Interactive comment on "First ground-based FTIR-observations of methane in the tropics" by A. K. Petersen et al.

Title changed to "First ground-based FTIR observations of methane in the inner tropics over several years"

Anonymous Referee #2

Received and published: 11 March 2010 AUTHOR COMMENT: We would like to thank the referee for reviewing the manuscript and for the helpful comments.

General comments:

The authors present measurements of CH4 retrieved from ground-based FTIR observations in the tropics. These data are compared with SCIAMACHY satellite and TM5 model data.

CH4 is an important greenhouse gas and measurements in the tropics are quite sparse and are important to investigate the atmosphere. I agree with referee #1, the observations are important, but should be discussed in more detail. In particular, different sampling may affect the comparison with SCIAMACHY and model data. See also specific comments.

The subject is fully appropriate for publication in ACP. I recommend publication after major revisions.

Specific comments:

The title of the paper and the content of the paper differ. While the paper hints to an investigation of the tropical atmosphere the paper itself mainly discusses the validation of SCIAMACHY data. If the paper is intended to validate SCIAMACHY data this should be reflected in the title, too.

Several times 'validation of SCIAMACHY retrievals' is stated. At the current stage it is a comparison rather than a validation. For a validation a quantitative analysis of the comparison is missing as well as an error budget of the FTIR data and a comparison of the sensitivity of both sensors. Furthermore, due to the different sampling a quantitative validation is quite difficult to perform. Since the scatter of the SCIAMACHY data is quite large (in particular in 2007 and 2008) a 15 days average is given. Maybe a 15 days average of the FTIR data can be used as a measure to compare with.

The aim of the paper is the comparison of the only available FTIR measurements in the inner tropics with satellite and model data. The limitations of the satellite data makes is difficult to perform a more quantitative validation.

We tried several sampling methods for the comparison, especially, where we only used SCIAMACHY data at the same days as the FTIR measurements and within different radii around the FTIR observations site. Unfortunately, this reduces the amount of SCIAMACHY data, while the scatter of the data still remains. We found that the best way for a comparison is the presented data, where we take a reasonable large area and average over this data and than do a running average to smooth the data.

It is very common that satellite data is averaged over several months, up to one year or over large areas to reduce the scatter and to receive a good precision.

To address the referees comment, we included a table and a plot with means over the years (for the satellite retrievals and the model) and with means of the FTIR observations days for each campaign, including the standard deviations. The campaign-means gives a better measure for the agreement of the datasets and their differences.

Since the FTIR data have been taken during 2 short periods per year only, an annual cycle cannot be recorded with the FTIR data. Therefore, such an annual cycle cannot be compared with FTIR data. Furthermore, the scatter of the SCIAMACHY data is quite large. The statement of 'good agreement' needs some quantitative justification.

It should be stated that also the satellite observations need in principle clear sky conditions, which are most likely during the dry seasons.

We added the comment "... in general a good agreement within the limitations of the satellite data quality".

The FTIR observations are limited to the dry seasons. The comparison of the FTIR data with the TM5 column simulations and the in situ observations with the TM5 surface values gives a good verification of the seasonal cycle of the TM5 model for these times of the year. The comparison of the satellite retrievals with the TM5 model allows then the validation of the annual cycle of the satellite with in the limitations of the data quality.

We added a table with annual means and with means for each measurement campaign (we used only the data at the same days of the FTIR measurements) and modified Figure 1 to make the comparison of the different data sets more clear and to confirm the statement of generally good agreement.

The comparison with model data is a bit hidden in Fig. 1. At least a link to Fig. 1 should be added or even better add the FTIR data points in Fig. 3. Then it might be easier to follow the argument 'The good agreement also in 2007 of the TM5 model with the "clean air" surface in situ measurements as well as with our FTIR observations is consistent : ::'

The FTIR data points cannot be added in Figure 3, because Fig. 3 shows surface data, while Figure 1 gives total column data.

In order to make the data more clear, we splitted Figure 1 in three parts, the lower most gives is the old figure including the standard deviations of the observations (as Figure 1 before). The middle part shows the data without the standard deviations and on a larger scale. For the satellite data, only the running mean is shown. This illustration shows details more clearly e.g. the enhancement of the TM5 model in 2007. The upper most panel illustrates the yearly means of the model and the satellite retrievals as well as the campaignmeans of all the data (only the data of days with FTIR observations are averaged for each campaign).

": : : the first CH4 total column measurements showing this anomaly.": The FTIR time series doesn't show an increase in 2007. Again, an average value for each campaign might be a measure to see a variation from campaign to campaign.

The FTIR observations are in good agreement with the TM5 model, showing the 2007 anomaly. Since the TM5 model is assimilated with surface observations showing the 2007 anomaly, the TM5 model "contains" the 2007 enhancement. We only want to state a good agreement between the TM5 model with the observed FTIR and in situ data; the conclusion is that the FTIR data and the in situ data are not in contradiction with the recent findings, but confirm the methane anomaly. This can be seen in Figure 1, especially in the campaignmeans. The FTIR observations are in agreement with the TM5 model, apart from the biomass burning events during the LDSs 2004 and 2005, where the FTIR observations are higher than the model.

We removed the last part of this paragraph and extended the discussion:

"As reported recently by Rigby et al. (2008) and Dlugokencky et al. (2009), global surface in situ measurements show enhanced methane levels in 2007 compared to earlier years. The TM5 model based on assimilations of NOAA surface observations shows this anomaly being ~10ppb higher in 2007 than in the years before (see Figure 1 and Table 2 and 3).

Apart from the biomass burning periods, the FTIR observations are in good agreement with the TM5 model (see Figure 1 and Table 3), especially during the SDS and LDS 2007, when the TM5 model shows the methane enhancement compared to the years before. So the ground-based methane total column FTIR observations are consistent with the observations of Rigby et al. (2008) and Dlugokencky et al. (2009)."

A few times 'the first tropical ground-based FTIR measurements : : :' is stated. On Hawaii FTIR measurements of CH4 have been performed and reported (Rinsland et al. (1988), Infrared Measurements of Atmospheric Gases Above Mauna Loa, Hawaii, in February 1987, J. Geophys. Res., 93(D10), 12,607–12,626).

We want to clearify, that these measurements are the only inner-tropical FTIR measurements. Hawaii, as well as La Reunion and Darwin are at the outer part of the tropics (around 20 N or 20 S). Especially for Hawaii it is documented, that the probed air masses are mostly influenced by the Northern Hemisphere, especially North America and Eurasia (Buermann et al., The changing carbon cycle at Mauna Loa Observatory, PNAS, 2006). The measurements on Hawaii of Rinsland et al. report only on 4 day average for methane and have not been compared with model data or satellite data.

We added a small section addressing the methane FTIR observations of Rinsland et al and Senten et al in the introduction.

What is the typical column amount of methane in the tropics and how does it compare with the sub-tropics or mid-latiudes? There are several measurements (and also satellite comparisons) made in the sub-tropics and mid-latitudes to compare with, for example Payan et al., ACP, Vol. 9, 413-442, De Mazière et al. ACP, Vol. 8, 2421-2435, and Sussmann et al., ACP, Vol. 5, 2419–2429.

We included now NOAA flask data from Ascension Island (8°S) and Ragged Point, Barbados (13°N) in Figure 3 and bring the in situ data in Paramaribo and the TM5 surface data in context with the measurements from the NOAA network.

There are several papers mentioned in the introduction investigating methane on a global scale. We compare the inner tropical FTIR observations with global data sets like the TM5 model and SCIAMACHY data. These data sets are discussed in many publications in the global context and compared to local datasets.

The comparison of our FTIR observations with other data sets than the global data like TM5 and SCIAMACHY would be beyond the limits of this publication.

A figure of the spectral fit is missing. Since a wide spectral window is used a graph would be nice to illustrate the fitting quality in a broad window.

The figure of the spectral fit has been included.

The channeling visible in the spectral fit is caused by a infrasil glass filter used in the instrument in Paramaribo. This is not influencing the results.

Technical corrections:

- products represent (instead of represents) Done.

- with respect to (instead of 'of')? Sentence has been changed to "... and taking into account instrumental influences..."

- A break is needed in line 16 on page 2308 and in line 14 on page 2309 since the topic shifts.

- 'a priori' instead of 'prior' Done.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 2303, 2010.