Thank you very much for the review and the helpful comments. I really appreciate the input and I would like to respond to the comments and offer some changes/suggestions that hopefully will result in changing the recommendation.

First let me provide some background. The manuscript was supposed to be submitted to a special issue (Special Issue Tropospheric Profiling) that includes presentations from the ISTP 2009 congress. I apparently made a mistake in the submission process and I take responsibility for that. I am working with the editors to correct the problem. Given this background information I would like to address the comments one by one if I may and offer revisions that I hope will improve the manuscript.

"The manuscript describes a study aiming at evaluating the potential of trace gas measurements in the atmospheres of both Earth and Mars with lidar. The focus is on the greenhause gases CO_2 and CH_4. My impression is that this project is clearly behind what would be needed for characterizing lidar missions. Instead (see abstract), calculations are stressed to support the claim of unprecedented accuracy. For instance for CO_2 it is well known that the lidar approach, at this time, does not fulfill the requirements."

It is unfortunate that the title is "LIDAR technology for Measuring trace gases on Mars and Earth" and the readers may get the impression that we are trying to measure CO2 on Earth. That was not the intention. I was under the assumption I was submitting to the special issue therefore I tried to be consistent and kept the title the same as the ISTP 2009 conference presentation.
The manuscript is describing the technology for measuring Methane on Earth and Methane and possibly other biogenic gases on Mars. We do not claim to use this approach to measure CO2 on Earth using this approach. CO2 is mentioned because it is the dominant greenhouse gas and a comparison with methane as a greenhouse gas is made. It is also mentioned because the NASA Earth Decadal survey for the Active Sensing of CO2 Emissions Over Nights, Days, and Seasons (ASCENDS) mission recommended that methane be included. However, we do not claim anywhere in the paper that this is the preferred approach for measuring CO2 although other groups have demonstrated airborne CO2 measurements using OPOs. We do have an alternative approach for CO2 that was published elsewhere (will be happy to provide references) but CO2 measurements on Earth are <u>not</u> the emphasis of this paper. We mentioned "trace gases" since for Mars (only), our approach can measure other biogenic or gases (including CO2).
Clearly I have failed to convey that the focus is Methane and not CO2 and I would be happy to revise the title accordingly. I'd be happy to change the title to:
"A lidar approach of measuring methane on Mars and Earth" or "Lidar technology for measuring methane on Mars and Earth".
In addition, I propose the following revision to the abstract to clearly state that CO2 is not the focus of the paper.
Trace gases such as methane and their isotopic ratios in planetary atmospheres offer important clues as to the origins of a planet's atmosphere, hydrology, geology, and potential for biology. An orbiting laser remote sensing instrument is capable of measuring methane on Mars and possibly Earth on a global scale with high accuracy, and higher spatial resolution that can be obtained by passive instruments. Our proposed lidar uses Integrated Path Differential Absorption

technique, Optical Parametric Amplifiers, and a high sensitivity receiver to measure methane on Mars and Earth. For Mars we use the 3–4 μm spectral range to map methane and possibly other biogenic gas concentrations and search for the existence of life. For Earth we use the 1.65 μm spectral range for greenhouse has monitoring applications. Preliminary results demonstrating methane and water vapour detection using a laboratory prototype illustrate the viability of the technique.

"Introduction
A lot of information is given on both species, but the true requirements are missing. For instance, the variability of CO_2 in the atmosphere of our planet is known to be extremely low. This makes the job of identifying sources and sinks rather demanding. For the reader this kind of information would be necessary. For a well-mixed gas no lidar measurements are necessary since a simpler approach will be adequate. There is no description how the measurements would look."
The reviewer is criticizing a measurement approach for CO2 on our home planet. Again that is not what we are addressing in this paper and in any case the requirements for the NASA ASCENDS mission have not been finalized so it would not be possible to list the "true requirements" that everyone can agree on.
The "true requirements" for an earth methane mission as far as NASA is concerned do not exist yet. There has been a lot of discussion in the literature and other forums but there is no official agreed upon requirements document I can point the audience to that lists the mission requirements for an Earth Methane mission. There is a proposed European mission to measure methane and they are currently in the process of generating the level-1 requirements. I can also quote more references from the literature but those do not constitute "true requirements" for a space mission. If the author could point us to an approved requirements document I would be happy to remedy the omission.
For Mars some preliminary work has been done by the MEPAG and the Science Working Group for the Mars Trace Gas Mission. The Planetary Decadal Survey for Mars is expected out shortly but was not available at the time of submission.

Rest of the paper:
P. 4679, line 7: A reference for these numbers is missing
I was assuming that the reader would be able to calculate the Doppler width of an absorption line listed in the HITRAN database. I will add the detailed a reference to the HITRAN database as follows:
L.S. Rothman, I.E.Gordon, A.Barbe, D.ChrisBenner, et.al. The HITRAN 2008 molecular spectroscopic database, Journal of Quantitative Spectroscopy& Radiative Transfer110 (2009) 533–572

I still believe a calculation of the Doppler width is not needed for a peer reviewed journal that deals with atmospheric physics.

P. 4679, line 8: 0.03 cm^{-1} is not "very high resolution".
The adjective very high resolution clearly refers to a [space flight] FTIR spectrometer. We are not aware of any FTIR instruments that have flown in space with higher resolution. I propose to change the wording to:
"high resolution"
If that's acceptable, or if the reviewer could provide us with an example of an FTIR instrument with higher resolution that has flown in space I'd be happy to change the entire paragraph.

P. 4679, line 9: minimum atmospheric width?
The lines on Mars are not pressure broadened. As stated 4 lines above: "The average surface pressure is ~6–7mbar, which minimizes pressure broadening and results in narrow absorption lines." So the Doppler width dominates and was listed (but admittedly not calculated) in the next sentence.

P. 4679, line 10: "and therefore sensitivity" is unclear.
Agreed – I will remove the phrase.

P. 4679, line 15-16, throughout paper (also figures): Use "transmittance" and "absorbance"; "transmission" and "absorption" are processes!
Will revise the manuscript accordingly and use "transmittance" and "absorbance"

P. 4679, line 21: better; "within a few hundred".
Will change to:
"within a few hundred".

P. 4680, line 7: better: "and idler emission is generated"
Will change to:
"and idler emission is generated ".

P. 4681, line 14: For a demonstration for a space mission this does not look sufficient and clearly below the state of the art (much stronger narrow-band pump lasers exist).
I fully agree this is not sufficient for a space mission nor do we claim it is. This section had signal to noise plots and calculations for Mars which showed the required laser power. We felt compelled to remove them because it required discussion of a specific detector which falls under ITAR restrictions (US export regulations). I propose one of the following:

1) **Either state or show (without any explicit reference to a detector) the laser energy needed for a Mars lidar.**
2) **Insert the phrase: "This is not sufficient for a space mission" and change the heading to OPA Performance.**

I disagree with the reviewer that much stronger narrow-band pump lasers exist. I'd be very grateful if the reviewer can point me to a commercial product. Our review of commercial (not expensive custom-made items) has not revealed any stronger or better narrow-band lasers.

P. 4683, lines 5-7: This should be demonstrated here! Anything else is nothing particularly new.
I am not sure what this criticism is about. We showed equivalent absorbance sensitivity using two different methane mixture concentrations.

Sec. 4.2., first paragraph: What is the difference in absorption cross section? There are also other advantages at the shorter wavelength (higher lidar signal, more sensitive detectors)

The number of Figures is excessive.
We will remove the following figures and associated text.
Figure 1, Figure 6, Figure 7, Figure 13 or 14.

Will the measurements on Mars be made with an open cell? There is no description what is be planned.
This technology is for a proposed **remote sensing** instrument. The measurements will be made from a Mars orbit. This is stated clearly in the introduction and abstract.

In summary, there are too many deficiencies that I can recommend publication.
I sincerely hope that with the proposed changes the reviewer will change his recommendation