



Asia Center for Air Pollution Research
Japan Environmental Sanitation Center

6 July, Wednesday, 2022

Workshop on National Air Quality Monitoring Systems and Methodologies with Related Partners

Session 1: Introduction of monitoring systems of the EANET Participating Countries

Monitoring methodologies and QA/QC activities in the EANET

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OUTLINE

- **Air concentration monitoring network in East Asia (EANET)**
- **Air concentration monitoring method and QA/QC activities**
 - **Monitoring station**
 - **Automatic method**
 - PM_{2.5} sampler, Ozone monitor**
 - **Manual method**
 - Particulate components monitoring (Filter pack)**
- **Air concentration monitoring results in EANET**
- **Future activities**

Air concentration monitoring network in East Asia (EANET)



Air concentration (dry deposition) monitoring sites are expected to monitor the parameters of **sulfur** and **nitrogen** compounds associated with acid deposition problems, **PM** and **O₃** associated with air quality issues, meteorological parameters associated with local meteorology and estimation of dry deposition flux. This monitoring might employ either of **real-time monitors** or **manual samplers** (filter packs or passive samplers). So far, there are 54 monitoring sites of dry deposition in EANET including 41 sites using filter pack method, 34 sites using automatic method and 6 sites using passive sampler method in 2019. **The number of monitoring sites in EANET is increasing in the past 20 years.**

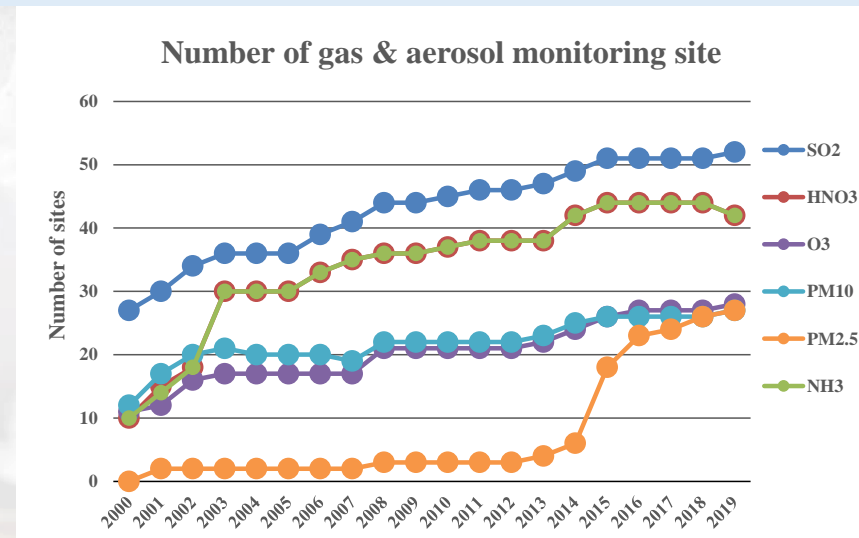


Figure 1. Location and number of air concentration monitoring sites in EANET (2019)

Air concentration monitoring method

Monitoring site in EANET



Pollution Control Department (PCD) site, Thailand

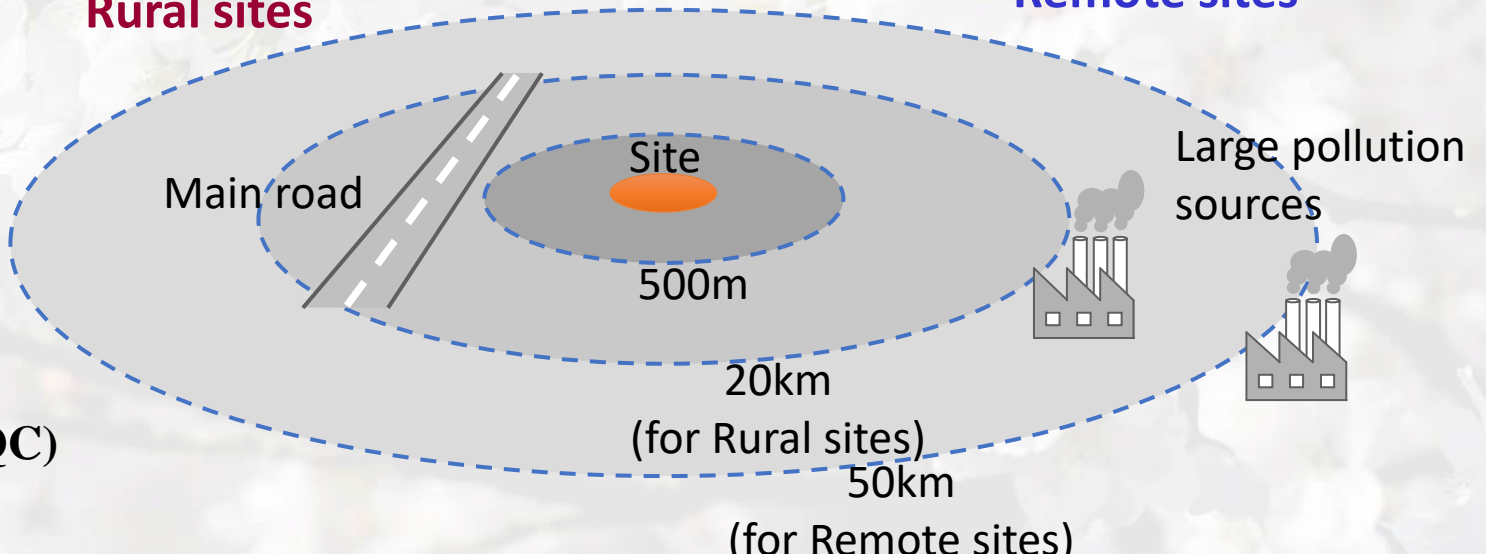
Niigata-maki site, Japan

Mondy site, Russia

Urban sites

Rural sites

Remote sites



Quality assurance/Quality control (QA/QC) Guidebook for EANET (2016)

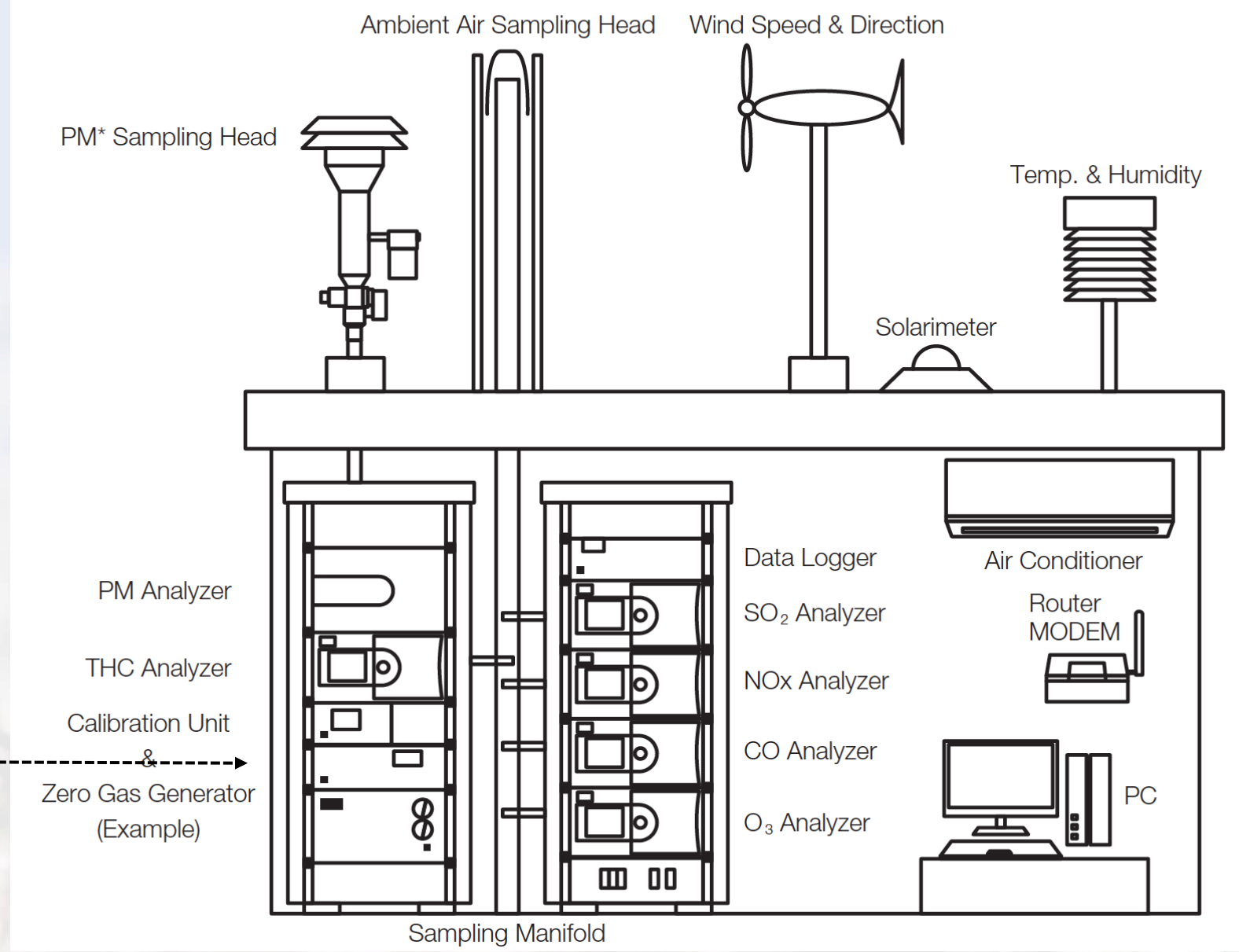
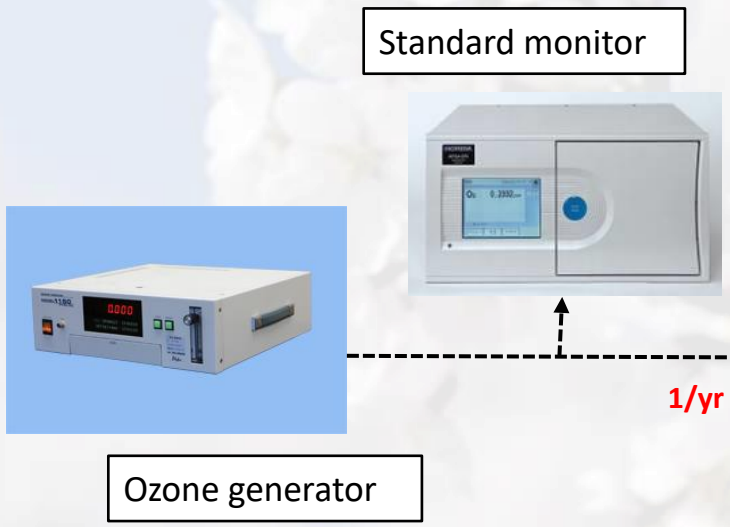
Air concentration monitoring method and QA/QC activities

Automatic method

Air Quality Monitoring Station (AQMS)



Niigata-maki site, Japan

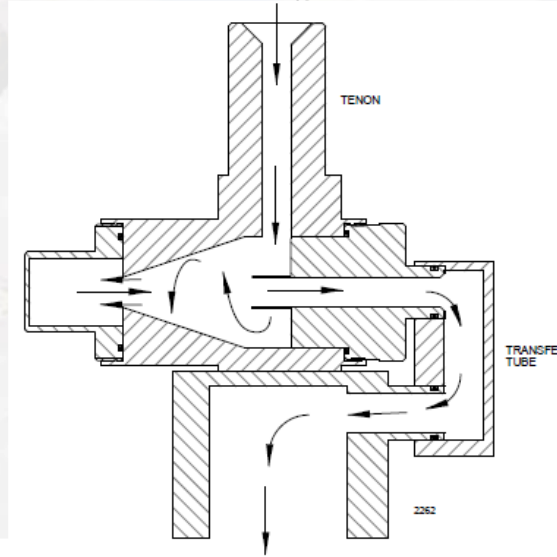


PM_{2.5} automatic monitor

Inlet



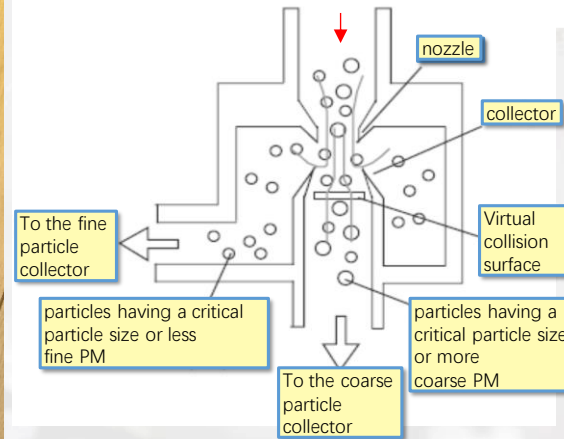
Particle size classifier:
PM_{2.5} cyclone



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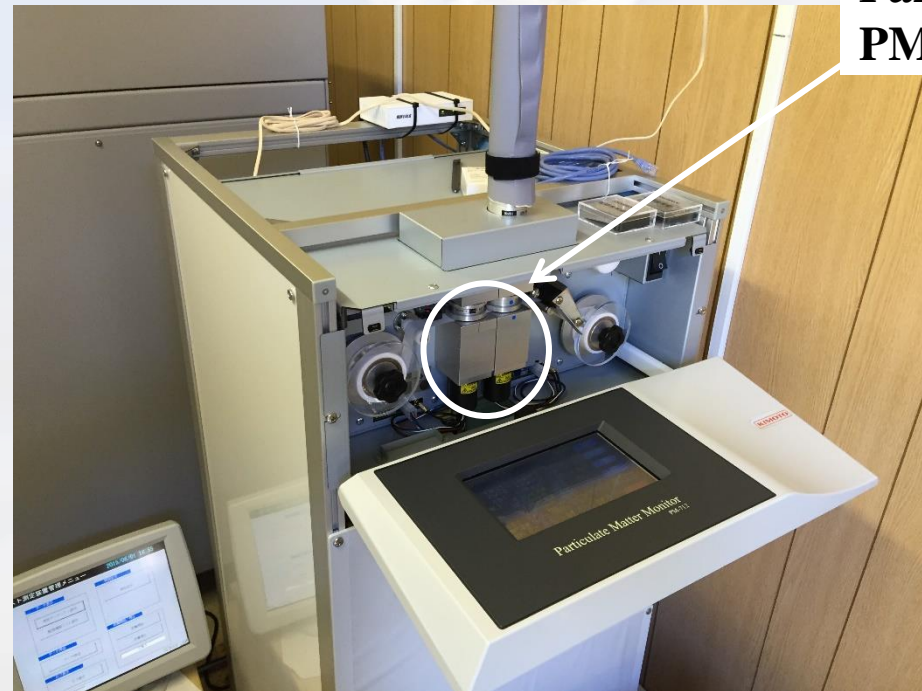


Particle size classifier:
PM_{2.5} Virtual impactor



Principle of Virtual Impactor Sizing Device

Indoor model:
KIMOTO sampler



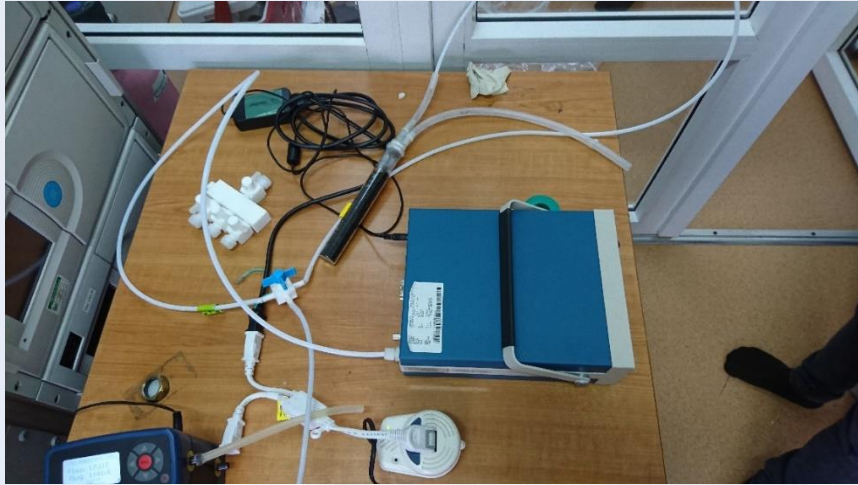
Outdoor model:
Environmental S.A.
sampler

QA/QC activities in site (Automatic air monitor)

- ✓ Type, manufacturer, model, years in use
- ✓ Condition (Manifold, Tube, Diurnal variation)
- ✓ Standard gas (Dilution system), Calibration record
- ✓ Frequency of maintenance



QA/QC of Ozone monitoring: Calibration (Traceability)



Ozone monitor calibration at Hanoi, Vietnam



Ozone monitor calibration in Japan

Establishment of O₃ traceability system in Japan

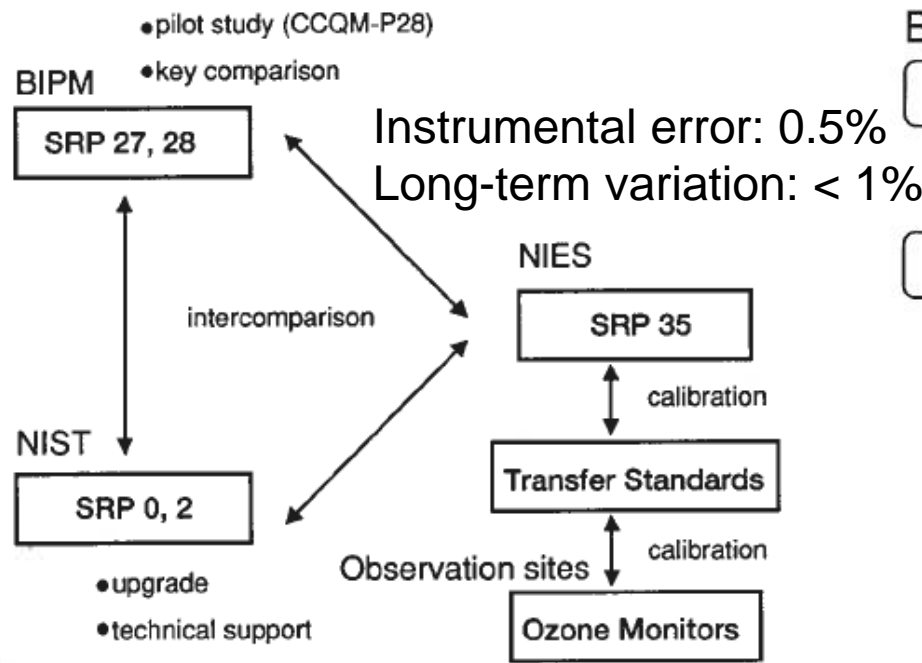


Figure 5. The NIES SRP-based traceability network in collaboration with BIPM and NIST. Quality of SRP35 is maintained through intercomparisons with NIST and BIPM. Ozone monitors at observation sites are calibrated by means of transfer standards (TS) scaled to SRP35.

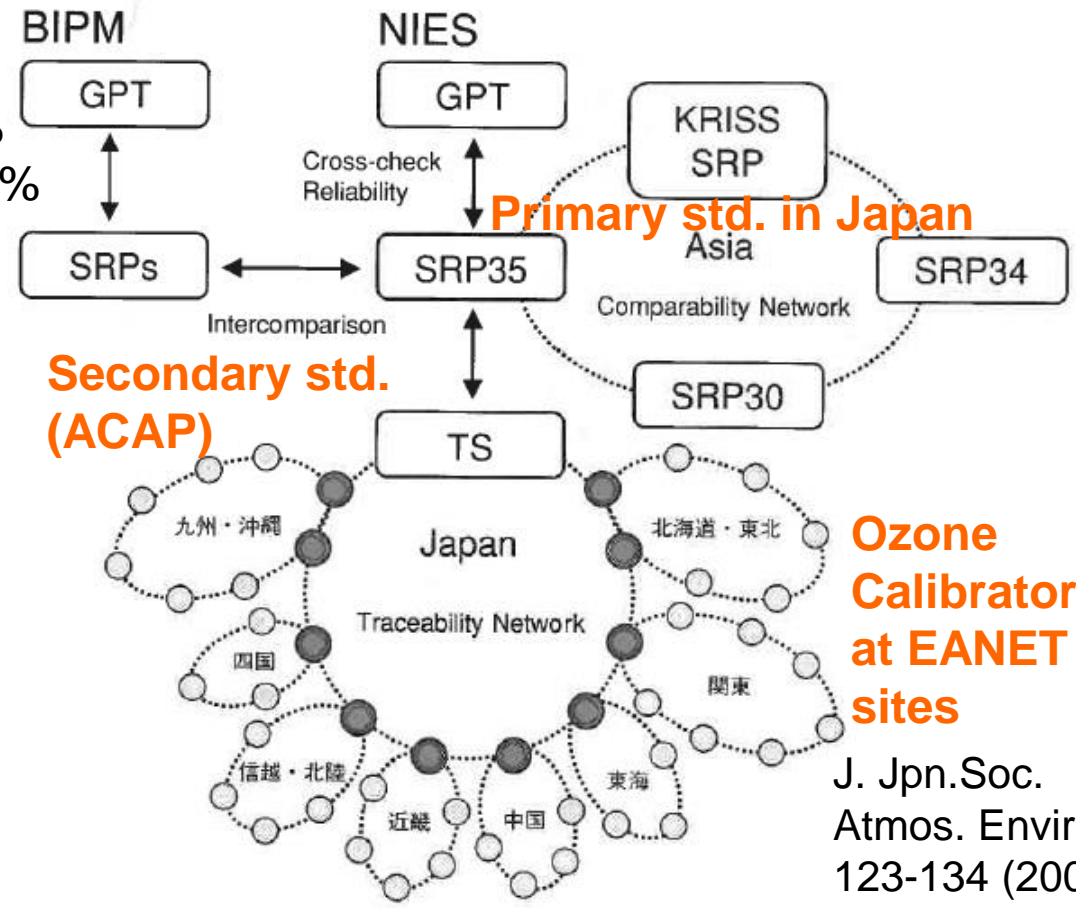
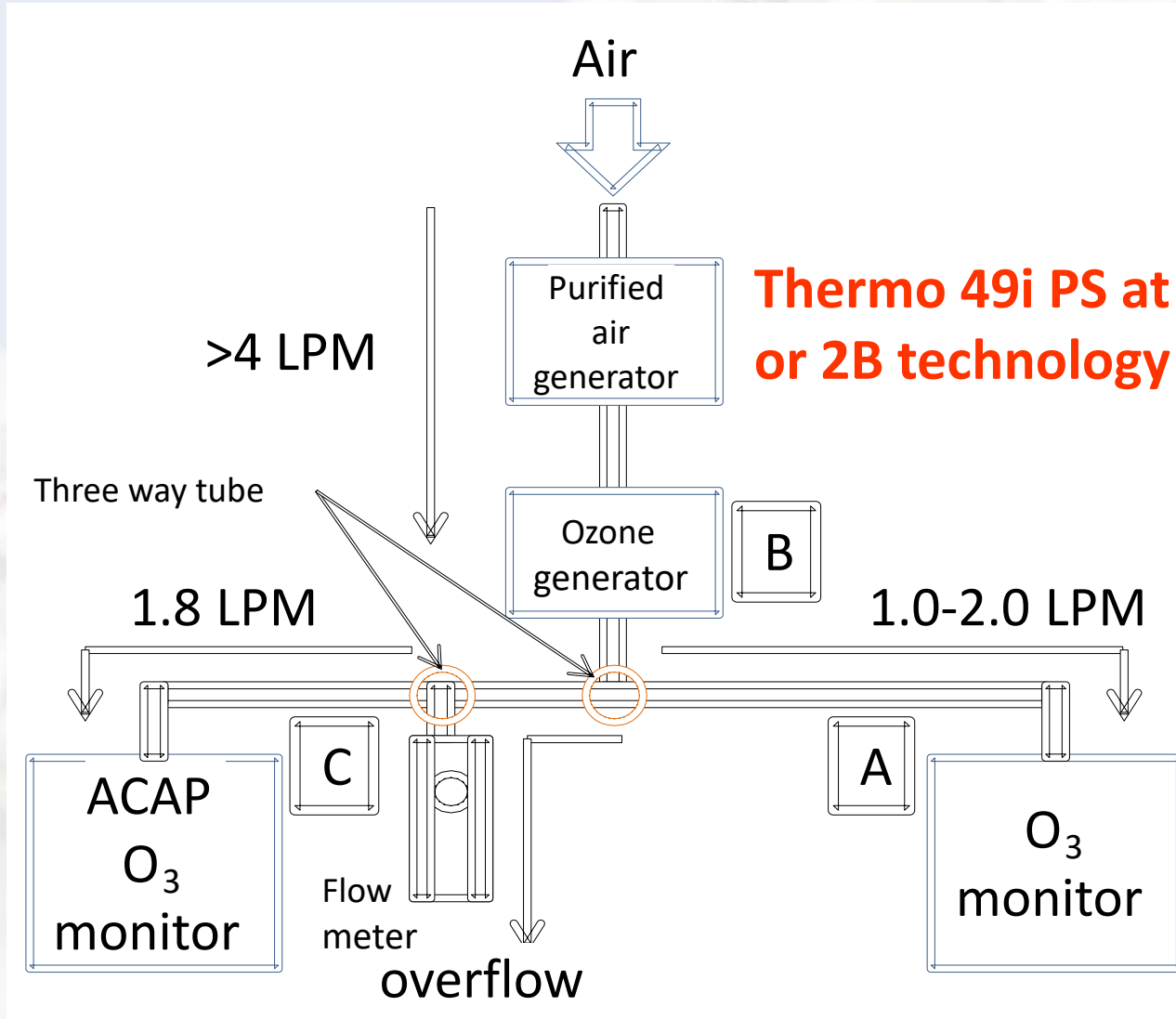


Figure 8. The SRP35-based traceability system for ozone at ambient levels in Japan. The system is a combination of main-comparisons of 8 regionally representative laboratories with SRP35 and sub-comparisons within the individual regions. Linkage with BIPM's and East Asian SRPs are also shown.

J. Jpn.Soc.
Atmos. Environ.
123-134 (2006)

- 8 regional and ACAP ozone secondary standards are calibrated by NIST SRP35.
- Ternary standards installed at each prefecture are calibrated by the secondary standard.

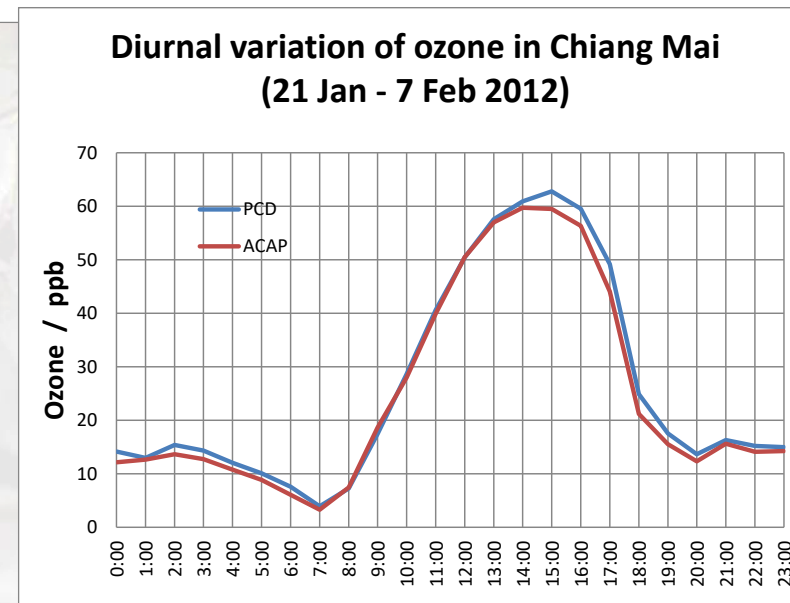
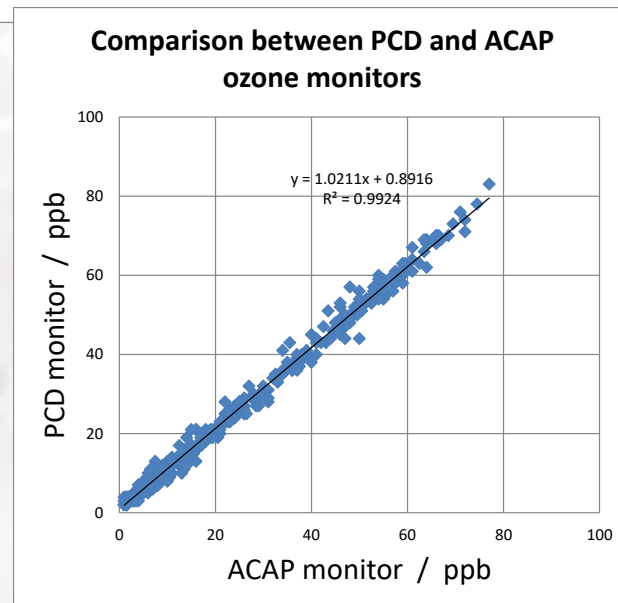
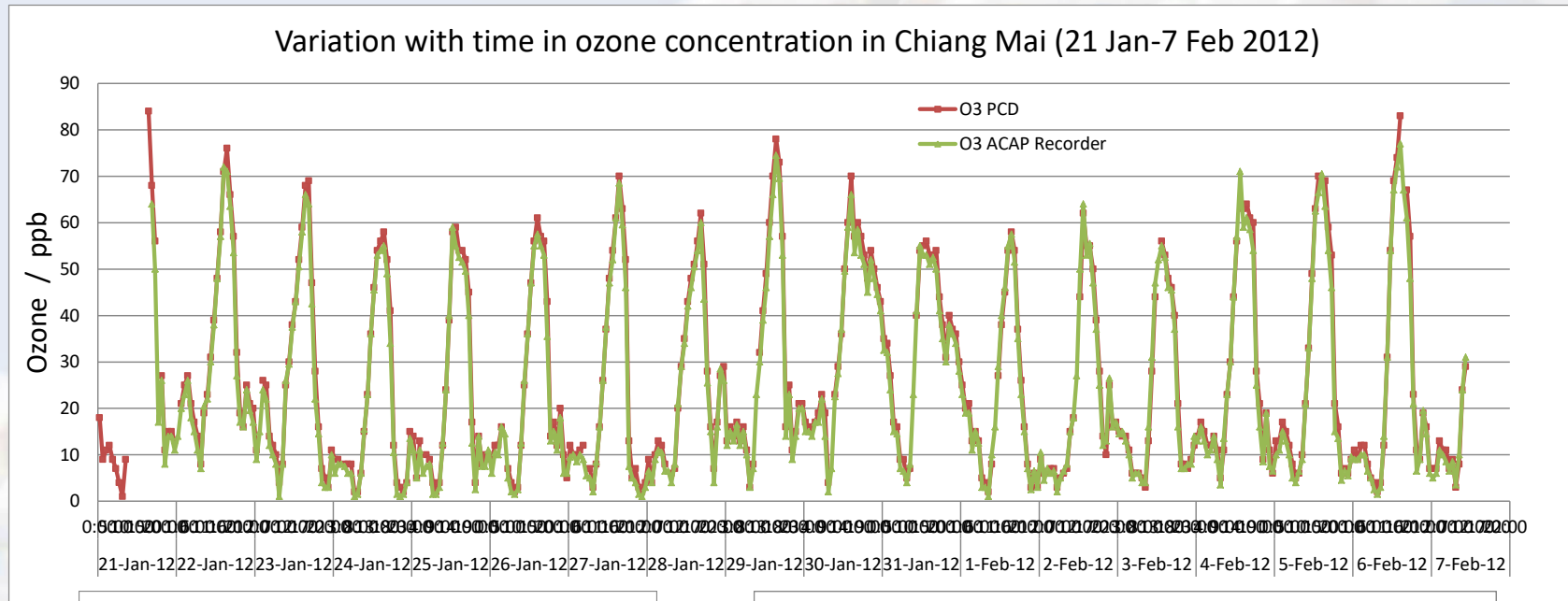
Example: Flow of ozone calibration



**Thermo 49i PS at the site
or 2B technology Model 306**

**UV Ozone Monitor
in the station**

An example of parallel monitoring between ACAP monitor and monitor in the station



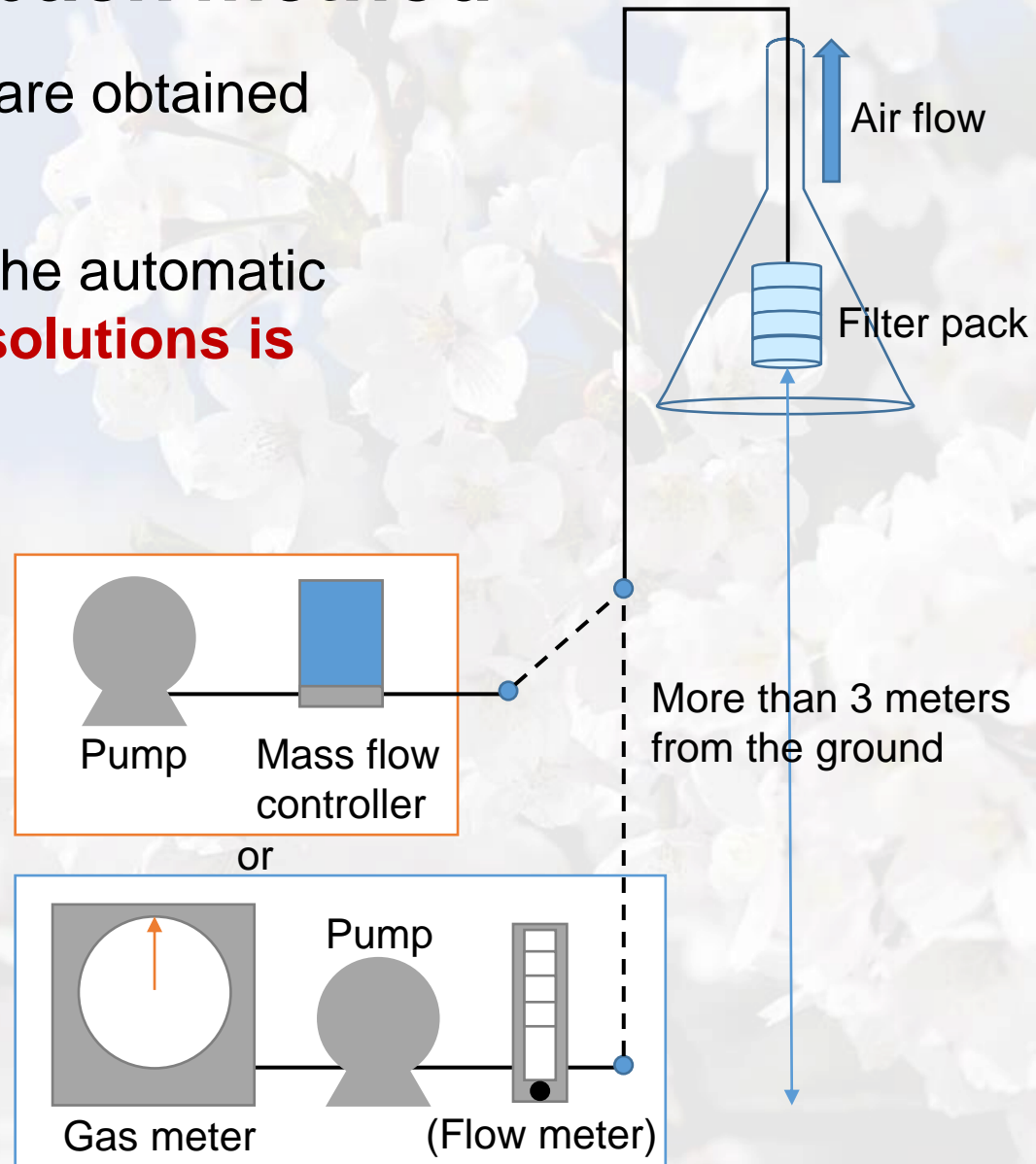
Outline of filter pack method

The gas and particulate are obtained using the filter pack.

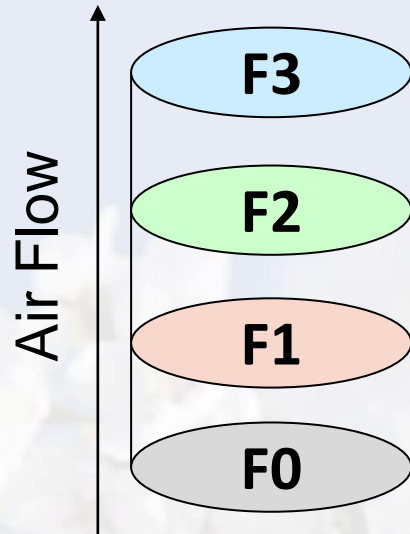
The **cost is lower** than the automatic monitor, but the **time resolutions is lower**.

Filter pack system

- Filter pack holder
- Filters (4 kinds)
- Pump
- Flow meter & Gas meter
or
Mass flow controller



Outline of filter pack method



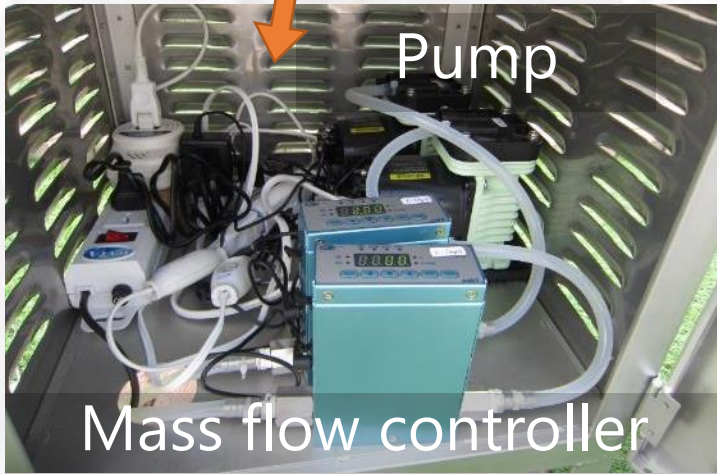
Filter packs are usually exchanged weekly or biweekly.

Filter type	Measured component	Extraction solution
H ₃ PO ₄ impregnated cellulose	NH ₃	Ultra pure water
K ₂ CO ₃ impregnated cellulose	SO ₂ , HCl	0.05% H ₂ O ₂
Nylon	SO ₂ , HNO ₃ , HCl	Ultra pure water
PTFE	Particle (SO ₄ ²⁻ , NO ₃ ⁻ , Cl ⁻ , NH ₄ ⁺ , Na ⁺ , K ⁺ , Mg ²⁺ , Ca ²⁺)	Ultra pure water

(pp.84-91 in Technical Manual)



Filter pack



Pump

Mass flow controller

or

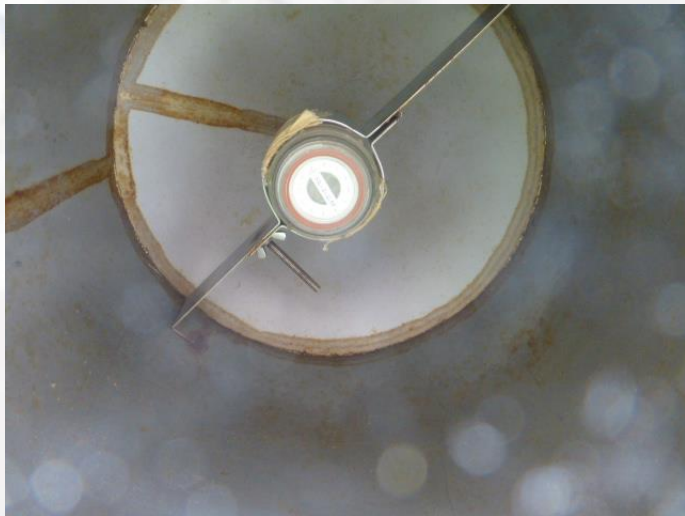


Gas meter

Pump & Flow meter

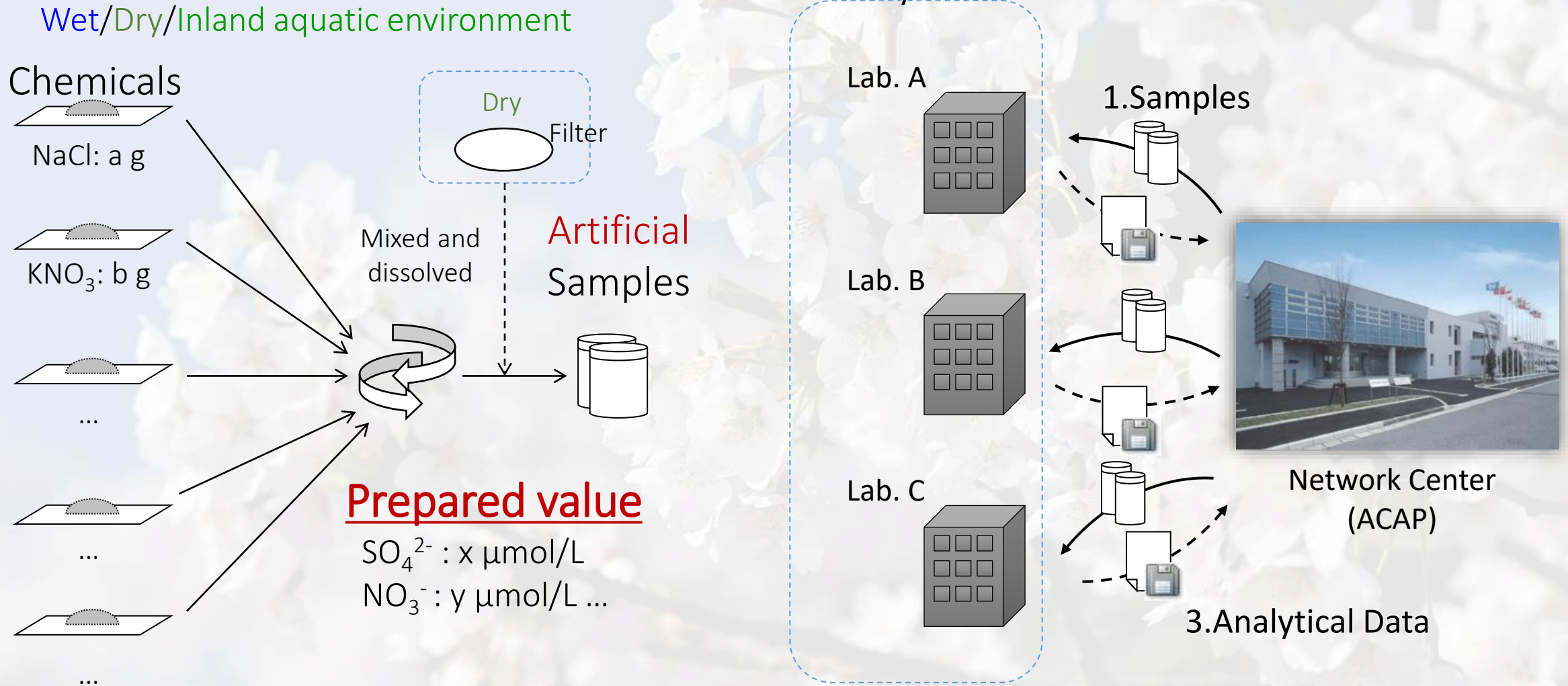
QA/QC activities in site (Filter-pack sampler)

- ✓ Type, manufacturer, model, years in use
- ✓ Condition (Pump, Tube, Filter-holder, Mass flow controller)
- ✓ Flow rate
- ✓ Frequency of maintenance



QA/QC activity of measurement of filter pack sample

Outline of Inter-lab comparison project



Manual method



Passive samplers

Gravimetric method PM_{2.5} -Federal Reference Method (FRM) sampler



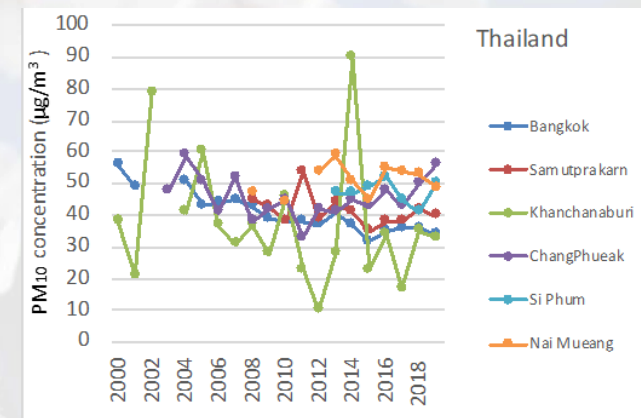
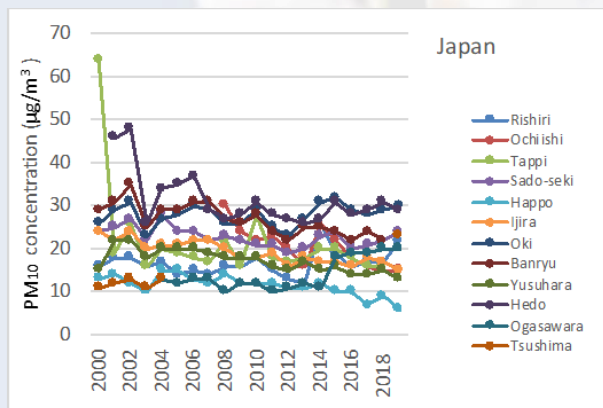
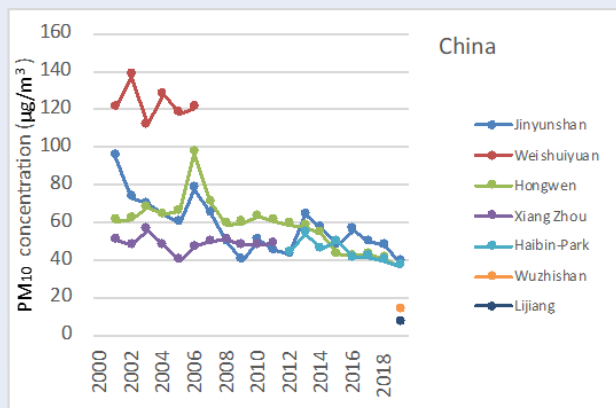
Equivalent test



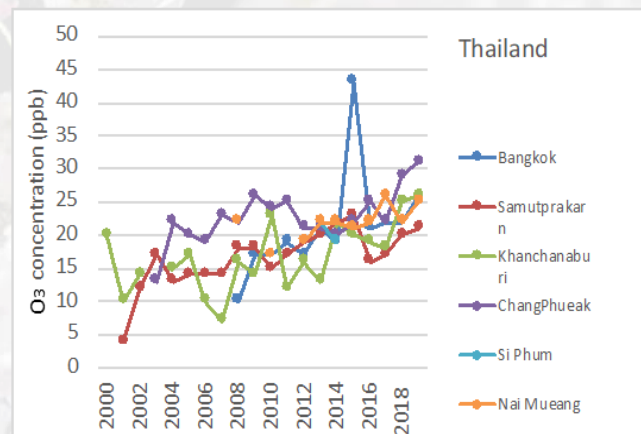
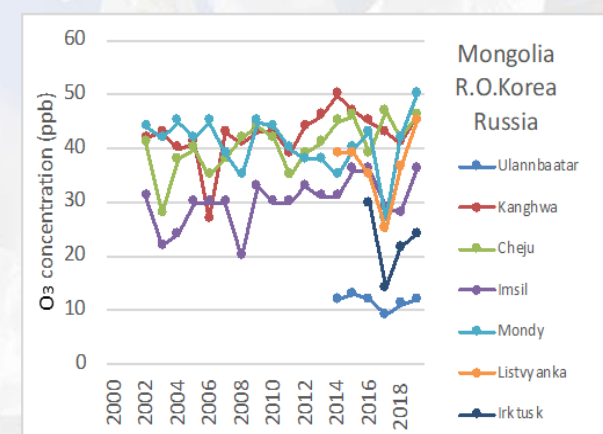
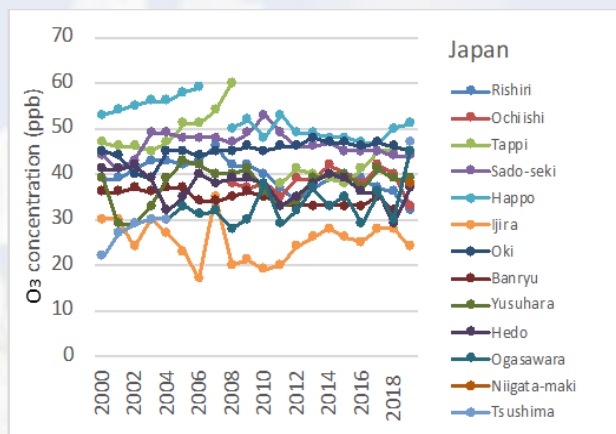
Target Gas	Reagent for filter	Analysis method
SO ₂	10% Triethanolamine(TEA) or K ₂ CO ₃	SO ₄ ²⁻ (IC)
O ₃	NaNO ₂ +K ₂ CO ₃	NO ₃ ⁻ (IC)
NH ₃	Citric Acid	NH ₄ ⁺ (IC) NO ₂ ⁻ (Spectrophotometer)
NO ₂	10% Triethanolamine (TEA)	NO ₂ ⁻ (IC or Spectrophotometer)
NO _x	10% Triethanolamine + PTIO* ¹	NO ₂ ⁻ (IC or Spectrophotometer)

PM₁₀/PM_{2.5} and O₃ concentration at EANET sites 2000-2019

Annual variation of PM₁₀



Annual average concentration of O₃



PRASD4, EANET 2022

- Ulaanbaatar of Mongolia, Jakarta of Indonesia Hoa Binh of Vietnam reported the high PM_{2.5} concentration. Ulaanbaatar also had high PM₁₀.
- The Republic of Korea had the highest nationwide O₃ 5-year average concentration, and Japan reported the next highest nationwide averaged O₃ concentration.

Future Activities

- Monitoring targets and sites are increasing in EANET. Long-term monitoring is important to be conducted at more sites for the assessment of air quality, climate change and other environmental impact.
- Revision of the Technical Manuals of EANET (QA/QC activities of Network Center)
 - 1) Technical Manual for Air Concentration Monitoring in East Asia -2013
 - 2) Technical Manual on Dry Deposition Flux Estimation in East Asia -2010
- Monitoring activities supported by EANET Project Fund
 - 1) Expanding monitoring system using Low-cost sensor
 - 2) The feasibility study for promotion of VOCs related capacity building in EANET



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Thank you very much for your attention



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