

Interactive comment on “The impact of spectral resolution on satellite retrieval accuracy of CO₂ and CH₄” by A. Galli et al.

Anonymous Referee #2

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Galli et al. 2013 discuss the effect of different spectral resolutions on the accuracy of CO₂ and CH₄ measurements. They employ two different sets of spectra measured from space by GOSAT. The first set includes measurements collocated to TCCON sites, whereas the second set incorporates measurements over Europe and North-Africa to encompass a greater range of geophysical scenarios. The study is completed by analysing the effect of spectral resolution and different signal to noise ratios (SNR) on the retrieval, which need to be considered together to assess future satellite instrumentation.

The investigations discussed in the manuscript are well in the scope of Atmospheric Measurement Techniques. It addresses scientific questions which have to be answered every time a new earth observation mission is prepared and their methodology

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is sound. The broad range of geophysical scenarios used in all three sets of measurements allows to draw valuable general statistical conclusions. Special interest has been given to study the effect of individual physical parameters like dependencies on water and albedo, the effect of degradation of spectral resolution of individual windows as well as the mitigation of diminished spectral resolution by an increased SNR.

The work is fit for publication in AMT with minor comments to be addressed. However, the authors might increase the impact of their work. In its current state, the manuscript is very descriptive. The authors went to great lengths to disentangle the observed dependencies (using single window degradation and synthetic spectra), but the explanation of increased error remains somewhat speculative (spectroscopic errors, mainly for CH₄). Some additional elaborating on causes of the observed changes to facilitate a deeper understanding may greatly increase the impact of the work.

1 General comments

- Aerosol size parameter is among the studied parameters, but this one is specific parameter of the RemoteTec algorithm and not generally applied in other retrievals. Since it shows one of the greatest impacts when degrading the spectral resolution, the results may only indicative for other algorithms employing different schemes to deal with aerosols. The authors may want to include a sentence to make the reader aware of this, although this is also speculative on the part of the reviewer.
- For the study of synthetic spectra in Sec. 3.4 / Fig. 9, the authors only describe changes in standard deviation of results but do not give any indication of possible changes in bias. From the following discussion it seems that there is no bias present, but this should be explicitly mentioned or shown with an appropriate figure

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- CO₂ shows a peculiar behaviour if one is looking at the results of the data set collocated to TCCON sites: Whereas the expected increase in scatter can be observed while reducing spectral resolution, the bias first shows a strong increase comparing a FWHM of 0.24cm⁻¹ with 0.5cm⁻¹, but a subsequent decrease for larger FWHM. This jump in bias can also be observed for CH₄ when moving from original ISF to reduced ISF as discussed by the authors on P10412. This is not further discussed, but raises questions of possible errors induced by the convolution, especially because the change in bias is relatively large.

2 Minor comments

- P10401 L21: please specify “interference errors”
- P10402 L19-P10403 L2: General specifications of Sentinel 5 are missing here.
- P10403 L1-5: The authors should mention that their study can only be indicative for some of the missions due to different wavelength windows (compare e.g. Sentinel 5)
- P10403 L15: The authors introduce “the first dataset”, but do not further elaborate on the other datasets used.
- P10409 L9: Move definition of collocation to first mentioning
- P10411 L8 Varying number of retrievals for different spectral resolutions: how does this introduce a bias in favour of low resolution?
- P10411 L18 How does the performance at original GOSAT resolution artificially improve because the number of data points drops by 50%? This questions also relates to the previous minor comment. This paragraph may need better explanation.

- P10411 L20: Tables 2 to 5 list (... moved to the end of the sentence ...) the retrieval performance for XCO₂ or XCH₄ for all six TCCON stations...
- P10412 L7: The change in CO₂ bias is described as seemingly random. However, a pattern is visible: A strong increase in bias after convolving the spectra to FWHM=0.5cm⁻¹ with subsequent decrease in bias with increasing FWHM. The reason behind this should be discussed, as it directly relates to the core of the manuscript.
- P10412 L18: (comment to the previous point) A shift observed by Petri et al for XCH₄ may be indicative, but they observed no shift for XCO₂ in contrast to this study
- P10414 L4-7 and Figure3: The differences in global bias with applied method to decrease spectral resolution raises the question how the method affects the retrieval. This is also visible for Fig.3. Although the general trend is the same for both, truncated interferograms and convolution, the differences depicted seem to be on the same order as seen in Fig.4. Also the results of the fits should be added for Fig.3.
- P10414 L28: Only Figure 5 shows CH₄. Maybe it would be better to put the last sentence in the paragraph (dealing with CO₂) before this one, which would make the numbering of figures coherent.
- P10416 L1: The authors speculate that the different effects of degrading different bands on XCO₂ may be explained with the fact that only the SWIR 2 band contains information on scattering by cirrus clouds. However, degrading the SWIR 2 band does not have such a strong effect on the retrieval, and basically none for CH₄. If SWIR 2 is also used in the CH₄ retrieval, an effect due to aerosol scattering should be apparent in the SWIR 1b band as well, which determines CH₄. So it seems that the argument is flawed or should be made clearer.

- P10416 L25: The positive bias is indeed the most obvious bias. However, the low amount of coverage over the Sahara raises the question how many retrievals were successful over the desert, given that it is a two year data set. What is the statistical base for this observation?
- P10417 L27: The restriction of COT to smaller than 0.02 seems reasonable given the filter for real measurements. A problem might be that scenes with a low COT in general will become effectively scenes without cirrus cover. The possibility of introducing a bias might be slim (judging also from the referenced literature), but a check might have been worthwhile.
- P10418 L14-...: Discussed and depicted is only the scatter of XCH_4 and XCO_2 , but not whether or not a bias is introduced. It should be mentioned if the retrieval does not yield any significant bias, or otherwise shown as for the scatter. This important point seems to be implicitly assumed for the following discussion.
- P10420 L7: The discussion is valid as long as the only errors present are spectroscopic and calibration errors. Other errors present may be, e.g., radiative transfer induced due to simplified aerosol representation, cirrus, etc. Then the discussion and its conclusion is indeed misleading.
- P10421 L6: see previous comment on the effect of aerosol scattering
- P10421 L12-15: The paragraph may be moved forward to follow the structure of the manuscript and most results are only discussed for the convolution.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 10399, 2013.

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