WCC and QA/SAC activities and GHG observation by JMA

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Summary

1. In the CH_4 round-robin conducted over the last decade, almost all laboratories have shown a good agreement within the GAW compatibility goal of ±2ppb [9] after applying conversion factor [1][7].
2. The differences of CH_4 mole fraction at MNM between flask data of each laboratory and JMA in-situ data are about ＋3.5±3.3 ppb and ＋3.7±2.6 ppb for AIST and NIES, respectively. These values agree well with the differences between the standard gas scales used for atmospheric observations, which are derived from Inter-Comparison Experiments for Greenhouse Gases Observation (iceGGO) conducted during the period from 2012 to 2016 [7].
3. And also, there are not significant time-dependent trend of the differences within 95% confidence interval.
4. These results indicate that JMA, AIST, and NIES have maintained quality of the CH_4 observation for a long time.
5. JMA has been systematically measuring HFCs (Hydrofluorocarbons) at Minamitorishima GAW Global station since 2020.

CH_4 Inter-comparison (round-robin) experiments

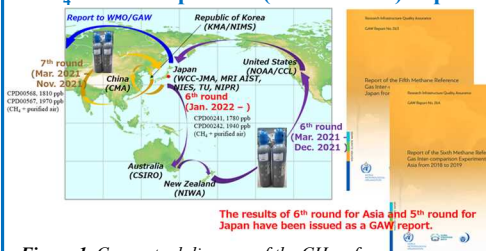

Figure 1. Conceptual diagram of the CH_4 reference gas inter-comparison (round-robin) experiments.

The Japan Meteorological Agency (JMA) serves as the World Calibration Centre (WCC) for methane (CH_4) and the Quality Assurance/Science Activity Centre (QA/SAC) for carbon dioxide (CO_2) and CH_4 in Asia and the South-West Pacific within the framework of the Global Atmosphere Watch (GAW) Programme of the World Meteorological Organization (WMO).

The WCC-JMA organized seven rounds of the CH_4 reference gas inter-comparison experiments from 2001 to 2022 as one of the WCC activities in Asia and the South-West Pacific in cooperation with NOAA (WMO/CCL, USA), CSIRO (Australia), NIWA (New Zealand), CMA(China), KMA/KRISS (Republic of Korea), IITM (India), MRI (Japan), NIES (Japan), AIST (Japan), NiPR (Japan), JAMSTEC (Japan) and Tohoku University (Japan); the sixth and the seventh round are still in progress (**Figure 1**).

Comparison results

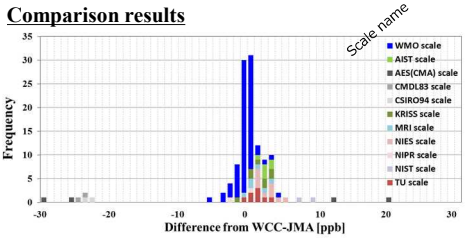

Figure 2. Frequency distributions of the differences from WCC-JMA (WMO scale) in the 7 round-robin experiments. The differences mostly distribute within ± 5ppb, but some measurements are largely deviated with the range of -30 to 20 ppb, due mainly to differences of CH_4 calibration scales.

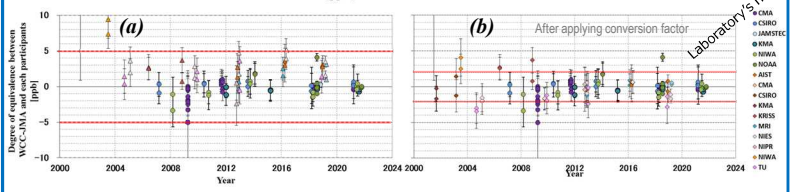

Figure 3(a)(b). Temporal variations of the differences between WCC-JMA and each participant in the 7 round-robin experiments from 2001 to 2022. In the right figure, the measurement results by each institution are converted to the WMO mole fraction scale using conversion coefficients [1][7].

➡ Summary 1

JMA's HFCs observation at MNM

JMA has been systematically measuring HFCs (Hydrofluorocarbons) at Minamitorishima GAW Global station since 2020 (**Figure 6**), as it relates to the Kigali amendment to Montreal protocol that restricts the production and emission of HFCs. HFCs are known as highly potent greenhouse gases and we observe the 8 species that have the biggest contribution to the Global Warming (**Figure 7**).

Figure 6. JMA's HFCs observation system

➡ Summary 5

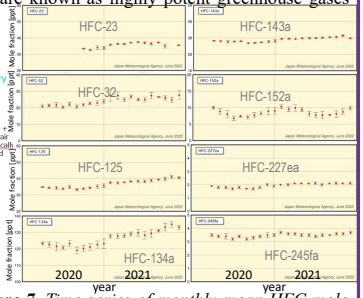

Figure 7. Time-series of monthly mean HFC mole fractions at JMA's Minamitorishima Station.

JMA (in-situ) and AIST/NIES Flask Air Inter-comparison at MNM

Figure 4. Location of Minamitorishima island and ground-based GHG observation stations of JMA

In addition to the GAW-centre activities, the JMA has made long-term continuous observations of atmospheric mole fractions of major greenhouse gases such as CO_2 and CH_4 at Minamitorishima GAW Global station (MNM) since 1993 (**Figure 4**). Since 2011, other major observation laboratories in Japan have been systematically measuring O_2 / N_2 ratios, stable isotopes of CO_2, and other trace gas species using a flask sampling method that JMA doesn't observe at MNM. They also measure CO_2 and CH_4 mole fractions in the same sample. By comparing the data between JMA and these laboratories, we can evaluate the consistency of CO_2 and CH_4 observations (**Table 1**).

***Table 1.** Overview of CH_4 observation at MNM. Each laboratory collects air samples independently and ships flask samples to their laboratories for analysis.*

Lab	Sampling type	Sampling frequency	Measurement method	Instrument	Measurement Scale
JMA	in-situ	Analyzed every 10 minutes	GC/FID	Round Science Inc. RGC-1	WMO CH_4 X2004A Scale
AIST	flask	Fill the flask with ambient air up to 0.3 MPa in minutes once a week	GC/FID	GC-14BPF (FID), Shimadzu	AIST Scale
NIES	flask	Fill the flask with ambient air up to 0.15 MPa in minutes twice a month	GC/FID	HP7890 (FID), Agilent	NIES 94 CH_4 Scale

Data screening and analysis method

Step 1. Extract "JMA in-situ data" observed at the closest time to the flask sampling
Step 2. Calculate the differences between "flask data of each laboratory" and "JMA in-situ data"
Step 3. Calculate the standard deviation (σ) of the differences calculated in step 2
Step 4. Select data within the three standard deviations (3σ) calculated in step 3
Step 5. Calculate the mean of differences for the data selected in step 4

Comparison results

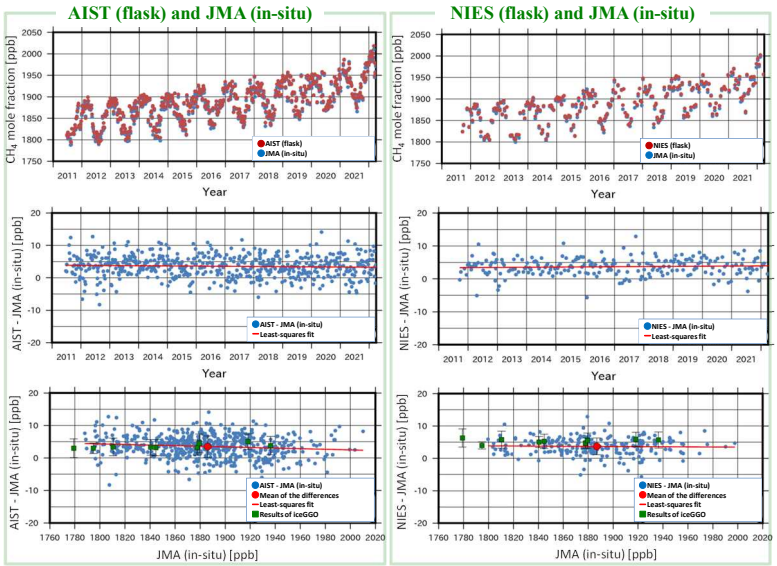

Figure 5. Comparison results of greenhouse gas observation data from different institutions and different methods at the same station. The upper two graphs show the temporal variations of CH_4 concentrations observed by each laboratory. The middle two graphs show the temporal variations of differences between "flask data of each laboratory" and "JMA in-situ data". The lower two graphs show the concentration dependence of the differences between "flask data of each laboratory" and "JMA in-situ data". The green squares show the differences between the standard gas scales used for atmospheric observations, which are derived from the iceGGO cylinder comparison [7].

➡ Summary 2, 3, 4

Acknowledgements

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References

[1] Dlugokencky et al. (2005): Conversion of NOAA atmospheric dry air CH4 mole fractions to a gravimetrically prepared standard scale, J. Geophys. Res., 110, D18306, doi:10.1029/2005JD006035.
[2] Matsueda (1993): Intercalibration experiment of methane standard gas scale between NOAA/CMDL and MRI/GRL, Papers in Meteorology and Geophysics, 44, No.2, 45-56, 1993.
[3] Matsueda et al. (2018): Evaluation of a new methane calibration system at JMA for WCC Round Robin experiments, Pap. Meteorol. Geophys. 67, 57-67, doi:10.2467/mripapers.67.57.
[4] Matsueda et al. (2004): Methane standard gases for atmospheric measurements at the MRI and JMA and intercomparison experiments. Pap. Meteorol. Geophys., 54, 91-109, doi:10.2467/mripapers.54.91.
[5] Tsuboi et al. (2013): Evaluation of a new JMA aircraft flask sampling system and laboratory trace gas analysis system. Atmos. Meas. Tech., 6, 1257−1270, doi:10.5194/amt-6-1257-2013.
[6] Tsuboi et al. (2016): Scale and stability of methane standard gas in JMA and comparison with MRI standard gas, Pap. Meteorol. Geophys., 66, 15-24, doi:10.2467/mripapers.66.15.
[7] Tsuboi et al. (2017): InterComparison Experiments for Greenhouse Gases Observation (iceGGO) in 2012–2016, Technical Reports of the Meteorological Research Institute, No.79, 1-72, doi:10.11483/mritechrepo.79.
[8] World Meteorological Organization (WMO), 2016: 18th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and Related Measurement Techniques (GGMT-2015), No.229, 104-109.
[9] World Meteorological Organization (WMO), 2020: 20th WMO/IAEA Meeting on Carbon Dioxide, Other Greenhouse Gases and Related Measurement Techniques (GGMT-2019), No.255, 4-7.
[10] World Meteorological Organization (WMO), 2021: Report of the Fifth Methane Reference Gas Inter-comparison Experiment for Japan from 2018 to 2019, No.263
[11] World Meteorological Organization (WMO), 2021: Report of the Sixth Methane Reference Gas Inter-comparison Experiment for Asia from 2018 to 2019, No.264