Study for dynamical process of atmospheric compositions in troposphere and stratosphere using satellite data - Part II: Seasonal and Intraseasonal variations of CO_2 and CH_4 from GOSAT FTS TIR -

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Introduction

This study aims to investigate dynamical processes of transport in free-troposphere and stratosphere-troposphere exchange by profile data of GOSAT TANSO-FTS* Level 2 (e.g., carbon dioxide (CO_2) and methane (CH_4) profiles) and of the other trace gases (e.g. ozone) which are long-lived in troposphere and lower stratosphere, retrieved mainly from radiance spectra of Band 4 of TANSO-FTS [Saitoh et al., 2009].

*GOSAT TANSO-FTS : Greenhouse gases Observing SATellite, Thermal And Near infrared Sensor for carbon Observation - Fourier Transform Spectrometer [Yokota et al., 2009]

Analysis Data

The present study has reported the initial analysis of CO_2 and CH_4 profiles from FTS TIR CO_2 and CH_4 Level2 product (the latest version 01.00). This version data are validated by using the in-situ observation data (CONTRAIL, Continuous CO_2 Measuring Equipment (CME)) [Saitoh et al., 2016 (S16)]. The CO_2 and CH_4 amounts are good agreement with those from in situ measurements: At the upper troposphere/ lower stratosphere, the differences of CO_2 and CH_4 between TIR retrievals and in situ measurements are 1-3 ppmv [S16] and -5±15 ppbv, respectively [cf. Saitoh et al., 2012].

The analysis period for CO_2 is about 3-year from 1 March 2010 to 30 November 2012. The bias values were adopted to the retrieved data along the method of [S16]. The analysis period for CH_4 is CO_2 and 4-year from 1 January 2010 to 31 2013 for CH_4. To discuss the seasonal variation, the linear trend that is simple linear-fitting by minimizing the chi-square error statistic was removed.
For reference, the a priori that is NIES Transport model calculation [Saeki et al., 2014] are also shown.

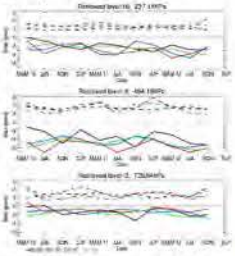

Figure A: Time series of the bias values of TIR CO_2 and CONTRAIL CO_2 at 237 (top), 464 (middle), 735 hPa (bottom). Solid and dashed lines indicate bias and STD. The colors shows each latitudinal band.

Summary

- The spatial and temporal variations of CO_2 and CH_4 are similar with respect to the previous studies, for example, the seasonal march of latitudinal distribution, the hemispheric contrast and the minimum values over Siberia and the north part of North America in the boreal summer.
- The year-to-year variations of CO_2 and CH_4 are also similar with the a prior data (NIES Transport model), although the difference of CO_2 at the upper troposphere and lower stratosphere between the retrieved data and CONTRAIL data increase larger with year [cf. Kimoto, Saitoh et al., Atmospheric Chemistry Meeting in Japan, 2015].
- It was found that the CH_4 transports from the lower to the upper troposphere over the convective regions continuously. By using the bias correction, the isolated maximum at the upper troposphere in the CO_2 field are not seen through the year. We will analyze further about this topic, especially over the tropic.
- Another topic of new findings is that the distribution of retrieved CO_2 in the upper troposphere (237hPa) has the stratospheric characteristic contrary to a priori field.

Results

(top) retrieval
(middle) a priori (NIES-TM)
(bottom) Difference (ret.-a priori)

Several years average seasonal variation (removing trend)

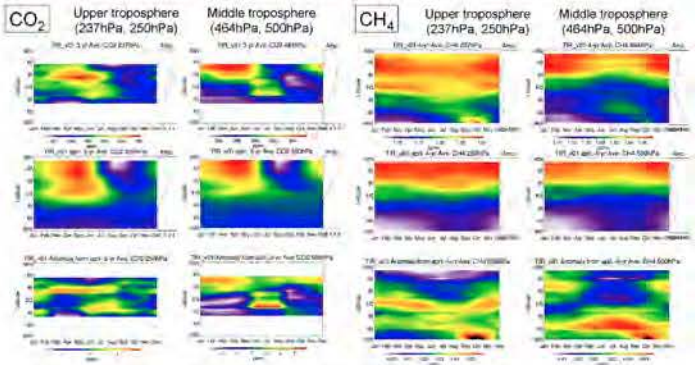

Figure1: seasonal march removing linear-trend of CO_2 with bias correction and CH_4 at upper (left) and middle (right) troposphere. The top, middle and bottom panels show the retrieval (TANSO-FTS TIR), a priori (NIES-TM) and the difference. The line ploot at each panels is the seasonal amplitude at each latitude.

year-to-year variation (with / removing trend)

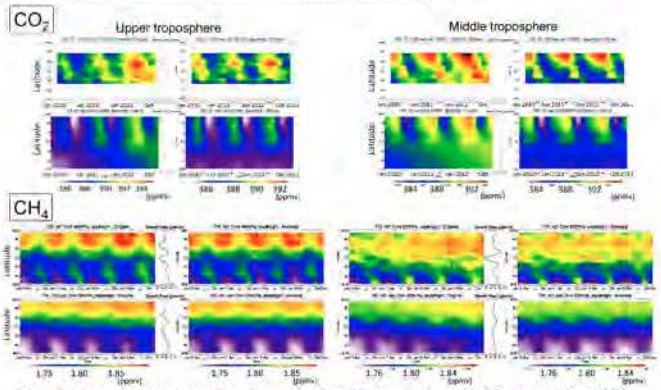

Figure2: Time and latitude section at upper and middle troposphere of CO_2 from 1 Mar 2010 to 30 Nov 2012 and CH_4 from 1 Jan 2010 to 31 Dec 2013. Left panel is the original and Right panel is anomaly from linear trend. The line plot is linear trend (ppmv(ppbv)/year).

Latitude-Pressure section (several years average removing trend)

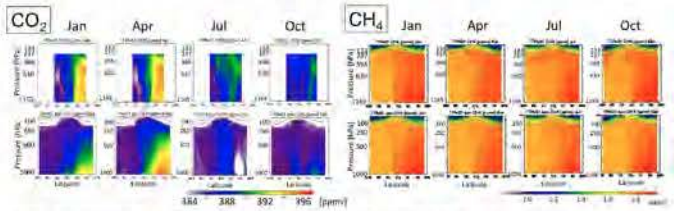

Figure3: Latitude and pressure section of zonal mean CO_2 and CH_4 averaged 3-year (without trend) on Jan, April, Jul. and Oct. Top and bottom are the retrieval and a prior, respectively.

References:

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