

# Methane profiles from GOSAT thermal infrared spectra

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**Abstract.**

## 1 Introduction

### General

We would like to thank the Editor for the two constructive comments. Below we will provide our replies both comments.

- 5 The original comments made by the Editor are typeset in italic font, followed by our reply. We provide a new version of the manuscript but in our replies to the comments we provide line numbers, page numbers and figure numbers referring to the original version of the manuscript.

### Response to Editor

#### Editor's Comment 1

- 10 *During the original Editor response I had asked for the authors to discuss the uncertainties that result from comparing the TCCON total column to the thermal IR based total column. I think this was implicitly addressed in the manuscript by using the MACC model but these uncertainties should be explicitly estimated. You could use the approach discussed in Rodgers and Connor 2003: Rodgers, C. D. & Connor, B. J. Intercomparison of remote sounding instruments. Journal of Geophysical Research-Atmospheres 108, 4116 (2003).*

- 15 We fully agree with the Editor that the uncertainty by the MACC profiles to the total columns should be explicitly calculated. However, this is not possible due to the lack of an estimate of the accuracy in these profiles. One of the major problems in satellite methane profile validation is that there is only a limited set of reference profiles of sufficient quality available. If these were available we would have validated directly with this reference data.

- To answer your request more specifically, when following the suggested reference, one needs the error covariance matrix  
20 of the MACC data, and this is an unknown quantity. Even the diagonal elements of this matrix, which could be used when assuming no correlations between altitudes, are unavailable. The uncertainties in the MACC dataset is derived from two studies in which the total column of TM5 (the underlying model for the MACC methane data) is verified against independent measurements. Both studies are referred to in the text (p. 11, lines 1 and 5 respectively).

In order to map the uncertainty of the MACC methane data onto the uncertainty of the GOSAT-TIR methane total column, the averaging kernel should be applied to the uncertainty of the MACC methane profile. However, from the studies mentioned above, an uncertainty has been derived for the total columns, and not the profile. As a first order approach, one could assume that the uncertainty in the MACC profile is evenly distributed over the profile. However, in case of correlated errors in the  
5 MACC profile, this assumption would lead to a too low error estimate. To account for this, we assumed an uncertainty of 2%, rather than 1% as the other studies indicated. With this assumption, the error contribution of the MACC profiles is estimated to be 0.6% of the overall 2% uncertainty in the GOSAT-TIR total column values (see p11).

## **Editor's Comment 2**

*Also, please remove or modify this statement (Page 9 Line 14) "Here, both the ground-based and satellite observations show  
10 homogeneous methane retrieval sensitivity over all atmospheric altitudes, leading to highly accurate estimates of the total column of methane rather than a profile. " as the statement is mis-leading. The TIR based estimates are primarily sensitive to the mid-troposphere to lower stratosphere methane and NOT the total column.*

I am afraid that there is a misunderstanding. Indeed the statement would have been incorrect if it would refer to TIR measurements, but it refers to measurements in the SWIR. Since both referee Payne and the Editor are confused by the statement,  
15 we have adapted the wording to explicitly refer to SWIR measurements:

"Here, both the ground-based and satellite observations show homogeneous methane retrieval sensitivity ..." has been changed into "In this particular case of the SWIR wavelength regime, both the ground-based and satellite observations show homogeneous methane retrieval sensitivity ..."

## **2 Conclusions**