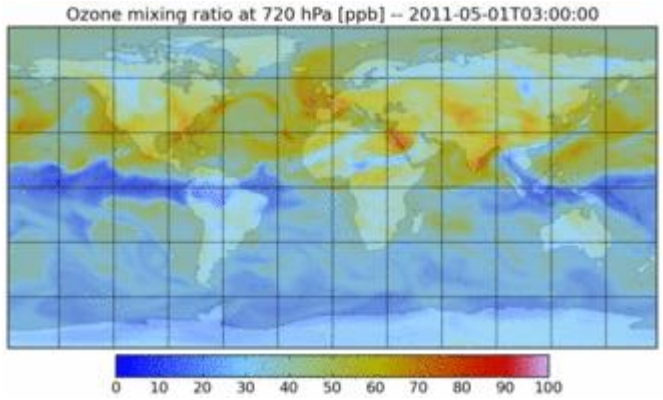

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WMO/GAW reactive gases activities

Martin G. Schultz, Hajime Akimoto*, Jan Bottenheim*, Brigitte Buchmann*, Ian Galbally, Stefan Gilge, Detlev Helmig, Allistair Lewis, Christian Plaß-Dülmer, Tom Ryerson, Valerie Thouret, Hiroshi Koide, Paul Novelli, Keiichi Sato, Rainer Steinbrecher, Kjetil Tørseth, Christoph Zellweger, Oksana Tarasova

SAG RG members

* recently stepped down

WMO GAW

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What is the GAW Programme?

WMO/GAW was established in 1989 by merging GO_3OS and BAPMoN.

GAW is a partnership involving contributors from about 100 countries.

Surface-based *in situ* and remote sensing observations are the backbone of the GAW network, which consists of Global and Regional stations and stations working within contributing networks.

Currently GAW coordinates activities and data from 30 Global stations, 400 Regional stations, and 100 Contributing stations.

GAW is working towards better integration of aircraft and satellite observations and the development of services.*

* New implementation plan under development

GAW Principles

Within its measurement activities, GAW wants to achieve:

- Long-term continuity and consistency
- Reasonable global coverage
- Consistency across the network and among contributing networks
- Good (and known) data quality and accuracy

In the past, the focus has often been on achieving excellent measurement quality. While this remains a fundamental backbone of GAW, more emphasis is now also placed on the quality of the data for the user (i.e. in the archive), and on ensuring that the data are “fit for purpose”.

WMO GAW

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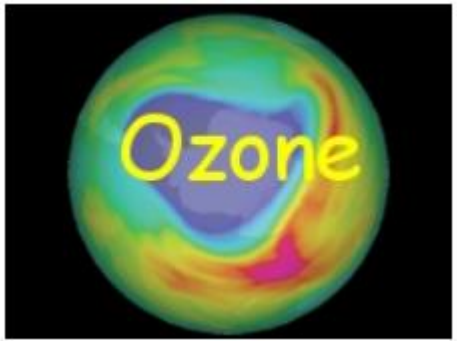
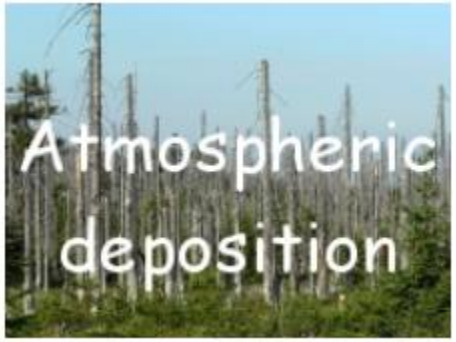
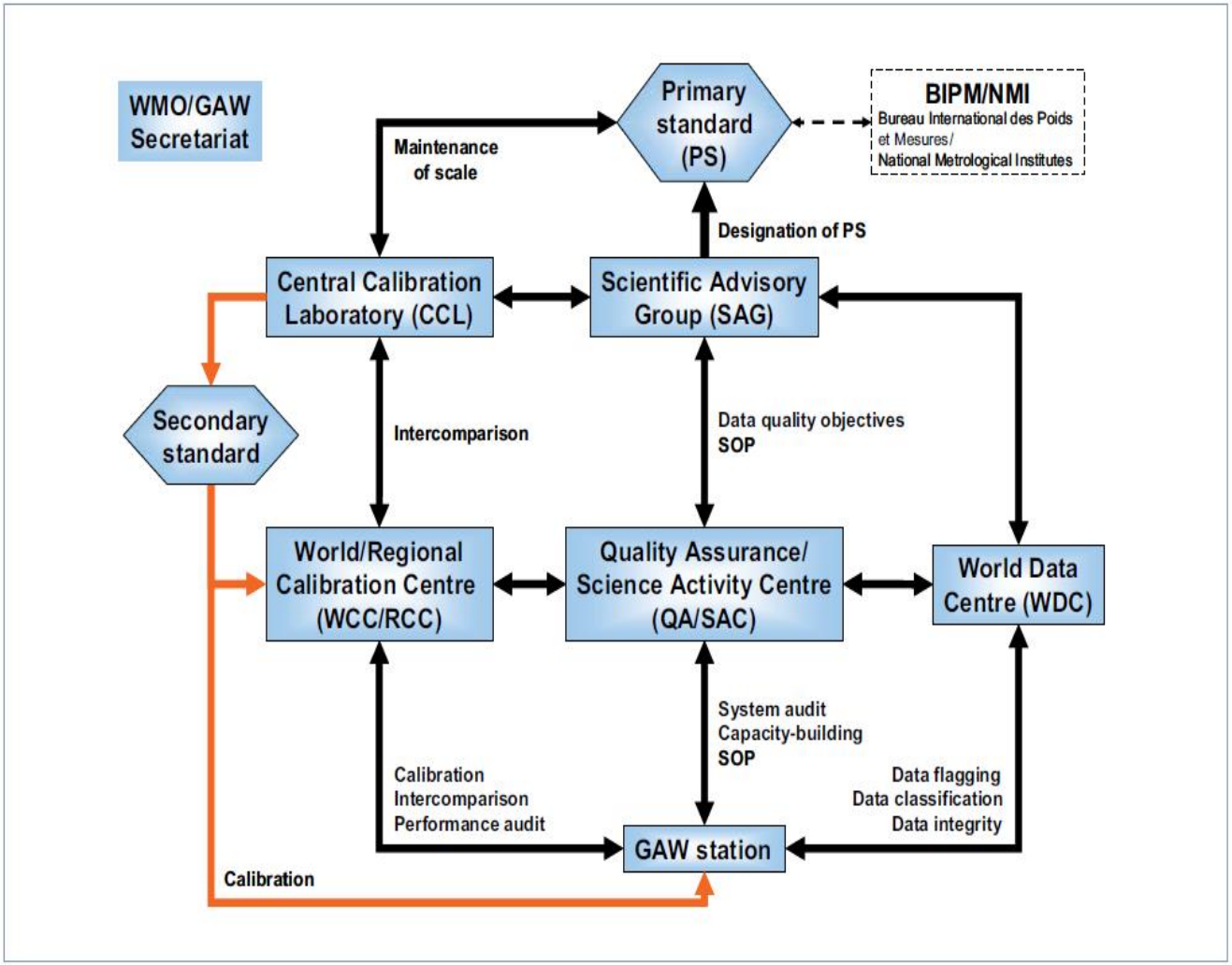
GAW Focal areas





Projects:

GAW Quality Assurance system



Quality Management Framework principles

- ✓ Network-wide use of only one reference standard or scale (primary standard).
- ✓ Ensure full traceability to the primary standard of all measurements.
- ✓ Definition of data quality objectives (DQOs) based on application.
- ✓ 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).
- ✓ Training of station personnel (GAWTEC)
- ✓ 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.

GAW World Central Facilities

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 (round robin) Empa (audits)		JMA
carbon isotopes		MPI-BGC			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
SF_6		ESRL			JMA
H_2		MPI-BGC			JMA
Total Ozone	JMA (A/O)	ESRL[1], EC[2]	ESRL[1], EC[2]	BoM[1], ESRL[1], IZO[2] JMA[1], MOHp[1], MGO[3], OCBA[1], SAWS[1], SOO-HK[1]	EC[5], DLR[6]
Ozone Sondes	IEK-8	IEK-8	IEK-8		EC
Surface Ozone	Empa	NIST	Empa	OCBA	JMA
Precipitation Chemistry	NOAA-ARL	ISWS	ISWS		NOAA-ARL
CO	Empa	ESRL	Empa		JMA
VOC	UBA	NPL	IMK-IFU		JMA
SO_2					JMA
NO_x	UBA		IEK-8 (NO)		JMA
Aerosol	UBA (physical properties)		IfT (physical properties)		NILU[5], DLR[6]
Optical Depth		PMOD/WRC[4]	PMOD/WRC		NILU
UV Radiation				ESRL (Am), EUVC/PMOD (E)	EC
Solar Radiation		PMOD/WRC	PMOD/WRC		MGO

[1]Dobson, [2]Brewer, [3]Filter instruments, [4]Precision Filter Radiometers (PFR), [5]ground-based, [6]satellite-based

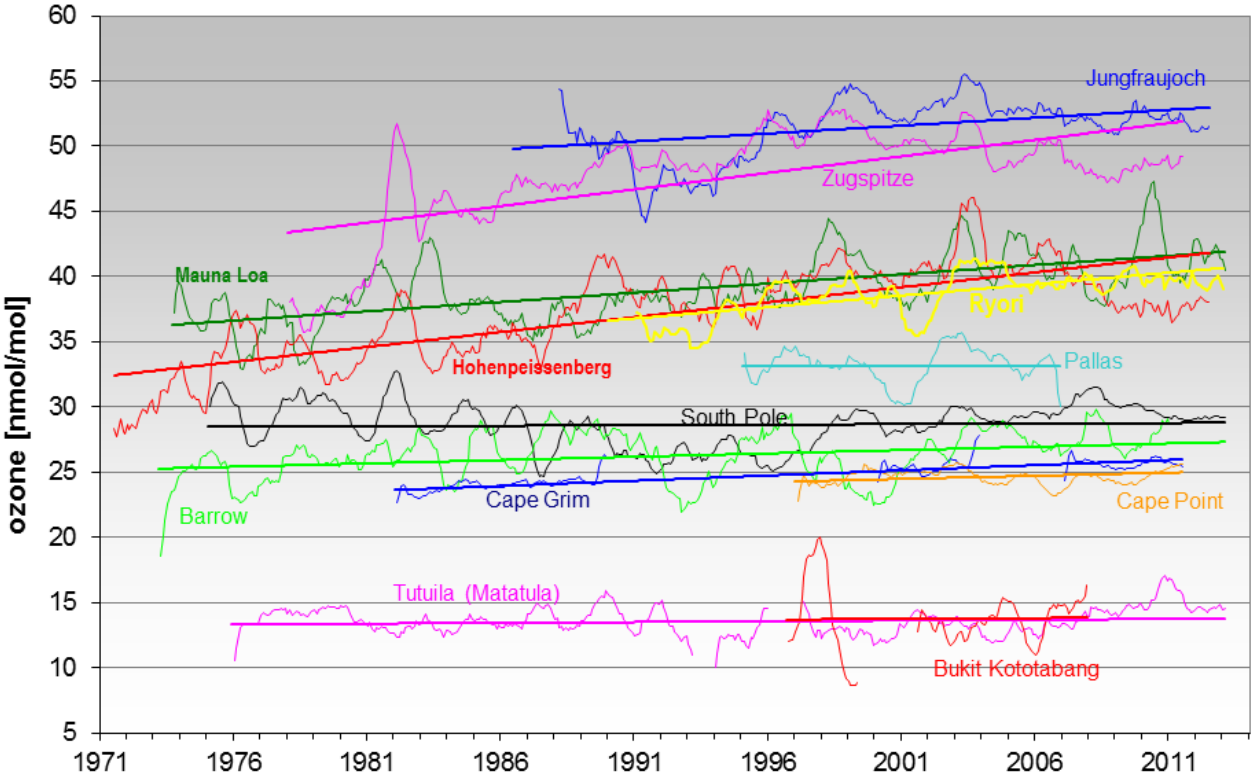
GAW Reactive Gases

- Ozone
- CO
- NO_x
- VOC
- SO_2

Future additions planned to complement analyses of sulphur and nitrogen cycles.

GAW surface ozone data (after 1971) available from the WDCGG archive

Global surface ozone observations



Time series of surface ozone observations at selected sites

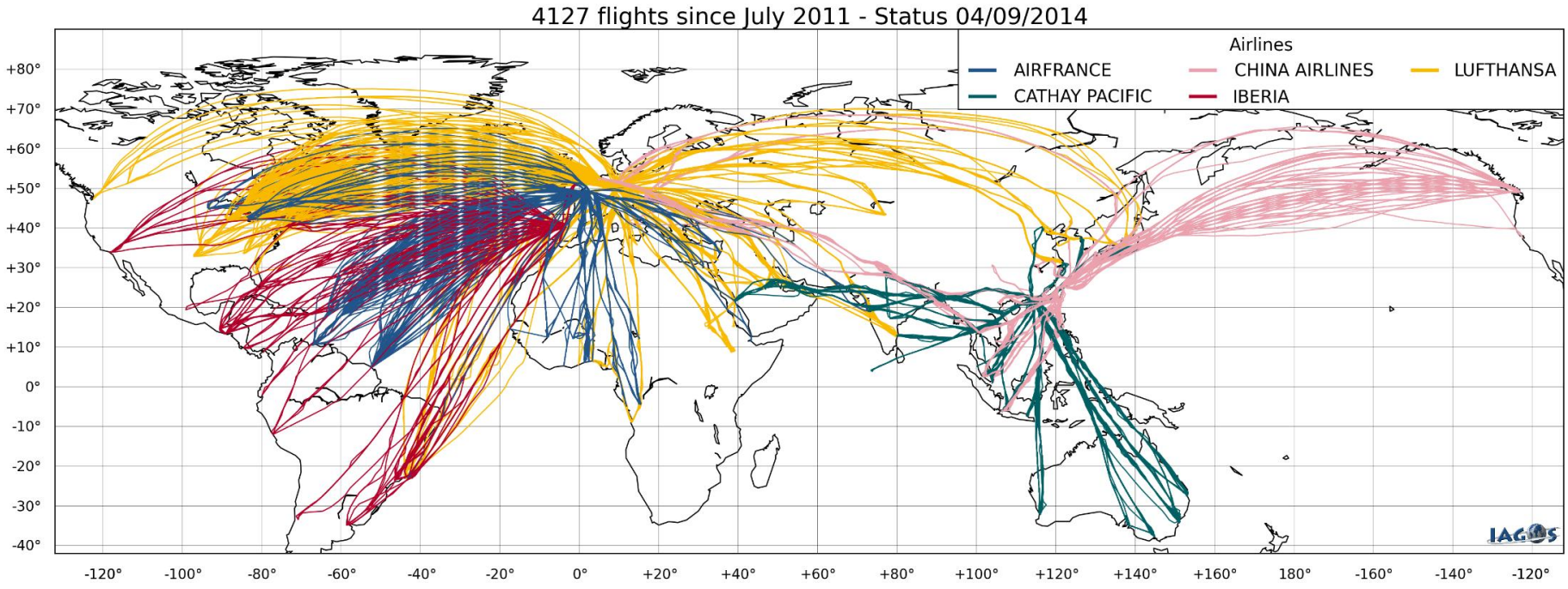
Status of the GAW surface ozone network

- Well-established network and measurement procedures (new measurement guidelines published in 2013)
- Since early 2000‘s: decrease of stations in Europe, increase of stations in Asia
- Data have been used in several trend analysis papers
- Few stations deliver early data for model validation to MACC
- Very good consistency after ~1995, larger uncertainties in older time series
- Data quality control effort launched in the context of TOAR*
- New ozone absorption cross sections will require re-calibration (~2%)

* Tropospheric Ozone Assessment Report, co-sponsored by IGAC and GAW

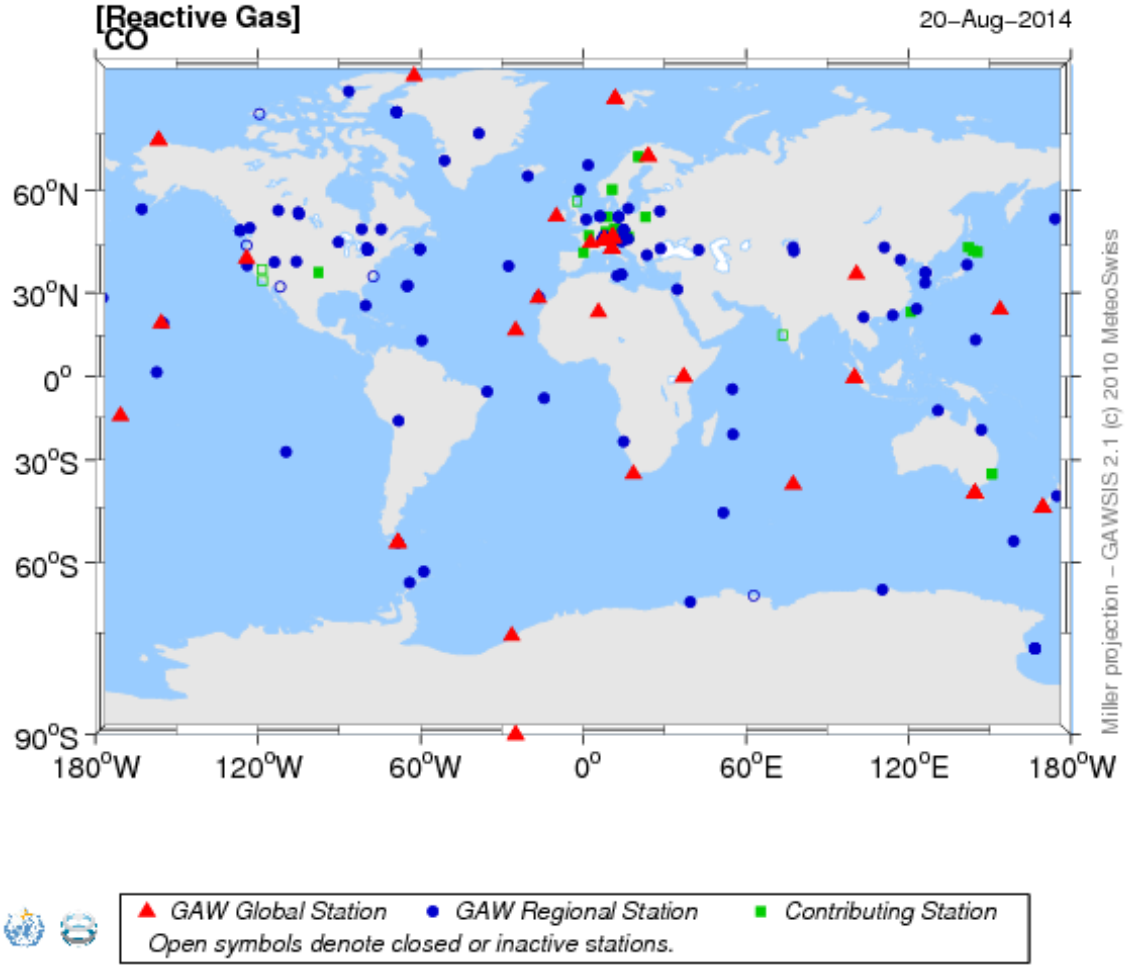
Integration of aircraft measurements

In-service Aircraft for a Global Observing System (IAGOS)
- follow-on to MOZAIC (1994-2013)



IAGOS uses GAW Quality Assurance concept

Surface CO observations



Global monitoring network of CO

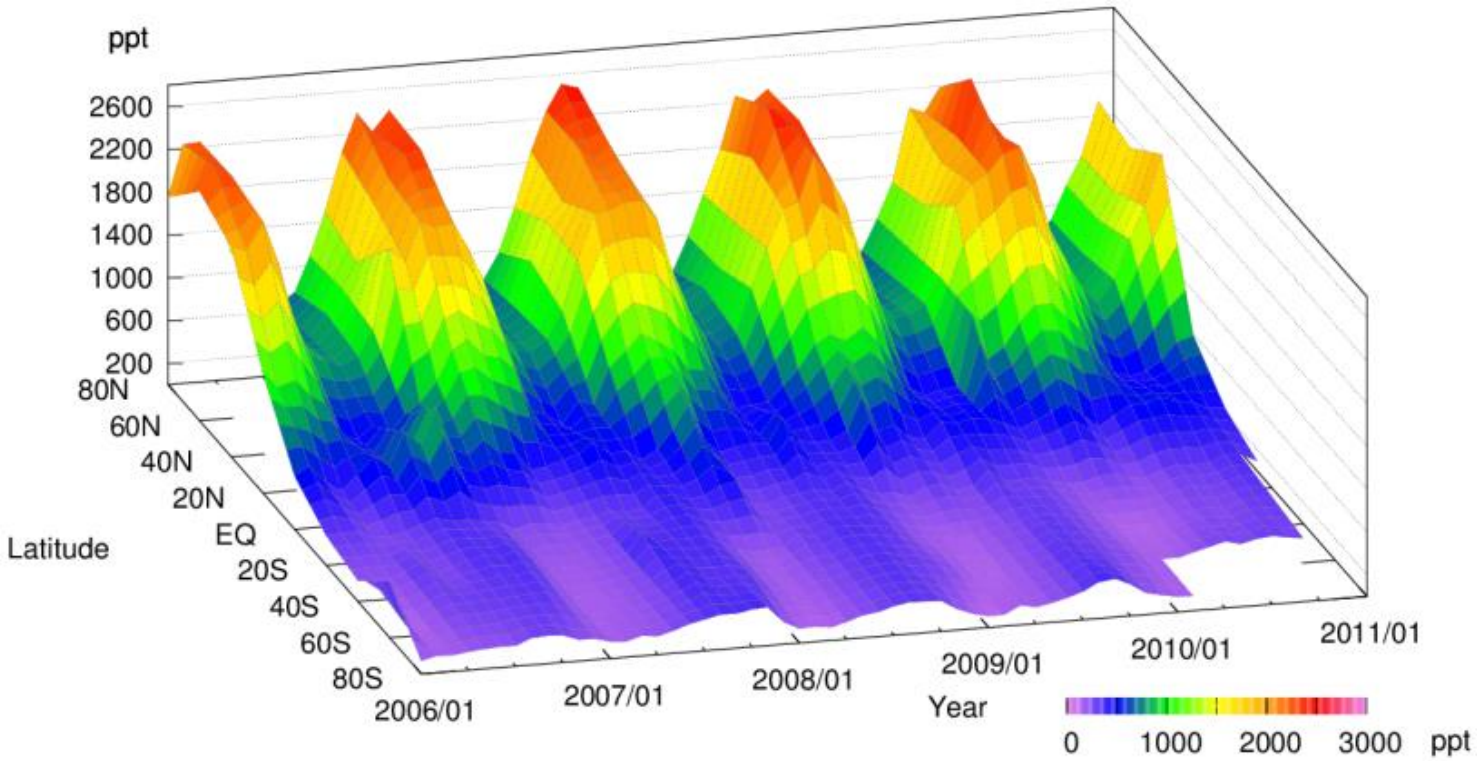
Status of the GAW surface CO network

- Measurements initiated with flask samples and GC-HgO detection, current measurements mostly NIR absorption
- Various new measurement methods under investigation; CRDS may become the new measurement standard
- Plan to organize dedicated session on CO measurement techniques (GGMT meeting 2015)
- Revision of the CO scale (NOAA-CMDL) ongoing; data revision necessary due to drifts in primary standards

Status of the GAW surface NO_X network

- Network in build-up phase; large parts of present network from European ACTRIS project
- Measurement guidelines are being established (ACTRIS)
- World calibration center (Jülich) started operation in 2014
- Primary standard to be determined
- Focus on NO and NO_2; other NO_Y components potentially later

Global surface observations of VOC



Temporal evolution of ethane mixing ratios

Priority VOCs in GAW

Molecule	Lifetime ($OH=10^6$ cm^{-3})	Steel flask	Glass flask	Analysis Method
Ethane	1.5 months	√	√	GC/FID
Propane	11 days	√	√	GC/FID
Acetylene	15 days	√	√	GC/FID
Isoprene	3 hours	?	?	GC/FID, PTR-MS
Formaldehyde	1 day	-	-	DOAS
Terpenes	1-5 hours	-	-	GC/MS, PTR-MS
Acetonitrile	0.5-1 year	-	?	GC/MS,PTR-MS
Methanol	12 days	-	?	GC/FID, PTR-MS
Ethanol	4 days	-	?	GC/FID, PTR-MS
Acetone	1.7 months	?	?	GC/FID, PTR-MS
DMS	2 days	?	?	GC/FID, PTR-MS
Benzene	10 days	√	?	GC/FID, GC/MS
Toluene	2 days	-	?	GC/FID, GC/MS
Iso and normal Butane	5 days	√	√	GC/FID, GC/MS
Iso/normal Pentane	3 days	√	√	GC/FID, GC/MS

Status of the GAW surface VOC network

- About 7 years of data with reasonable global coverage
- Lab intercomparison indicates very good performance for synthetic samples; more discrepancies in real air
- Regular meetings of VOC experts
- Measurement guidelines are being established (ACTRIS); initial focus on NMHC
- WCC and CCL in place for NMHCs

Status of the GAW surface SO_2 network

- Archive of older SO_2 measurements exists; unknown quality
- Efforts under way to re-establish SO_2 network under GAW QA/QC principles
- GAW SO_2 measurements shall become part of sulphur cycle analysis

The Future of GAW RG activities

- Integrate more contributing networks:
  - CASTNET (under way)
  - EMEP (finally a plan emerges)
  - EANET (requires political discussions)
  - IAGOS (under way)
  - NDACC
- Work towards a GAW data portal and interoperable access to all GAW data
- Establish expert teams to control data *before* archiving; re-assess existing datasets
- Foster enhanced use of GAW data and develop applications („Science for services“)
- Keep up the excellent work to ensure high-quality observations!

Thank you!

Group photo of the SAG RG meeting participants in Daejeon, South Korea. Back row (from left to right): Kjetil Tørseth, Christian Plaß-Dülmer, Hajime Akimoto, Ian Galbally, Christoph Zellweger, Rainer Steinbrecher, Stefan Reimann, Keiichi Sato, Paul Novelli, Allistair Lewis; Front row: Brigitte Buchmann, Oksana Tarasova, Valerie Thouret, Detlev Helmig, Martin Schultz, Hiroshi Tanimoto, Hiroshi Koide