MSD03-01 会場:201A 時間:5 月 22 日 09:05-09:25

GEOSS および GEO Grid の構築
Development of GEOSS and GEO Grid

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Global Earth Observation System of Systems "GEOSS" aimed to build the "system of systems" or the global earth observation collaboration where all satellite, aircraft, and in-situ observations of earth, which were individually gathered by countries, and all observation systems, earth datasets, prediction models, and services for earth are combined. The GEOSS 10-year Implementation Plan was drafted in Brussels in 2005, and its ultimate goal was to reflect the scientific findings obtained through earth observation collaboration in policies. Specifically, nine societal benefit areas including disaster, health, energy, climate, weather, water, ecology, biodiversity, and agriculture were selected, and immediate issues that must be solved within 10 years were extracted. While the GEO Grid, which is the AIST initiative, its concept and goal are similar to that of GEOSS. In the presentation, these activities and the relationships will be introduced.
Keywords: Global Earth Observation System of Systems, Group on Earth Observations, GEO Grid, GEO task

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GEO CL-02 task and activity of EMTech/AIST related to GEO carbon task
GEO CL-02 task and activity of EMTech/AIST related to GEO carbon task

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As shown in the web site of GEO (http://www.earthobservations.org/about_geo.shtml) GEO (Group on Earth Observation) is a voluntary partnership of governments and international organizations for the period 2005 to 2015. The Research Institute of Environmental Management Technology/AIST joined the carbon task of GEO since 2009. The carbon task is under the "climate" area, which is one of the nine social benefits areas. Now is in the last term and the strategic target of this area is,

Before 2015, GEO aims to: Achieve effective and sustained operation of the global climate observing system and reliable delivery of climate information of a quality needed for predicting, mitigating and adapting to climate variability and change, including for better understanding of the global carbon cycle.

There are two tasks under the climate area and one of them is "CL-02, Global carbon observation and analysis", which has only one sub-task "CL-02-C1: Integrated Global Carbon Observation and Analysis System". For this sub-task, Expected Achievements by 2015 is declared as follows.

-Global carbon monitoring networks improved and coordinated, toward a sustained and operational Integrated Global Carbon Observation and Analysis System by 2020.

-A Carbon portal (linked to the GEO Portal) as a single access point to the global carbon cycle data, containing a geo-referenced database and complying with the GEOSS Data Sharing Principles.

-Updates of global and regional carbon (CO_2 and CH_4) budgets, considering also fossil fuel emissions, provided annually, with a continuously reduced uncertainty.

-Improved methodologies for measuring and analysing carbon cycle data: develop agreed standards, improve Global Carbon Cycle Data Assimilation Systems (CCDAS); calibrate and validate space based observations.

-Provide easily understandable and accessible information and products, useful for decision makers and the general public.

The coordinator of this task is Antonio Bombelli (CCMS, Italy). However the coordination of the communities related above achievement is not always good, as pointed out at the work plan symposium at Geneva last year not only in Japan but in the world.

Keywords: Group on Earth Observation, carbon task

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GEO 炭素観測解析システムの整備とアジアにおける貢献の提案
GEO Carbon Observations and Analysis System and the idea of Asian contribution

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Recognizing the growing need for improved Earth observations, over 130 governments and leading international organizations are collaborating through the Group on Earth Observations (GEO) to establish a Global Earth Observation System of Systems (GEOSS) by the year 2015. They are contributing their respective Earth monitoring systems to GEOSS and interlinking these systems so that they work together better.

GEO through its Members and Participating Organizations, has begun work to implement a global carbon observation and analysis system addressing the three components of the carbon cycle (atmosphere, land and ocean) to provide high quality information on carbon dioxide (CO?) and methane (CH?) concentrations, and emission variations. By combining observations, reanalysis and product development we will be able to develop tools for carbon tracking and carbon storage evaluation, including improved global networks of atmospheric CO2 observations, airsurface exchange flux networks, as well as surface ocean CO2 and related marine biochemistry observations.

GEO Members and Participating Organizations: Australia, Canada, France, Japan, Netherlands, Norway, UK, Italy, USA (NASA,NOAA,USGS,USDA), Committee on Earth Observation Satellites (CEOS), European Space Agency (ESA), Food and Agriculture Organization (FAO) Global Climate Observing System (GCOS), Global Terrestrial Observing System (GTOS), World Meteorological Organization (WMO) and the World Climate Research Program (WCRP) are supporting the development of an integrated global carbon observation system.

In close collaboration with national governments, space agencies, and relevant technical experts, GEO will demonstrate this capability through the establishment of robust methodologies, satellite acquisition plans and a series of regional pilot studies, which will provide a template for a consistent and reliable global carbon monitoring system.

One of major activities is to foster the use of space-based greenhouse gas (GHG) observations and consolidate data requirements for the next-generation GHG monitoring missions. By establishing close cooperation with CEOS and the GEO Carbon Community of Practice plans will be 5 implemented for the end-to-end utilization of space-based GHG data, particularly those of Japan's GOSAT mission and NASA's replacement OCO mission, and other GHG observation missions being prepared in Europe.

The global carbon cycle determines the amount of carbon dioxide and methane that accumulates in the atmosphere, increasing the Earth's greenhouse effect. It is therefore a key component of the global climate system. The carbon cycle also responds to climate change, and understanding the ability of the carbon cycle to continue to act as a partial sink of fossil fuel emissions into the future will be a vital factor in determining the "allowable" fossil fuel emissions, while keeping concentration below certain levels.

Current uncertainties on the space-time distribution of CO2 and CH4 fluxes are very large. For well informed policy action aiming to curve down the future increase of CO2 and CH4, these uncertainties must be reduced, by establishing an Integrated Global Carbon Observing system (IGCO). The main goal of this report is to describe the building blocks and coordinated implementation of such an Integrated Global Carbon Observing system.

In Japan, IBUKI(GOSAT) satellite has been launched and been monitoring global atmospheric GHG since 2009. In asian region, Japan has been strongly promoted to develop the AsiaFlux network. Furthermore, Japan is active to develop integrated global carbon cycle model. It will propose the way towards more integrated approach in order to integrate each Japanese activity for contributing as Asia component of the integrated global carbon observations and analysis system.

キーワード: 地球観測政府間作業部会, 全球地球観測システム, 炭素, 地球観測衛星委員会, GOSAT
Keywords: GEO, GEOSS, Carbon, CEOS, GOSAT

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GOSAT プロジェクトの全球炭素観測と炭素収支推定への貢献
Contribution of GOSAT Project to global carbon observation and carbon flux estimation

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The GOSAT (Greenhouse gases Observing SATellite) Project is a joint effort being promoted by Japan Aerospace Exploration Agency, National Institute for Environmental Studies, and the Japanese Ministry of the Environment. The primary objective of the Project is to observe the global distributions of the two major greenhouse gases and their temporal variations. Nearly four-years-worth of observational data was collected with the satellite by now, and the concentration data, retrieved from the GOSAT observational data, were found to effectively fill out gaps in the distribution of CO_2 and CH_4 data collected in ground-based monitoring networks. The latest version of the Level 2 CO_2 and CH_4 concentration data products (version 02.**) are now publicly available. Through data validation activities, the uncertainties of both the CO_2 and CH_4 concentrations were now found to be less than 1%, which is smaller than originally targeted. Seasonal variations and annual growth trends were found from the four-year-long datasets; the data will be further analyzed together with more data to be accumulated. The concentration data are also being utilized for estimating regional CO_2 fluxes. The result of the estimation for the period between June 2009 and May 2010 was recently released to the public in December 2012 as the Level 4A data product. Efforts in improving the quality of these data products, which are the results from one of the "top-down" approaches to reveal global carbon cycle, will be continued. We herein summarize the progress of the Project.

キーワード: 温室効果ガス, 二酸化炭素, メタン, 全球分布, 大気輸送モデル, 二酸化炭素収支推定
Keywords: greenhouse gases, carbon dioxide, methane, global distribution, atmospheric transport modeling, CO_2 flux estimation

MSD03-05 会場:201A 時間:5 月 22 日 10:15-10:30

地上設置および船舶搭載高分解能分光計を用いた海洋上の GOSAT CO2 および CH4 カラム平均濃度の検証
Validation of GOSAT column-averaged mole fractions of CO2 and CH4 over the sea with ground- and ship-based spectrometers

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Hirofumi Ohyama[1*], KAWAKAMI, Shuji[1], SHIOMI, Kei[1], NAKAJIMA, Masakatsu[1], NAKANO, Yoshiyuki[2], MIWA, Tetsuya[2], FUKAMACHI, Takuya[3], TAURA, Choyo[3], ARAI, Kohei[3], OKUMURA, Hiroshi[3]

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To accurately predict future atmospheric greenhouse gas concentrations and their impacts on climate, it is necessary to quantify the global distribution and temporal variations of greenhouse gas sources and sinks. Greenhouse gases Observing SATellite (GOSAT) has observed the global distribution of the atmospheric greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4) since April 2009. Thermal And Near infrared Sensor for carbon Observation-Fourier Transform Spectrometer (TANSO-FTS), which is one of the sensors onboard the GOSAT, measures the sunlight backscattered by the Earth's surface and atmosphere as well as the thermal radiance emitted from the Earth. Column-averaged mole fraction of CO_2 (XCO_2) and CH_4 (XCH_4) are derived from the sunlight spectra by an optimal estimation retrieval approach. Over the ocean, the GOSAT measures sunglint region because the reflectance is higher than other ocean region. In terms of treatment of surface reflection, the retrieval algorithm is different between the land and ocean scenes. Therefore, it is desirable to validate the XCO_2 and XCH_4 values separately for the land and ocean scenes. We obtain direct sunlight spectra with a high-resolution FTS (Bruker IFS 125HR) not only on the ground but also onboard the research vessel (R/V) owned by the JAMSTEC, and indicate that the XCO_2 and XCH_4 could be retrieved from the spectra with precisions needed to validate the GOSAT data.

We performed the observations with the high-resolution FTS onboard the R/Vs in the three cruises operated by the JAMSTEC: the R/V *Kaiyo* cruise (4?13 August 2010), the R/V *Kairei* cruise (10 September?5 October 2010), and the R/V *Mirai* cruise (14 April?5 May 2011). Then, the high-resolution FTS was located in Saga in June 2011, and has acquired continuously the validation data over the land. The high-resolution FTS is a large instrument and make it difficult to carry many times. An automated compact measurement system is developed for acquiring more data over the ocean. The new equipment consists of a solar tracker and an optical spectrum analyzer (OSA: Yokogawa AQ6370C) as described in Kawasaki et al. [2012]. Sunlight is introduced into the OSA through optical fiber. We obtain the solar spectra whenever the solar elevation angle is greater than 10 degrees, weather permitting. The system has obtained the validation data over the ocean in the 2013 world cruise with the R/V *Yokosuka*.

The residual between the observed and the calculated spectra fluctuates with respect to the scan time (i.e., along the wavenumber direction). This is likely due to limit of tracking speed of the solar tracker. In the case of a larger wave, the motors of the solar tracker could no longer keep the image of the Sun on the center of optical fiber inlet. The intensity variation in the measured spectrum is corrected by a low-frequency correction method [Keppel-Aleks et al., 2007]. Total column abundances are retrieved from the measured spectra with a nonlinear least squares spectral fitting algorithm, which scales an a priori profile to produce a synthetic spectrum that achieves the best fit to the measured spectrum. In the case of OSA system, it is found that measurement accuracy is reduced by vibration transmitted from the ship and insufficient tracking performance, which is the issue to be improved. The GOSAT XCO_2 and XCH_4 are compared with the ground-based and the ship-based validation data. For our coincidence criteria, we find GOSAT measurements within 2 hours of the high-resolution FTS measurement time and within plus or minus 5 degrees latitude and plus or minus 10 degrees longitude of the high-resolution FTS location. The seasonal trends of the retrieved XCO_2 are consistent with those of the validation data. The TANSO-FTS XCO_2 retrievals exhibit a negative bias of ~1 ppm with a root-mean-square difference of ~2 ppm compared to the high-resolution FTS measurements.

キーワード: 二酸化炭素, メタン, 遠隔計測
Keywords: carbon dioxide, methane, remote sensing

MSD03-06 会場:201A 時間:5月22日 10:30-10:45

Global monitoring of greenhouse gases using various earth observation platforms
Global monitoring of greenhouse gases using various earth observation platforms

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Center for Global Environmental Research (CGER), National Institute for Environmental Studies (NIES) has established a fundamental infrastructure for strategic monitoring of global environment with an emphasis on climate change since the early 1990s. The monitoring covers the atmosphere, ocean, and terrestrial biosphere particularly in Asia and the Pacific regions. The data have been acquired from different kinds of earth observation platforms such as ground-based stations, ships, and airplanes. A large number of studies have been conducted based on the datasets to detect changes in the atmospheric greenhouse gas concentrations and in the carbon exchanges among the atmosphere, surface oceans, and terrestrial biosphere.

The long-term datasets help to estimate temporal and spatial variations of regional and global carbon budgets, to clarify the mechanisms of essential processes of carbon cycle, and to predict future climate changes and its uncertainties. Since the dataset obtained from the monitoring would be an essential source of knowledge for global carbon cycle studies as well as a valuable validation dataset for earth system modeling and remote sensing, further efforts are still required to establish more effective data acquisition, quality control, and data sharing systems.

キーワード: Greenhouse gas concentration, carbon budget, atmosphere, ocean, terrestrial
Keywords: Greenhouse gas concentration, carbon budget, atmosphere, ocean, terrestrial

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MSD03-07 会場:201A 時間:5 月 22 日 11:00-11:20

温暖化予測モデル開発の立場からの炭素循環観測研究への期待
Expectations for carbon cycle observation from a global warming projection modeler

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2013 年の IPCC 第 5 次評価報告書へ向け多大な貢献が予想される「第 5 次結合モデル相互比較プロジェクト」(CMIP5) では、地球システムモデル（ESM; 生物地球化学的過程を含む気候モデル）が必須となる予測実験がいくつか設定された。2013 年 2 月現在、各国研究機関が開発した ESM による予測データが CMIP5 に提出され、国際的なデータ配信システム ESG から結果が入手可能である。そうしたデータの解析作業が現在進行中であり、人間活動による土地利用改変が将来の全球規模炭素循環の振舞に大きな影響を与えること、窒素と炭素それぞれの循環の相互作用を考慮するか否かが将来予測に決定的に重要であること、フィードバックに関するモデル間の結果のばらつきは光合成の定式化の違いによりもたらされている可能性があること、などが示唆されている。これらは観測研究における課題の優先度を検討する際に有用な情報となりうるだろう。また、モデルの検証のために観測データを用いる際には、グリッド化され整理されたデータの内容に十分な説明がなされていることが望ましい。GEO の炭素循環観測方針では、得られたデータに対してメタデータを付加することの重要性が指摘されているが、モデル開発者の立場から見ても適切な指摘と言える。モデル出力に関しても系統だったメタデータ設計の必要性は叫ばれており、観測とモデル開発に携わる研究者に共通の課題と言えるかもしれない。

キーワード: 炭素循環, モデリング, 地球温暖化
Keywords: Carbon cycle, Modeling, Global warming

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衛星 RS を使った広域炭素収支評価における地上検証および長期観測の重要性
Importance of long-term and ground truth observations on the regional carbon budget evaluation by Satellite RS

原薗 芳信 [1*], 岩田拓記 [2], 大月基 [3], 岩田徹 [3], 植山雅仁 [4], 永野博彦 [1]
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キーワード: 地上検証, 長期連続観測, 広域評価, 陸域炭素収支, 衛星リモートセンシング
Keywords: ground truth, long-term observation, regional estimation, terrestrial carbon budget, satellite remote sensing

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MSD03-09 会場:201A 時間:5 月 22 日 11:35-11:50

産総研における長期森林生態系炭素収支観測とそのデータ解析
Long-term observations of carbon budget in forest ecosystems at AIST stations and their data analyses

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Shohei Murayama[1*], Hiroaki Kondo[1], MAEDA, Takahisa[1], Shigeyuki Ishidoya[1], Nobuko Saigusa[2], YAMAMOTO, Susumu[1]

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Impacts of climate change on the activity of terrestrial biosphere have been predicted in recent studies. In East Asia and Southeast Asia strongly influenced by Asian Monsoon, changes not only in temperature but also in amounts of precipitation and length of the rainy season associated with the climate change could have much influence on the carbon budget in the terrestrial biosphere. However, responses of the terrestrial biosphere to climate change are not yet fully understood. For the better understanding of the responses, further analyses using long-term measurement data of the carbon budget in terrestrial ecosystem are necessary.

National Institute of Advanced Industrial Science and Technology (AIST) has made long-term systematic measurements of CO2 flux between the atmosphere and forest ecosystem and the related parameters in collaboration with some research groups, in a cool-temperate deciduous forest at Takayama (36.13degN, 137.42degE, 1420 m a.s.l.), Japan since 1993, and in seasonal tropical forests at Mae Klong (mixed deciduous forest, 14.58degN, 98.85degE, 231 m a.s.l.) and at Sakaerat (dry evergreen forest, 14.50degN, 101.92degE, 543 m a.s.l.), Thailand since 2001. Takayama is the longest monitoring site in the AsiaFlux network, while Mae Klong and Sakaerat are the longest AsiaFlux monitoring sites in Thailand. The CO2 concentration data at Takayama have also been submitted to the World Data Centre for Greenhouse Gases of WMO. In this presentation, our research activities and some of the results obtained from the long-term measurements will be introduced. Some results of analyses of inter-annual variation of the carbon budget observed at our sites and environmental factors governing the variation will also be presented. Furthermore, improvement of methodology of measurement and data analyses will be discussed.

Keywords: Carbon budget, Forest ecosystem, AsiaFlux, Long-term measurement, Data analyses

MSD03-10 会場:201A 時間:5 月 22 日 11:50-12:05

GOSAT から GOSAT-2 へ：宇宙からの高精度 CO2,CH4 観測を目指して
Space-based Carbon Monitoring by GOSAT and GOSAT-2: Towards better accuracy of XCO2 and XCH4 observation

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To observe the global column concentration of carbon dioxide (CO_2) and methane (CH_4) from space, the Greenhouse gases Observing SATellite (GOSAT) was launched on January 23, 2009, and has started the operational observation. Thermal and Near Infrared Sensor for Carbon Observation ? Fourier Transform Spectrometer (TANSO-FTS) has been continuously measuring CO_2 and CH_4 distributions globally, and the retrieved column CO_2 and CH_4 data have been distributed to the public. Over four-years operational periods, the useful scientific data sets and interesting articles for carbon source/sink evaluation were produced and published, and these results have been supporting to well understanding of carbon cycle. Currently, the importance of space-based carbon observation has been approved and desired the continuous observation in toward. Through the TANSO-FTS operation with the radiometric, geometric and spectroscopic characterizations, we learned how to improve the accuracy of X_{CO2} and X_{CH4} based on short-wavelength FTS. The correction procedures for micro-vibration from companion components, non-linear response of analogue and digitizing circuit are key role on the current on-board operating TANSO-FTS. These procedures were applied on operational level-1 processing algorithm. On instrumental aspects, the robustness and improvements will be required on the future mission to obtain the better spectral quality, and it will be able to lead more accurate X_{CO2} and X_{CH4} retrievals. The current retrieval accuracy of X_{CO2} by GOSAT spectra is around 2 ppm, which is determined by comparing with ground- and aircraft- sampling measured dataset. It suggests that the accuracy of space-based carbon observation is much smaller than 4 ppm of the GOSAT mission target. The improvement of retrieval algorithm for X_{CO2} and X_{CH4} is also important both of the accuracy and the processing speed. To elucidate the carbon cycle more precisely, our experiences have to be summarized and applied in the future missions. To continue and improve the space-based carbon monitoring, the conceptual design work of GOSAT-2 has been started. The science and technical highlight of GOSAT and the preliminarily design of GOSAT-2 will be presented with current status.

キーワード: GOSAT, GOSAT-2, 二酸化炭素, メタン
Keywords: GOSAT, GOSAT-2, CO2, CH4