Next Presentation starts at: 3.00 pm

Presentation and discussion of pre-submitted abstracts

Bureau
International des
Poids et
Mesures

Session II: Carbon measurement and other related climate variables: Global systems, principals and traceability

1. The Role of WMO in Developing a Space-Based Architecture for Climate Monitoring,
Wenjian Zhang (WMO)

2. Coordination of U.S. Civil Earth Observations: Assessing Earth Observations for Societal Benefit and Greenhouse Gas Monitoring
Christopher Clavin, Jason Gallo (IDA)

3. Overview of the 'Metrology for Climate' Workshop
Nigel Fox (NPL)

4. Metrology issues in establishing a Climate Reference Upper Air Network
Tom Gardiner (NPL)

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5. Traceability of Greenhouse Gas Measurements within the Global Atmosphere Watch Programme: Results from the World Calibration Centre WCC-Empa, Christoph Zellweger, (Empa)

6. Metrology for High Impact Greenhouse Gases
Paul Brewer (NPL)

7. IAEA stable isotope reference materials: addressing the needs of atmospheric monitoring,
S.Assonov (IAEA)

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1. The Role of WMO in Developing a Space-Based Architecture for Climate Monitoring,

Wenjian Zhang (WMO)

The Architecture development through the Rolling Review of Requirements (RRR)

1. From Global Societal Needs **dimension** in 2040, project to anticipation of climate services **requirements** 2040

2. Then from services 2040 **dimension**, project to anticipated climate observing and monitoring **requirements** in 2040–covering all WMO programmes areas (GFCS: health, energy, DRR, water & food) user driven approach !

3. From advances in technology 2040 **dimension**, to compare with the requirements. – technology driven approach !

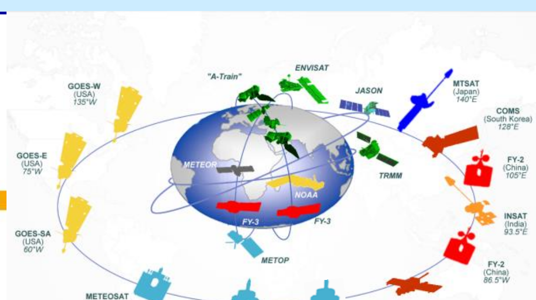
Requirements

Requirements

Requirements

Critical review

Observing capabilities (space & surface)



Statements of Guidance

Long-term vision of WIGOS

Implementation Plan for Evolution *Recommendations*

Members' programmes (including space agencies)

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2. Coordination of U.S. Civil Earth Observations: Assessing Earth Observations for Societal Benefit and Greenhouse Gas Monitoring

Christopher Clavin, Jason Gallo (IDA)

U.S. National Plan for Civil Earth Observations: GHG Monitoring Priorities

- National Plan (2014) lays out measurement categories for sustained research observations and priorities for planned improvements:
  - Measurement categories: Earth's energy budget, GHG emissions and concentrations (including sources, sinks, short-, long-lived gases)
  - Priorities: public service observations, Earth system research, experimental observations
- Ongoing: triennial assessment of U.S. civil Earth Observation portfolio to quantify impact of observation systems on meeting societally relevant goals
  - Climate change research, mitigation, and adaptation planning
  - Energy and mineral resource development
- Request to international GHG monitoring community:
  - Need for standards and priorities for observation requirements
  - Identification of long-term sustained monitoring requirements, including continuity of existing observation
  - Framework for experimental monitoring needs and priorities
  - Prioritization of other climate variables and associated observation systems

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3. Overview of the 'Metrology for Climate' Workshop

Nigel Fox (NPL)

BIPM Workshop on Global to Urban Scale Carbon Measurements, 30 June 2015

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‘Metrology for Climate’ workshop @ NPL May 2015

2 day meeting of ~50 invited climate related experts – to prioritise metrology effort to address ‘community assessed’ needs derived from **all** ECVs (using a variety of criteria).

Used GCOS themes, Reviewed GCOS criteria, adequacy & limitations of achieving

- Simplify problem by considering FCDRs as first stage (each enablers of many ECVs)
- Stability requirement most demanding – how to robustly link time series data sets?
  - Sampling, noise + ‘events’, sensor design differences, duration of overlaps, define
- How to assess and propagate uncertainties (end to end) (FCDR & algorithms)
  - GUM 4 EO/Climate, Analyse traceability chain from ECV to sensor (inc metadata)
  - Derive Data (measurand + metadata) Uc requirements from application
  - Gap analysis of traceable rigour
- SI traceable ‘on-board Cal’ / Benchmark sensors (TRUTHS/CLARREO + Microwave)
  - Also pre-flight particularly Microwave
- Surface SI traceable ‘Reference’ Validation networks (hierarchal / super-sites) delivering ‘Fiducial’ data (Land/atmosphere/oceans)
  - ‘fit for purpose’ travelling standards and ‘affordable’ but traceable Cal labs.
- Greater dialogue
  - Community a little disappointed on time lapse from 2010 BIPM/WMO meeting
  - Regular focussed technical workshops - possible newsletter/website
  - Embed metrology – starting EU EMRP, FP7, H2020 (& coordinate between)
    - e.g. MetEOC 1, 2, Meteomet 1,2, QA4ECV, FIDUCEO, GAIACLIM

Metrology for Earth Observation and Climate
EMRP European Metrology Research Programme ▸ Programme of EURAMET
The EMRP is jointly funded by the EMRP participating countries within EURAMET and the European Union
EUMETSAT University of Reading NPL National Physical Laboratory Centre for Carbon Measurement esa European Commission Met Office

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4. Metrology issues in establishing a Climate Reference Upper Air Network

Tom Gardiner (NPL)

BIPM Workshop on Global to Urban Scale Carbon Measurements, 30 June 2015

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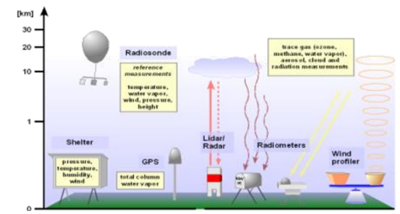
METROLOGY ISSUES IN ESTABLISHING A CLIMATE REFERENCE UPPER AIR NETWORK

NPL National Physical Laboratory

The Issue

- Upper atmosphere crucial to global climate, but challenging environment to make high quality measurements.
- Need measurement traceability and uncertainty to provide :
  - long term climate records;
  - validation for other data sources (satellites, operational meteo.)

GCOS Reference Upper Air Network



- Characterize atmospheric column ECVs with measurement redundancy.
- Provide observational uncertainties, with traceability to SI units or accepted standards

Measurement Challenges

- Establishing robust uncertainties for upper atmosphere measurements.
- Comparing/combining measurements with spatial and temporal differences.
- Dealing with atmospheric variability in comparisons and long-term trends.
- Traceable linking of optical radiance to geo-physical properties.

Requirements / Opportunities

- Important and urgent need for collaboration between metrology, meteorology and EO communities.
- No direct funding for international networks, so need coordinated national and international support.
- Examples include MeteoMet EMRP and GAIA-CLIM Horizon2020 projects.

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5. Traceability of Greenhouse Gas Measurements within the Global Atmosphere Watch Programme: Results from the World Calibration Centre WCC-Empa, Christoph Zellweger, (Empa)

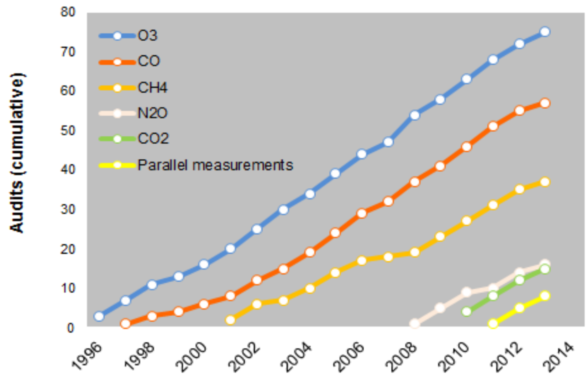
Traceability of GHG Measurements within the GAW Programme: Results from the World Calibration Centre WCC-Empa

Christoph Zellweger, Martin Steinbacher, Lukas Emmenegger, Brigitte Buchmann

Empa, Laboratory for Air Pollution / Environmental Technology, Dübendorf, Switzerland

Empa operates the World Calibration Centre (WCC-Empa, CO_2, CH_4, CO, O_3) since 1996.

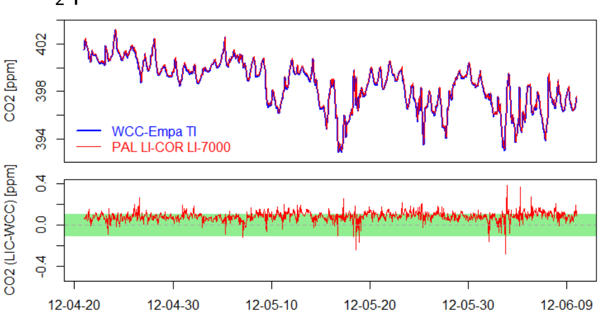
Audits by WCC-Empa from 1996 - 2014



Audits include:

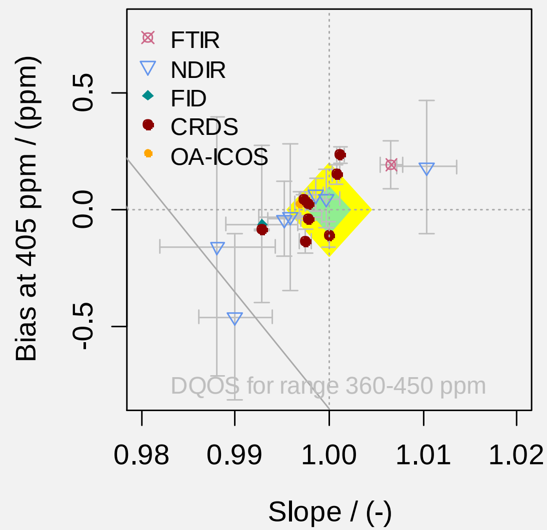
- Comparisons of travelling standards
- On-site comparisons over 1-2 months

CO_2 parallel measurements at Pallas



In the recent years, new measurement techniques became available.

CO_2 audit results with respect to different measurement techniques



New spectroscopic techniques (e.g. CRDS, QCL) clearly show improved performance compared to traditional methods.

Many measurement stations changed their instruments / techniques recently.

QA/QC challenges in a global network with a long-term perspective:

Network:

- Number of players as well as number of techniques is increasing…

Measurements:

- Consistent, stable standards.
- Requirements on standards might change (isotopic composition, matrix).
- Ensuring that new techniques result in homogeneous data series with no (unexplainable) jumps.

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6. Metrology for High Impact Greenhouse Gases

Paul Brewer (NPL)

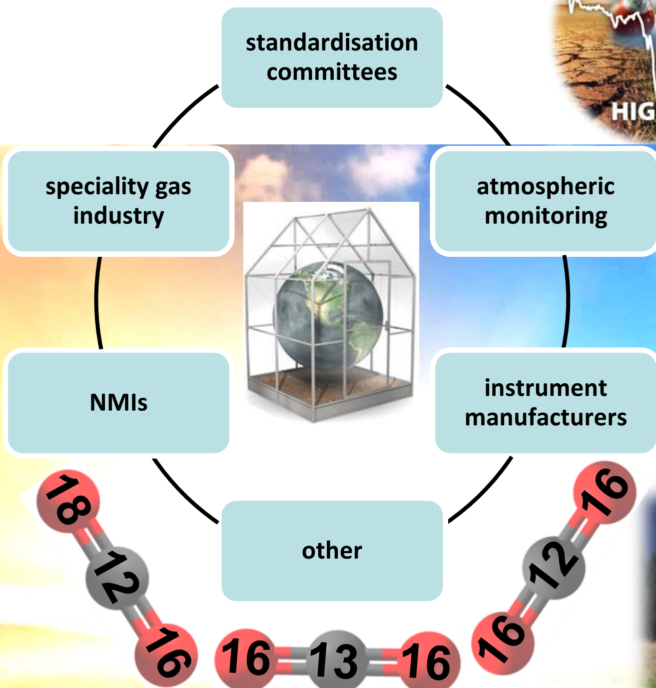
BIPM Workshop on Global to Urban Scale Carbon Measurements, 30 June 2015

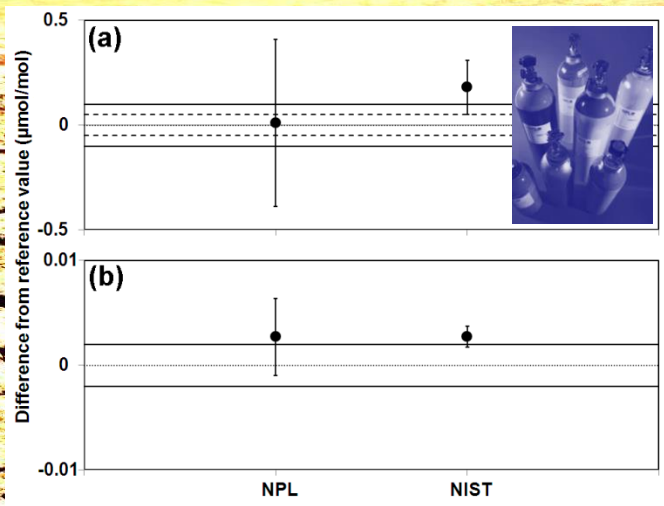
Metrology for high impact greenhouse gases

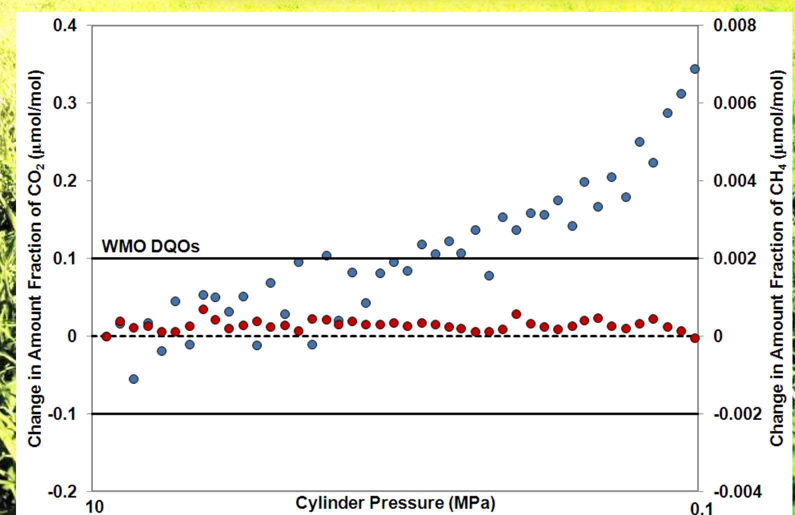
composition quantification

passivation chemistry

isotopic composition







Paul J Brewer 30th June 2015

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7. IAEA stable isotope reference materials: addressing the needs of atmospheric monitoring,

S.Assonov (IAEA)

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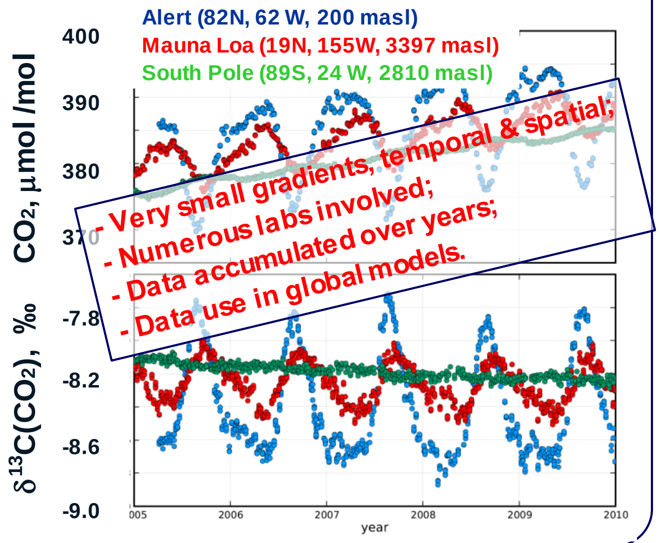
IAEA stable isotope reference materials: addressing the needs of the atmosphere monitoring.

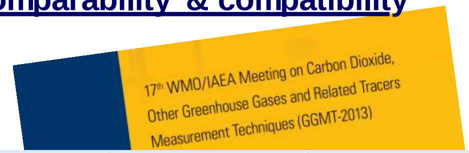
S.Assonov, M.Groening, A. Fajgelj, IAEA

International Atomic Energy Agency

1. Isotopes of air CO_2 and air CH_4



2. Requirements from data use: Comparability & compatibility

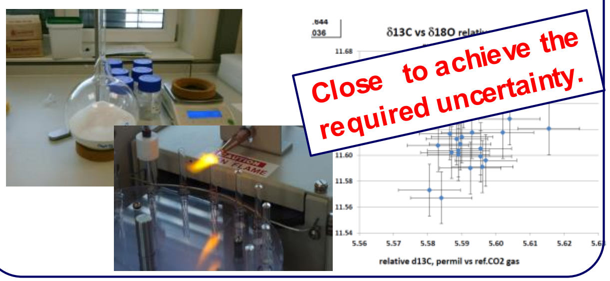


	Compatibility goal	Range of values
$\delta^{13}C(air\text{-}CO_2)$	0.01 ‰	-7.5 to -9 ‰
$\delta^{13}C(air\text{-}CH_4)$	0.02 ‰	about -47 ‰

These goals can be achieved through the use of reference materials (RMs) with low uncertainty.

3. Isotope $\delta^{13}C$-scale:

- Artefact-based, like kg & meter scales;
- Maintaining scale-artefacts is crucial;
- Presently: the highest RM (NBS19 marble) has to be replaced. Work on the replacement-RM (IAEA-603 marble) is ongoing.



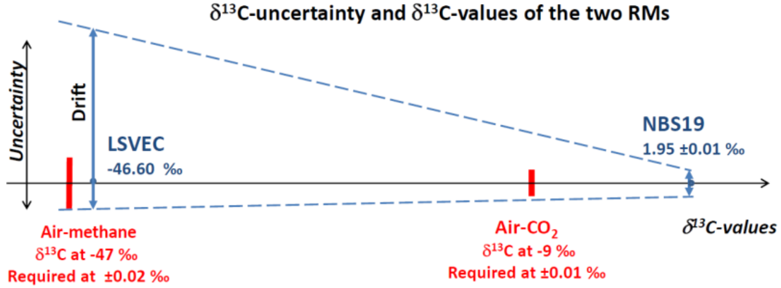
4. The second RM, LSVEC

- Intended use: to normalize all $\delta^{13}C$-calibrations at low-end $\delta^{13}C$;
- Introduced in 2006; the material - Li_2CO_3;
- $\delta^{13}C$=-46.60‰, initially assumed uncertainty of ≤ ±0.02‰.

Problems recognised only in 2014-2015:

- $\delta^{13}C$-scatter found: up to 0.25 ‰;
- Increased uncertainty, potential bias to positive $\delta^{13}C$.

$\delta^{13}C$-uncertainty and $\delta^{13}C$-values of the two RMs



5. Strategy for $\delta^{13}C$-RMs:

- General-1: Reconsider hierarchical structure of ^{13}C-RMs, with current metrological principles/approaches to be followed;
- General-2: Proper tests for stability, homogeneity and properly evaluated uncertainty for each RM;
- Priority-1: to finalize IAEA-603;
- Priority-2: to introduce replacement for LSVEC (RM at low $\delta^{13}C$);
- Families of RMs to be created: several carbonates, several CO_2 gases, several CO_2-air mixtures. Later: calibrated CH_4-air mixtures and N_2O-air mixtures;
- Monitoring RMs: to be established based on metrologically reliable method(s).

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8. Brad Hall (NOAA)

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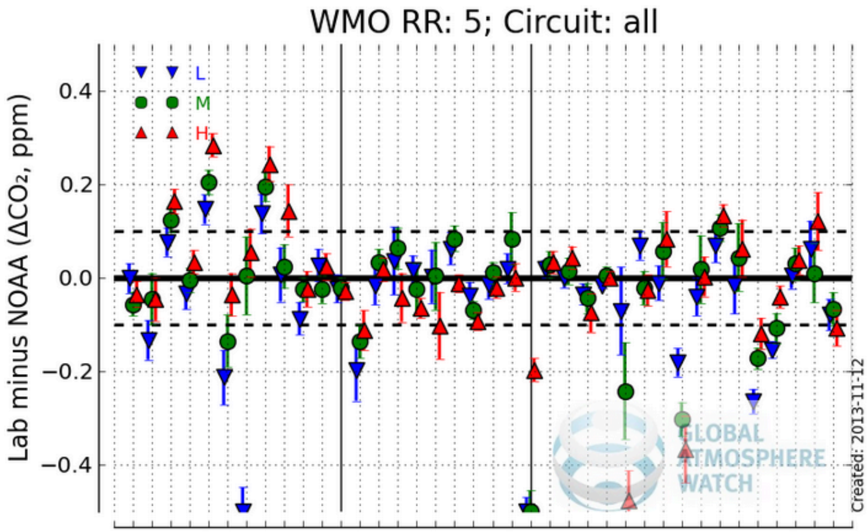
As more calibration scales are introduced, how we will ensure compatibility?
Key Comparisons are necessary: are they enough? (cost, frequency)



GAW Strategy

- informal, managed comparisons
- 2-yr cycle
- data hosted by NOAA
- self-reporting

•co-located sampling
•sample exchanges