Quality Assurance in the Global Atmosphere Watch (GAW)

Oksana Tarasova

Scientific Officer

WMO Atmospheric Environment Research Department

OTarasova@wmo.int

The rationale for Global Atmosphere Watch (GAW) is driven by the need :

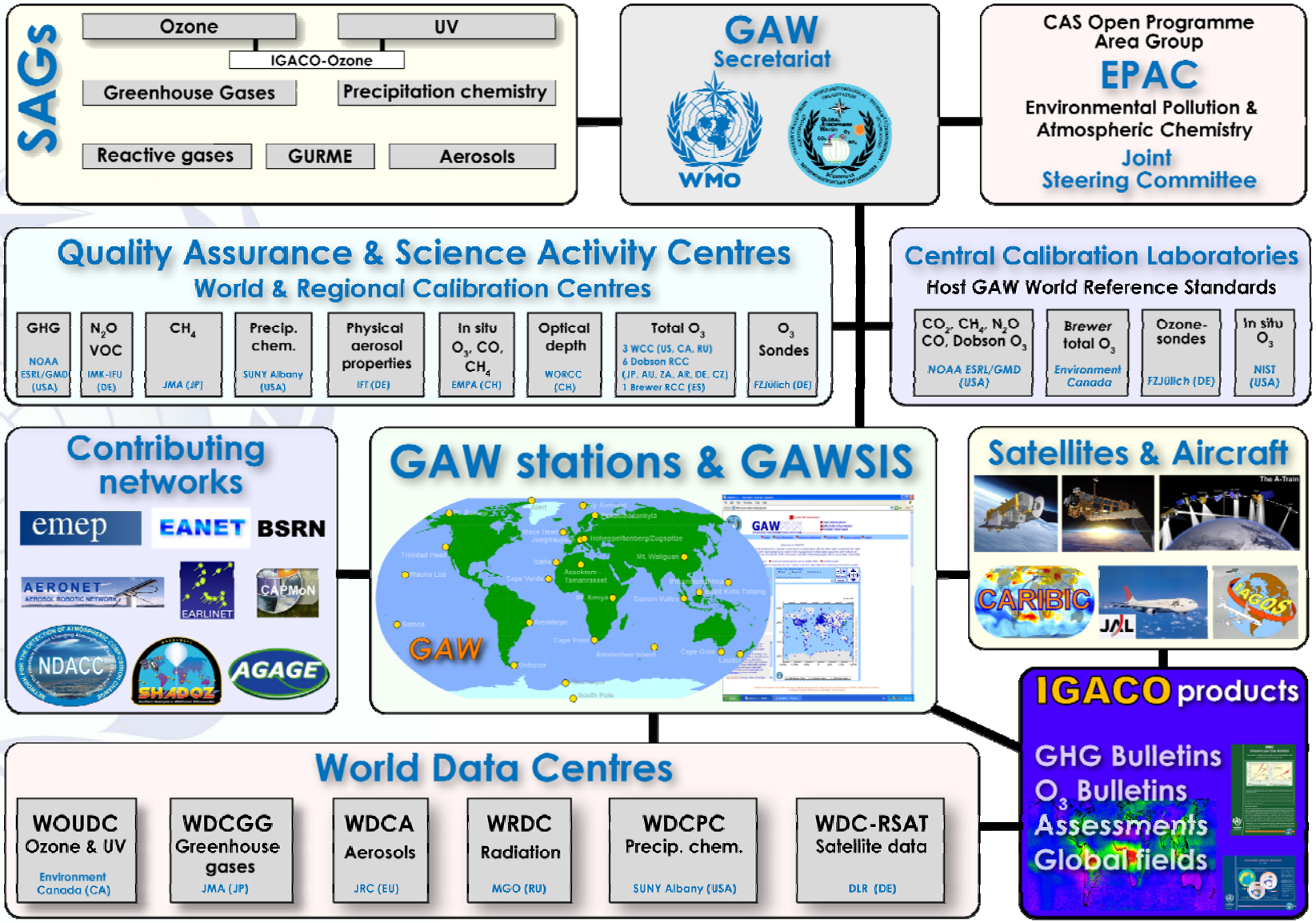
- to understand the complex mechanisms with respect to natural and anthropogenic atmospheric change;
- improve the understanding of interactions between the atmosphere, ocean and biosphere;
- provide **reliable** scientific data and information for national and international policy makers.

GAW Strategy in achieving the goals in presented in the GAW Strategic Plan : 2008-2015

What is GAW?

- WMO/GAW was established 1989 by merging GO_3OS and BAPMoN.
- GAW focuses on global networks for **GHGs, ozone, UV, aerosols, selected reactive gases, and precipitation chemistry**.
- GAW is a partnership involving contributors from 80 countries.
- GAW is coordinated by the Environment Division of WMO/AREP under the purview of WMO Commission for Atmospheric Science (CAS)
- Currently GAW coordinates activities and data from 26 Global stations, 410 Regional stations, and 81 Contributing stations (http://gaw.empa.ch/gawsis/)

How does GAW work?



Quality assurance

The GAW quality assurance (QA) system impacts all aspects of atmospheric chemistry observations, including

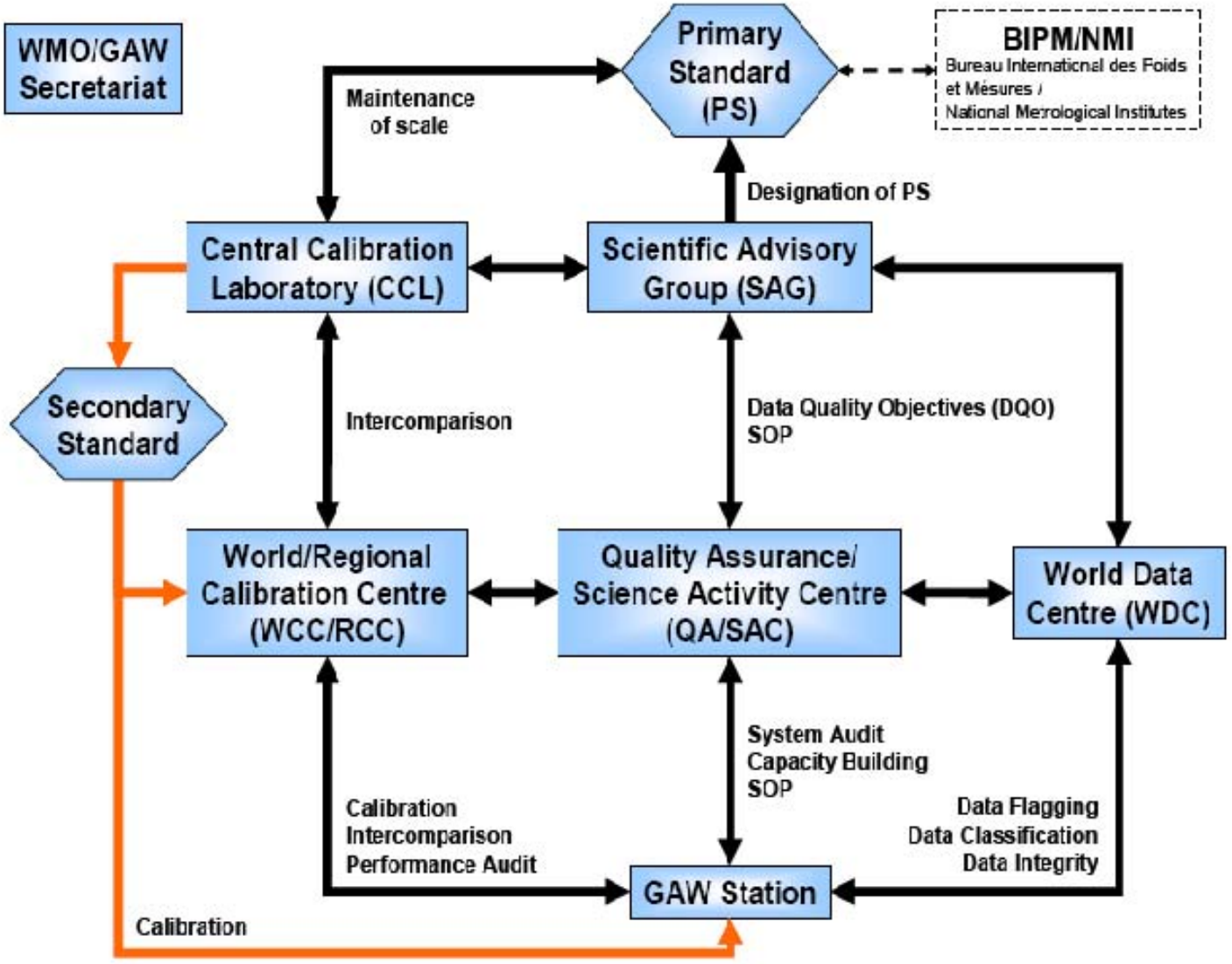
- training of station personnel;
- assessment of infrastructures, operations and the quality of observations at the sites;
- documentation of data submitted to the WDCs;
- improvement of the quality and documentation of legacy data at the WDCs.

The *primary objectives* of the GAW QA system are to ensure that the data in the WDCs are **consistent, of known and adequate quality**, supported by comprehensive metadata, and sufficiently complete to describe global atmospheric states with respect to spatial and temporal distribution.

The *principles* of the GAW QA system

- ✓ Full support of the GCOS Climate Monitoring Principles
- ✓ Network-wide use of only one reference standard or scale (primary standard). In consequence, there is only one institution that is responsible for this standard.
- ✓ Full traceability to the primary standard of all measurements made by Global, Regional and Contributing GAW stations.
- ✓ The definition of data quality objectives (DQOs).
- ✓ Establishment of guidelines on how to meet these quality targets, i.e., harmonized measurement techniques based on Measurement Guidelines (MGs) and Standard Operating Procedures (SOPs).
- ✓ Establishment of MGs or SOPs for these measurements.
- ✓ Use of detailed log books for each parameter containing comprehensive meta information related to the measurements, maintenance, and 'internal' calibrations.
- ✓ Regular independent assessments (system and performance audits).
- ✓ Timely submission of data and associated metadata to the responsible World Data Centre as a means of permitting independent review of data by a wider community.

Conceptual framework of the GAW quality system



GAW World Central Facilities (as of May 2007).

Variable	QA/SAC	Central Calibration Laboratory (CCL) Host of Primary Standard	World Calibration Centre (WCC)	Regional Calibration Centre (RCC)	World Data Centre (WDC)
CO_2	JMA (A/O)	ESRL	ESRL		JMA
CH_4	Empa (Am, E/A) JMA (A/O)	ESRL	Empa (Am, E/A) JMA (A/O)		JMA
N_2O	UBA	ESRL	IMK-IFU		JMA
CFCs, HCFCs, HFCs					JMA
Total Ozone	JMA (A/O)	ESRL[1], Environment Canada[2]	ESRL[1], Environment Canada[2]	BoM[1], ESRL[1], IZO[2] JMA[1], MOHp[1], MGO[3], OCBA[1], SAWS[1], SOO-HK[1]	Environment Canada[5], DLR[6]
Ozone Sondes	FZ-Jülich	FZ-Jülich	FZ-Jülich		Environment Canada
Surface Ozone	Empa	NIST	Empa	OCBA, SOO-HK	JMA
Precipitation Chemistry	ASRC-SUNY	ISWS	ASRC-SUNY		ASRC-SUNY
CO	Empa	ESRL	Empa		JMA
VOC	UBA		IMK-IFU		JMA
SO_2					JMA
NO_x					JMA
Aerosol			IfT (Physical Properties)		JRC[5], DLR[6]
Optical Depth		PMOD/WRC[4]	PMOD/WRC		JRC
UV Radiation				ESRL (Am)	Environment Canada
Solar Radiation		PMOD/WRC	PMOD/WRC		MGO

Conceptual framework of the GAW quality system

WMO/GAW Secretariat

GAW Secretariat

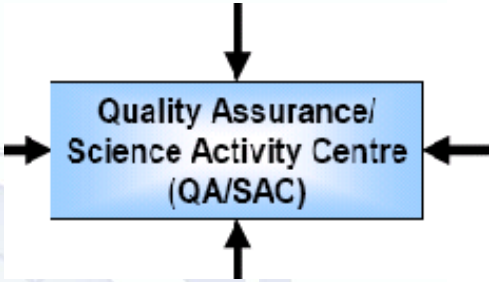
- ✓ Implement the recommendations of the JSSC OPAG-EPAC.
- ✓ Establish clear responsibility and accountability for managing key activities.
- ✓ Oversee and document the work of the SAGs and other GAW Central Facilities.
- ✓ Ensure that the information flow within GAW is timely, sufficiently accurate and reliable.

Conceptual framework of the GAW quality system

Scientific Advisory Groups

- ✓ Establish DQOs for each assigned parameter.
- ✓ Develop and approve Measurement Guidelines and SOPs.
- ✓ Provide guidelines and recommendations for achieving the DQOs and implementing the SOPs.
- ✓ Develop and approve methods to trace observations to the WMO primary standard.
- ✓ Promote training and twinning in developing countries.
- ✓ Critically review GAW services and products.

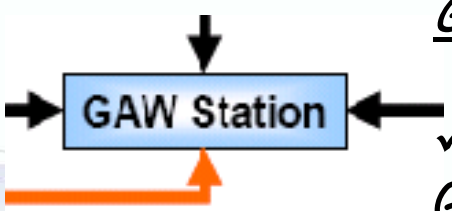
Conceptual framework of the GAW quality system



Quality Assurance/Science Activity Centers

Follow the SAGs' guidelines and recommendations and assist the SAGs' in establishing Measurement Guidelines and SOPs.

Conceptual framework of the GAW quality system



GAW Stations

✓ Adopt and follow the GAW Measurement Guidelines and SOPs and identify the need for such documents where these are missing.

✓ Establish quality control procedures by following the guidelines of the responsible QA/SAC and WCC.

✓ Practice quality control of all parameters and identify questionable data residing at WDCs.

✓ Submit data in a timely manner and no later than one year after data collection to the responsible WDC so as to allow further analysis and comparison with other stations.

Goals of QA development (1)

- ✓ Define a quality management system for GAW to meet the requirements of the WMO Quality Management Framework and to consider the development of joint ISO/WMO technical standards.
- ✓ Complete the GAW organizational structure (i.e., SAGs, Central Facilities) and harmonise the GAW QA procedures across parameters and station types.
- ✓ Increase the frequency of instrument calibrations and inter-comparisons at Global stations and explore other means of ensuring the traceability to the WMO primary standard of measurements made at Regional and Contributing stations.

Goals of QA development (2)

- ✓ Build alliances between and among Global and Regional stations (scientific and technical co-operation, twinning), and twinning between individuals (scientists, station personnel).
- ✓ Develop and implement methods for ensuring the traceability of remote sensing equipment, both ground- and satellite-based, to the WMO primary standard.
- ✓ Continue to improve the quality and interoperability of data sets residing at the GAW World Data Centers.
- ✓ Define and harmonize the core and extended metadata set for GAW observations.

Does it "fit" to QA4EO concept ?

GEOSS: seamless & continuous delivery of information products to meet needs of societal themes

All data (independently of the source) has to be traceable to WMO standard

Interoperability arrangements to allow combination of disparate sources of data

Data policy

Accessibility

Availability

Strategy:
Establish set of guidelines based on"best practises" to be endorsed by QA4EO, under auspices of GEO and implemented by the agencies

Suitability

Reliability

Fit for purpose

Serves to Environmental Conventions

Free access to the data in the WDCs

All data products must have associated with them a Quality Indicator based on a documented quantitative assessment of its traceabilty to an agreed reference standard (ideally tied to SI).

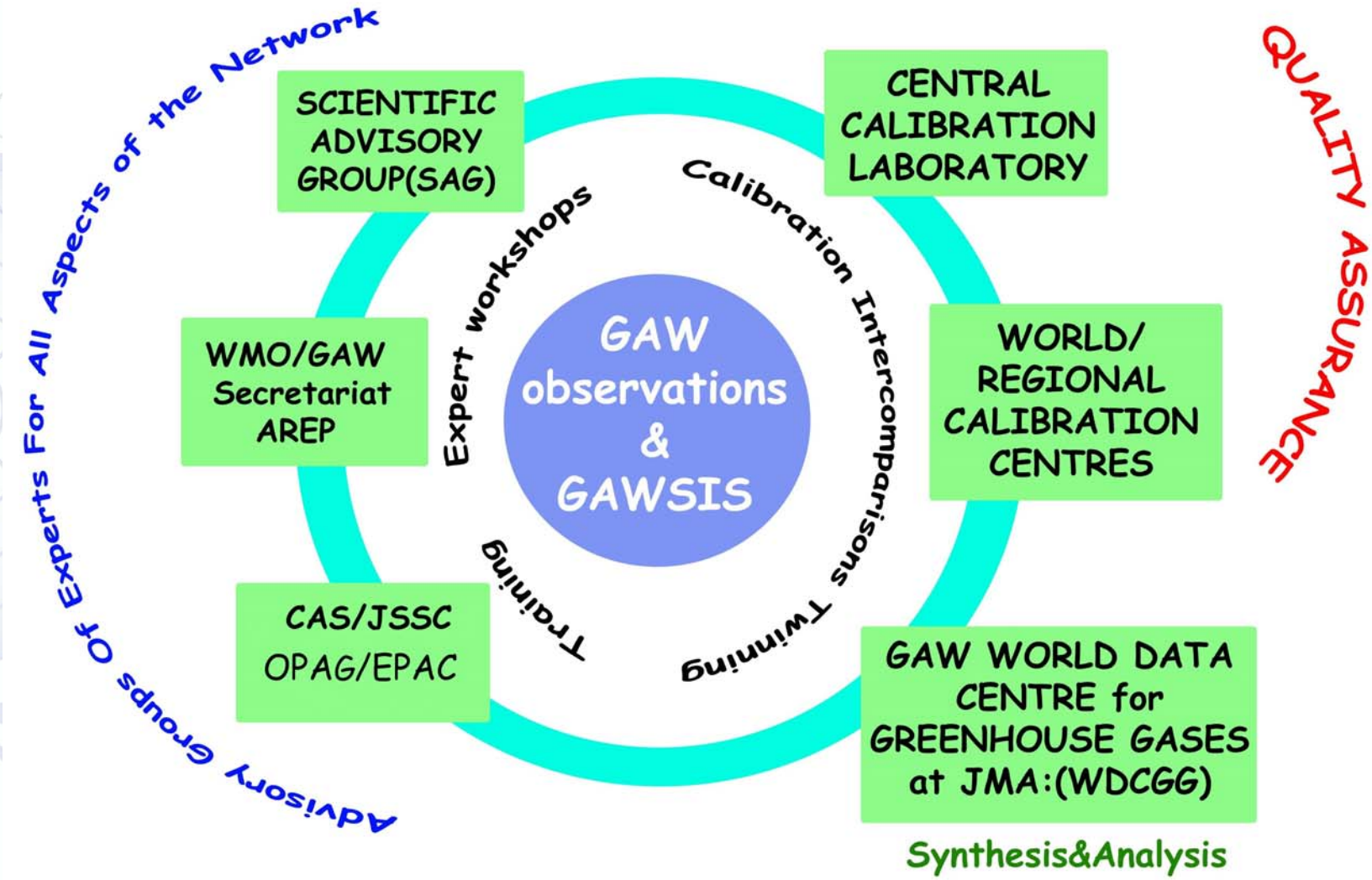
Comparisons

Procedures

Reference standards (with method of use): Including designation of "test sites"

CCLs are established for most parameters

GAW Global CO_2 & CH_4 Monitoring Network Components



Primary Standards

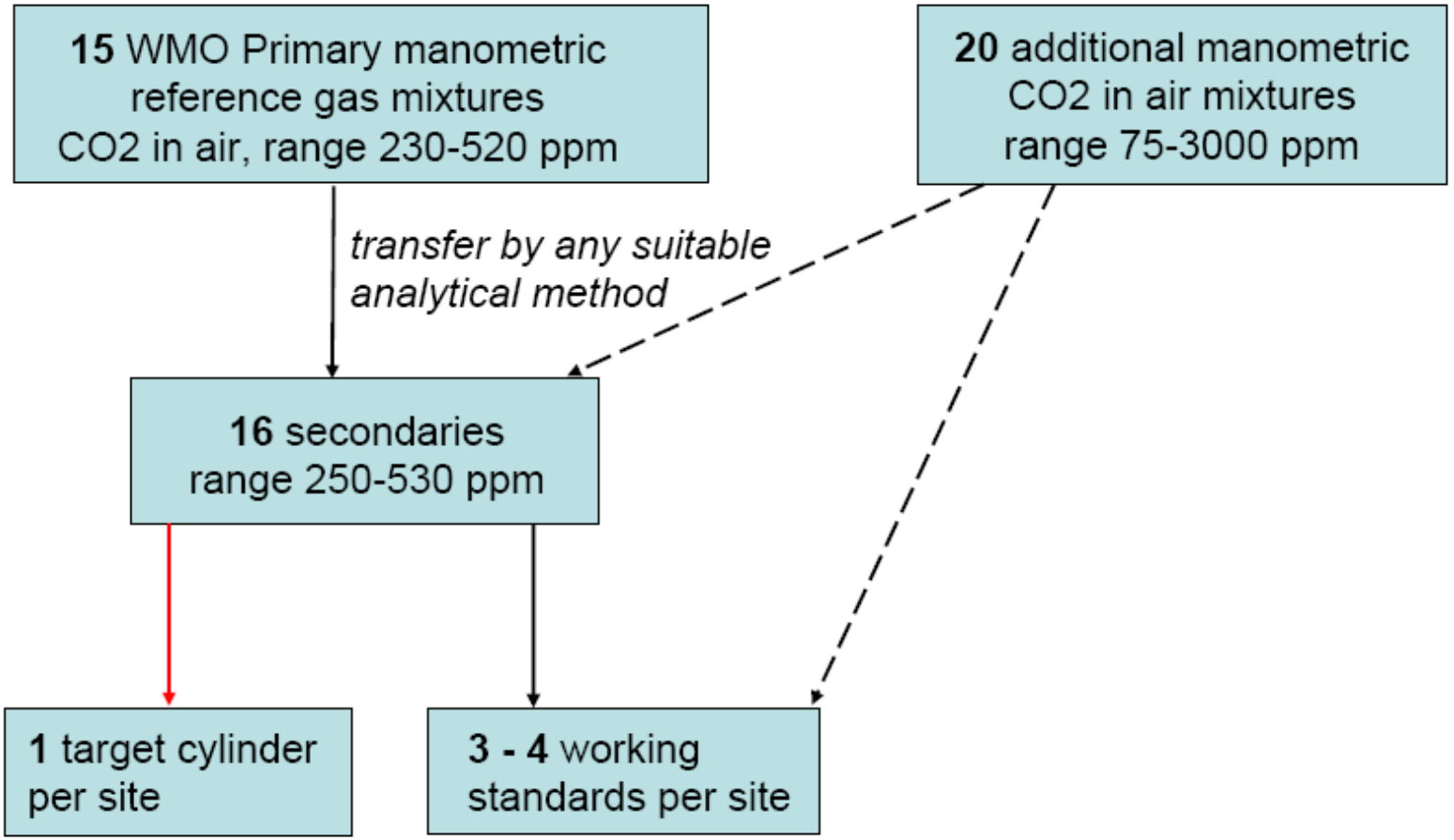
Central Calibration Laboratories

Hosts of WMO World Reference Standards for long-lived GHG

- CO_2, CH_4, N_2O

NOAA ESRL USA

Propagation of WMO Mole Fraction Scale for CO_2



Propagation of WMO Mole Fraction Scale for CO_2

Standard deviation of individual cylinder manometric calibrations during each calibration episode.

	N	St.Dev. (all) ppm	St.Dev. (one sigma) (300-420) ppm
1996	64	0.12	0.09
1998	58	0.14	0.13
2000	55	0.11	0.10
2001	62	0.09	0.08
2003	62	0.06	0.06
2004	48	0.04	0.04
2006	41	0.03	0.03

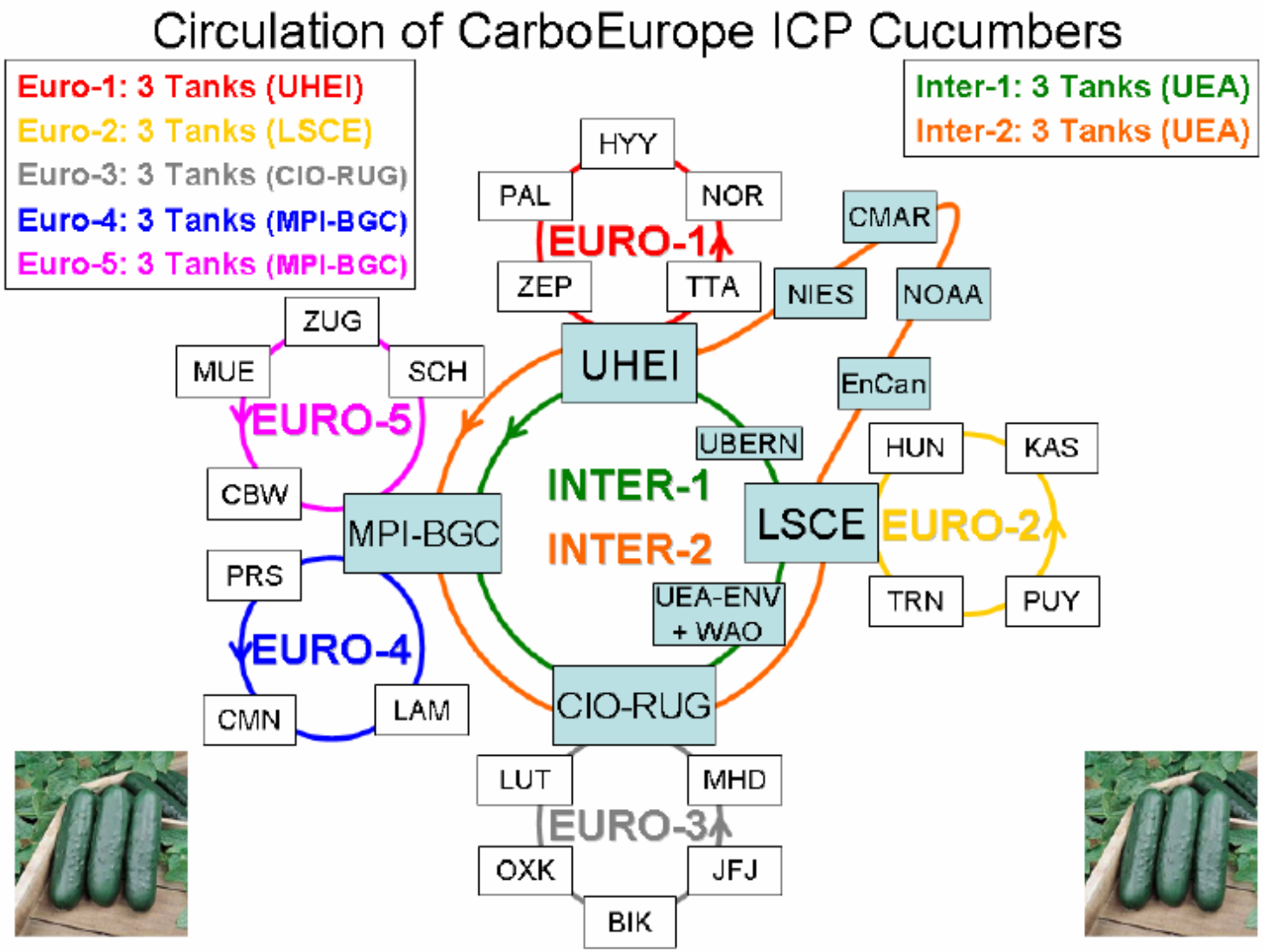
Quality Assurance I

World or Regional Calibration Centres

Linking Observations to World Reference Standards and Ensuring Network Comparability through intercomparison campaigns and regular audit

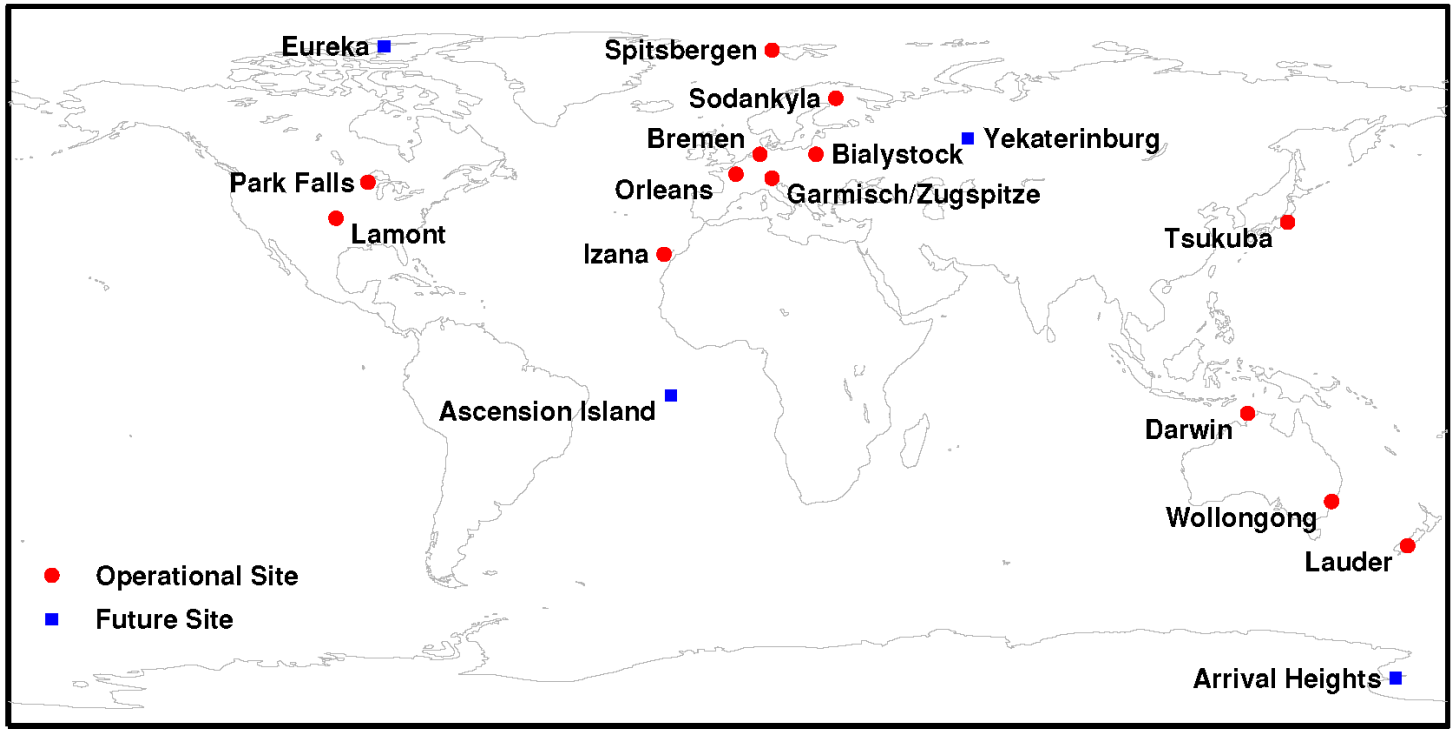
- CO_2 - NOAA ESRL USA
  - EMPA, Switzerland
- CH_4 - EMPA, Switzerland (Am, E/A)
  - JMA, Japan (A/O)

Example of comparison

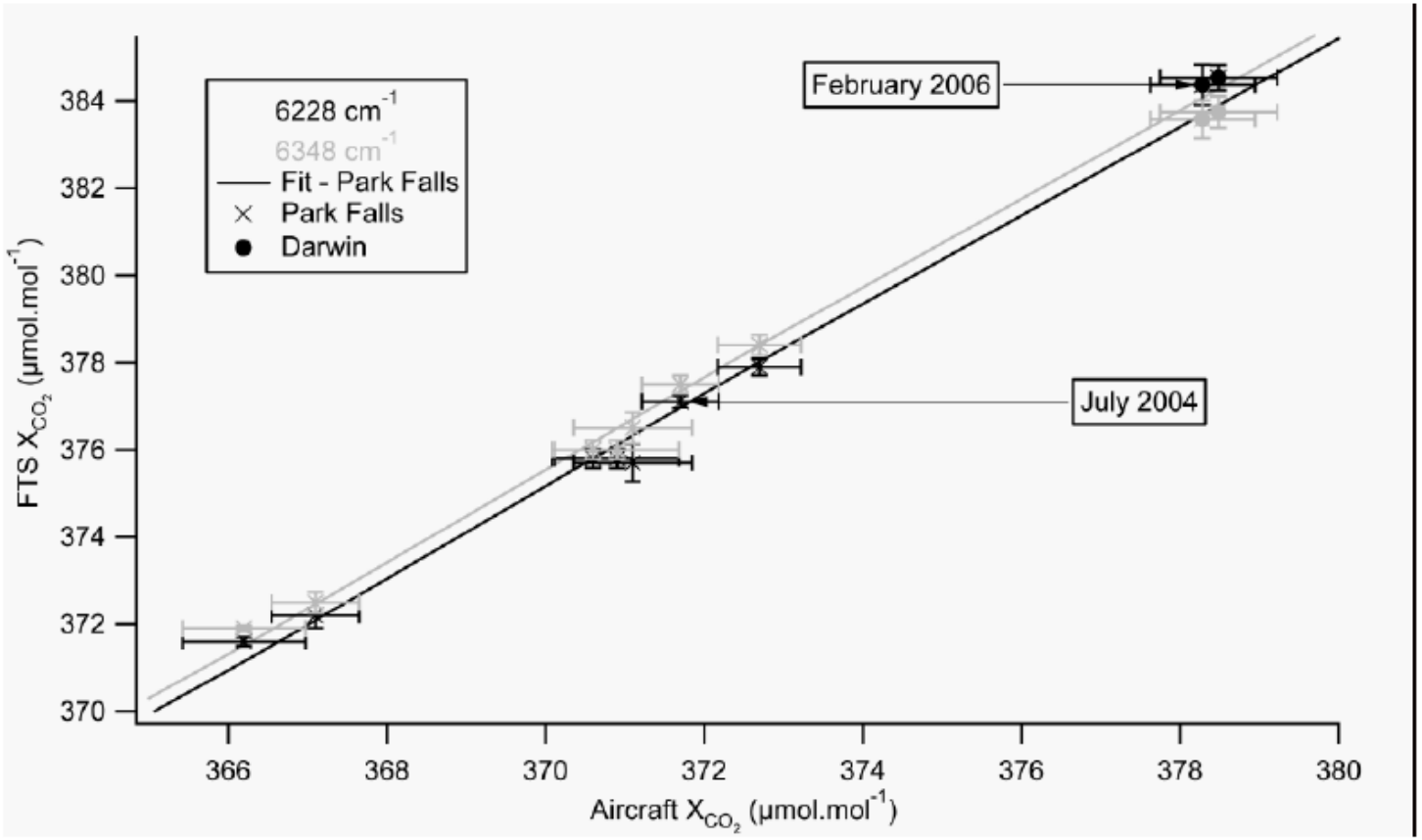


Propagation of the WMO scale to different platform

TCCON – the Total Carbon Column Observing Network.

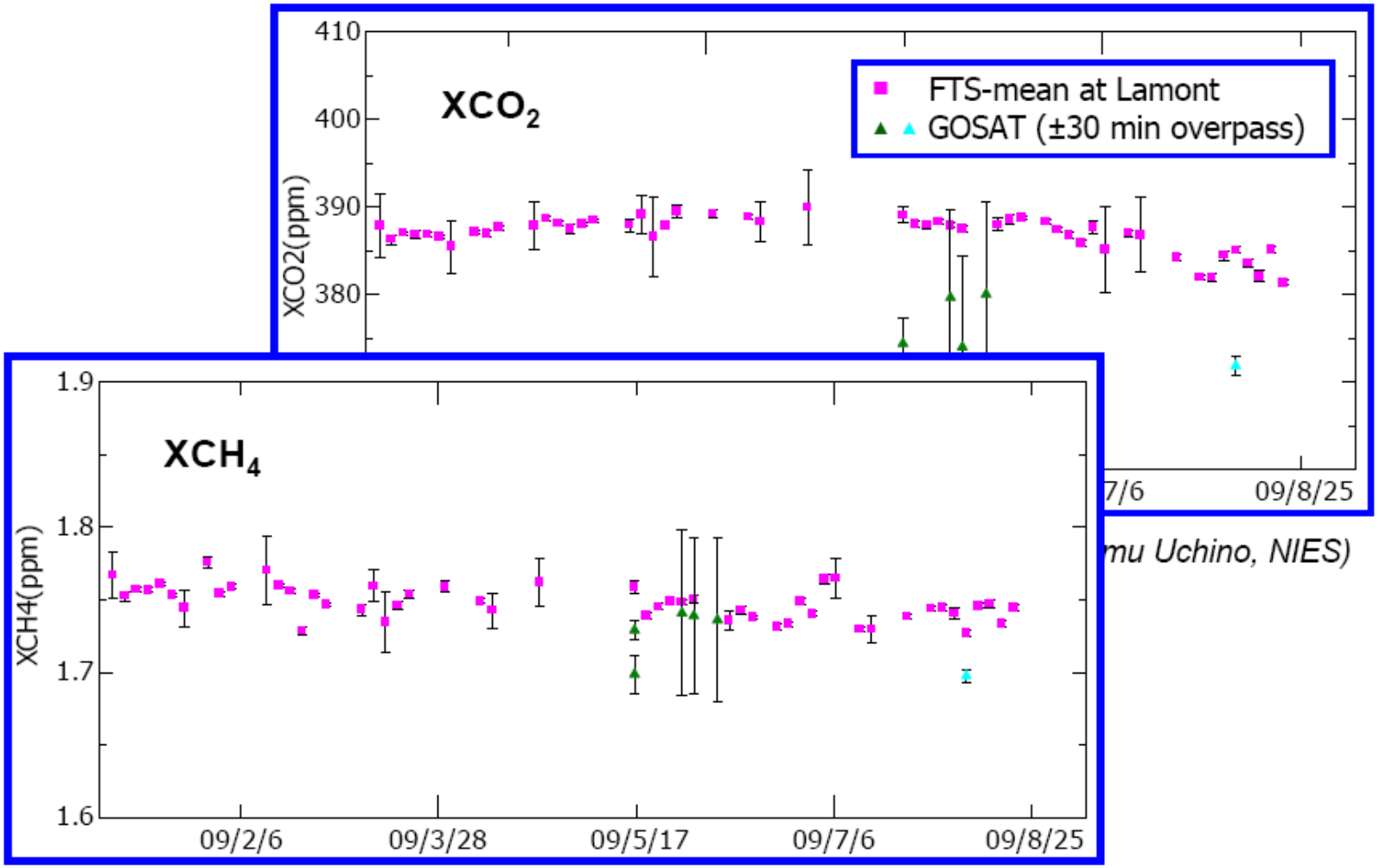


Calibration of the column measurements



(Courtesy of N. Deutscher and D. Griffith, University of Wollongong)

Comparison GOSAT with ground-based FTS at Lamont (36.6N)



(courtesy of Osamu Uchino, NIES)

Quality Assurance II

Standard measurements procedures and measurements guidelines

- CH_4 and N_2O - updated GAW report 185
- CO_2 - GAW report 134 (evolving through biannual meetings)

The Guide for Data submission and dissemination (by WDCGG) is updated (GAW report 188 to be published this month)

Quality Assurance III

Stations twinning/ Training/Expert workshops

Twinning

- Empa - Assekrem (Algeria), Bukit Koto Tabang (Indonesia) and Mt. Kenya (Kenya)
- The Institute for Meteorology and Climate Research, (IMK-IFU) - Cape Point (South Africa).
- NOAA (ESRL) - Ushuaia (HATS group), Tiksi (Russia) and a number of others

Training

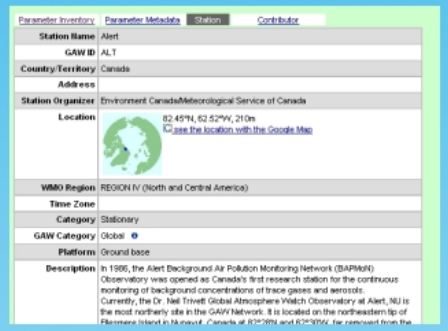
- The GAW Training and Education Centre (GAWTEC)
- EMPA conducts training for operators of stations Mt. Kenya (Kenya), Bukit Koto Tabang (Indonesia), Assekrem (Algeria), Shangdian'zi (China)
- NCAR (Boulder) has provided training for Mt. Kenya operators specifically for their CO_2 analyzer installed in 2008.

Expert meetings

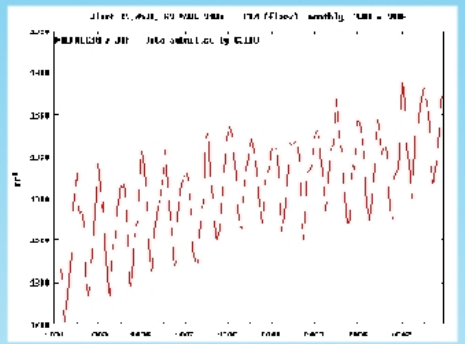
- Biennial WMO/IAEA Meeting of Experts on Carbon Dioxide, Other Greenhouse Gases, and Related Tracer Measurement Techniques (since 1975)

World Data Centre for Greenhouse Gases

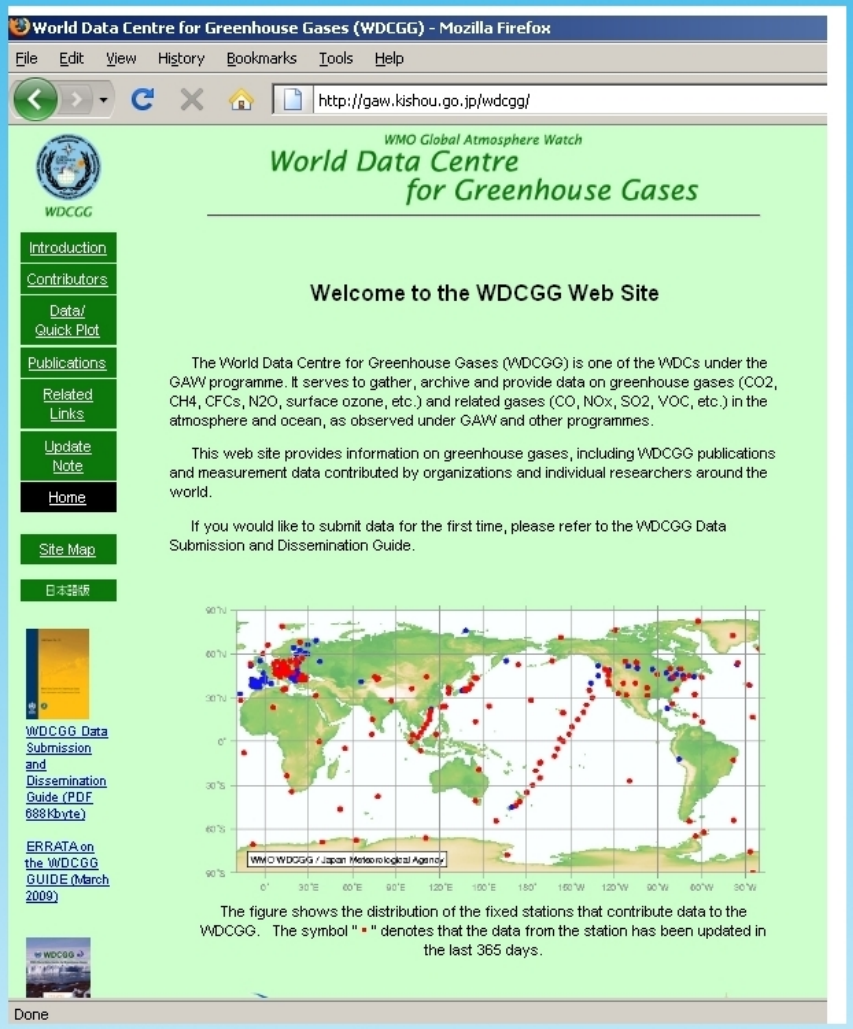
Searchable Station Directory & Metadata



Online data Plot and download

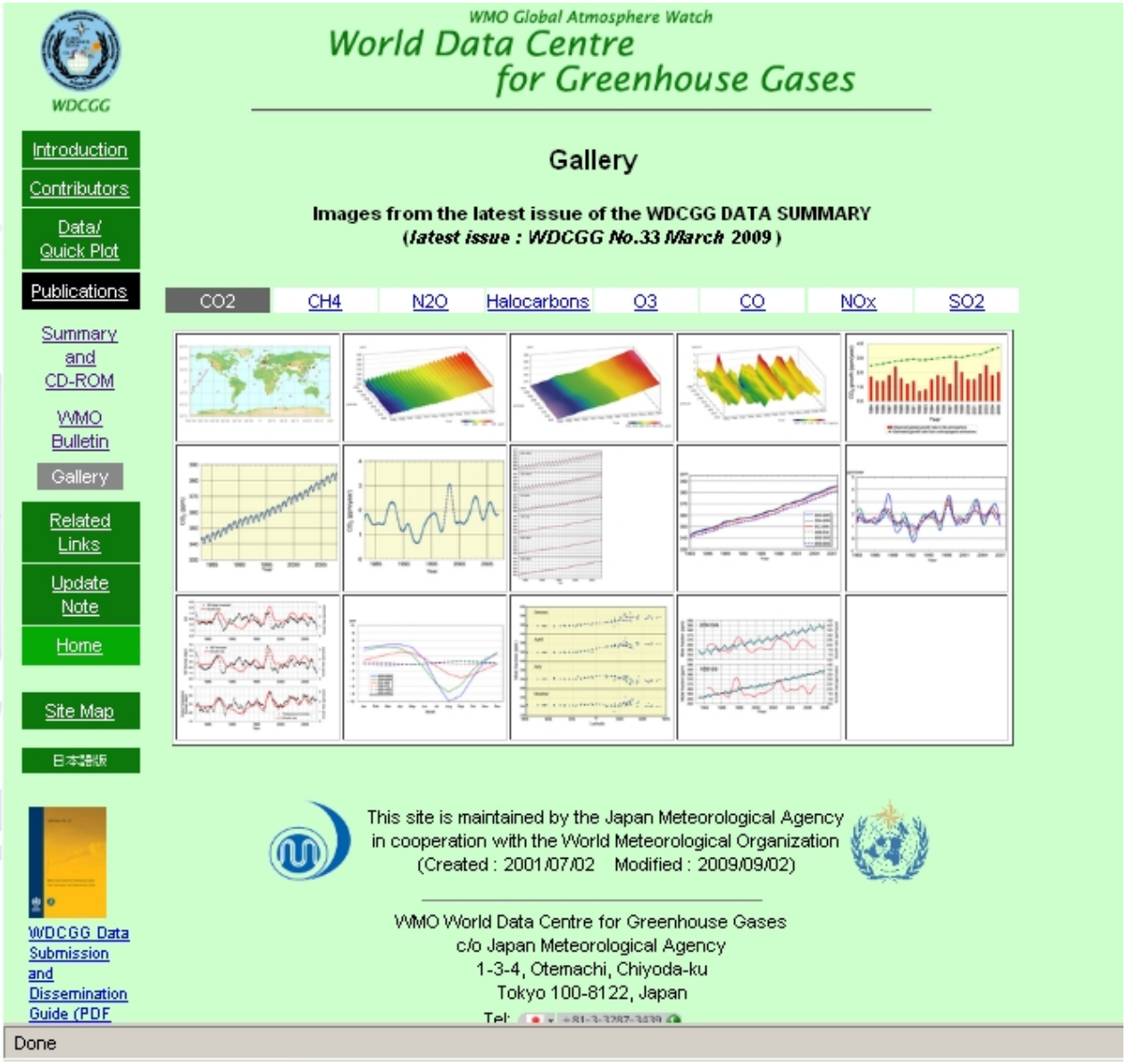


Downloadable Publications

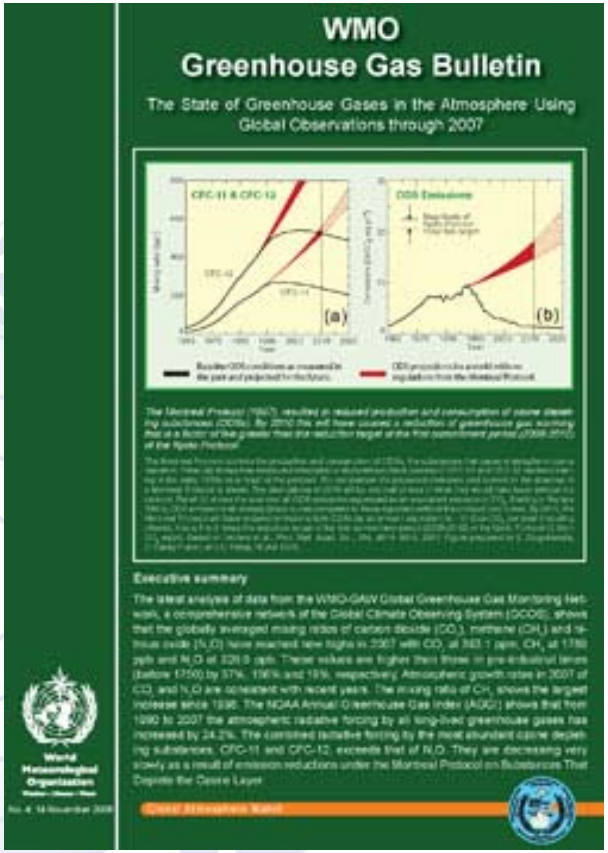


http://gaw.kishou.go.jp/wdcgg/

World Data Centre for Greenhouse Gases



Annual Greenhouse Gas Bulletins



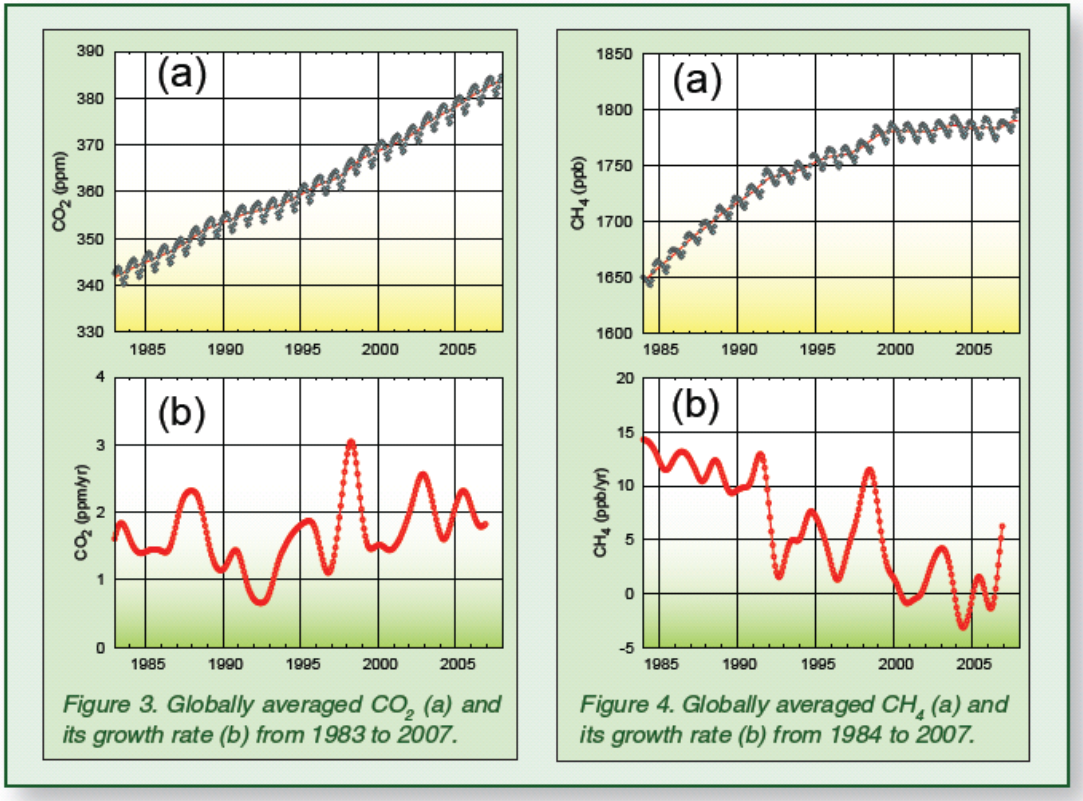


Figure 3. Globally averaged CO_2 (a) and its growth rate (b) from 1983 to 2007.

Figure 4. Globally averaged CH_4 (a) and its growth rate (b) from 1984 to 2007.

Bulletin 1 (March 2006) CO_2 global distribution
Bulletin 2 (November 2006) CH_4 global distribution
Bulletin 3 (November 2007) *NOAA's CarbonTracker model*
Bulletin 4 (November 2008) Montreal Protocol
Bulletin 5 – in preparation

WMO

THANK YOU