EGU21-15638
https://doi.org/10.5194/egusphere-egu21-15638
EGU General Assembly 2021


# Error source analysis for $CH_4$ retrievals in the TIR

Charles Robert[1], **Claude Camy-Peyret**[2,3], Pascal Prunet[3], Ann Carine Vandael[1], Justin Erwin[1], Bastien Vispoel[1,5], Martine De Mazière[1], Yannick Kangah[3], Olivier Lezeaux[3], Carmine Serio[4], Guido Masiello[4], Muriel Lepère[5], and Anne Grete Straume[6]

[1]Royal Belgian Institute for Space Aeronomy, Uccle, Belgium
[2]Institut Pierre-Simon Laplace, IPSL/Sorbonne Université, Paris, France
[3]SPASCIA, Ramonville-Saint-Agne, France
[4]Scuola di Ingegneria, University of Basilicata, Potenza, Italy
[5]Institute of Life, Earth and Environment (ILEE), University of Namur, Namur, Belgium
[6]ESA/ESTEC (TEC-EEP), Noordwijk, Netherlands

Atmospheric methane is measured continuously from space, providing valuable information at global/regional scales for atmospheric monitoring as well as for surface flux estimates. However, as shown by several studies, $CH_4$ atmospheric concentration retrievals from thermal infrared (TIR) nadir sensors exhibit significant biases compared to independent observations, or when intercompared between different TIR and SWIR/TIR sensors products. It is necessary to analyse the possible causes of biases and to investigate potential retrieval improvements and/or bias-correction for proper and consistent $CH_4$ measurements in the TIR: this is the objective of the ESA CH4TIR project.

The CH4TIR project brings together the expertise of researchers using different state-of-the-art forward/inverse model and retrieval schemes, namely ASIMUT-ALVL and σ-δ-IASI, to identify the possible causes for the observed biases and quantify the uncertainties linked with the forward modelling and inversion of $CH_4$ in the TIR region. Due to its accurate measurements and well-characterized noise, IASI observations are used as the main data source for the project, but TANSO-FTS observations are also used for comparison.

First, we present a sensitivity analysis carried out for the $CH_4$ retrievals performed with IASI and TANSO-FTS data in the TIR region using ASIMUT. We assess the impact of the retrieval spectral range, the measurement uncertainty, uncertainties in the spectroscopic data, and the inclusion of different species in the retrieval. An analysis of the IASI spectral residuals from both ASIMUT-ALVL and σ-δ-IASI retrievals shows that residuals are largest in the strongest part of the Q branch (1300-1310 $cm^{-1}$), where line mixing effects are most significant. Dedicated laboratory measurements of $CH_4$ lines in this spectral domain are being performed and analysed in the frame of this project.

An important feature of the project is to call on two different approaches and tools for the retrieval of $CH_4$ from IASI observations. We therefore characterize the differences between the σ-

IASI and ASIMUT-ALVL radiative transfer modelling in the 1190 - 1350 $cm^{-1}$ region based on 6 AFGL atmospheres. To further assess the error from the forward/inverse model, the results of a round robin exercise is also presented, where the output from one RTM is used as input for the other RTM/inversion scheme.

Finally, we explore how critical a priori temperature and $H_2O$ profiles are to the accuracy of the $CH_4$ inversion. To investigate this effect, a two-step retrieval approach is used where a first retrieval by σ-δ-IASI exploits the entire IASI spectral range and is used as a priori for the CH4 retrieval performed on a narrower spectral range (1190 – 1350 $cm^{-1}$).

This ongoing work already provides a comprehensive analysis and prioritisation of error sources for the retrieval of $CH_4$ from TIR hyperspectral measurements, emphasizing the critical need of spectroscopy measurements and line interference modelling in the Q branch around 1300 $cm^{-1}$ for reducing $CH_4$ retrieval biases and improving the retrieval sensitivity in the lowermost levels of the atmosphere.