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Facilitating the development of a global measurement infrastructure for the measurement of stable isotope ratios for greenhouse gases source apportionment

One sentence summary

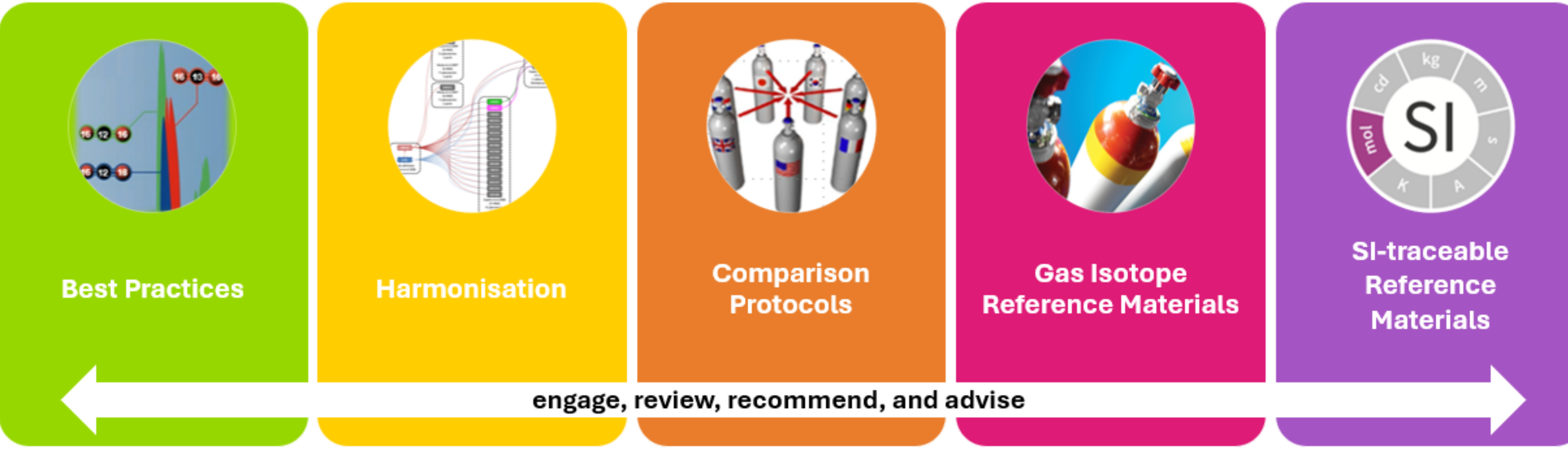
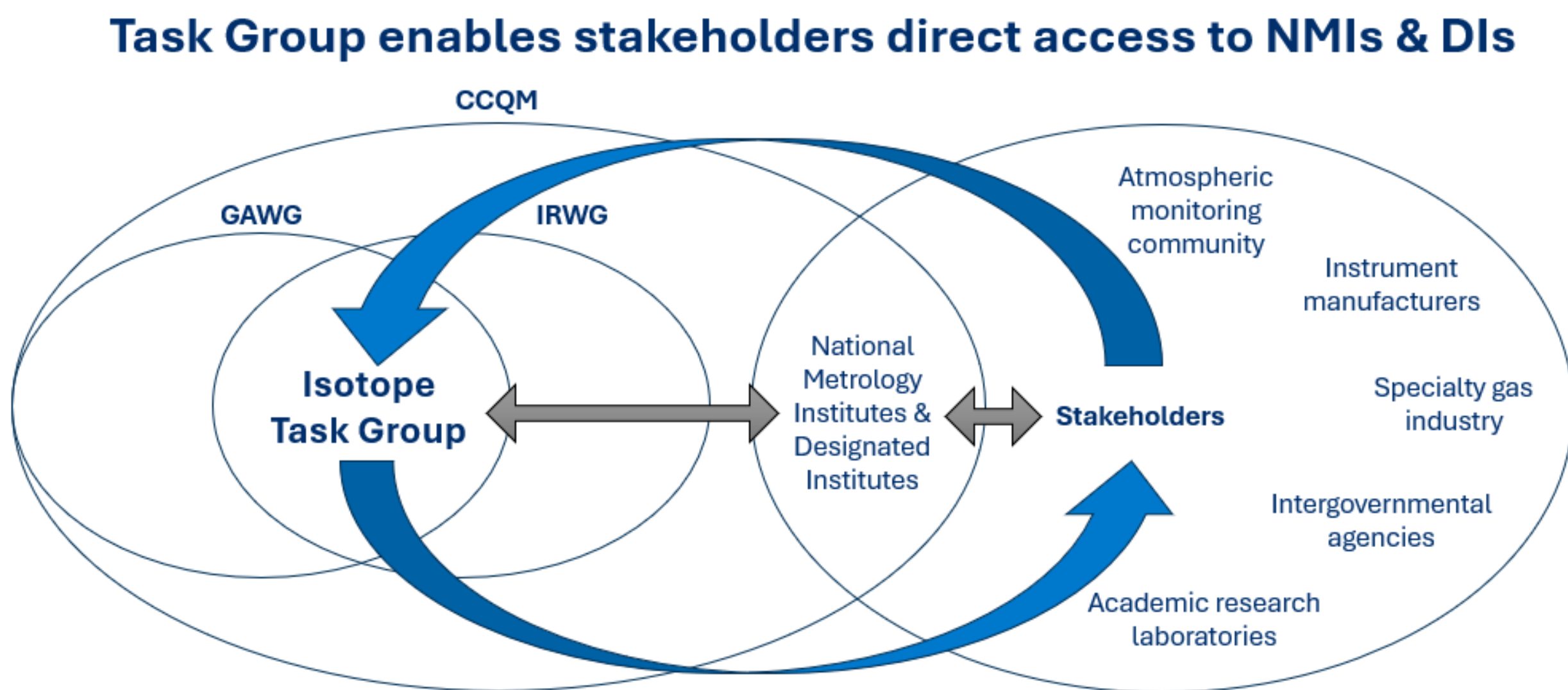
A new CCQM task group has taken up its work to streamline and coordinate global efforts to foster a robust metrological support infrastructure for the accurate, real-time measurement of stable isotope ratios for atmospheric gases source apportionment

1 Background

- Stable isotope ratios of atmospheric greenhouse gases (GHG) show **small yet significant gradients over large spatial and temporal scales** requiring precise and accurate measurements¹
- To make best use of **atmospheric stable isotope ratio data** from different atmospheric monitoring stations and laboratories these data **must be compatible well below the 1‰ level**²; however, even expert laboratories struggle to achieve the required level of compatibility³
- Part of the issue is related to challenges with inconsistent methodologies for realising the **artefact-based reference scales**, such as the Vienna Pee Dee Belemnite (VPDB) scale in the case of carbon³
- Measurements of stable isotope ratios represent the **only traceability exception** across all Consultive Committees **under the CIPM MRA**⁴
- Recent advancements in the field of laser spectroscopy have enabled real-time measurements of GHG in the atmosphere creating an **immediate demand for a robust metrological measurement infrastructure** to underpin this growing amount of atmospheric monitoring data

2 CCQM Isotope Task Group

- The Gas Analyses Working Group (GAWG) and the Isotope Ratio Working Group (IRWG), both part of the Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology (CCQM), have founded a joint task group on **Stable Isotope Ratio Metrology for Atmospheric Source Apportionment** in 04/2023
- Tasks to facilitate the development of a robust measurement infrastructure include **engaging with stakeholders to develop best practise guidelines**; **harmonising current calibration hierarchies**; supporting CCQM GAWG/IRWG and BIPM HQ on the **development of comparison protocols** to improve **gas isotope reference materials (RMs)**; and **review alternative traceability schemes** including to the SI
- The focus of the task group will be on measurements of: $\delta(^{13}\text{C}/^{12}\text{C})$ in CO_2 and CH_4 , $\delta(^{18}\text{O}/^{16}\text{O})$ and $\delta(^{17}\text{O}/^{16}\text{O})$ in CO_2 , $\delta(^2\text{H}/^1\text{H})$ in CH_4 and the isotope ratios $R(^{13}\text{C}/^{12}\text{C})$, $R(^2\text{H}/^1\text{H})$, $R(^{17}\text{O}/^{16}\text{O})$ and $R(^{18}\text{O}/^{16}\text{O})$ in CH_4 and CO_2



3 Workshop

- A foundational workshop was held in 10/2023 at Laboratorio Tecnológico del Uruguay in Montevideo to map the stakeholder needs, understand the challenges hindering global data compatibility and **prioritise actions by the task group**
- The hybrid **workshop was attended by 100 experts** from NMIs & DIs, instrument manufactures, speciality gas suppliers, as well as members of the atmospheric monitoring community
- The workshop resulted in a **set of recommendations** shown in the table below

Area	Activity
Carbonate- CO_2	Pilot study in 2025/26 to quantify variability and uncertainty. Development of best practises for carbonate digestion as a result.
Pure CO_2	Support development of ease-of-use pure CO_2 reference materials (RMs)
CO_2 in air	Standardisation of CO_2 -air scale realisation, stability, best practises for the preparation of isotopic reference material, CCQM-P239 in 2025
SOP for optical analysers	Consolidate current and develop new best practises for calibration
Quality management systems	Support QMS practises with isotope laboratories, ICOS, WMO GAW CCL labs
CH_4 (pure and in air)	Develop comparison protocols for gas isotope reference material
Others	Support efforts for SI-traceable isotope reference materials as well as expanding range of existing RMs for ice-core and $\Delta^{17}\text{O}$ (CO_2) triple oxygen measurements

4 Ongoing Activities

- Priority task areas have been chosen and terms of reference have been developed, namely i) **Standardisation of optical isotope ratio analyser calibrations practises** and ii) **NMI/DI's calibration and measurement capability requirements for atmospheric CH_4 stable isotope ^{13}C and ^2H ratio measurements**
- White paper entitled “Developing Calibration and Measurement Capabilities for Atmospheric CH_4 Stable Isotope Ratios at NMIs/DIs: Metrology for Global Comparability by **Srivastava et al.** is **currently under review**
- Survey launched mapping the global measurement capabilities for stable isotope ratio of methane (CH_4)** and documenting the communities’ requirements for meaningful metrological support

References

- ¹ Scripps CO_2 Program
² WMO/GAW network compatibility goals (Table 1)
³ CCQM-P204 report
⁴ CCQM traceability exception

