Review of EGUsphere-2024-2365

Retrieving the atmospheric concentrations of carbon dioxide and methane from the European Copernicus CO2M satellite mission using artificial neural networks

By Maximilian Reuter, Michael Hilker, Stefan Noël, Antonio Di Noia, Michael Weimer, Oliver Schneising, Michael Buchwitz, Heinrich Bovensmann, John P. Burrows, Hartmut Bösch, and Ruediger Lang

General comments.

The authors present a new retrieval method from Level 1B of CO2M data. I understand that this activity is important to retrieve a good XCO_2 and XCH_4 products from CO2M data with acceptable computational time. However, some description and assumption are unclear or missing in the text. For example, to retrieve the XCO_2 and XCH_4, the instrumental model is very important. In this manuscript, only the random noise is assessed. The authors should concern the other parameters at least the uncertainly of instrumental line shape function and its wavelength depended response. In addition, the authors were used the actual space-based observation data such as OCO-2 during the FOCAL development. To evaluate the new NRG-CO2M algorithm with actual space-based observation data with realistic uncertainty is also important and informative. However, the authors are only focused the simulation-based dataset. I understand the CO2M will not be launched until 2026. The authors should be considered the evaluation plan with the updated instrumental model data and the realistic characterization error, and these impact on the NRG-CO2M processing. Furthermore, the application for the actual space-based observation dataset, currently available dataset, is also informative and productive for the evaluation purpose. The authors should be considered the evaluation plan for the NRG-CO2M with currently available observation dataset. I recommend the authors will add the sentences and clarify for some of unclear sentences.

For these reasons, I recommend this paper for publication with minor changes to the technical content.

Specific comments.

Abstract

1. Page 1, line 13: Spell out first for "NRG-CO2M". -> Neural networks for Remote sensing of Greenhouse gases from CO2M (NRG-CO2M)

2. Page 1, line 19: The definition of "spatio-temporal systematic errors" is unclear. The authors should add the definition or more clear explanation for the condition.

1. Introduction

3. Page 2, line 39: add the "," between "5ppb" and "respectively".

4. Page 2, line 41: Spell out first for "CO2I".

5. Page 2, line 42: Spell out first for "MAP".

6. Page 2, line 42: Spell out first for "BRDF".

7. Page 2, line 43: Spell out first for "CLIM".

8. Page 2, line 44: XCO2 or XCH4 -> XCO2 and/or XCH4

9. Page 2, line 47: 2017b,a -> 2017 a, b

10. Page 2, line 49: Spell out "EUMETSAT".

11. Page 2, line 57: The meaning of "3D effects" is unclear. The authors should add the explanation.

12. Page 3, line 61: Spell out first for "OCO-2".

13. Page 3, line 62: Spell out first for "GOSAT".

14. Page 3, line 77: the meaning of "meteorology and angles" are unclear. The authors should add the explanation.

15. Page 3, line 83: Krasnopolsky and Schiller (2003). -> (Krasnopolsky and Schiller, 2003).

16. Page 4, line 116: Spell out first for "OSSE".

17. Page 4, line 116: In the previous works, the authors were developed FOCAL full physics algorithm. During the development phase of FOCAL, the authors are actually used the space-based observation data such as OCO-2 and GOSAT. To evaluate the new NRG-CO2M algorithm with actual space-based observation data is quite realistic and import. However, the authors are only focused the

simulation-based dataset. So, the authors should be considered the evaluation plan with actual space-based observation dataset or current limitations.

2. Data sets and methods

18. Page 5, line 154: What is the instrumental line shape model? It also has several uncertainties. It is not clear how to take account spectrally depended uncertainties. The authors should add the explanation.

19. Page 7, line 193: How to consider the bias in a priori? Especially in the future prediction, not only a standard deviation but also the bias has to be considered. The authors should add the explanation.

3. Results

20. Page 18, Figure 5: How is the slope? It seems that the linearity can be directly estimated from this analysis. However, it is not mentioned in the text.

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