Study for dynamical process of atmospheric compositions in troposphere and stratosphere using satellite data
- Part I: Seasonal and year-to-year 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 has been validated by using the in-situ observation data (eg. CONTRAIL, HIPPO) [Saitoh et al., submitted to AMT (AMTD)]. 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 and -5±15 ppbv, respectively [cf. Saitoh et al., 2012].
The analysis period is 4-year from 1 January 2010 to 31 December 2013. 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.

Summary

- The differences in the distributions and values between day-time and night-time are seen in the CO_2 and CH_4 fields (not shown), however, the discussion of the quality is remained because the quantitative uncertainty is not done yet.
- Except the day/night difference, 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, on the other hand, the isolated maximum at the upper troposphere in the CO_2 field are 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)

4-yr average seasonal variation (without trend)

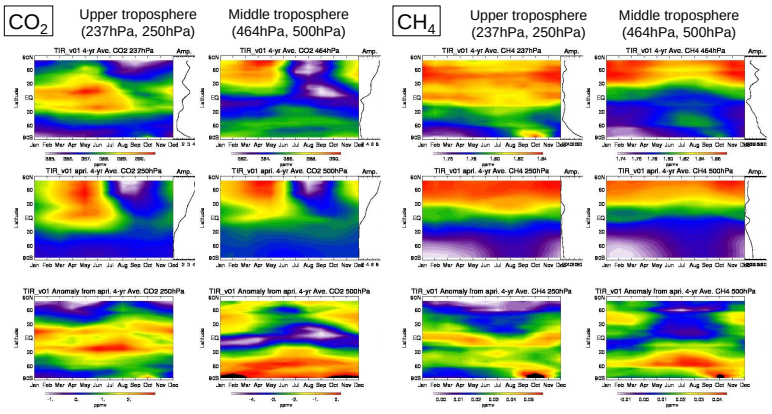

Figure1: 4-year averaged seasonal march without linear-trend of CO_2 and CH_4 at upper (left) and middle (right) troposphere. The top, middle and bottom panels show the retrieval (TANSO-FTS TIR), a priori (NIES-TM) and the difference. The line ploot at each panels is the seasonal amplitude at each latitude.

year-to-year variation (with / without trend)

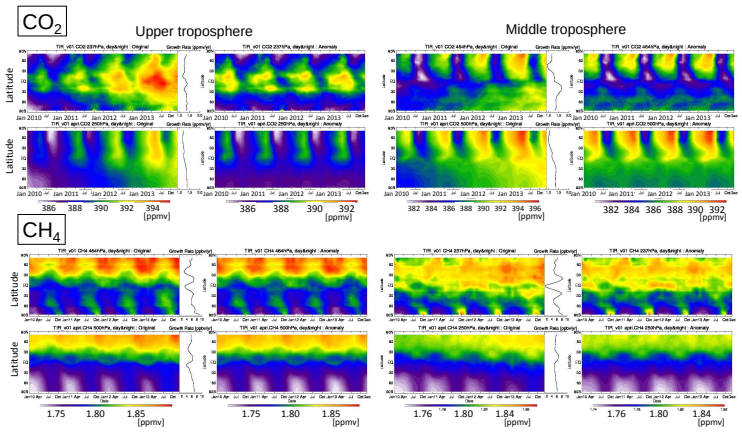

Figure2: Time and latitude section of CO_2 and CH_4 at upper and middle troposphere from 1 Jan 2010 to 31 Dec 2013. Left panel is the original and Right panel is anomaly from linear trend. The line plot is linear trend (ppmv(ppbv)/year).

Latitude-Pressure section (4-yr average without trend)

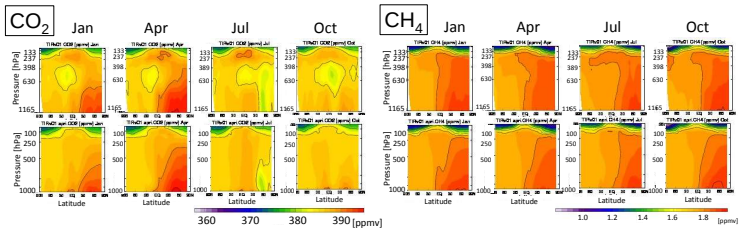

Figure3: Latitude and pressure section of zonal mean CO_2 and CH_4. averaged 4-year (without trend) on Jan, April, Jul. and Oct. Top and bottom are the retrieval and a prior, respectively.

References:
Saitoh, N., et al. (2009) CO2 retrieval algorithm for the thermal infrared spectra of the Greenhouse Gases Observing Satellite: Potential of retrieving CO2 vertical profile from high-resolution FTS sensor, J. Geophys. Res., 114, D17305, doi:10.1029/2008JD011500.
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