

Interactive comment on “Accurate mobile remote sensing of XCO₂ and XCH₄ latitudinal transects from aboard a research vessel” by F. Klappenbach et al.

Anonymous Referee #1

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General overview

The paper by Klappenbach et al describes the use of, and data set produced by, a Bruker EM27/SUN during a ship campaign. This particular instrument is a relatively new addition to the TCCON network which uses the high resolution Bruker HR125, an expensive lab based spectrometer. The EM27/SUN is designed to be used as a complementary measurement. The spectrometer has a much lower resolution (0.5 cm⁻¹) and has yet to be formally adopted as part of the TCCON network. As part of this ongoing process and network acceptance, the use and deployment of the instrument as a field usable spectrometer under a variety of conditions is just what is needed. De-

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ploying the instrument on a ship is demanding primarily due to the unstable platform any instrument that is remote sensing must cope with. In this paper the authors describe how they have modified the EM27/SUN successfully to obtain a level of accuracy and precision in xCO₂ and xCH₄ that is required (by TCCON). The data processing is described and data quality controls explained in terms of operating in such a hostile environment, for example, interference from the ship's funnel exhaust.

The paper then compares the data with collocated satellite measurements (GOSAT), and model data. Given the apparent cursory nature of the comparison the EM27/SUN does reasonable well against satellite measurements and model.

This paper makes an important contribution to the atmospheric CO₂ and CH₄ measurement community and should be published. The paper is clearly written, well organised, with readable and clear figures. However there are a few issues that need addressing that are listed below in the major comments, while a number of minor typos/grammar type comments are also listed. If these major issues are addressed to the satisfaction of the editor then the publication of the paper is recommended.

Major Comments:

1. Section 3.1. In the description of the PROFFIT setup, it is stated that the software is configured to do a scaling of the apriori with a single factor. This is of course the manner in which the official TCCON analysis product, GFIT, operates its inverse method. The question is though is it completely the same? Is this the only regularisation that is applied? Is PROFFIT effectively running in more or less the exact same way as GFIT. Are the degrees of freedom for signal the same, more or less?

2. Section 4, page 19. This leads onto another issue of the characteristics of the retrievals. The authors state that the effects of the measurement averaging kernels have been neglected. The EM27/SUN has a significantly different OPD to the HR125, the standard TCCON instrument. Since the averaging kernel (and dof) are largely driven by the OPD, apriori profile, solar zenith angle, and the apriori and measurement

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covariances, I would have thought that it is important to first show that the averaging kernel of the EM27 (the early EM27 papers did not do this). The assumption the authors are making here is that the smoothing effects from the EM27 are relatively small. This should be demonstrated explicitly.

3. Section 4 discussion and Figure 9. Following on from point 2 above, all comparison data should be smoothed with the EM27/SUN averaging kernel, both model and satellite. That is, unless it can be demonstrated in point 2 above that the averaging kernel effects are very small.

4. Section 3.3: it would be interesting to know from an operational point of view, why the ILS of the EM27 changed by opening it. Other users of the EM27/SUN may want to know what was adjusted, if anything, and what this implies for the instrument stability while on a campaign. Clearly it is mandatory to measure the ILS before and after such a campaign. But what if, for some reason, it was required to open the instrument more than once? Does this mean the ILS must be remeasured each time?

5. Page 7445, Figure 2, the red line is missing in the figure key.

Minor comments: (using the corrected online AMTD version)

6. Page 7417, line 1, remove extra "the"

7. Page 7417, line 5, compensates => compensate

8. Page 7424, line 21, "..DC-correction removes not the entire ..." => "...DC-correction does not remove the entire ..." 9. Page 7425, line 25, analogue => analogous

10. Page 7425, line 26, smoke pipe => funnel

11. Page 7426, line 12, "..and plume, the parameter..." => "..and plume, and the parameter..."

12. Page 7426, line 16, "...records of onboard..." => "...records of the onboard..."

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13. Page 7428, line 1, "...effect remains unclear. Although uncertainties ..." => "...effect remains unclear, although uncertainties..."

14. Page 7430, line 16, "...few ten samples ..." => "...few tens of samples ..."

15. Page 7433, lines 22-23, "The solar tracking device could be adapted in hard- and software such that direct-sun absorption spectra could be recorded regardless of the ship's movements ..." => "The solar tracking device has been adapted in hard- and software such that direct-sun absorption spectra have been recorded regardless of the ship's movements ..." 16. Page 7434, line 13, "Although, the number of satellite ..." => "Although the number of satellite ..."

17. Page 7434, line 22, public => publically

18. Page 7447, figure 4 caption, instable => unstable

19. Page 7450, Figure 7 caption, line 3, Is the "s." meant to be there?

20. Page 7451, Figure 8 caption, the grey dots are not explained in the figure.

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