Current Activities of World Calibration Center for SF_6

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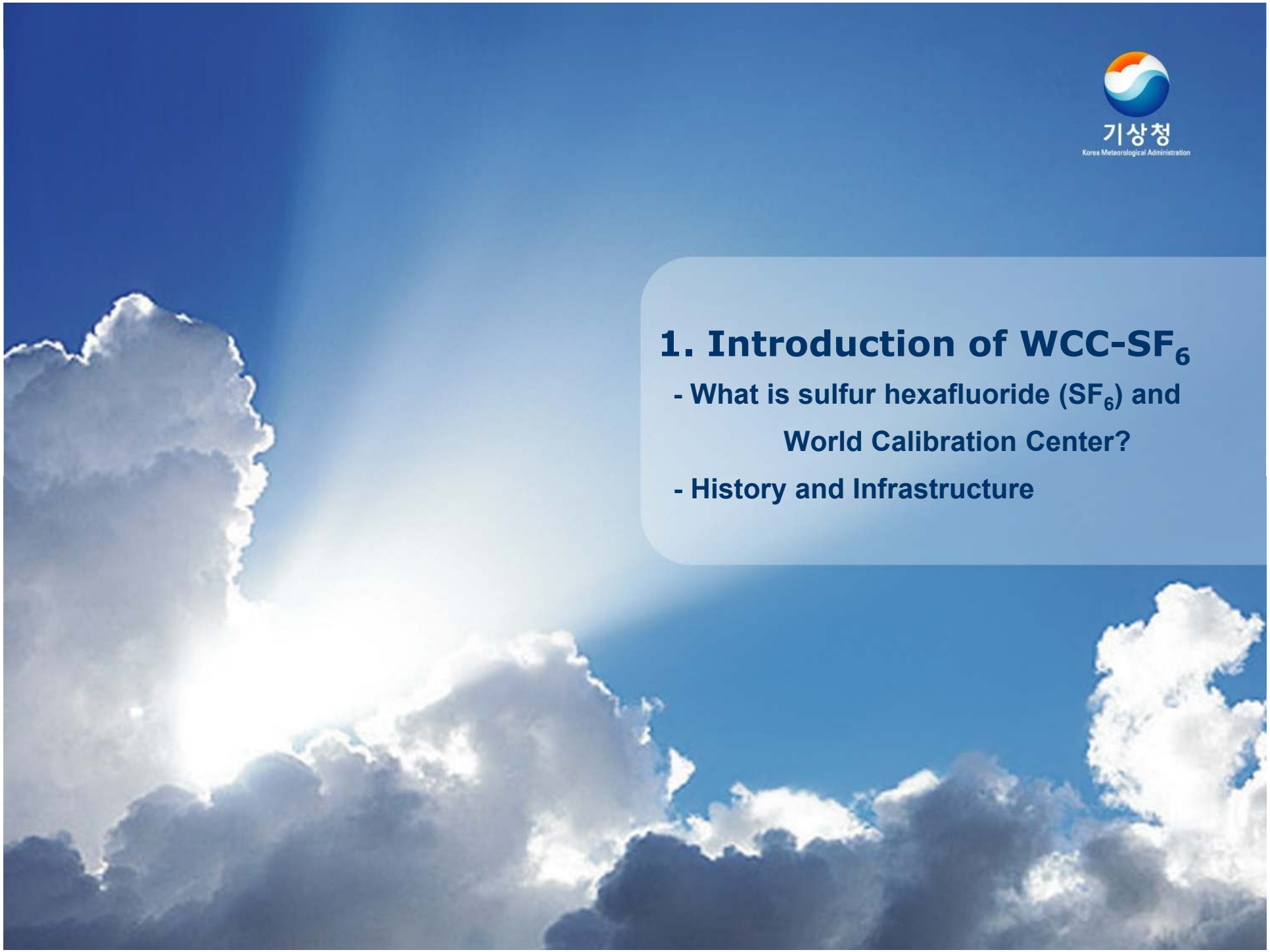
Outline

- **Introduction of WCC-SF_6**
  - What is WCC and sulfur hexafluoride (SF_6)?
  - History and Infrastructures of WCC-SF_6
- **Intercomparison between CCL and WCC-SF_6**
  - Outline of intercomparison
  - Sample Analysis (analysis condition, etc.)
  - Intercomparison Result
- **Future Plans of WCC-SF_6**

Korea Global Atmosphere Watch Center, the regional GAW station in Anmyeon island, Rep. of Korea

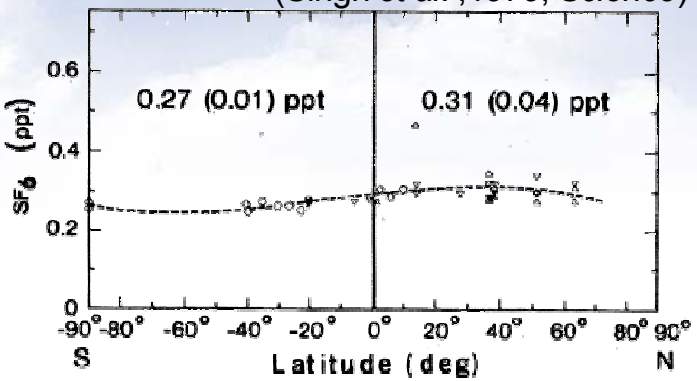


1. Introduction of WCC-SF_6

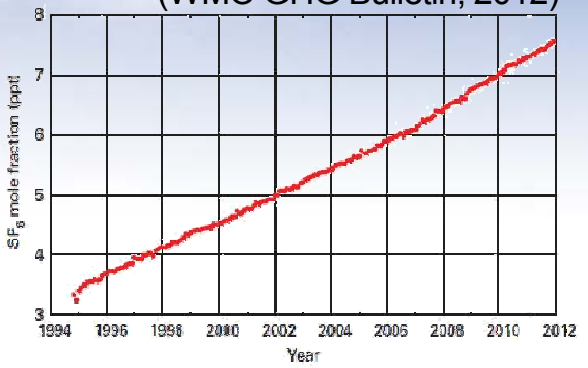
- What is sulfur hexafluoride (SF_6) and World Calibration Center?
- History and Infrastructure

Sulfur Hexafluoride, SF_6

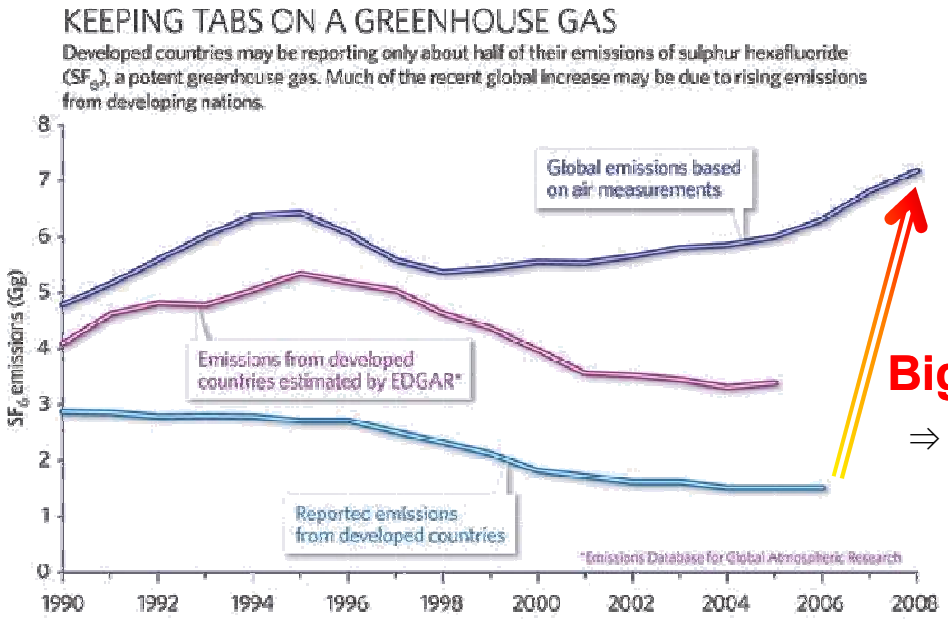
(Singh *et al.* ,1979, *Science*)



(WMO GHG Bulletin, 2012)



0.3 ppt in 1970s → **7.5 ppt in 2011**



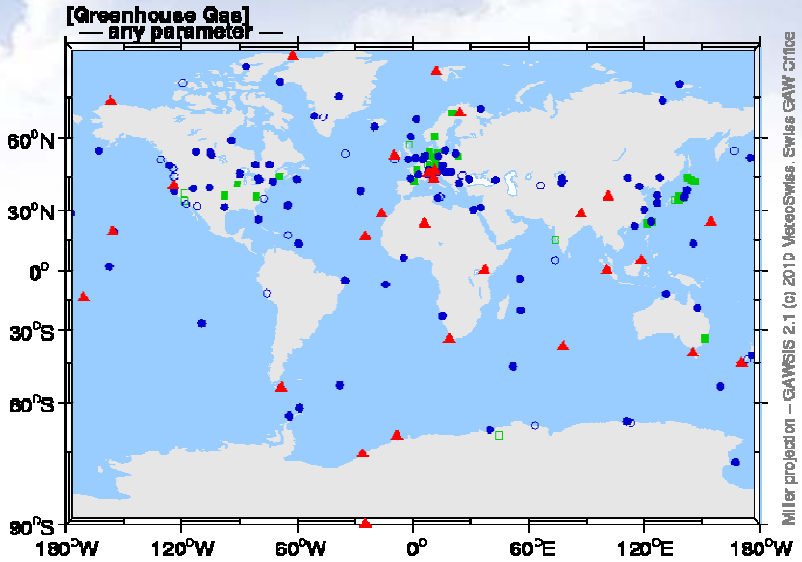
(Levin *et al.*, 2010, *Atmos; Chem. Phys.* & Tollefson, 2010, *Nature*)

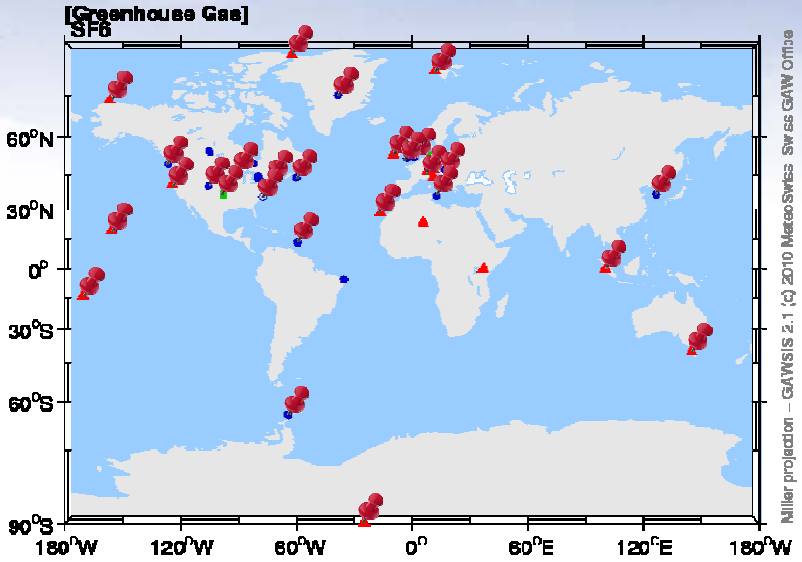
Aluminum industry
Semiconductor manufacturing
Electrical transmission equipment

Big difference of SF_6 emissions

⇒ Observation is important
to verify the global and regional emissions

Observation Stations in WMO/GAW Programme

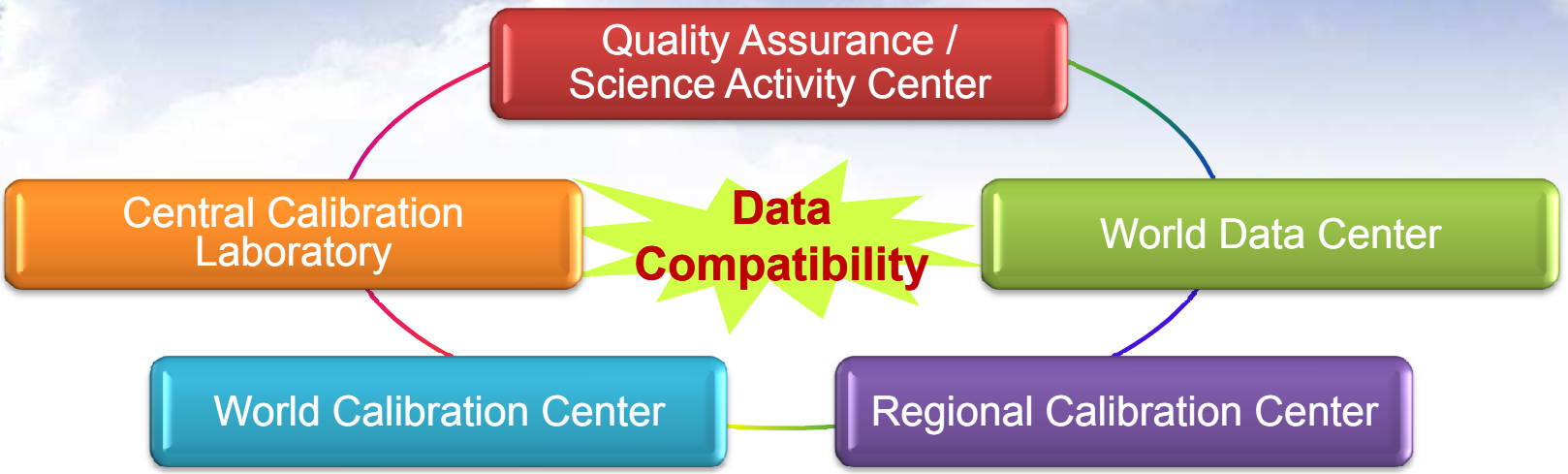




Region / Species	Total	Africa	America	Asia	SW Pacific	Europe	South Pole
Greenhouse Gases	189	13	48	40	16	59	13
SF_6	40	3	16	1	5	12	3

(GAW Station Information System at http://gaw.empa.ch/gawsis/)

WMO/GAW Quality Assurance System

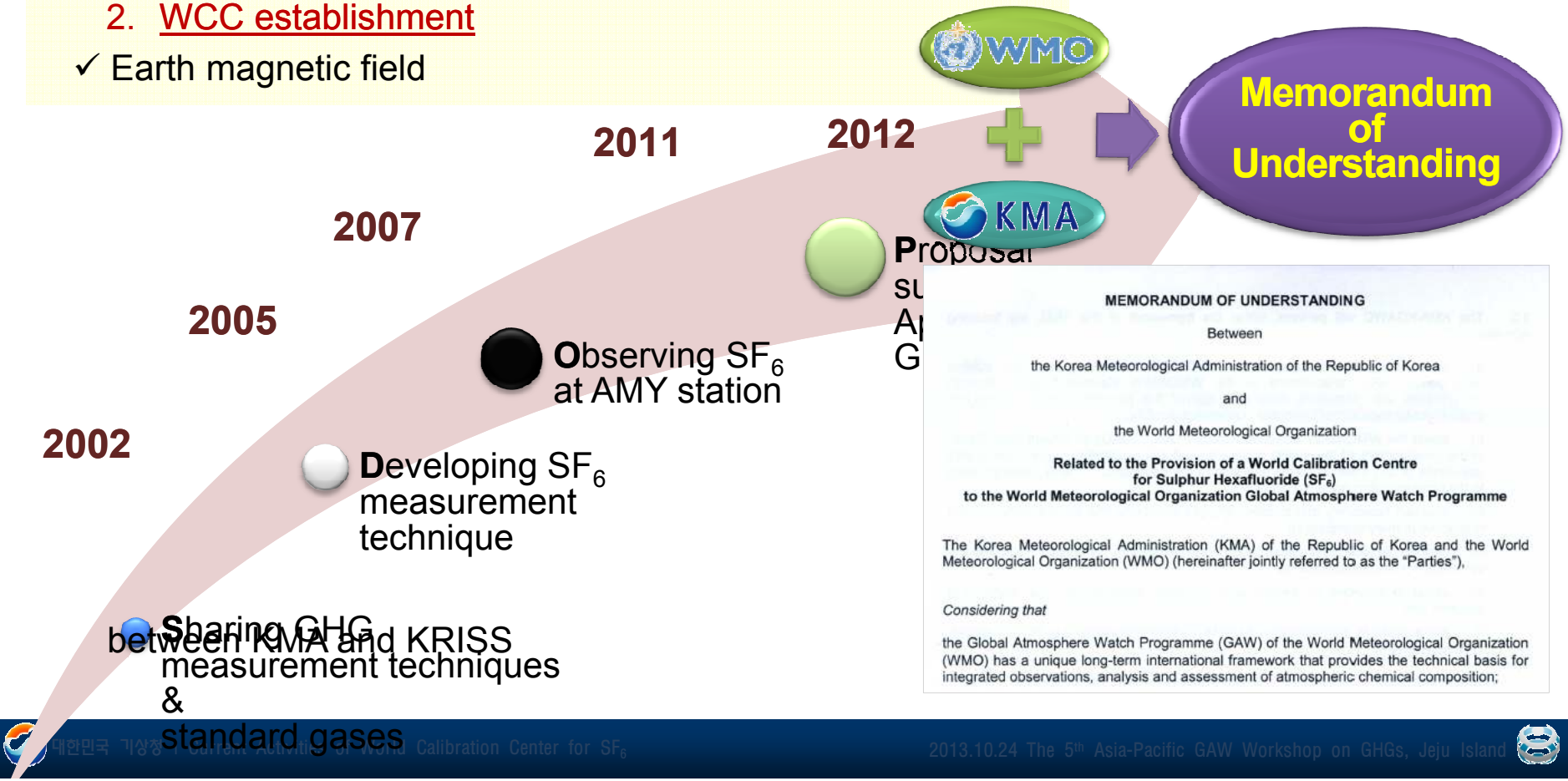


Missions of WCC

- ✓ To develop and publish **quality control procedures** required to support the quality assurance of measurements
- ✓ To prepare and maintain **laboratory standards** which are traceable to the **WMO reference scale**
- ✓ To perform **intercomparison campaigns, system/performance audits**, and provide a training and long-term **technical help** for those who work for WMO/GAW stations

History of WCC-SF_6

- **Agreement with mutual cooperation between KMA and KRISS (2010)**
  - ✓ **Climate change**
    1. Greenhouse gas analysis for aircraft air samples (NIMR)
    2. WCC establishment
  - ✓ Earth magnetic field



MEMORANDUM OF UNDERSTANDING

Between

the Korea Meteorological Administration of the Republic of Korea

and

the World Meteorological Organization

Related to the Provision of a World Calibration Centre for Sulphur Hexafluoride (SF_6) to the World Meteorological Organization Global Atmosphere Watch Programme

The Korea Meteorological Administration (KMA) of the Republic of Korea and the World Meteorological Organization (WMO) (hereinafter jointly referred to as the "Parties"),

Considering that

the Global Atmosphere Watch Programme (GAW) of the World Meteorological Organization (WMO) has a unique long-term international framework that provides the technical basis for integrated observations, analysis and assessment of atmospheric chemical composition;

Infrastructure

Cylinder and evacuation system

Cylinders

Evacuation system

Analysis system and standard gases

Analysis system(GC/ECD)

Standards (NOAA-2006)

Preparation of compressed dry air

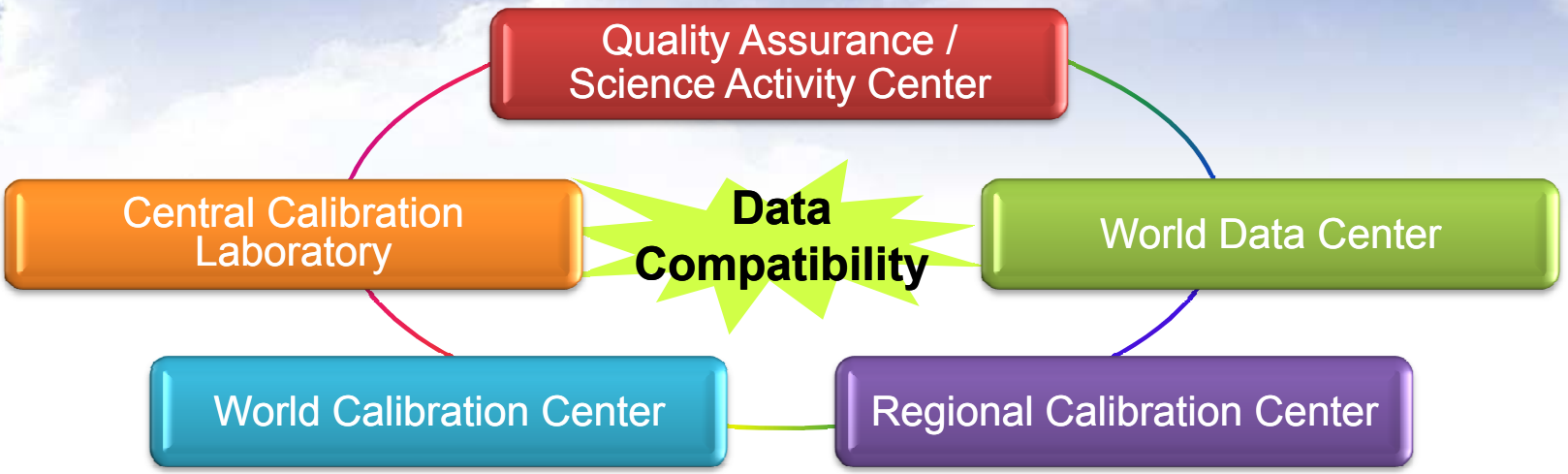
Sampling tower

Air compressor

Sampling system

Mixing system

WMO/GAW Quality Assurance System



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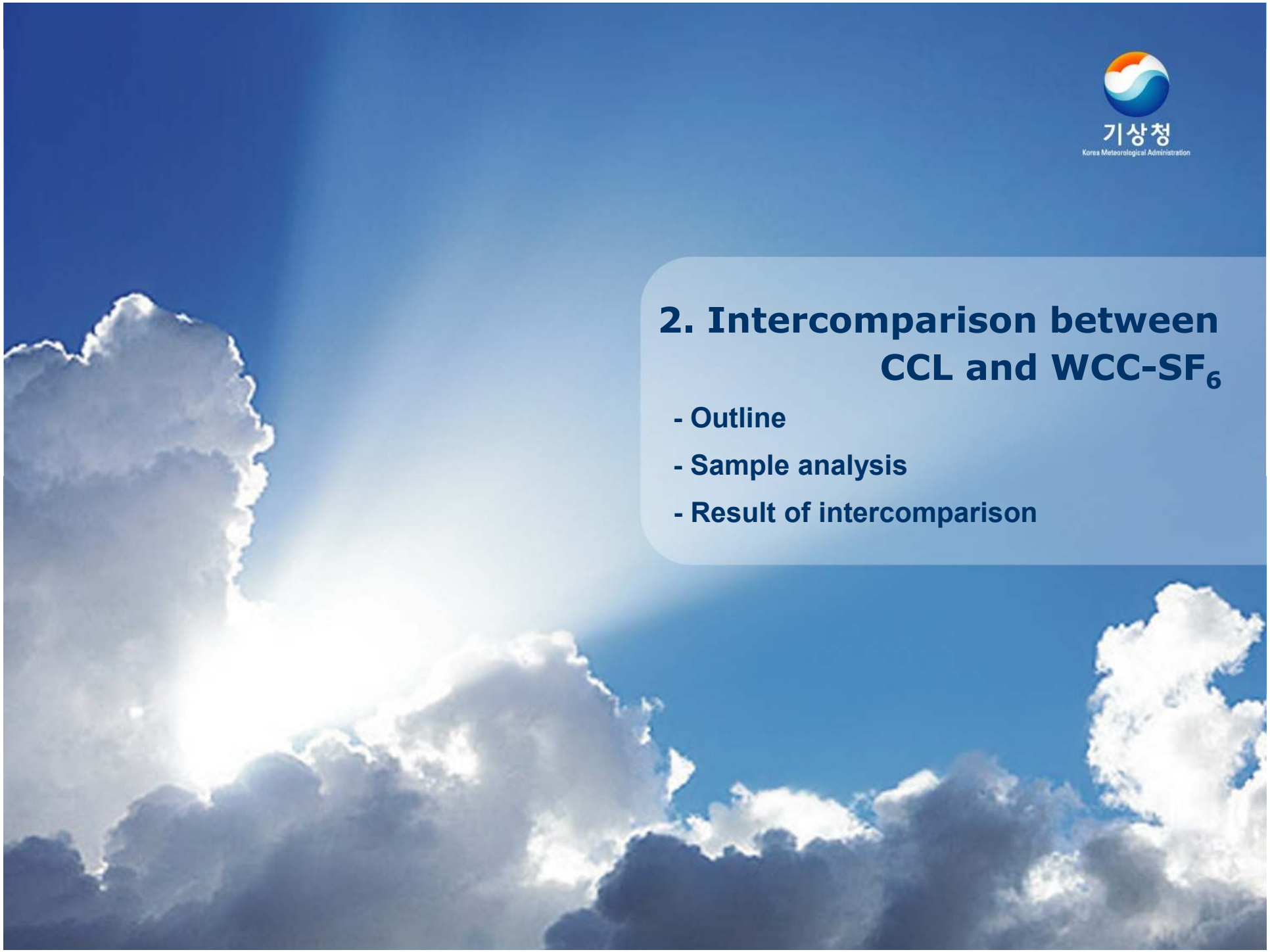


2. Intercomparison between CCL and WCC-SF_6

- Outline
- Sample analysis
- Result of intercomparison

Outline of Intercomparison

➢ Schedule

- ✓ Suggestion of comparison by CCL: 28 Nov., 2012
- ✓ Sending samples to WCC: Last week of Jan., 2013
- ✓ Arrival of samples at WCC: 5 Feb., 2013
- ✓ Sample analysis by WCC: 6~27 Feb., 2013
- ✓ Submission of result to CCL: 15 Mar., 2013
- ✓ Sending back sample to CCL: 9 May, 2013

FB03560 & FB03054

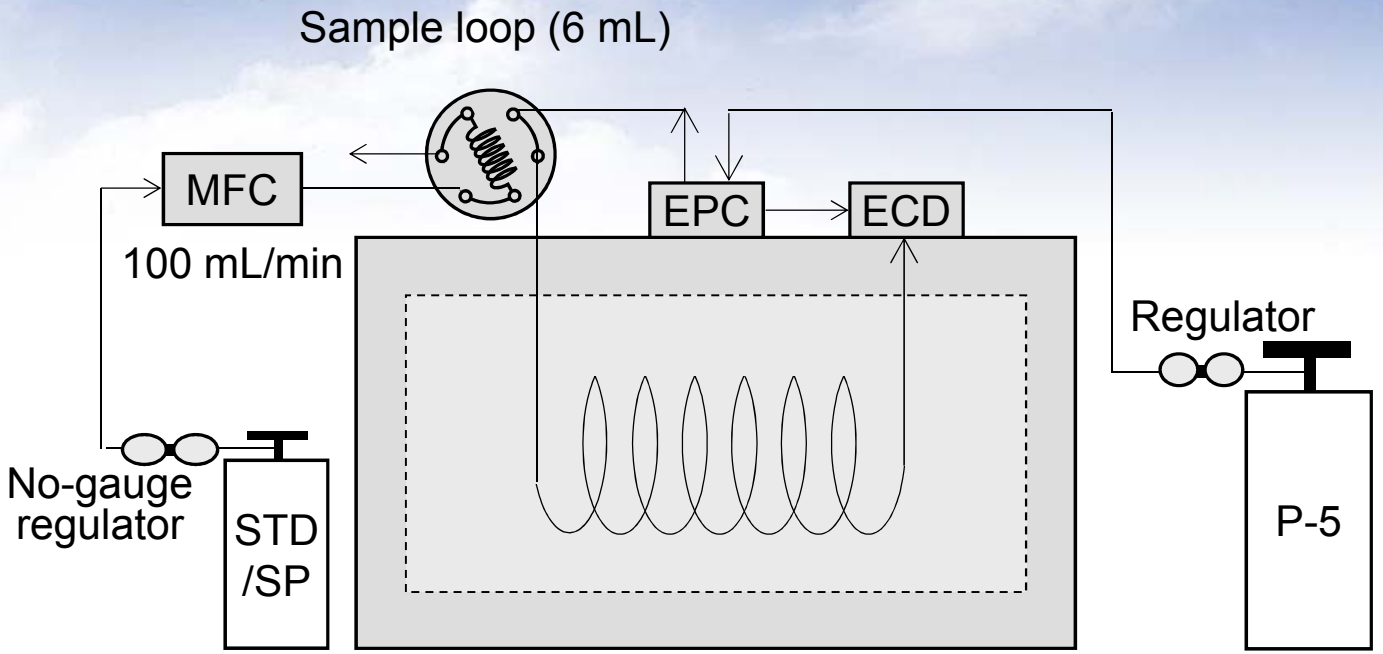
➢ Reference Gases

- ✓ Traceable to the WMO mole fraction scale (NOAA-2006)

Cylinder Number	FB03443	FB03444	FB03447	FB03450
SF_6 Conc. (ppt)	5.920	7.972	9.595	11.887
SD (ppt)	0.017	0.023	0.018	0.020

SF_6 standard gases

Schematic Diagram of Analysis System



GC/Electron Capture Detector
(7890A/G3440A, Agilent, USA)

➢ Analysis Condition

- ✓ Oven temp.: 50 ℃ (or 60 ℃), isothermal
- ✓ Column: Activated Alumina F-1 (80/100),
  4 m length, 1/8” OD (Restek, USA)
- ✓ Carrier gas: 20 mL/min of P-5 (CH_4 5 % in Ar)
  with makeup 30 mL/min
- ✓ GC injection method: 6-port gas sampling valve

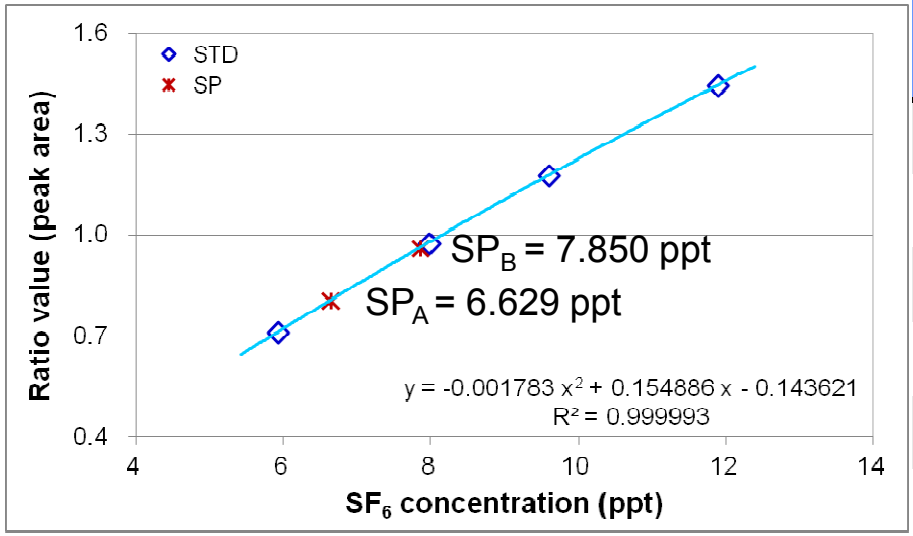
Measurement Result (4-point calibration)

A → B → A' method

* Ratio value of SP(or STD) = 2*B / (A+A')

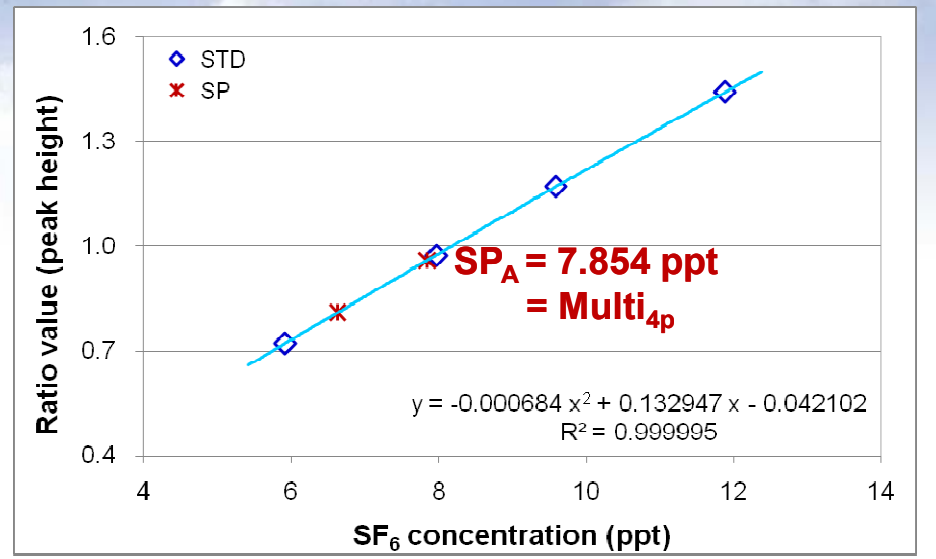
Cylinder	WS	SP_A	WS	$STD_{8\ ppt}$	WS	SP_B	WS
Peak area	160.57	128.66	159.17	156.04	160.32	154.54	160.84
Ratio value		0.8048		0.9768		0.9624	

Cylinder	$STD_{6\ ppt}$	WS	$STD_{10\ ppt}$	WS	WS	$STD_{12\ ppt}$	WS
Peak area	113.92	159.58	187.94	159.18	159.28	230.43	159.58
Ratio value	0.7111		1.1793			1.4453	



Cylinder	SF_6 (ppt)	Ratio value	Cal. SF_6 (ppt)	Difference (Cal-Ref)
FB03443	5.920	0.7111	5.922	0.002
FB03444	7.972	0.9768	7.964	-0.008
FB03447	9.595	1.1793	9.603	0.008
FB03450	11.887	1.4453	11.885	-0.002
FB03054	6.629	0.8048	/	/
FA03560	7.850	0.9624	/	/

Selection of Calibration Method



1-point Calibration

Standard gas	6 ppt	8 ppt	10 ppt	12 ppt
Cal. SF_6 (ppt)	7.879	7.861	7.863	7.916
Difference (single-$multi_{4p}$)	0.025	0.007	0.009	0.062

2-point Calibration

Standard gases	6 ppt, 8 ppt	8 ppt, 10 ppt	6 ppt, 10 ppt	6 ppt, 12 ppt
Cal. SF_6 (ppt)	7.861	7.860	8.869	7.898
Difference ($multi_{2p}$-$multi_{4p}$)	0.007	0.006	0.015	0.044

3-point Calibration

Standard gases	6 ppt, 8 ppt, 10 ppt	8 ppt, 10 ppt, 12 ppt
Cal. SF_6 (ppt)	7.861	7.862
Difference ($multi_{3p}$-$multi_{4p}$)	0.007	0.008

Intercomparison Result

Multi-point calibration (4 standard gases ranged 6~12 ppt)

(unit: ppt)

# of meas. / Sample	1	2	3	4	5	SF_6 from WCC [SD]	SF_6 from CCL [SD]	Difference (WCC-CCL)
FB03054	6.651	6.649	6.629	6.636	6.612	6.635 [0.016]	6.633 [0.012]	**+0.002**
FB03560	7.841	7.833	7.851	7.828	7.901	7.851 [0.029]	7.885 [0.019]	**-0.034**

WMO recommended measurement target for SF_6: 0.02 ppt

Two-point calibration (6, 8 ppt)

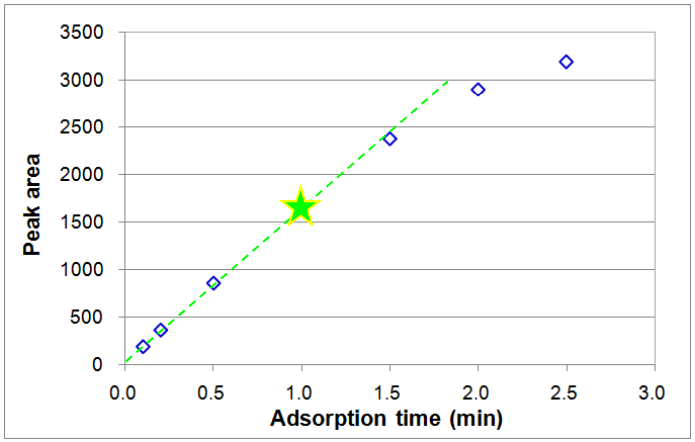
(unit: ppt)

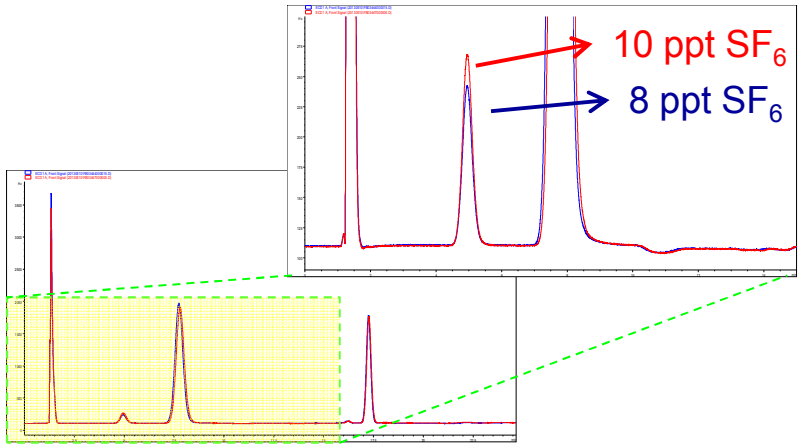
# of meas.	1	2	3	4	5	SF_6	SD
Working Standard	8.169	8.212	8.148	8.224	8.165	8.179	0.033

Pre-concentration System

➢ Analysis Condition

- ✓ Adsorption/Heating temp.: -40 ℃ / 200 ℃
- ✓ Adsorbent: 100 mg of HayeSep D (80/100, Hayes Separation Corp.)
- ✓ Sample/Standard gas flow: 50 mL/min
- ✓ Adsorption time: 1 minutes





GC without this system

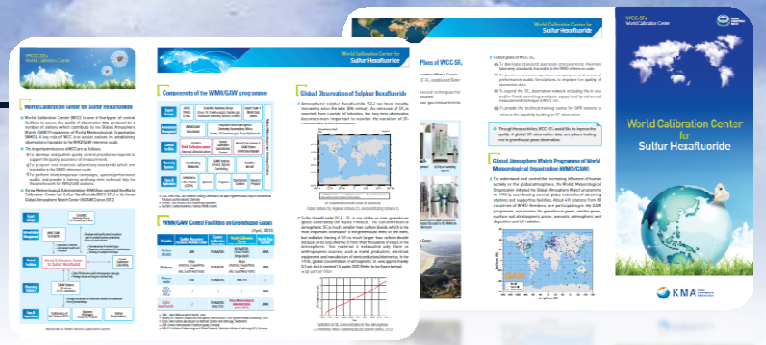
GC with this system

(unit: ppt)

# of meas.	1	2	3	4	SF_6	SD
WS	8.374	8.388	8.323	8.354	8.339	0.022

3. Future plans of WCC-SF_6

Challenges of SF_6



Future Plans

- ✓ To prepare standard operation procedures to maintain laboratory standard gases traceable to the WMO reference scale
- ✓ To develop the measurement guideline for SF_6 observation in cooperation with KRISS
- ✓ To provide the technical training course for GAW stations to enhance their capability building for SF_6 observation
- ✓ To conduct intercomparison campaigns and system/performance audits for stations to improve the quality of observation data
- ✓ To expand the SF_6 observation network including the *in-situ* and/or flask sampling analysis supported by several funding sources

World Meteorological Organization
Weather · Climate · Water

GLOBAL ATMOSPHERE WATCH

Korea Meteorological Administration

Thank you for your attention!