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Atmospheric Measurement Techniques Discussions

Interactive comment on "LIDAR technology for measuring trace gases on Mars and Earth" *by* H. Riris et al.

Anonymous Referee #2

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This manuscript reports on the development of critical lidar technology for space-borne measurements of the greenhouse gases CH4 and CO2 or H2O on Mars and Earth. The authors describe the optical setup that is based on an injection seeded OPA and demonstrate by absorption measurements in a gas cell that the required tunability and sensitivity can be achieved both application on Earth and Mars. This is because of the possibility to operate the proposed radiation source in both spectral domain at 1.6 μm for measurement on Earth and at 3.3 μm where strong absorption lines exist for measurement on Mars where the trace gas concentration is much lower. This is a timely study that treats a potential lidar system for of much importance in Mars and Earth science. I recommend that it be published, subject to substantial revisions in response to specific comments that follow.

Page 4676-4678, Introduction:

Significant information on the status of remote sensing instruments for CH4 is missing in the manuscript: - In the context to passive sensors methane measurements with SCIAMACHY on ENVISAT need to be mentioned since those data have already been used in flux inversion studies (P. Bergamaschi et al).

- In case of active remote sensing of CH4 reports on operational instruments for gas leak detection operating in the 3.3 μm or 1.6 μm spectral regions are available in the literature, For example, Milton M.J.T., T.D et al, 1997, Minato A. et al. (1999). Menyuk N. and D. K. Killinger (1987). Fix A. et al. G. Ehret, A. Proc. 22nd International Laser Radar Conference, ESA SP-561, (2004) or others? What's the difference to those systems and what is the development status of the selected technology compared to previous similar systems.

- In addition, as a reader, I found myself wanting more information about the measurement/instrumental requirements for methane observation on Earth versus Mars. I assume that the requirements are quite different because the different level of knowledge and research goals.

- The phrase "... increased production of methane by methanogenic microbes ..." needs a reference.

Page 4679, lines 19-25 - The statement that the 3.3 μm spectral region is not well suited for methane measurements in the Earths's atmosphere is questionable. As above mentioned, the 3.3 μm spectral region is well suited for gas leak detection. The authors should be more precise on this point. Why not use spectral lines around 2.2 μm?

Page 4680, lines 1-12 - This is textbook style information and should be shortened. OPO's and their modifications have widely been used in the past and many systems are reported in the literature. The authors should refer here to the literature.

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Line 20: - Here some information about the spectral bandwidth requirement is missing. The assumption that the NPRO provides transform-limited pulses should be better justified or shown by a measurement.

Lines 21-25: - the design and spectral performance of the seed-laser system is not adequately described. Not only the line width is a critical parameter but the temperature sensitivity or spectral drift of the DFB-laser would be of interest. What is the cause of the Erbium- doped fiber amplifier? What happens to the spectral performance of the DFB-laser after passing the amplifier stage.

Page 4681, paragraph 3.1 - In this paragraph the OPA performance is characterized. The authors mention in line 13, that a 20 dB intensity suppression over the gain bandwidth of 2 nm could be achieved, when the OPA-setup is seeded. I don't agree that this value would be sufficient for any high accurate methane measurements in the Earth's atmosphere. It is mandatory that the authors commend on the level of spectral purity that can be achieved with the proposed OPG setup. Furthermore, the measured value should be compared to the requirements for soundings on Mars and the Earth.

- Besides severe lack of information on the spectral purity, this paragraph is in general too short with respect to fully characterize the performance of the selected OPG-setup. In particular, the results presented in the figures need more discussion. For instance, it is not clear to the reader, where are the limitations in terms of optimum seed power, pulse energy, spectral bandwidth, spectral purity, and overall efficiency. Fig 7 should be discussed in more detail. What was the basis for the theoretical calculation. Also a brief comparison to similar systems that using OPOs or other radiation sources would certainly improve the quality of this manuscript, substantially.

Page 4682, line 6: - The version of which HITRAN data base was used should be added .

Page 4683, line 4-7: - The calculation of the measurement sensitivity on Mars is not clear to the reader

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- The sentence, " . . . with a well engineered instrument . . .we can increase the detection sensitivity limit even further" is an empty phrase and should be deleted.

Page 4684, lines 1-10: - More or less a repetition of what was said in the section 2 lines 20-26. Needs revision.

Page 4685, lines 1-5: - Description of Fig. 16/17 is a bit thin. What is the measured column-integrated mixing ratio and what is the measurement precision?

lines 5-20. - The conclusion needs major revision. The formulation is too general and does not really reflect the results of the study.

References: s. comment to the introduction

Table 1. should be described in the text. The paper does not report on how the calculations are of the SNR are performed.

Fig. 3: What are the other lines in the spectrum?

Fig. 4: textbook info should be deleted

Fig. 5: Erbium doped amp. not described in the text. Also other sub-systems not explained.

Fig. 9: the transmission should be given in log coordinates

Fig. 12: not clear to the reader. What is meant by methane mixture? Why is the transmittance larger than 1? Also the app. Wavelength must be described.

Fig. 13: similar to Fig. 12

Fig. 17: difference between on- and off-line not visible in a black and white copy

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Interactive comment on Atmos. Meas. Tech. Discuss., 3, 4675, 2010.