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Atmospheric Chemistry and Physics Discussions

Interactive comment on "OH level populations and accuracies of Einstein-A coefficients from hundreds of measured lines" *by* Stefan Noll et al.

Anonymous Referee #2

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General Comments

This is a very well written manuscript based on a detailed analysis of one very high-quality mean spectrum derived from more than 530 individual high-quality spectra obtained during 536 hours of observations with the high-resolution Ultraviolet and Visual Echelle Spectrograph (UVES) at the telescope with a primary mirror of 8 m diameter located at Cerro Paranal in Chile. The primary target of the study is the emissions emanating from OH radicals located in a narrow layer near the Earth's mesopause. The motivation for such a study is clearly explained in the Introduction which provides a comprehensive description of the historic use of these spectra in remote sensing of the mesopause temperature and the retrieval of atomic oxygen abundances. The criteria applied in the selection of the individual spectra used to generate the very

high quality mean spectrum and the rationale behind them are well described in Section 3 as are the various corrections applied, such as the van Rhijn effect, and the solar activity correction. Historically, the calculation of the mesopause temperature was based on the assumption that the populations in the rotational energy levels are in thermal equilibrium, i.e., it is typically Trot that is determined from individual rotational transitions between different vibrational levels. The calculation of Trot and the OH populations within individual upper states depends on the Einstein-A coefficients. The wavelength range covered by the mean spectrum ($\sim$ 0.57-1.04 μm) has enabled the authors of this manuscript to examine the Einstein-A coefficients of 15 OH bands with upper vibrational levels between 3 and 9 and Δv=v'-v" between 3 and 6. Six of the most widely used sets of Einstein-A coefficients are tested by the very high quality mean spectrum, all of which have some failings, but having identified the optimal set (Brooke et al., 2016), the authors adopt an empirical approach to improve these coefficients. Use of the improved Einstein-A coefficients to analyse the rotational level populations indicated that the latter included a cold (largely thermalized) component together with a hot (non-thermalized) component. The values of Trot derived from OH bands, particularly those arising from higher vibrational levels, are well known to be susceptible to non-LTE effects. It is the hot populations that give rise to these non-LTE effects. These results are valuable because they quantify the extent to which different bands suffer from these non-LTE effects The authors divided the original set of UVES spectra used to produce the very high quality mean spectrum into two on the basis of the effective emission height of each individual UVES spectrum. This was already achieved in earlier work by Noll et al., (2017 and 2018a) by linking the ground-based spectra with space-based measurements of altitude profiles of the OH emissions from the SABER radiometer (Russell et al., 1999). The degree of thermalization was found to decrease with increasing altitude which could be explained by the higher fraction of the hot component. The assumptions used in the calculations, the criteria applied at each stage and the significance of the results are clearly explained. The manuscript is very well referenced and certainly deserves to be published with only very minor

textual corrections.

Specific Comments

The authors should make the empirically corrected Brooke et al. (2016) set of coefficients available as supplementary material so that others may benefit from this work.

Very minor textual corrections

This manuscript contains a lot of very detailed information: it is clear that the authors have gone to great lengths to achieve the level of precision shown in these details. I have found only one typographical error which occurs in line 630.

Line 630: refers to “553 spectra”, when it should be “533 spectra” as specified in lines 90 and 95.

Lines 113-114: the final sentence of the paragraph beginning with “The smoothing . . .” is not clear.

Lines 255, 313 and 416: the authors use the word “satisfying” or “satisfyingly” when referring to the quality of Einstein-A coefficients and in line 498 when referring to the OH level populations. The words “satisfactory” or “satisfactorily” are suggested as a better alternative.

Similarly, lines 281, 302, 375, 685 include the words “unsatisfying” or “unsatisfyingly”. The words “unsatisfactory” or “unsatisfactorily” would be better choices.

Line 306: suggest replace “neglection of” by “omission of” or “negligence of”.

Line 498: suggest “cannot be reproduced satisfactorily” instead of “cannot satisfyingly be reproduced”.

Line 662: suggest “OH emission layer there should have the strongest impact” instead of “OH emission layer should there have the strongest impact”.

References

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