The 7th Asia-Pacific GAW Workshop on Greenhouse Gases

Oct. 22-23, 2015 / Jeju, Republic of Korea
Hosted by **KMA**

KMA Korea Meteorological Administration

GAW Global Atmosphere Watch

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Program

Time		Program
10.22. (Thur)	09:00–09:30 ('30)	Registration / Coffee Break
	9:30–10:20 ('50)	**Welcome(MC Chulkyu Lee)** Welcome speech • ('5) Hee-Dong Yoo, Director General of Climate Science Bureau, KMA • ('5) Oksana Torasova, Chief of AER/RES Keynote • ('30) Martin Schultz: Reactive gases in the GAW program Photo • ('10) Photo
	10:20–12:00 ('100)	**Session1: Station and network activities of greenhouse gases (Chiar Marcel van der Schoot)** ① ('20) Korea : Chulkyu Lee • Recent activities on Global Atmosphere Watch in Korea ② ('20) Japan : Yoki Mori • The JMA activities and network for GHG observation and recent topics ③ ('20) India : Yogesh Tiwari • Continuing efforts on greenhouse gases monitoring and modeling in India ④ ('20) South Africa : Lynwill Martin • N_2O and SF_6 trends as observed at Cape Point, South Africa ⑤ ('20) Korea : Taeyoung Goo • Improved FTS measurement for remotely-based CO_2 retrieval
	12:00–13:20 ('80)	Lunch
	13:20–15:20 ('120)	**Session2: Station and network activities of greenhouse gases (Chiar Lingxi Zhou)** ① ('20) Australia : Scott Chambers • Improving the representation of cross-boundary transport of anthropogenic pollution in Southeast Asia using Radon-222

Time		Program
10.22. (Thur)	13:20–15:20 ('120)	② ('20) Malaysia : Aminah Ismail • Monitoring Carbon Dioxide and other Greenhouse Gases in GAW Danum Valley Station ③ ('20) Vietnam : Han Thi Ngan • Advantages and difficulties of greenhouse gases observations at the national hydro-Meteorology service (NHMS), Vietnam ④ ('20) Australia : Marcel van der Schoot • GHG Observation Capability Developments and Research Applications at Cape Grim Baseline Air Pollution Station (from 1970's air archiving to 2015 laser absorption) ⑤ ('20) Jordan : Haytham Malkawi • Monitoring methane (CH_4) and other greenhouse gas emissions in the sector of wastewater in Jordan ⑥ ('20) Indonesia : Agusta Kurniawan • N_2O measurement at global GAW station Bukitkototabang (indonesia) during period June 2013 to May 2014
	15:20–15:40 ('20)	Coffee Break
	15:40–17:00 ('80)	**Special Session: Greenhouse gas standard and its application (Chiar Yogesh Tiwari)** ① ('20) KRISS: Jeong-Soon Lee • Standards for greenhouse gas monitoring ② ('20) China: Lingxi Zhou • WMO/IAEA 6th Round Robin inter-comparison and related progress ③ ('20) Kyungpook National University: Shanlan Li • In situ monitoring of halogenated compounds at Jeju Island, Korea; Chemical evidence of inter-hemispheric air intrusion in the mid-latitudes ④ ('20) Yeonsei University: Jinwoong Kim • Estimattion of surface CO_2 flux and observation impact using carbon tracker
	17:00–17:30 ('30)	Break
	17:30–19:30 ('120)	Banquet
10.23. (Fri)	9:00–11:30 ('150)	Technical tour of Gosan station

Reactive gases in the GAW program

Martin G. Schultz* and the GAW Science Advisory Group on reactive gases

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Long-term observations of reactive gases in the troposphere are important for understanding trace gas cycles and the oxidation capacity of the atmosphere, assessing impacts of emission changes, verifying numerical model simulations, and quantifying the interactions between short-lived compounds and climate change. The World Meteorological Organization's (WMO) Global Atmosphere Watch (GAW) program coordinates a global network of surface stations some of which have measured reactive gases for more than 40 years. Gas species included under this umbrella are ozone, carbon monoxide, nitrogen oxides, and volatile organic compounds (VOCs). There are many challenges involved in setting-up and maintaining such a network over many decades and to ensure that data are of high quality, regularly updated and made easily accessible to users. This overview describes the GAW surface station network of reactive gases, its unique quality management framework, and discusses the data that are available from the central archive as well as their integration with data from regional networks. Highlights of data-use from the published literature are reviewed, and a brief outlook into the future of GAW is given.

Reference

[1] Schultz M.G., Akimoto H., Bottenheim J., et al. (2015). The Global Atmosphere Watch reactive gases measurement network.*Elementa – Science of the Anthropocene*, in press.

Recent Activities on GAW in Korea

Chulkyu Lee*, Haeyoung Lee, Sangsup Park, Mi-Jeong Shim, Jeongsoo Kim, Mae-Hyang Lee, Bok-Haeng Heo, Hee-Dong Yoo, Sang-Ok Han, Han-Cheol Lim, Hyuk-Je Lee, Je-Gyu Yu, Hee-Jung Yoo, Hee-Jong Rho, Sang-Boom Ryoo

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Regarding with the GAW related activities,KMA focuses on measurement stations, atmospheric measurement variables,the GAW central facility, World Calibration Centre for SF_6 (WCC-SF_6), and integration of GAW-related activities in the Korean Peninsula. KMA has three main measurement stations, which are located in the west (at Anmyeon), south (at Gosan), and east (at Ulleungdo) of Korea, in aim of monitoring of transportation of the atmospheric substances and variation in the atmospheric composition over the Korean Peninsula. From the measurement stations, KMA collects the atmospheric observation data of 37 components in the fields of greenhouse gases, aerosols, reactive gases, stratospheric ozone, precipitation chemistry, and atmospheric radiation including UV radiation, in accordance with the measurement recommendations of GAW program. To enhance the effectiveness and application of the long-term measurements within GAW, KMA cooperates with the atmospheric measurement networks worldwide along with focusing on the quality assurance and control.WCC-SF_6 was designated to be established in KMA in 2012, and has been operated since 2013. WCC-SF_6 conducts the missions for the traceability and compatibility of the SF_6 measurements in the GAW network. In practice its missions has been initiated in 2014 and first applied to the Korean domestic stations in 2014. It covers the stations at the Asia-Pacific region in 2015. The Korea Aerosol LIDAR Observation Network (KALION) has been constructed through integrating the LIDAR observation sites which are operated by 11 institutes includingKMAin Korea. It is to cope with aerosol-related environmental issues in the atmosphere, e.g., smog and haze, originating both from the Asian Continent and in Korea. The KALION, which consists of 14 sites in the Korea Peninsula, produces the vertical information on aerosols in real time, e.g., classification of aerosols and mass concentrations as well as optical properties. The KALION has a plan to cooperate with GAW Aerosol LIDAR Observation Network (GALION) in near future.The Asia-Pacific GAW Workshop on Greenhouse Gases (APGG) has annually been held by KMA since 2009. The APGG has been designed to introduce the measurement technologies, quality control/assurance methodologies, and new monitoring stations as well as to share major research findings.The APGG has become a venue for cooperation on the greenhouse gases (GHGs) activities. It provides a good opportunity to share our knowledge on greenhouse gas measurements. The workshop is in connection with the technical training/education course in part of the WCC-SF_6 activities.

The JMA activities and network for GHG observation and recent topics

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Kohshiro Dehara[1], Shuichi Hosokawa[1], Teruo Kawasaki[1], Hiroshi Koide[1],
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The Japan Meteorological Agency (JMA) has been operationally monitoring atmospheric greenhouse gases (GHG) in the western North Pacific region under the Global Atmosphere Watch (GAW) Programme using 3 ground-based stations, 2 research vessels and an aircraft. In the ground-based station, we began continuous GHG observation in Ryori (RYO, GAW regional station) located at the northern part of Japan in 1987. We have made observations in Minamitorishima (MNM, GAW global station), where is the easternmost island far from industrial activities, since 1993, and in Yonagunijima (YON, GAW regional station), where is the westernmost island near continent, since 1997. We have been continuing the long-term observation over nearly 30 years. In 2011, we began aircraft observation in the mid-troposphere at an altitude of about 6kmfrom Atsugi air base near Tokyo to MNM once a month. This observation is made by using a cargo aircraft C-130H of the Japan Ministry of Defense (Tsuboi et al., 2013, Niwa et al., 2014). The data obtained in these observations have been published in the world through the World Data Centre for Greenhouse Gases (WDCGG) operated by the JMA, and widely used in the latest studies.

The JMA is proceeding joint research by sharing platforms with domestic research organizations. It will enhance the value of the data and help quality check. Specifically, we have been conducting the observation of Radon-222 in ground-based stations with the Meteorological Research Institute (MRI)since 2007(Wada et al., 2013). In addition, several co-operative research groups（MRI, National Institute for Environmental Studies (NIES) and National Institute of Advanced Industrial Science and Technology (AIST)）have joined us at MNM for flask measurementssince 2011. We have been measuring O_2/N_2, isotopic composition of CO_2, halocarbons and SF_6 in this research. Through such cooperation, we have been extending the observation parameters. The data obtained in this activity will be reported to WDCGG from each researcher.

The JMA operates the World Calibration Centre (WCC) for Methane (CH_4) in Asia and the South-West Pacific within the framework of the GAW. We have been working to ensure the traceability of CH_4 standard gases and to improve the quality of CH_4 observation in this region by intercomparison.

In this presentation, we will introduce the JMA observation network and activities which the JMA has been doing under the GAW programme and show recent topics.

Reference

[1] 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.*

[2] Niwa et al. (2014), Seasonal Variations of CO_2, CH_4, N_2O and CO in the Mid-Troposphere over the Western North Pacific Observed Using a C-130H Cargo Aircraft, *J.Meteorol. Soc. Japan, 92(1), 55-70, doi:10.2151/jmsj.2014-101.*

[3] Wada et al. (2013), Quantification of emission estimates of CO_2, CH_4, and CO for East Asia Derived from atmospheric radon-222 measurements over the western North Pacific, *Tellus B 2013, 65, 18037, doi:10.3102/tellusb.v65i0.18037.*

Continuing efforts on greenhouse gases monitoring and modeling in India

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India has one of the largest and fastest growing economies in South Asia and is emerging as a major contributor to CO_2 emissions among developing nations. However, there has been relatively little monitoring of atmospheric CO_2 over India to date. The Carbon Dioxide Information Analysis Center (CDIAC), USA, estimates the total fossil-fuel CO2 emissions from India as 189 TgC in 1990, 324 TgC in 2000, 385 TgC in 2005 and 508 TgC in 2009, and the annual rate of increase as ~7% per year during 2005-2009. Some of these emissions may be compensated by vegetation uptake. According to a report published in May 2010 by the Ministry of Environment and Forest (MoEF), Govt of India, the total greenhouse gases emissions in India have grown from 1252 million tons in 1994 to 1905 million tons in 2007 at a compounded annual growth rate of 3.3%. Between 1994 and 2007, some of the sectors indicate significant growth in GHG emissions such as cement production (6.0%), electricity generation (5.6%), and transport (4.5%). In order to improve our understanding in this field, we are involved in: i) ambient CO_2 and other GHGs monitoring at the surface ii) air sample analysis using WMO/GAW calibration standards, iii) airborne campaigns at different locations iv) carbon flux monitoring at different ecosystems in India v) CO_2 transport as well as lagrangian particle dispersion modeling activites, etc. Present study is an attempt to analyze available CO_2 and other GHGs observations and model simulations over India which may help to improve our understanding on GHGs variability and CO2 sources and sink estimate over this region.

N_2O AND SF_6 MONITORING AT CAPE POINT GLOBAL ATMOSPHERE WATCH (GAW) STATION: SOUTH AFRICA

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The Cape Point (CPT) Global Atmosphere Watch (GAW) station has a history of more than 30 years of atmospheric trace gas data, which are representative of southern hemispheric mid-latitudes of the Atlantic Ocean. Measurements include all the climatic significant greenhouse gases as well as certain reactive gases such as carbon monoxide (CO) and surface ozone (O_3).

Here we report for the first time on the CPT N_2O and SF_6 time series which started in 1994 and 2010 respectively at CPT. Furthermore, averages of monthly medians for SF_6showed an increasing trend for the past 5 years which was also observed at other GAW stations. Similar for N_2O, the observed trends and growth rates at CPT are in good agreement with what is being observed globally for this greenhouse gas.

Improved FTS Measurement for Remotely-based CO_2 Retrievals

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National Institute of Meteorological Research, KMA

The National Institute of Meteorological Research has operated a ground-based Fourier Transform Spectrometer (FTS) at Anmyeondo, Korea since December 2012. Anmyeondo FTS site is a Total Carbon Column Observing Network (TCCON) operational station. The FTS is IFS-125HR model which is manufactured by the Bruker, Gremany. Instrument specification is almost same as the TCCON configuration such as a spectrum range of 3,800~16,000 cm^{-1}, a resolution of 1 cm^{-1}, InGaAs and Si-Diode detectors and CaF_2 beam splitter.

The Observation and Analysis System on Intensity of Sunray (OASIS) is developed by the NIMR. The OASIS has a merit to control the solar intensity for example eliminations of noise andinstantly sharp variation due to scattering and absorption. Since the operation of the OASIS, the accuracy and stability of spectrum measurement has remarkably improved.

FTS CO_2 retrieval algorithm which is the latest version of GGG released in 2014 was employed. Site-specific input data such as weather parameters (pressure, temperature, wind speed and wind direction) and surface pressure were used and model-related background information was based on NCEP reanalysis which has 17 layers from 1000 to 10 hPa. After cloud filtering to exclude the spectra contaminated by cloud, XCO_2 was retrieved and was validated against ground- and aircraft-based in-situ measurements using the Cavity Ring-Down Spectroscopy analyzer manufactured by Picarro.

Acknowledgement

This study is supported by the Development and Application of Methodology for Climate Change Prediction [NIMR 2012-B-2]. Data from Ground-based in-situ CO2 measurement were produced by the Korea Global Atmosphere Watch Center.

Improving the representation of cross-boundary transport of anthropogenic pollution in Southeast Asia using Radon-222

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Anthropogenic emissions are integrated by, and mixed within, the atmospheric boundary layer (ABL). In the absence of removal mechanisms such as fronts or deep convection, constituents not subject to dry/wet deposition or chemical transformation remain in the ABL long enough to travel large distances to different geo-political regions. This is particularly pertinent in Southeast Asia, where political boundaries are close and rapid industrialisation, economic growth, and increasing energy and transport demands have resulted in a disproportionately large fraction of global anthropogenic emissions in recent decades.

The most holistic understanding of anthropogenic emissions and their effects is achieved by coupling models, inventories and remote sensing. Ideally, subsequent results are evaluated against ground-based measurements with a view to iterative improvement of model representations or inventory data. To ensure meaningful comparisons, ground-based reference observations need to be as representative as possible of fetch regions of interest.

We report on 10 years of hourly atmospheric radon, CO, and SO_2 observations at Gosan Station, Korea. A technique is described whereby radon concentrations can be used to select air masses most representative of emissions across a fetch region. Radon is also used to demonstrate and characterise contamination of remote-fetch pollution observations by local emissions at Gosan. For days on which diurnal cycles are evident, a seasonally-varying diurnal sampling window is proposed to minimise these effects. Based on a subset of observations most representative of the remote fetch regions, and least affected by local emissions, seasonal estimates of CO and SO_2 originating from South China, North China, Korea and Japan are provided, and compared across the decade of observations. By comparison, traditional approaches underestimate emissions from North and South China, and overestimate emissions from Japan.

Monitoring Carbon Dioxide and other Greenhouse Gases in GAW Danum Valley Station

Aminah Ismail*, Mohd Firdaus Jahaya, and Maznorizan Mohamad

MetMalaysia, Malaysia

Danum Valley, Malaysia has been established as GAW station since 2003. As a background monitoring station, Danum Valley has participated in Greenhouse Gases (GHG) monitoring program such as Carbon Dioxide (CO_2) and other elements of GAW focal areas. The main objective of this study is to observe the pattern of CO_2 concentration at Danum Valley Station for the first 6 months of 2015, as well as to show the comparison of the short term pattern data from two different instruments - (Lo Flo Mark II CO_2 Analyzer and CO_2 continuous measurement instrument by NIES). This study will also focus on the pattern of CO_2 concentration and fluctuation in different areas such as Sepang, Tawau and Kota Kinabalu. In addition, the result also will be compared with other tropical GAW Stations within the same time frame. The methodology used is the time series analysis to observe the pattern diurnally and monthly. The monitoring of GHG is important to provide the information on the changes in atmospheric composition in the forest that may affect the flora and fauna. Besides, the information will guide to better understanding with regard to the patterns of absorption and emission of GHG in tropical forests.

Reference

[1] Castanho, A. D. D. A., Galbraith, D., Zhang, K., Coe, M. T., Costa, M. H., & Moorcroft, P. R. (2014, December). The Influence of Atmospheric CO2 Concentration and Climate Variability on Amazon Tropical Forest. In *AGU Fall Meeting Abstracts* (Vol. 1, p. 04).

[2] Maznorizan Mohamad et al. (2012). The Measurement and Analysis of Greenhouse Gases at GAW Station in Danum Valley, Malaysia, *Asian GAW Greenhouse Gases Newsletter*, Volume No. 3: 22-30.

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Advantages and Difficulties of Greenhouse Gases Observations at the National Hydro-Meteorology Service (NHMS), Vietnam

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National Hydro-Meteorology Service, Vietnam

The hydro-meteorological sector was established in Vietnam more than 100 years ago. On the 25th April, 1900, the Governor of Indochina issued Decree No. 421 that approved the construction of the Indochinese Department of Meteorology's main building at Phu Lien Hill (Kien An District, Hai Phong City), both the design and the construction of which were done by the French. Since then, along with the rise and fall of the national history, the hydro-meteorology sector in Vietnam has been maintained and developed. Vietnam's hydro-meteorological sector joined the World Meteorological Organization (WMO) on the 7th May, 1975, which was its mark of integration and international cooperation.

At present, there are 194 meteorological stations and 233 hydrological ones. The position of each station was scientifically investigated. Their operation has been carried out according to basically good conditions. Through years, their sets of data have become a very useful reference for weather forecast, climate change monitoring, environmental protection, and scientific researches. Therefore, the use of these stations in observing greenhouse gases was taken into account in order to take full advantage of these stations in facilities, human resources, and favorable observation positions.

However, until now, only 11 stations carry out greenhouse gases observations. Apart from advantages mentioned above, this paper will also point out difficulties that the greenhouse gases observation has met during the last 10 years since the work began, which are: 1) Many measurement instruments do not adapt to the climatic conditions in Vietnam; 2) Both calibrated gas and accessories must be imported, which has sometimes led to untimely supply of spare parts; 3) Cost of maintenance for one station is high in the context of Vietnam's developing economy; 4) High technology has not been regularly updated; and 5) Experience of work management and operation is still deficient. Some proposals based on these facts will also be put forward in the paper for the purpose of improving the quality and effect of greenhouse gases observation in Vietnam.

Keywords: greenhouse gases, greenhouse gases observation, meteorology, environment

GHG Observation Capability Developments and Research Applications at Cape Grim Baseline Air Pollution Station (from 1970's air archiving to 2015 laser absorption)

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The WMO/GAW Cape Grim Baseline Air Pollution Station (CGBAPS) is the central reference observation site in the expanding Australian regional Greenhouse Gas Observation Network (AGGON). Cape Grim was established in the mid-1970's with an ex-NASA caravan as a laboratory, setup on a windy hill in north-west Tasmania. In 1978 Dr. Paul Fraser started the collection of air samples from this site, which continues to this day, forming a continuous air archive - aninvaluable resource for unique atmospheric composition studies. This presentation will show some of the historical developments in the CGBAPS GHG program, up to recent developments and research applications, whichinclude new *in situ* analyzers for N2O/CO and 13CO2/12CO2 using Quantum Cascading Lasers (QCL) (Aerodyne, QC-TILDAS).

A key research application of CGBAPS is to monitor changes in the efficiency of the Southern Ocean CO2 sink using a well inter-calibrated, high precision, Southern Ocean atmospheric observation sub-network. The atmospheric data from this network are dominated by regional ocean-atmosphere exchange, making this an important top-down complement to ocean-based Southern Ocean carbon observation and modelling research. Recent analysis of this data has revealed small but consistent diurnal and seasonal variations that will improve our understanding of Southern Ocean CO2 exchange such as that related to biological production.

In addition to the ground-based AGGON, a new CSIRO Australian Marine National Facility blue water research vessel, the RV Investigator, was recently commissioned with dedicated atmospheric observation capability on-board. This includes in situ N2O/CO (Aerodyne, QC-TILDAS) and CO2/CH4 (CRDS) (Picarro, G2300) analysers in the GHG program. This new capability offers a unique opportunity for collaborative atmospheric-focussed research and campaigns to be undertaken in relation to the Southern Hemisphere oceans, sea-ice zones and coastal and tropical regions.

The status of these new developments will also be presented here, including a selection of data and results from recent network developments.

Monitoring Methane (CH_4) and other Green House Gas (GHG) emissions in the sector of Wastewaterin Jordan.

Haytham Malkawi*

Royal Department for Environmental Protection, Jordan

This study is made with reference to short term assignment for the preparation of Jordan's Green House Gas (GHG) emissions by source and removals by sinks with the UNDP for the wastewater sector.

The work done in order to complete this study is identifying the Sources of GHG emissions within the Sector which are the domestic/commercial treatment plants and the industrial treatment plants, the data sources for this sector are the Jordan Water Authority, Jordan Industrial Estates Company, Jordan Petroleum Refinery& the Department of statics. And after identifying the data to be collected about the sector and the methodology of collection, processing and reporting. And finally Collecting the data requested for the Inventory of the Sector, Preparing the inventory of anthropogenic greenhouse gas emissions by sources and removals by sinks for 2006 Using the 1996 IPCC GL.

Thehandling of wastewater streams with high contents of organic material, including domestic and commercial wastewater and some industrial wastewater streams can emit significant amounts of methane

The principal factor that determines methane generation potential ofWastewater is the amount of organic material in the wastewater stream.For domestic and commercial wastewater and sludge, this is indicated bythe Biochemical Oxygen Demand (BOD); for industrial wastewater, the Chemical Oxygen Demand (COD) is used.The quality of CH_4 emissions estimates for wastewater handling is directly related to the quality and availability of the waste management data used to derive these estimates.

References:

[1] IPCC, 1997. Revised 1996 Guidelines for National Greenhouse Gas Inventories.
[2] Water Authority of Jordan (WAJ) Annual report 2006 of Directorate of Operating Wastewater Systems.
[3] Jordan Industrial Estates Company.
[4] Jordanian Department of Statistics Annual reports.

N_2O MEASUREMENT AT GLOBAL GAW STATION BUKIT KOTOTABANG (INDONESIA) DURING PERIODE JUNE 2013 TO MAY 2014

Agusta Kurniawan*

The Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG)
Global Atmosphere Watch (GAW) Station Bukit Kototabang – Indonesia

N_2O measurement has been done at Global GAW Station Bukit Kototabang (Indonesia). Measurement conducted using Thermo Scientific™ IRIS 4600 Mid-IR Laser-Based N_2O Analyzer.The Principle of the measurement is Tunable Diode Laser Absorbance Spectroscopy (TDLAS). Measurement started since June 2013 and still running well until recent. Mixing Ratio of N_2Oin monthly aggregate during period of June 2013 to May 2014 showed two peaks,smaller peak occur aroundin July-September 2013 and higher peak occur around in January-March 2014.Those happened perhaps because of intensity of the farming/agriculture activity near our observatory.

Keyword: RIS 4600 Mid-IR Laser, TDLAS, Bukit Kototabang

Reference

[1] Ken Soleyn, 2009, Development of a Tunable Diode Laser Absorption Spectroscopy Moisture Analyzer for Natural Gas, Gas 2009 Rotterdam, page 1-13

[2] Dianna signor and Carlos Eduardo Pellegrino Cerri, 2013. Nitrous Oxide emissions in agricultural soils: a review. PesqAgropcc Trop., Goiania, vol 43, no.3 p. 322-338, jul.set. 2013, e-ISSN 1983-4063 – online www.agro.ufg.br/pat

Standards for greenhouse gas monitoring

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For the purpose of accurate monitoring of GHGs, it is essential to have a accurate standard gas mixtures with highly qualified and global scale. We have developed the standard gas mixtures by using a gravimetric method since 2002 and those of carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, carbon monoixide and 3 chloro-fluorocarbons are now available. Their specifications are introduced and some some results obtainedfrom the CCQM Key comparisonsare presented.

WMO/IAEA 6th Round-Robin Inter-comparison and related progress

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2. National Oceanic and Atmospheric Administration, Earth System Research Laboratory, USA

The primary goal of the WMO/IAEA Round Robin Comparison Experiment is to assess the level to which participating laboratories maintain their link to the WMO scales using normal operating procedures. Maintaining a direct link to the WMO scales and successfully propagating the scales to working laboratory scales are fundamental to the measurement process and to achieving the desired levels of compatibility between laboratories as specified by the GGMT meetings.

A dedicated website (http://www.esrl.noaa.gov/gmd/ccgg/wmorr) was developed and works well which covers General Information (Documentation & Guidelines), Products (Archived Results & WMO Reports), Current Round Robin (Instructions, Participants, Calibration Scales, Cylinders, Time-Table, Status, and Reporting function such as Account Information, Cylinder Arrival, Cylinder Shipping and Measurement Results) as well as Contact & Feedback. Participants will no longer report results directly to the WMO/IAEA RR referee.

The 6th Round Robin started in January 2014 and officially closed on 7 September 2015. Laboratories in each of the 5 circuits (Circuit 1: 13 labs, Circuit 2: 8 labs, Circuit 3: 10 labs, Circuit 4: 11 labs, Circuit 5: 6 labs) received a set of two RR cylinders. As in previous RR, air in each cylinder is near ambient range of CO_2, CH_4, CO, H_2, N_2O, SF_6, O_2/N_2, and $\delta^{13}C$ and $\delta^{18}O$ of CO_2. The preliminary results reported by the participants will be posted to the dedicated RR website on 8 September (the week before the GGMT-2015).

40 Participating labs reported for CO_2, 36 for CH_4, 28 for N_2O, 18 for SF_6, 27 for CO, 10 for H_2, 15 for CO_2 stable isotopes, and 6 for O_2/N_2. For reference, the 5th RR had 39 labs for CO_2, 26 for CH_4, 21 for N_2O, 17 for SF_6, 23 for CO, 10 for H_2, and 10 for CO_2 stable isotopes. The 4th RR had 26 labs for CO_2, 12 for CH_4, 6 for N_2O and SF_6, 8 for CO, 2 for H_2, and 7 for CO_2 stable isotopes. Stability of cylinders in the period of 6th RR for CO_2, CH_4, CO, H_2, N_2O and SF_6 will be discussed. Because most participants reported uncertainty as one standard deviation about the mean of N measurements, the reference labs (e.g., NOAA, INSTAAR, NCAR) will report the one standard deviation estimate of the reproducibility. This is an easy way to ensure that uncertainties are reported in a consistent and meaningful way across all parameters. It is not terribly useful to send results once the RR results are made available to all participants because the experiment is no longer a blind.

In situ monitoring of Halogenated compounds at Jeju Island, Korea: Chemical evidence of inter-hemispheric air intrusion in the mid-latitudes

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Understanding and better prediction of the East Asian Summer Monsoon (EASM) are crucial, but difficult mainly due to its significant inter-annual variations, which have been generally explained by highlighting complicated zonal interactions between the Asian continent and the Pacific Ocean (PO). In contrast, meridional circulations and associated impacts on the EASM variations have been less recognized because it is impossible to establish a clear linkage between the rapid, large-scale air movements crossing the tropics and the EASM activity by usingconventional meteorological indices. Here we report high-precision and high-frequency 5-year record of hydroflorocarbons (HFCs) that first depicted direct, rapid intrusion of air mass from the Southern Hemisphere (SH) across the tropics reaching up to ca. 35°N as rapidly as a couple of days during the EASM. The SH air intrusion explained ca 42% of maritime EASM air masses, and was responsible for ca. 63% of the EASM precipitation unlike the conventional thinking on main moisture sources for the EASM. The HFCs records also demonstrated evidential differences corresponding to inter-annual and intra-seasonal variations of the EASM onset and intensity, and thus, providing new insight into multi timescale variations of EASM in context with its interactions with other climate systems.

Estimation of surface CO_2 flux and observation impact using the Carbon Tracker

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Estimation of the surface CO_2 flux is crucial to understand the mechanism of surface carbon source and sink. In Asia, there are large uptake regions such as forests in boreal and temperate regions.In this study, to diagnose the surface CO_2 fluxin the globe and Asia and the effect of CO_2 observations on an analysis of surface CO_2 flux, CO_2 observations were assimilated in the CarbonTracker (Peters et al., 2007) developed by National Oceanic and Atmospheric Administration (NOAA). The CarbonTracker is an inverse modeling system that estimates the surface CO_2 flux using an ensemble Kalman filter with atmospheric CO_2 measurements as a constraint. Different from the CarbonTracker developed by NOAA, a nesting domain centered on Asia was used with additional observations including in Asia. In addition, a diagnostic tool to calculate the effect of individual CO_2 observations on estimating the surface CO_2 flux was developed using the analysis sensitivity to observation and information content in the CarbonTracker framework (Kim et al., 2014).

The results showed that CarbonTracker works appropriately for estimating surface CO_2 flux. The nesting domain centered in Asia produces a detailed estimate of the surface CO_2fluxes and exhibited better agreement with the CO_2 observations in Asia. Additional observations including provide beneficial impact on the estimated surface CO_2 flux in Asia and Europe. The analysis sensitivity showed seasonal variations with greater sensitivities in summer and lower sensitivities in winter. Strong correlation exists between the information content and the optimized surface CO_2 flux.

Reference

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