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Atmospheric Chemistry and Physics Discussions

Interactive comment on "$CO_2(\nu_2) - O quenching rate coefficient derived from coincidental SABE$

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We thank the Reviewer 4 for his/her analysis and comments on the paper. The responses to major and minor comments are given below. We marked the reviewer's and the author's comments by "**RC:**" and "**AC:**", respectively.

General comments

RC: My major objection to this work is the omission of several systematic uncertainties in this study. These are the atomic oxygen abundance,
AC: Please, see the response to the first general comment of the Reviewer 2.

RC: ...the carbon dioxide volume mixing ratio
AC: We have added the figure where ACE-FTS, WACCM, and SABER CO_2 profile retrieved by Rezac, (2011) are shown. Please, also see the answer to the 4-th specific

comment of the Reviewer 3.

RC: ...radiance uncertainties (affecting the upwelling radiation)
AC: For the 15μm CO_2 radiance the upwelling flux is defined by the radiative transfer in CO_2 spectral lines in the atmosphere and by the atmospheric profile itself. The radiative transfer is calculated in line-by-line mode in the ALI-ARMS non-LTE code and the accuracy is better that 1%. The main contributor to the flux at the mesospheric altitudes is the stratopause area where temperatures are high and the concentration of the emitters is still high. In this area, SABER temperatures are in good agreement with other measurements (Remsberg et al., 2008), and the uncertainty of the upwelling flux associated with temperature uncertainty can be estimated as $\pm$2%.

RC: ...the temperature dependence of the rate constant
AC: Please, see the response to the 5-th general comment of the Reviewer 2.

RC: ...or uncertainties of the Einstein coefficients.
AC: The Einstein coefficients for the $CO_2(\nu_2)$ fundamental band, which plays the main role in this study, are known with very high accuracy for a number of years (Rothman et al., JQSRT, 2008).

RC: Another point not addressed in the paper is the temperature dependence of of the SABER atomic oxygen retrieval. The k(O+O_2+M) rate constant utilized in the atomic oxygen retrieval has a noticeable temperature dependence, such that the choice of the temperature profile in this retrieval has some impact / feedback on the atomic oxygen profile. Was this effect estimated or considered in your work?
AC: The SABER atomic oxygen retrieval uses the SABER kinetic temperature from the same scan. Comparison with other observations presented by Remsberg et al. (2008) indicate that SABER T tends to be cooler by 0-5 K in the altitude range 60-85 km and that there does not seem to be a consistent bias above there. However, the amount of data available for comparison above 90 km was small. As discussed in Smith et al. (2010), the contributions of uncertainties in temperature or the reaction

rate mentioned above are small compared to other uncertainties in the O retrieval. Moreover, appreciable errors in either of these would upset the excellent agreement between daytime and nighttime O found with SABER O. See discussion in Smith et al. (2010), paragraphs 38-39.

RC: The carbon dioxide volume mixing ratio profile is another quantity relevant in the context of this paper. The authors should show the profile utilized in this study, since the reference (Rezak, 2011) is a PhD thesis, only. What are the uncertainties of the carbon dioxide volume mixing ratio profile utilized here, such as the NLTE processes involving O(1D) and its production, day-night extrapolations, or radiance uncertainties in the SABER 4.3 micron channel?
AC: The author of the Ph.D. thesis, Dr. Ladislav Rezac has kindly provided us with the download link to his thesis, which was added to the reference list. We have also added the figure, which shows ACE-FTS, WACCM, and SABER CO_2 VMR profiles.

RC: As stated above, all of these uncertainties should be considered in the non-linear fitting of the rate constants and expressed in the confidence limit of the fitting parameter.
AC: We have added the estimates for k_{VT} with negative temperature dependency and with low O(z) to Fig. 3. We believe that these cases should be treated apart from the k_{VT}(z) retrieval, and provide the grounds for that. Other uncertainties reveal themselves in the widths of ζ curves in Fig.2a.

RC: Another, more formal point, is the neglect of some references, such as Remsberg et al.[2008, JGR] or Carcia Comas et al. [2008, JGR]. The authors should put their results in the context of this work as well.
AC: Please, see the response to the second general comment of the Reviewer 2. We have added a reference to Remsberg et al. (2008) and a brief discussion to the Section 1 of the manuscript.

RC: Finally, the introduction of a new quenching process involving highly excited oxy-

gen atoms lacks a discussion about its relevance. The authors should estimate its impact quantitatively or shorten this paragraph significantly.
AC: We have added simple estimates of the hot oxygen concentration and excitation efficiency to the discussion. However, we do not see how one can shorten the paragraph without losing the pieces necessary for understanding the problem in general and the suggested formula (5), in particular. We even had to add a sentence describing other potential sources of $CO_2(\nu_2)$ pumping suggested by Reviewer 3.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 32583, 2011.