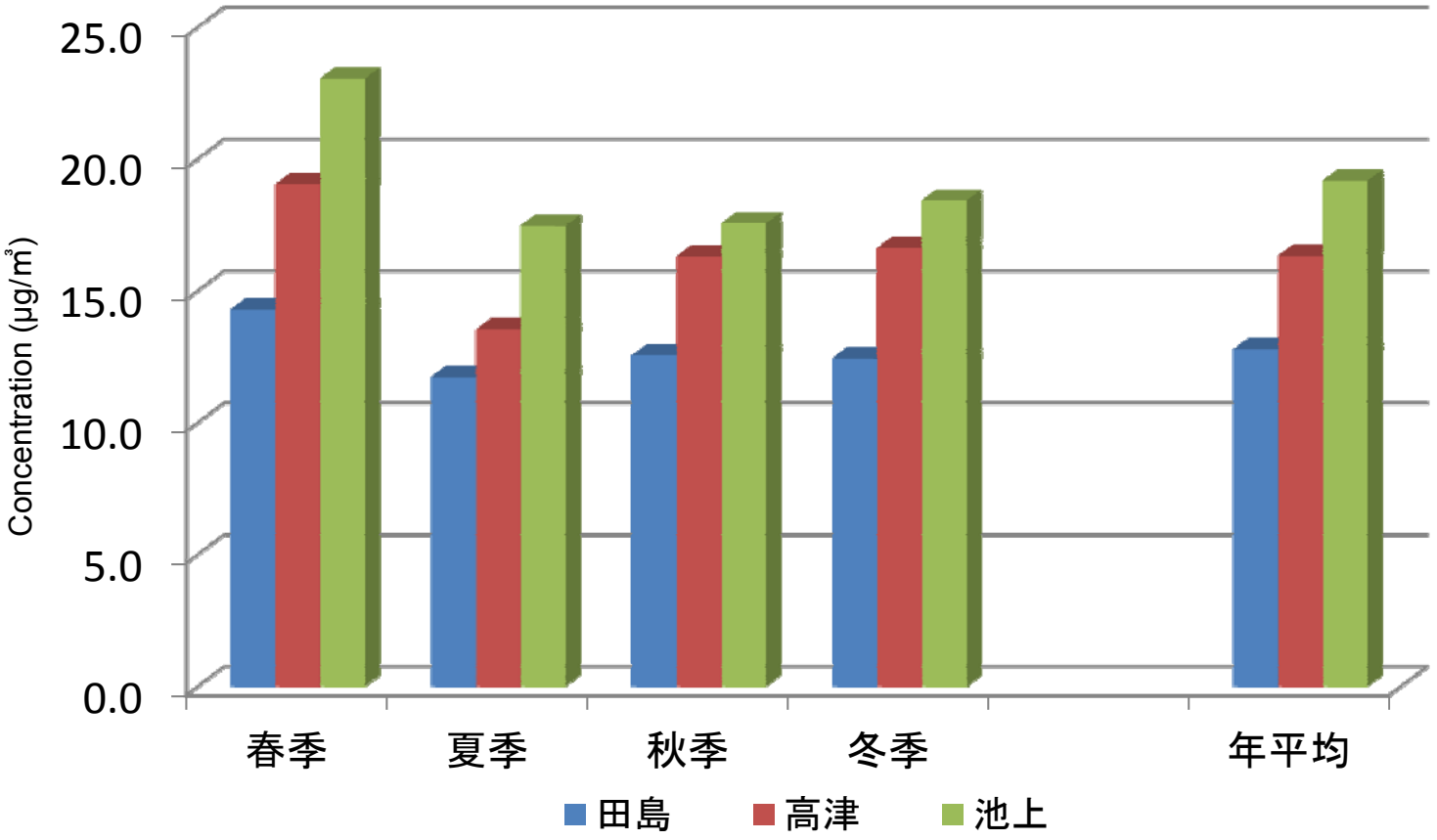
PM2.5 Concentration

Microbalance
(MX5, Mettler Toledo)

Before trapping
(quartz filter)

After trapping
(quartz filter)

Particulate Matter (PM2.5) Concentration Measurement Results

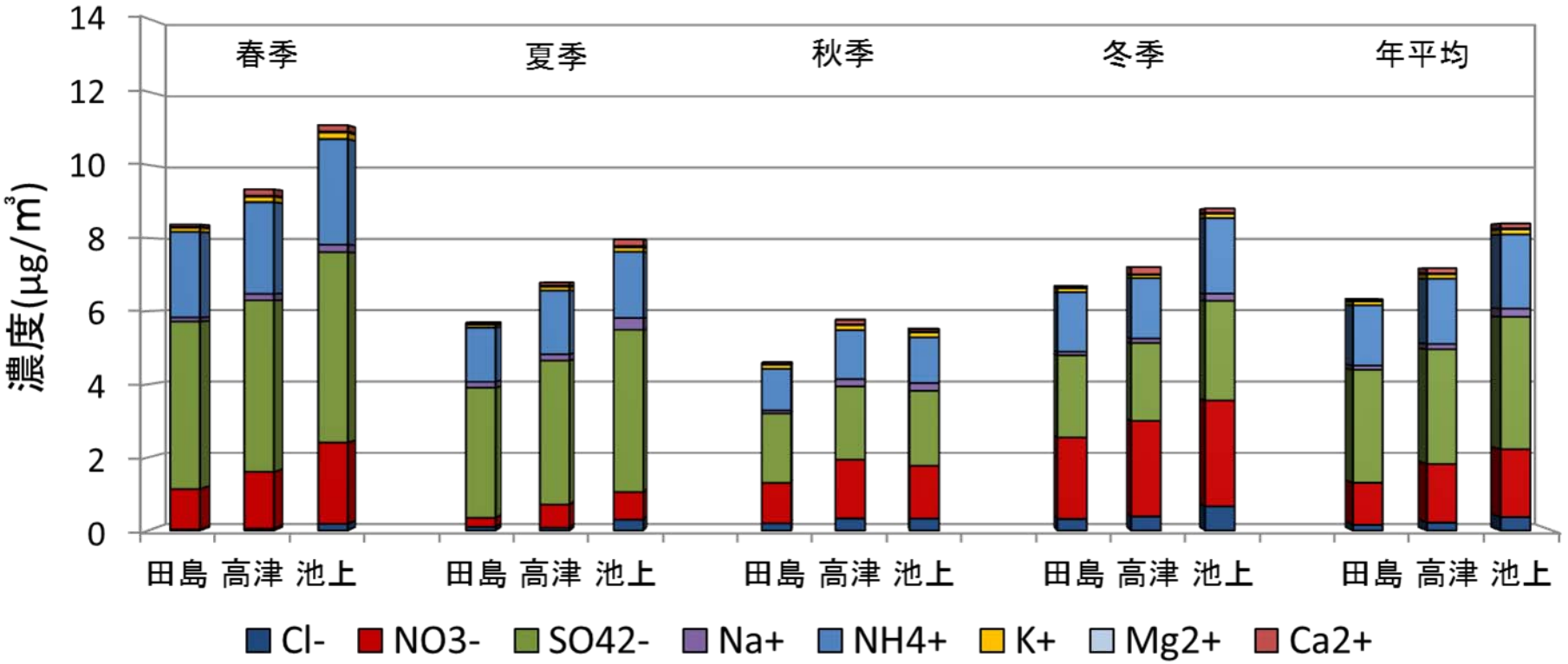


- Annual mean concentration: roadside (19.2 μg/m^3), general environment (12.8, 16.3 μg/m^3)
- PM2.5 concentration at the roadside was higher than that in the general environment
- PM2.5 concentration in the spring was the highest among the four seasons.

Ion Component Analysis

Ion chromatography system
(Dionex DX500, Thermo Fisher Scientific, Inc.)

Water-Soluble Ion Component Analysis Results



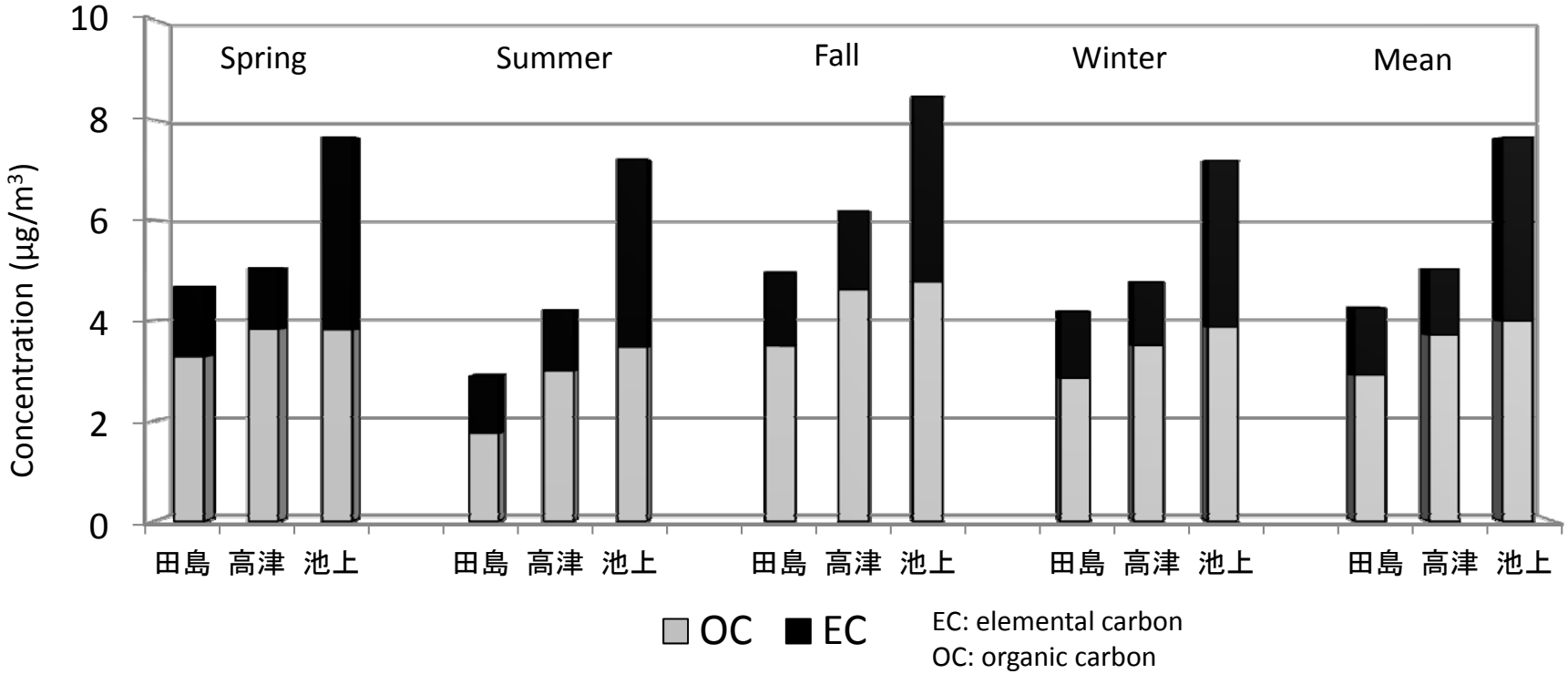
- The total ion concentration showed a tendency to increase in the spring and decrease in the fall.
- In comparing SO_4^{2-} and NO_3^-, which are representative ion components among secondary production particles, SO_4^{2-} was a predominant negative ion in the summer, while the concentration of NO_3^- was higher than SO_4^{2-} in the winter.

Carbon Component Analysis

Water-Soluble Organic Carbon (WSOC) Component Analysis

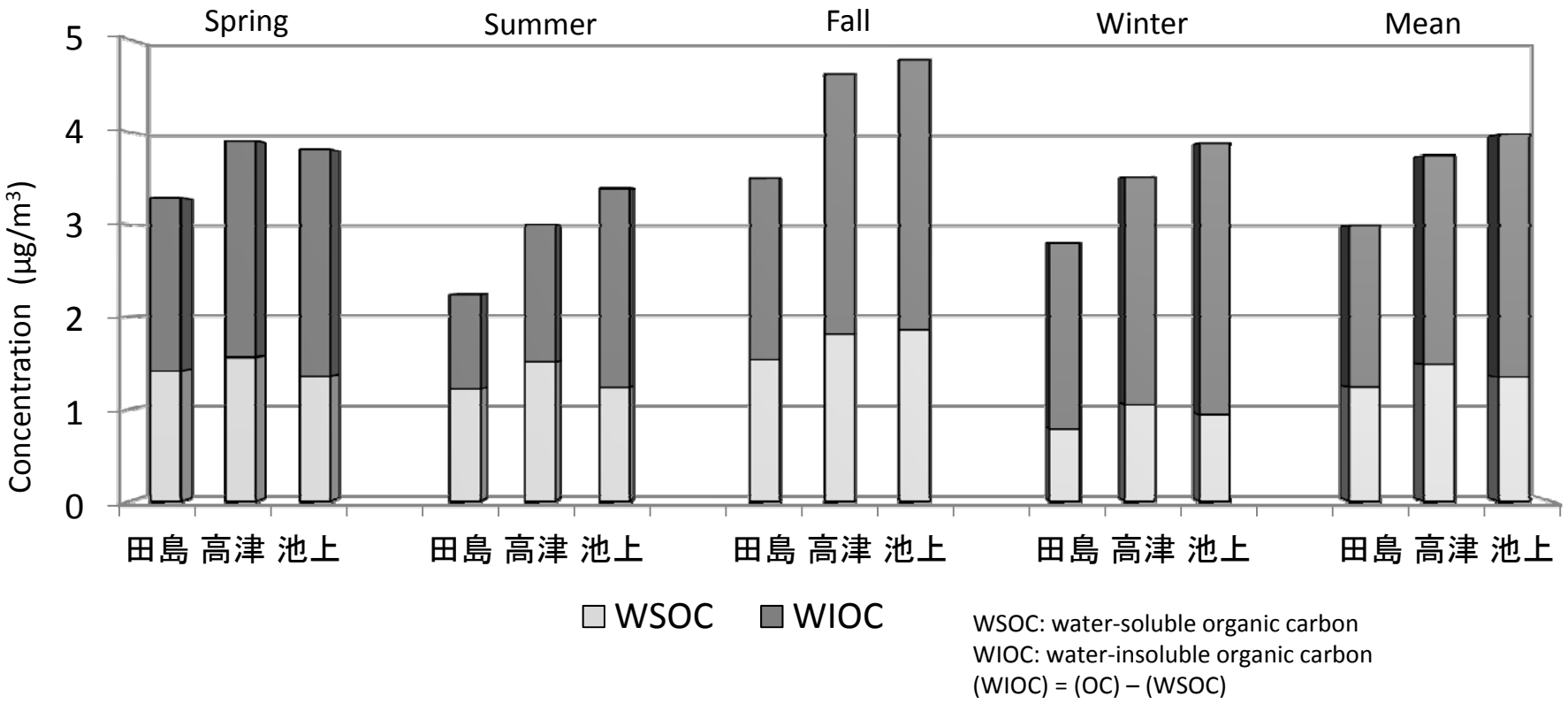
Carbon analyzer
(SUNSET Laboratory)

Carbon Component Analysis Results



- EC concentration at the roadside was markedly high in Ikegami.
- There was no marked difference in OC concentration between measurement points.
- The season specific transition of OC concentration showed a tendency to increase in the fall and decrease in the summer at all three measurement points.

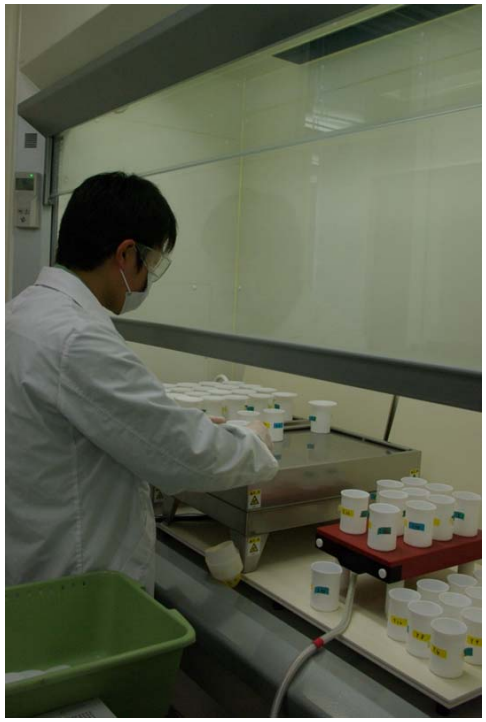
Water-Soluble Organic Carbon (WSOC) Component Analysis Results



WSOC: water-soluble organic carbon
WIOC: water-insoluble organic carbon
(WIOC) = (OC) – (WSOC)

- WIOC concentration was higher than WSOC concentration at all three measurement points
- No marked difference in WSOC concentration was observed between measurement points in the general environment and the measurement point at the roadside
- The season specific transition of WSOC concentration showed a tendency to increase in the fall and decrease in the winter

Metallic Component Analysis



Pretreatment process for metallic analysis (open system)

ICP mass spectrometer
(7700x, Agilent)

Metallic Component Analysis Results

Annual mean concentration of particulate matter (μg/m^3, 2012)

	Roadside	General environment	
	Ikegami	Tajima	Takatsu
Mg	0.042	0.021	0.038
Al	0.070	0.036	0.12
K	0.13	0.096	0.12
Ca	0.13	0.044	0.15
V	0.0091	0.0068	0.0071
Mn	0.021	0.0092	0.0071
Fe	0.37	0.17	0.19
Ni	0.0078	0.0054	0.0025
Cu	0.0088	0.0070	0.0051
Zn	0.055	0.034	0.033
Cd	0.00031	0.00022	0.00020
Sb	0.0017	0.0012	0.0013
Pb	0.013	0.0079	0.0071

- The mean concentrations of Al, K, Ca and Fe were higher than the remaining metals.
  ⇒ Influence of naturally-occurring metals
  Sea salt particles: K
  Soil particles: Al, Ca, Fe
- The concentration of Sb was higher at the roadside than in the general environment.
  ⇒ Involvement of automobile brake pads
- Characteristic seasonal variation consisted of the phenomenon where the concentrations of V and Ni, which are indexes of heavy oil combustion, increased in the summer when the south wind became predominant.

Summary of Constant Monitoring Results and Component Analysis Results

○ Constant monitoring

- A decreasing trend for PM2.5 concentration was observed over the long term; however, measurements still exceeded the environmental standard.

○Component analysis (2012)

- Carbon and ion components were the main components of PM2.5, as they accounted for about 60-70% of the total.
- Attention should be directed to carbon and ion components in order to control PM2.5 concentration.
- In Ikegami, the elemental carbon (EC) component contributed to an increase in PM2.5 concentration at the roadside. Because the source of EC is automobile exhaust gas, further control of automobile emissions would likely result in a reduction in PM2.5 concentration in Ikegami.

Future Strategies for Controlling PM2.5 (1)

Clarification of the actual conditions regarding PM2.5

Investigation of the concentration and components of PM2.5 in Kawasaki City
Investigation of component composition
Detection of components at high concentration
Clarification of characteristics in each region

Effort to promote source apportionment

Future Strategies for Controlling PM2.5 (2)

PM2.5 source apportionment

Identification of the source of responsible substances
(Local event? Widespread advection?)

Evaluation of strategies for reduction
(Kawasaki City performs all measures that they can achieve independently, but for those that can not be carried out independently, the city takes a cooperative approach with the Japanese government and other local governments.)

Future Strategies for Controlling PM2.5 (3)

Practical introduction of wide-ranging measures for cooperation

In cooperation with Kanagawa Prefecture, the Kanto region and other local governments, Kawasaki City investigates actual conditions regarding PM2.5

In cooperation with the above, Kawasaki City conducts an investigation and promotes control measures
A nationwide approach is taken to clarify the actual conditions regarding PM2.5
(efforts to control widespread advection)

Future Strategies for Controlling PM2.5 (4)

Industry-university/global investigation

Global awareness-raising campaign (to control advection), joint project to clarify the actual conditions regarding widespread advection of PM2.5
(e.g. sharing techniques for clarification of actual conditions, accepting interns, etc.)

International contribution through environmental technology
Reduction of PM2.5 in Japan and foreign countries

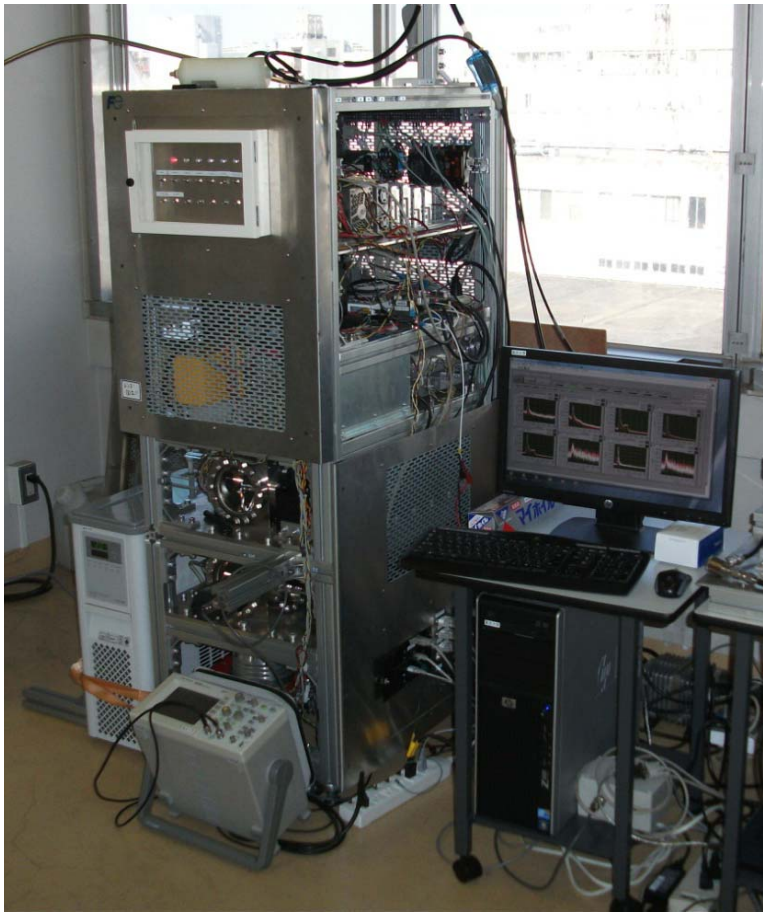
Shenyang City (China) officers visited Japan to observe the actual conditions regarding PM2.5.

Industry-University-Community Joint Research Project

- Fuji Electric Co., Ltd.
- Joint Research Project with Research Center for Advanced Science and Technology, The University of Tokyo

Field assessment using an ‘aerosol complex analyzer’

Evaluation by comparing with the standard measurement method
Validation of measurement data



Operation experiment in the Takatsu General Measurement Center

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Thank you for your kind attention