Reply

To the Interactive comment on "Comparisons of CH4 satellite GOSAT and ground-based FTIR measurements near Saint-Petersburg (59.9 N, 29.8 E)" by N. M. Gavrilov et al. Anonymous Referee #4 Received and published: 5 November 2013

We would like to thank Anonymous Referee #4 for his comments. Our replies are given below in bold font.

My original comment should have been posted on September 30, but I failed to do it because of my failure due to my lack of experience of interactive discussion. After reading all referees' comments and authors' replies to those comments dated on October 26 (but not revised manuscript), I found some problems in the paper and authors' opinion as below.

Major comments

The aim of this paper is not focused clearly. I cannot read if the authors intend to validate satellite data using a reliable ground-based instrument, or to compare two equivalent instruments, GOSAT TANSO-FTS and FTIR of SPbU. In this paper, the authors cite many papers on GOSAT validation, and therefore, their aim looks like adding another validation of GOSAT data at high latitude using a reliable ground-based instrument. However, the authors replied to Referee #2, "Indeed, one of goals of our paper is not "introduction", but "validation" of Saint-Petersburg measurement site." – **Replies depend on questions. The referee #2 asked about introduction and validation of our data. We answered that our results may be used for that.**

I do not think it is good way to validate a ground-based instrument by using satellite data, because satellite measurements could contain more uncertainties and assumptions than ground based measurements. In particular, I do not agree to their opinion "the GOSAT data seem to be better validated than Saint-Petersburg ground-based measurements." – **There are tens of papers about GOSAT validation, and very few papers (mainly in Russian) about validation of St.Petersburg measurements.**

As also mentioned by the authors, no TCCON site is at higher latitude than 55 degrees, which means that no GOSAT data have ever been validated at higher latitudes than 55 degrees. I think the most (and almost the only) merit of this paper is to validate GOSAT data at such high latitude. – **As you see, different readers may find different merits of the paper. Our results may be used for different applications.**

I recommend the authors should state possible uncertainty of FTIR measurements first and then interpret the difference between FTIR and GOSAT data as uncertainty of the GOSAT retrievals. I believe satellite data should have more uncertainties than ground-based measurements. Actually, in the last paragraph of section 2, the authors described that the random relative errors of individual XCH4 measurements by FTIR do not exceed 0.3-0.5%, which is much better than the errors of satellite measurements. – **Some published validations give biases between GOSAT and ground-based FTIR measurements less than 0.3-0.5%. It means that the GOSAT data seem to be quite reliable recently.**

If the authors are concerned with possible difference between their FTIR and TCCON instruments, they should discuss on it clearly in this paper. – **We personally are confident in our data, but it is not enough. We have to compare our results with other worldwide-approved measurements.**

2. The authors mentioned in discussion section as follows: "One should keep in mind that these measurements are carried out near the Saint-Petersburg megalopolis, so the total methane variability there might be higher than that for background measurements." I recommend the authors should describe the condition of their FTIR site in the introduction section, so that readers can understand the situation better. – **We added some details.**

In addition, the authors should add more discussion on differences of XCH4 (_XCH4) that could be originated from the methane emissions from surrounding areas. Most of GOSAT validation studies have been carried out at the background regions so far. However, comparison studies at the emission regions are very important to verify the inverse analysis of methane budget using GOSAT measurements. Discussion of the effect of methane emission on this comparison would be very informative for researchers doing inverse analysis. This is, I think, another advantage of this paper, because methane emission from Arctic region has lately attracted considerable attention. On the other hand, the regions where the emissions affect on ambient methane concentration, comparison of measurements at different times is difficult because of large variability of XCH4. As Makarova et al., (2006) reported, the site of FTIR-SPbU can be affected by methane emissions from surrounding urban areas and wetlands, then the authors must investigate the range of permissible time difference and distance more carefully. – **At present, very little is known about methane sources around our station. We hope that our measurements will allow to answer the referee's questions in our future papers.**

The distance of +/- 3 degrees in latitude and longitude is quite large. Careful discussion is needed on the surface conditions and possibility if those areas are related to methane emission sources or not. One idea to confirm the effect of such variability is to identify which data pairs were obtained on the same day or with 2-day-difference in Figure 2 by showing them in different symbols. Then it is possible to confirm if the difference of XCH4 depends on the time difference of the two measurements. – **We tried other distances in latitude and longitude. The results are briefly described in the present paper. The detailed results of comparisons for different distances will be presented in a special paper.**

3. I have checked the GOSAT V1 and V2 retrievals in the vicinity of Saint-Petersburg. I found V2 data are also available on 2011-04-25 and 2011-09-06, though the authors include only V1 data for those days (Table 1). As the V2 data on both days are open for all general users (GU), they should be included in the analysis. – **At the GOSAT website, we also found much more V2 data recently than those were available when we started the present study. We added some more data to Tables 2, 3 and Figures 1-3. This helped to increase statistical confidence of our comparisons. By the way, we found that the date 2011-04-25 was erroneously written in Tables 1, 2 (there were no such observations in St. Petersburg). The date is corrected to 2011-04-26 now.**

As the retrieval algorithm has been revised thoroughly in V2 (Yoshida et al, 2013), comparison with V1 data is not recommended at present, though only V1 data are available for some period (e.g., April 2009). – **Therefore, we think useful to keep Table 1 in the paper.**

In my original comment dated on September 30, I included some minor/technical comments, most of which are the same by other referees, and the authors have already replied to them. Then I would not add any more comments on technical problems.

Finally, we would like to thank all of the reviewers for interesting and useful discussion. We are a bit surprised, but pleased, by the abundance of comments to our humble work and their diversity. In any case, all these comments were very useful and helped to improve our paper.

One referee proposed to use the GOSAT data for validating our ground-based measurements, and we agreed that it is possible. The last referee assures us that we should rather validate the GOSAT data, because satellite measurements could contain more uncertainties and assumptions than ground-based measurements, and we also agree that our comparisons can be used for that.

Almost all referees demand that we clearly articulate the purpose of our work. However, the only purpose of our work is clearly articulated in the title – it is comparison of surface and satellite measurements. Attitudes to other merits depend, in general, on reader's assessments of our ground-based measurements. In the replies to the comments

and in clarifications of the paper text, we have tried to provide additional information about the quality of our measurements.

Another objective of our brief paper is informing the scientific community that a new point of measurement of atmospheric gaseous composition using modern equipment is operating since the year 2009. Unfortunately, we do not have enough resources for sophisticated and rigorous process of testing and inclusion of our equipment into the NDACC network. However, we permanently concern about estimates of our measurement errors. We are using the "standard" for the NDACC network device and periodically calibrate it using standard gas mixtures. We use standard internationally accepted computer programs, which allow estimate the measurement errors. In addition, we perform measurements in stable atmospheric conditions. In one of our responses, we presented examples of measured daily variations of methane total content. They usually are 0.3-0.5% and may be regarded as the evaluation of our random errors for this gas.

In years 2010-2013, more than 10 papers with results of our ground-based measurements of different gases appeared in Russian journals. In these papers, we analyzed the measurement errors for different gases, temporal changes of their total contents and comparisons with independent ground-based and satellite measurements. For example, we compared different ground-based and satellite measurements of O3, CO2, HCl, HF, HNO3, ClONO2, etc. These comparisons have helped us to understand the quality of our measurements and their agreement with broadly validated satellite devices (such as MIPAS, MLS, ACE, etc.). The mentioned papers have English translations in the journal "Izvestiya, Atmospheric and Oceanic Physics" and have been reported at many conferences. One of the aims of our publication is to inform about our ground-based measurements near Saint-Petersburg.

We offer to finish discussions about "merits" of the present paper, believing that our measurements have definite value and their comparison with the GOSAT data are of definite interest. Moreover, such measurements are the first in Russia.

Yours sincerely.
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