©2008 RSSJ Journal of The Remote Sensing Society of Japan Vol. 28 No. 2 (2008) pp. 190–197

Original Paper

Projected Impact of the GOSAT Observations on Regional CO_2 Flux Estimations as a Function of Total Retrieval Error

Shamil MAKSYUTOV*[1,2], Nikolay KADYGROV*[1], Yumiko NAKATSUKA*[1], Prabir K. PATRA*[2], Takakiyo NAKAZAWA*[2,3], Tatsuya YOKOTA*[1] and Gen INOUE*[4]

Abstract

We studied the impact of the planned atmospheric CO_2 observations by GOSAT (Greenhouse gases Observing SATellite) on the inverse model estimate of monthly and annual mean regional CO_2 fluxes, using the inverse models of the CO_2 fluxes for 22 large regions of a globe. The inverse model of the atmospheric transport uses monthly and annual means of simulated GOSAT CO_2 observation data, which were aggregated to grid cells with the size of 7.5° ×7.5° (horizontal), and surface-station observations as formulated in Transcom-3 inverse modelling inter-comparison. The observation frequency of GOSAT in our analysis was corrected for simulated probability of clear-sky conditions, assuming global mean clear sky probability of 11%. Our results demonstrate that the mean regional flux uncertainty can be reduced by about 50% by adding satellite observations with single shot precision of 5 ppm and randomly-distributed retrieval bias of 0.5 ppm.

Keywords : regional CO_2 fluxes, GOSAT orbit, CO_2 observations, satellite observations, remote sensing

1. Introduction

Surface CO_2 fluxes are estimated with atmospheric transport inversion models using the *in-situ* measurements of CO_2. Recently, there have been emerging possibilities of obtaining CO_2 distributions and time series from the satellite-borne sensors, such as SCIAMACHY[1)], which is already in orbit, and OCO[2)] and GOSAT which are planned to be launched in near future. In the past, utility of satellite measurements in surface source estimations has been studied based on moderate-resolution inverse modeling, i.e., about 20–100 region inversion[3)~7)], and assimilation-type inverse models at grid-size resolution[8)9)]. However, the precision requirements and observation impacts on the flux inversion are dependent on the observation frequency and accuracy, which are unique to each satellite observation mission. In this work, we used a rather standard inverse model setup that divides the globe into 22 regions to evaluate the benefit of column averaged CO_2 retrieved from spectra in the SWIR band of GOSAT (Greenhouse gases Observing SATellite). These results are also compared with the inversion flux uncertainties for surface measurement network.

2. Materials and Methods

2.1 Observation frequency and errors

The CO_2 observations by GOSAT satellite are planned to be acquired in nadir mode[10)]. According to the plan, successful observations of CO_2 column averaged concentration will be obtained under cloud free conditions with little disturbance from aerosols and thin clouds. Thus, only about 1000 observations per day are expected to be used in retrieval even though the data is planned to be acquired every 5 seconds. For estimating the average concentration and its error one needs estimate of the spatial and temporal distribution of the observation frequency. We estimated the observation frequency using a simulated GOSAT orbit, estimate of reflected sunlight intensity and the probability of clear sky conditions. The estimated climatology of clear-sky frequency is based on CALIPSO data[11)12)] for a period from June 2006 to August 2007 (Fig. 1). Even after reduction due to cloudy conditions, the number of the observations is still quite large to be treated directly in Bayesian inverse model by Enting et al.[13)]. To simplify the inverse modeling procedure by reducing the dimension of the data vector we aggregated the observations to monthly mean values over each 7.5°×7.5° grid box. We

(Received November 16, 2007. Accepted March 24, 2008)

*1 National Institute for Environmental Studies, 16–2 Onogawa, Tsukuba, 305–8605, Japan
*2 Frontier Research System for Global Change, 3173–25 Showa-machi, Yokohama, 236–0001, Japan
*3 Center for Atmospheric and Oceanic Studies, Tohoku University, Sendai, 980–8578, Japan
*4 Graduate School of Environmental Studies, Nagoya University, Nagoya, 464–8601, Japan

used two different configurations of GOSAT observations for "time-independent" (estimating annual mean fluxes) and "time-dependent" (monthly mean fluxes) inversions. The first one intends to imitate application of the GOSAT data in the time of the actual observations and present surface observing network, the second one looks at the utility of the GOSAT data in the context of the available surface observations and inverse modeling approach at the time of planning the GOSAT observations. For both cases data coverage was limited to over the land only.

2.2 Time-independent inverse model

We used a "time-independent" Bayesian inverse model by Gurney at al.[14] to estimate the uncertainties of annual mean regional CO_2 fluxes. The model uses annual mean observed CO_2 concentrations to constrain the fluxes. The earth's surface was divided into 22 regions, and a total of 1 Pg C/year of net annual flux was assigned to each region with spatial distribution which is similar to that of the net ecosystem production. The atmospheric transport of these basis functions were simulated using the NIES/FRSGC global transport model[15]. The NCEP reanalysis winds and meteorological parameters for year 1997 were used to drive the model transport, and the simulation was run for 3 years before collecting monthly mean concentrations and column-averaged concentration of each tracer. The tracers considered in this study are emissions from fossil fuel burning for 1990 and 1995, CASA (Carnegie-Ames-Stanford Approach) terrestrial biosphere flux and ocean-atmosphere exchange, as well as 22 tracers of regional emissions of 1 Pg C/year, all according to Gurney et al.[14].

The Bayesian inverse modeling procedure and its numerical realization used in this model is same as in Gurney at al.[14] and is based on the one described by Enting et al.[13]. In this method, we minimize a cost function (F) to reduce the mismatches between the atmospheric observations D and transport model predicted responses to surface fluxes, G-S (matrix G represents a transport operator and S a predicted flux), and *a priori* fluxes S^0 and predicted fluxes S :

$$F=(D-G\cdot S)\cdot C_D^{-1}\cdot(D-G\cdot S)^T + (S-S^0)\cdot C_{S^0}^{-1}\cdot(S-S^0)^T \quad (1)$$

The solution to the inverse model provides optimal estimates for regional fluxes, and a posterior error covariance of the flux estimates C_S, (see also Eq. 4.7 by Rodgers[16]),

$$C_S=(G^T\cdot C_D^{-1}\cdot G+C_{S^0}^{-1})^{-1} \quad (2)$$

where C_D and C_S^0 are error covariance matrices of the atmospheric observations and *a priori* fluxes, respectively.

According to Eq. 2, the flux uncertainties are independent of the observed concentrations as well as prior fluxes, and depend only on the observation data uncertainties, prior flux uncertainties, and atmospheric transport. Therefore, we can discuss flux uncertainties without using actual observations. Error covariance matrix C_D was assumed to be diagonal, where each diagonal element is equal to the squared data uncertainty (σ_{total}^2). The data uncertainty σ_{total} (Eq. 3) consists of two parts : the random part (which can be reduced by increasing the number of independent observations N) and systematic part σ_{syst}, such as a bias of the concentration retrieval procedure[10] and also includes clear-sky bias[17]. In this work, we assumed that the random errors result from errors of CO_2 column retrievals σ_{ret} and errors due to atmospheric variability[14] of CO_2 σ_{RSD}, which also contains the transport model error. In our tests, the single-shot retrieval error is assumed to be in the range of 2.5 to 10 ppm, which exceeds the estimated errors due to atmospheric CO_2 variability, so we simplified the analysis by considering globally homogeneous total random error. In our error model, the systematic error was not reduced by increasing the number of observations. It was composed of the spatial, temporal and representation biases in the concentration retrieval from the GOSAT SWIR spectra. Finally, expression for total column error is as follows :

$$\sigma_{total}=\sigma_{syst.}+\sqrt{\frac{\sigma_{ret}^2+\sigma_{RSD}^2}{N}} \quad (3)$$

while for the surface observation, we assumed the error is defined by σ_{RSD} as in Gurney et al.[14]. The mean of the annual number of the successful observations (N) in our estimates is based on estimated probability of cloud-free scenes along the track of GOSAT. The data uncertainties for surface observations were calculated from the GLOBALVIEW-CO_2[18] dataset. A surface measurement network with 77 sites is used in this work, for consistency with Gurney et al.[14]. The prior flux uncertainties C_S^0 for each region (see Eq. 1) were set proportional to regional NPP for land, and oceanic bulk exchange for ocean following the method used by Gurney et al.[14].

2.3 Time-dependent inversion

In the time-dependent inversion, we followed the method developed by Rayner et al.[19], and later modified to 22-region case by Gurney et al[20] and to 64-region setup by Patra et al[21]. We used the 66-region configuration model[22] and aggregated the results of monthly mean CO_2 fluxes to 22 regions used in the time-independent study. The monthly carbon emission pulse with intensity of 1 GtC/yr from each of 66 regions was transported using NIES tracer transport model[15] with $2.5°\times 2.5°$ horizontal resolution and driven by NCEP reanalysis winds for year 2005, so the influence of the regional fluxes to observed CO_2 concentrations are simulated and summarized as transport matrix for use in Bayesian synthesis inversion in a same way as in the report by Patra et al.[21]. The concentra-

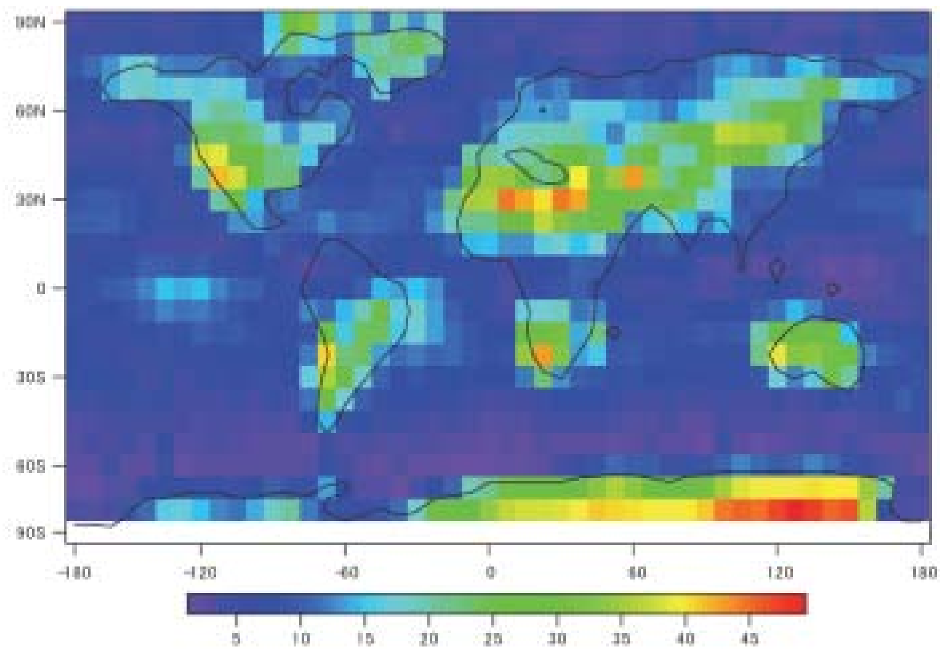

Fig. 1 Annual average probability of clear sky (%) derived from CALIPSO data.

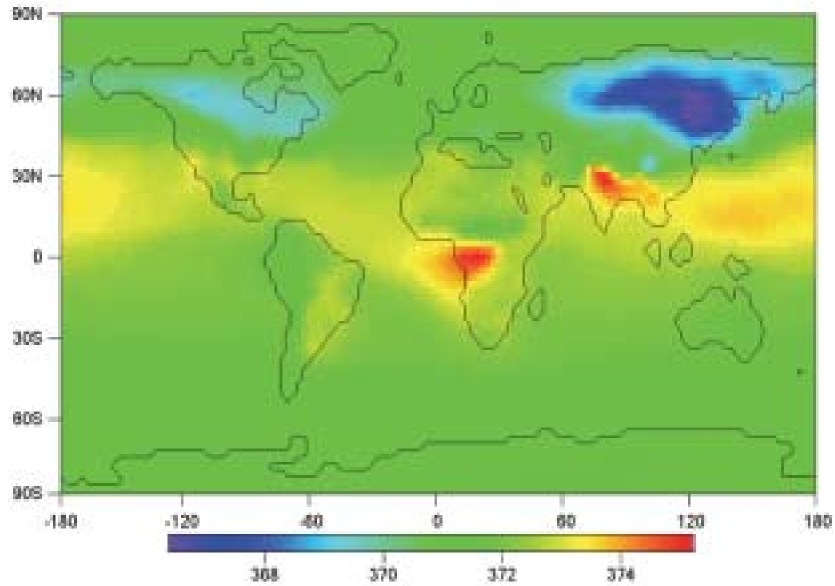

Fig. 2 Simulated total column CO_2 observations in ppm for July 2005.

tions of CO_2 at surface stations and global distribution of total column CO_2 were simulated for 2005 by transport model with climatological CO_2 fluxes obtained with the inverse model[23]. Figure 2 shows the simulated total column CO_2 for July 2005. Column-averaged CO_2 data were aggregated to $7.5^\circ \times 7.5^\circ$ grid cells. After the aggregation random part of observation errors (second term in Eq. 3.) is reduced to 0.8 ppm on average, assuming single shot retrieval error of 2.5 ppm. Simulations of total CO_2 errors were completed with 4 different values of bias, namely 0, 1, 2 and 3 ppm. Thus, the mean total error for monthly average total column CO_2 varied from 0.8 to 3.8 ppm. Figure 3 shows the simulated total column CO_2 by GOSAT observations and distribution of $\sigma total$ calculated by Eq. 3 for January 2005. We used simulated GOSAT observations only over the land. Observation data from only 151 surface stations were used in the inversion, and the uncertainties of concentrations at these surface stations were calculated from actual data and had seasonal variations according to multi-year average of atmospheric variability[18].

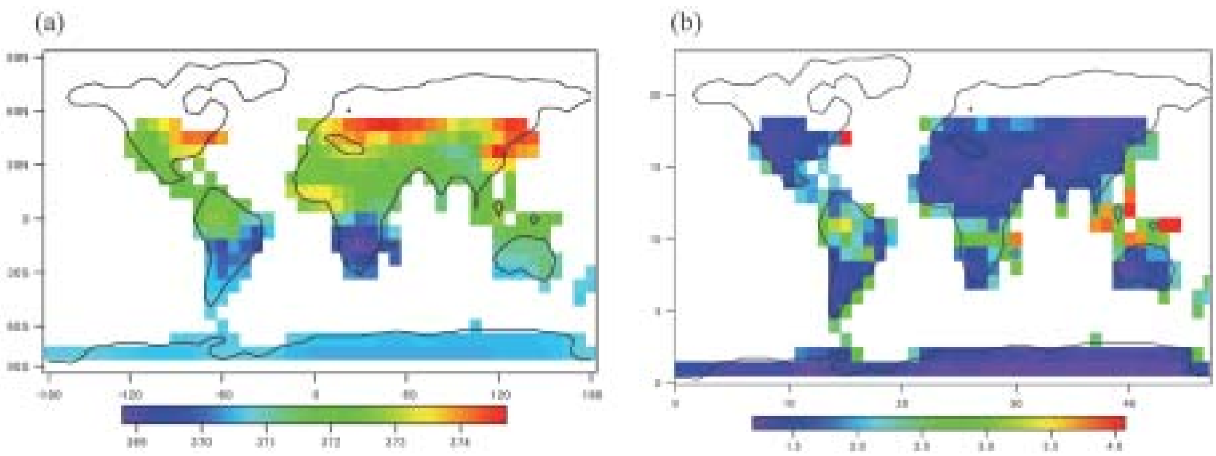

Fig. 3 (a) Simulated GOSAT total column CO_2 observations over the land in ppm, and (b) errors in ppm for monthly mean total CO_2 (bias is 1 ppm). Both (a) and (b) are for January 2005 and have horizontal resolution of 7.5° longitude×7.5° latitude.

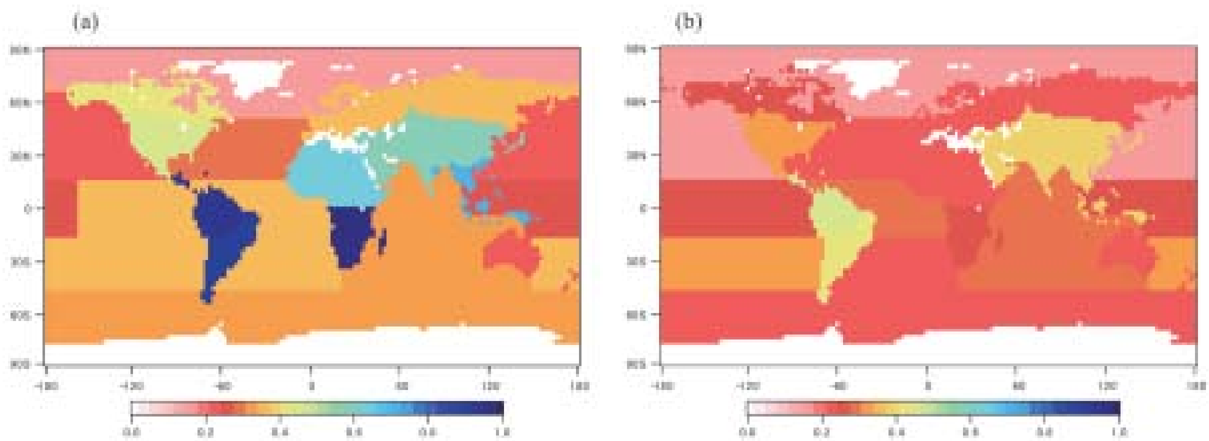

Fig. 4 Error (GtC/yr/region) map of annual mean CO_2 flux obtained with (a) ground-based observations and (b) both ground-based observations and simulated GOSAT observations. The errors in the GOSAT data were 0.5 ppm in bias and 5 ppm in random single-shot retrieval error.

3. Results and Discussions

3.1 Time-independent inversion results

The flux uncertainties are reduced first by adding ground-based observations according to Gurney et al.[14] and then by adding simulated GOSAT observations with assumed uncertainties. Figure 4 shows the flux uncertainties for both cases : (1) when only ground-based observations are used and (2) when ground-based observations are used together with GOSAT observations. In the first case we use 12 monthly mean observations from each of 151 stations, in the second case the number of observations is increased by number of GOSAT aggregated grid cells over land (490) for each month. Hereinafter, we will refer to the uncertainties in the flux obtained from the first case as $\sigma_{S,GV}$ and those of the latter case as $\sigma_{S,GV+GOSAT}$. In Fig. 4, GOSAT observation data were assumed to have 0.5 ppm bias and 5.0 ppm single-shot accuracy. For that case, the average reduction for land regions was about 50%. Adding the GOSAT observations in our analysis resulted in the reductions of uncertainties in the flux, while the degree of the uncertainty reduction depended on the magnitudes of bias and random retrieval error (Table 1). Relative reduction of mean flux uncertainty is defined as $(1-\sigma_{S,GV+GOSAT}/\sigma_{S,GV})$.

Compared to the estimates provided by earlier studies [e.g. 3] this study introduces explicitly a systematic bias component of the gross observation error thus resulting in the more conservative estimates of the flux uncertainty reduction. According to the flux uncertainty reduction dependence on errors (in Table 1), the bias component makes significant effect on inverse model simulated flux uncertainty, as it makes impor-

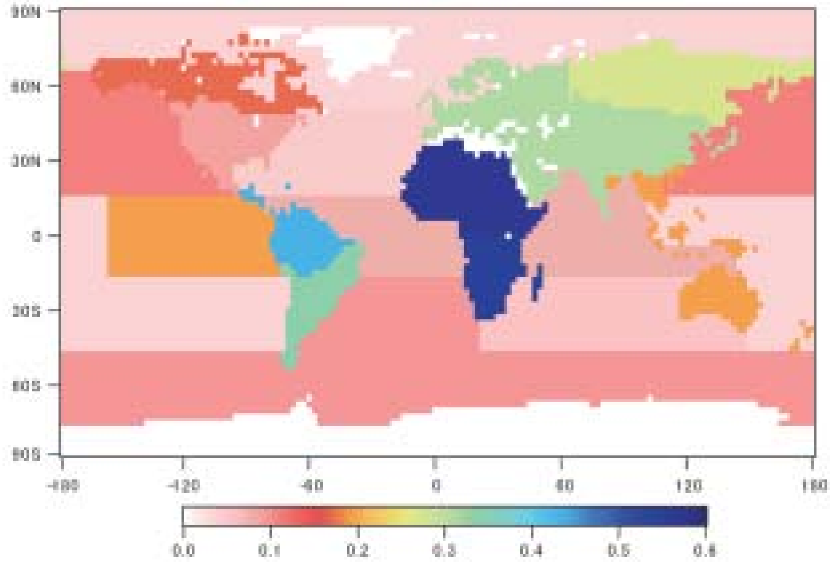

Fig. 5 Relative uncertainty reduction for 22 regions due to addition of GOSAT observation to ground based observations.

Table 1 Relative reduction of mean flux uncertainty, i.e. relative to use of only the ground-based observations.

Random error (ppm) / Bias (ppm)	Uncertainty reduction (%)			
	2.50 ppm	5.00 ppm	7.50 ppm	10.00 ppm
0.25 ppm	67	61	55	50
0.50 ppm	54	49	44	41
0.75 ppm	44	40	36	33
1.00 ppm	36	33	30	28

tant contribution to the total error.

3.2 Time-dependent inversion results

Figure 5 shows the relative reduction of flux uncertainty for each of 22 land regions with 1.8 ppm monthly mean σ_{total}. In the same way as it was suggested by Rayner and O'Brien[3], we calculated the total uncertainty Σ as :

$$\Sigma = \sqrt{\sum_n \sigma_n^2} \qquad (4)$$

where σ_n is the uncertainty of flux for region n and the sum is over all 22 regions. Following Rayner and O'Brien[3], we summarized the sensitivity of source uncertainty Σ as a function of the pseudo-data precision (Fig. 6). When compared to the existing network of ground stations (see Fig. 6), our results indicate that the precision of monthly-averaged column data σ_{total} on 7.5°×7.5° grids need to be better than 0.8 ppm to reduce the average uncertainties for all of 22 regions by 40%, at that point the mean flux uncertainty with GOSAT data only is about 1.1 times the one with the ground based observations. We can conclude that the high precision satellite measurements are as effective as the surface observations in reducing the estimated flux uncertainty both for time-dependent and time-independent inverse models. The data from GOSAT is expected to reduce flux uncertainty by as much as 60% for some regions with low density of existing ground-based observations (Fig. 5).

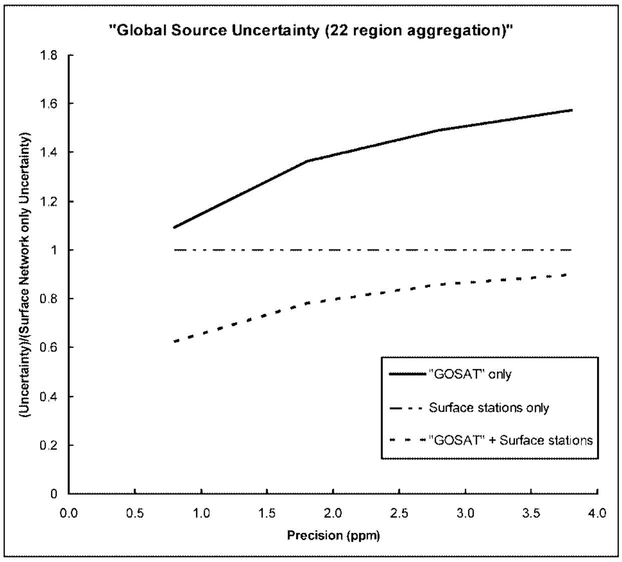

Fig. 6 Relative mean CO_2 flux uncertainties for different observing systems.

4. Conclusions

Use of GOSAT total column data in the flux estimation by inverse model of the atmospheric transport was evaluated. Monthly fluxes and flux uncertainties were estimated by inverse procedure. While the estimated fluxes are based on pseudo data, the flux uncertainties can be estimated if presumed observation accuracy is available. The procedure assumed that GOSAT data were aggregated to 7.5°×7.5° grid cells, and averaged over 1 month to derive total CO2 column monthly mean data. The observation frequency of GOSAT in our analysis was corrected for simulated probability of clear-sky conditions, assuming global mean clear sky probability of 11%.

Our results demonstrate that the time-independent inversion setup mean regional flux uncertainty can be reduced by about 50% by adding satellite observations with single shot precision of 5 ppm and randomly-distributed retrieval bias of 0.5 ppm. In the time-dependent setup, lower relative uncertainty reduction is estimated. Total error of monthly-averaged column data need to be better than 0.8 ppm to reduce the mean regional flux uncertainties by 40%

According to our estimate, bias part can contribute a lot to the total error. To compensate for that, reduction of the random (and retrieval) error is becoming even more important. This conclusion applies both the time independent case, based on annual mean concentrations and fluxes, and time-dependent cyclo-stationary case that used monthly mean concentration climatology and derives monthly mean fluxes.

More detailed study of the observation biases as function of thin cloud cover, aerosols and other retrieval-related parameters would be useful to evaluate the utility of the GOSAT observations for various applications.

Acknowledgements

The authors would like to thank Dr. Tadao Aoki and Dr. Nawo Eguchi for supplying aggregated CALIPSO dataset and GOSAT observing configuration. Comments and suggestions from all anonymous reviewers have helped to improve the quality of this paper.

References

1) S. Houweling, F.M. Breon, I. Aben, C. Rodenbeck, M. Gloor, M. Heimann, and P. Ciais : Inverse modeling of CO2 sources and sinks using satellite data : a synthetic inter-comparison of measurement techniques and their performance as a function of space and time, Atm. Chem. Phys., 4, 523–538, 2004.
2) C. D. Miller, D. Crisp, P. L. DeCola, S. C. Olsen, et al. : Precision requirements for space-based X_{CO2} data, J. Geophys. Res., 23, doi : 10.1029/2006JD007659, 2007.
3) P. J. Rayner and D. M. O'Brien : The utility of remotely sensed CO_2 concentration data in surface inversion, Geophys. Res. Lett. 28, 175–178, 2001.
4) B. Pak and M. J. Prather : CO_2 source inversions using satellite observations of the upper troposphere, Geophys. Res. Lett., 28, pp.4571–4574, 2001.
5) P. J. Rayner, R. M. Law, D. M. O'Brien, T. M. Butler, and A. C. Dilley : Global observations of the carbon budget, 3, Initial assessment of the impact of satellite orbit, scan geometry, and cloud on measuring CO_2 from space, J. Geophys. Res., 107 (D21), 4557, doi : 10.1029/2001JD000618, 2002.
6) P. K. Patra, S. Maksyutov, Y. Sasano, H. Nakajima, G. Inoue, and T. Nakazawa : An evaluation of CO2 observations with Solar Occultation FTS for Inclined-Orbit Satellite sensor for surface source inversion, J. Geophys. Res., 108 (D 24), 4759, doi : 10.1029/2003JD003661, 2003.
7) S. Maksyutov, P. K. Patra, and G. Inoue : Pseudo-data inversion of column-CO_2 observations by remote sensing using a high resolution inverse model, International Archives of Photogrammetry, Remote Sensing and Spatial Information System, Vol. XXXIV, Part. 7/W14, Paper No. J-2, 2003.
8) D. F. Baker, S.C. Doney, and D.S. Schimel : Variational data assimilation for atmospheric CO_2, Tellus, 58B, 359–365, 2006.
9) F. Chevallier, F.-M. Bréon, and P. J. Rayner : Contribution of the Orbiting Carbon Observatory to the estimation of CO 2 sources and sinks : Theoretical study in a variational data assimilation framework, J. Geophys. Res., 112, D09307, doi : 10.1029/2006JD007375, 2007.
10) T. Yokota et al. : Data retrieval algorithms of the SWIR bands of the TANSO-FTS sensor onboard GOSAT, J. Remote Sens. Soc. Jp., 28, 2 (this issue).
11) D. M. Winker, C. A. Hostetler, M. A. Vaughan, A. H. Omar : CALIOP, Algorithm Theoretical Basis Document, Part1 : CALIOP Instrument, and Algorithms Overview, 2006.
12) N. Eguchi and T. Yokota : Investigation of clear-sky frequency from CALIOP observation, in preparation.
13) I. G. Enting, C. M. Trudinger, and R.J. Francey : A synthesis inversion of the concentration of $\delta^{13}C$ of atmospheric CO_2, Tellus, 47B, pp.35–51, 1995.
14) K. R. Gurney et al. : Towards robust regional estimates of CO_2 sources and sinks using atmospheric transport models, Nature, 415, 626–630, 2002.
15) S. Maksyutov and G. Inoue : Vertical profiles of radon and CO_2 simulated by the global atmospheric transport model, In : CGER supercomputer activity report, CGER/NIES-I 039-2000, 7, Tsukuba, Japan, pp.39–41, 2000.
16) C. D. Rodgers. : Inverse Methods for Atmospheric Sounding : Theory and Practice, World Scientific Co., Singapore, 2000.
17) K. D. Corbin and A. S. Denning : Using continuous data to estimate clear-sky errors in inversions of satellite CO_2 measurements, Geophys. Res. Lett., 33, L12810, doi : 10.1029/2006GL025910., 2006.
18) GLOBALVIEW-CO_2, 2006, Cooperative Atmospheric Data Integration Project, *CD-ROM, NOAA-CMDL,* Boulder, CO, USA.
19) P. Rayner, I. Enting., R. Francey and R. Langenfelds : Reconstructing the recent carbon cycle from atmospheric

CO_2, $\delta^{13}C$ and O2/N2 observations. Tellus, 51B, 213–232, 1999.

20）K. R.Gurney, et al. : Transcom 3 inversion intercomparison : Model mean results for the estimation of seasonal carbon sources and sinks, Global Biogeochem. *Cycles,* 18, GB1010, doi : 10.1029/2003GB002111, 2004.

21）P. K. Patra., M. Ishizawa, S. Maksyutov, T. Nakazawa, and G. Inoue : Role of biomass burning and climate anomalies on land-atmosphere carbon fluxes based on inverse modelling of atmospheric CO_2, Global Biogeochem. Cycles, 19, GB3005, doi : 10.1029/2004GB002258, 2005.

22）S. Maksyutov, N. Kadygrov, Y. Nakatsuka, C. Carouge, et al. : Application of the transport model for inverse modeling studies of the regional and global budgets of CO_2, NIES Supercomputer Annual Report 2006, CGER NIES, Tsukuba, Japan, pp 23–32, 2008.

23）S. Maksyutov, R. Onishi, M. Naja, A. Yaremchuk, P. Patra and G. Inoue : Atmospheric CO_2 Simulations with a High Resolution Model and Synoptic Scale Variability of CO2 Column In : CGER Supercomputer activity report, vol. 14–2005, CGER-I070-2007, CGER NIES, Tsukuba, Japan, pp. 49–54, 2007

〔著者紹介〕

● **Shamil Maksyutov**

Shamil Maksyutov received a M.S. in Physics and Mechanics of Chemical Processes in 1980, and a PhD in Chemical Physics in 1983 from Moscow Institute of Physics and Technology. He was a research scientist at N. N. Semenov Institute of Chemical Physics, Russian Academy of Sciences from 1983 to 1990. Since 1990, he has held several positions at National Institute for Environmental Studies and Frontier Research Center for Global Change and worked on modeling and observations of atmospheric components. Currently, he is a senior researcher at NIES and involved in preparing inverse modeling of CO_2 fluxes with GOSAT CO_2 data. He is a member of American Geophysical Union and Japan Society of Atmospheric Chemistry.

E-mail : shamil@nies.go.jp

● **Nikolay Kadygrov**

Nikolay Kadygrov was born in 1980 in Moscow. He recieved a MS in Applied Physics and Mathematics from Moscow Institute of Physics and Technology (Moscow, Russia) and PhD in the field of Applied Physics and Mathematics with an emphasis in Physics of atmosphere and hydrosphere. His study toward PhD was conducted at Central Aerological Observatory (CAO ; Moscow, Russia). Since 1997, he has been involved in several projects in ozone monitoring department of CAO. Right after receiving his PhD, he joined NIES GOSAT project in Japan. His main research interests are analysis of long-term changes in different geophysical processes (e.g. ozone depletion and carbon cycle), modeling of transport of atmospheric gases and inverse modeling of atmospheric CO_2. He is a member of AGU and JPGU.

E-mail : nikolay.kadygrov@nies.go.jp

● **Yumiko Nakatsuka**

Yumiko Nakatsuka completed her B. S. in chemistry at Humboldt State University (California, USA) with honors (Summa Cum Laude) in 2003 and her M. S. in Physical Chemistry at Cornell University (New York, USA) in 2005. Since 2006, she has been working at National Institute for Environmental Studies in Japan where she has been involved in modeling carbon flux of terrestrial ecosystem and atmospheric tracer transport.

E-mail : nakatsuka.yumiko@nies.go.jp

● **Prabir K. Patra**

P. K. Patra was born in December 1968. He has earned Ph. D. degree from Gujarat University in 1998. Then he worked at the IBM India Research Laboratory as Research Staff Member. Presently he is employed as a Senior Scientist. His current research interests include design of effective observation strategy for CO_2, forward and inverse modeling of gases. He is a member of AGU and IMS.

E-mail : prabir@jamstec.go.jp

● **中澤　高清（ナカザワ　タカキヨ）**

1947年10月生。’70年高知大学文理学部卒，’73年東北大学大学院修士課程修了，’76年同大学大学院博士課程単位習得退学，’80年理学博士（東北大学）。’76年東北大学理学部教務系技官，助手，助教授，教授を経て，現職（東北大学大学院理学研究科教授）。’86年スクリップス海洋研究所客員研究員，’88年文部省宇宙科学研究所客員助教授，’93年国立極地研究所客員助教授。温室効果気体の地球規模循環および赤外活性気体の吸収特性に関する研究に従事。日本気象学会，大気化学研究会，米国地球物理学連合，米国気象学会。’88年日本気象学会賞，’93年山崎賞，’96年日産科学賞，’07年三宅賞，’08年島津賞。

●横田　達也（ヨコタ　タツヤ）

1956年3月生。1981年，東京大学大学院工学系研究科修士課程（計数工学専攻）修了。同年，環境庁国立公害研究所（現，国立環境研究所）に入所。1987年に工学博士（東京大学）。1989年より2005年までオゾン層観測センサILAS及びILAS－IIプロジェクトに従事。データ処理アルゴリズムの開発研究及び定常処理システムの開発運用管理を担当。2003年より温室効果ガス観測技術衛星（GOSAT）プロジェクトを担当。2006年4月，地球環境研究センター衛星観測研究室長，国環研GOSATプロジェクトリーダーとなり，現在に至る。当学会，計測自動制御学会，情報処理学会，IEEE－GRSSなどの会員。
E-mail：yoko@nies.go.jp

●井上　元（イノウエ　ゲン）

1945年6月生。'69年東京大学教養学部基礎科学科卒，'75年同大学大学院博士課程修了（理学博士）。'75年環境庁国立公害研究所入所，大気環境部，地球環境研究センターなどに所属。'06年名古屋大学大学院環境学研究科教授着任，現在に至る。大気化学，分光学，温室効果ガス観測などの研究に従事。'03年日本気象学会堀内賞。日本気象学会，日本地球化学会，EGUなど。
E-mail：inouegen@nagoya-u.jp