For research article

Response to Reviewer 1 Comments

1. Summary

Thank you very much for taking the time to review this manuscript. Please find the detailed responses below and the corresponding revisions/corrections highlighted/in track changes in the re-submitted files.

2. Point-by-point response to Comments and Suggestions for Authors

Comments 1: The authors need to define what the "spaceborne hyperspectral greenhouse gas (GHG) monitoring instrument" is. This needs a brief description and a reference(s) provided. What type of instrument are we talking about? What are its characteristics?

Response 1:

Thank you for pointing this out. Regarding the characteristics of the spaceborne GHG monitoring instrument, we have added some notes in lines 33-38 of the revised manuscript. In addition, the design parameters of the GHG detection instrument used in this study, which is named GHG Monitor in the article, are referenced from an instrument under development. Additional explanations are provided in the revised manuscript on lines 15-17 of the Abstract section, and lines 110-111 of Section 1. Furthermore, numerous potential ambiguities in the article have been corrected.

Comments 2: It should be stated that calibrating a real instrument against interpolated spectra poses it own problems. The data provide are not any better than their measured/published values. Interpolation provides smooth data that are well behaved when trying to fit a smooth function to. This may not be the case in reality.

Response 2:

I agree with this comment. Errors in the reference solar spectrum are also a source of error in the on-orbit wavelength calibration based on the Fraunhofer lines and this source of error is unavoidable. The spectral resolution of the Kurucz solar spectrum used in this study is one order of magnitude higher than that of the GHG Monitor, so the calibration error due to the reference spectrum is acceptable compared to the other sources of error analyzed in this study. Calibration based on solar observations is only one of the ways for the on-orbit wavelength calibration of instruments. In practical on-orbit wavelength calibrations of GHG Monitor, Multi-combined on-orbit calibration modes, including solar observation and Earth observation, should be used in combination to obtain more accurate spectral correction results.

As for the interpolation of Kurucz solar spectrum in the SCO2 band to 0.001 nm mentioned in lines 179-180 of the article, the purpose of it is to obtain a more accurate position of the Fraunhofer peaks, which results in a negligible error concerning the spectral resolution of 0.1 nm in the SCO2 band.

Comments 3: It should be made clear that the major problem may be in the radiometric arena and small perturbations in spectra wavelength may not be the major source of errors in the retrieval of GHGs. The real impact should be expressed as a function of retrieved GHGs and not observed

wavelengths. Do these error impact the retrieval of GHGs? What is this impact? How large an error in radiometric calibration is needed to insure that these values should be corrected and to what precision?

Response 3:

The accuracy of the radiometric calibration of the instrument is indeed the more important factor affecting the accuracy of the GHG concentration inversion. According to the results of existing studies, to realize the accuracy of GHG inversion of less than 4 ppm, the absolute radiometric calibration accuracy of the instrument needs to be less than 5%, the relative radiometric calibration accuracy between spectral bands needs to be less than 1%, and the relative radiometric calibration accuracy between channels needs to be less than 0.1%.

Regardless of the method of on-orbit radiometric calibration, such as solar or calibration lamp observations, the calculation of the center wavelength of each spectral channel of the instrument is a prerequisite for the radiometric calibration of the instrument. The wavelength calibration error will directly affect the accuracy of the absolute radiometric calibration of the instrument, which in turn will affect the accuracy of the GHG concentration inversion.

The main contribution of this study is to analyze the accuracy of on-orbit wavelength calibration of GHG Monitor based on Fraunhofer lines, whose impact on the accuracy of radiometric calibration and hence GHG concentration inversion is beyond the scope of this study and may be discussed in the results of the subsequent studies.

Comments 4: I have made a number of specific suggestions/comments in the attached version of the manuscript to hopefully aid in the review/publication process. I do think and editorial pass would be advised to enhance its overall readability/presentation. Some attention should be paid to the conclusion sections, and some of it may need to be reworded.

Response 4:

We sincerely thank you for your valuable comments on this article. We have further edited and revised the article to enhance its readability and presentation. The conclusion section of the article has been reworded in response to the comments and can be found in lines 575-577, lines 590-593, and lines 600-606 of the revised manuscript.

3. Additional clarifications

As for your note in line 179 of the first manuscript ("What diffuser? Is there a diffuser in the instrument in question?"), the spaceborne hyperspectral payload commonly uses a diffuser for solar observations. The “diffuser BRDF” mentioned in the article is a simulation value to calculate the solar-viewing spectrum of the instrument.