Response to comment by Referee #1 (Ernesto Oliva) on “OH level populations and accuracies of Einstein-A coefficients from hundreds of measured lines” by Stefan Noll et al.

The paper presents a very detailed analysis of OH lines intensities derived from a large set of archive spectra collected with the UVES spectrograph of the ESO-VLT telescope. It clearly shows that the molecular parameters (transition probabilities) available in the literature yield different results, none of them fully compatible with the data. The authors select the source that provides the better match and propose empirical corrections to achieve a better fit.

We thank the reviewer for preparing this positive report including two specific recommendations for improvements.

I am somewhat worried about the flux calibration of lines that fall in regions with significant telluric absorption, such as the (6-2)P2(12) doublet shown in Figure 9. The intrinsic widths of the airglow emission lines and of the telluric absorpion fatures could be narrower than instrumental resolution. In such a case the correction applied is strongly dependent on model parameters such as the velocity of the airglow clouds and the assumed spectral profile of the telluric absorption. I strongly suggest to perform a sanity check, e.g. by comparing the discrepancies of Lambda-doublets (Figure 9) with the telluric absorption in the spectral region where the lines are measured.

We agree that telluric absorption can be a serious issue that needs to be considered. As briefly described in the first paragraph of Sect. 3.2 and discussed in more detail in the cited papers, we performed a complex correction approach which included the derivation of the effective absorption for each line based on molecular absorption spectra with a resolving power of 10^6 and simulated emission line profiles assuming Doppler broadening. The latter causes FWHM of about 2 pm at 800 nm, while the absorption lines are several times broader. Winds are not an issue since the speed is usually below 100 m/s, i.e. the wavelength shifts are only a few tenths of a picometre. In order to obtain realistic absorption spectra, we considered the zenith angles and the precipitable water vapour (PWV) during each observation. The PWV was derived from the water vapour absorption in the corresponding astronomical target spectrum, which usually showed a sufficiently bright continuum.

The corrected line intensities are usually quite reliable. Only in the wings of very strong absorption lines where the transmission gradients are high, there might be significant uncertainties. However, these cases are rare in the wavelength range of UVES, where weak absorption dominates. For the measured lines, the mean transmission is 97%. Only 6% of the Λ doublets were absorbed by more than 10%. Hence, after the correction, which can reduce the absorption by up to an order of magnitude, the impact of telluric absorption on most lines is negligible. We add this information to the end of the first paragraph of Sect. 3.2:
“… spectra were averaged. The resulting mean absorption of the measured Λ doublets was 3% and only 6% of the doublets were attenuated by more than 10%. Hence, the related intensity uncertainty after the correction, which can reduce the absorption by up to an order of magnitude, is negligible for most lines.”

The distribution of data points in Fig. 9 depending on the transmission differences between both Λ doublet components can be used for a check. 8 of the 140 P-branch-related doublets show a transmission difference of more than 10%. However, their distribution well agrees with the one for the full sample. There is no increased scatter, which is confirmed by a regression analysis. Also note that the possible impact of absorption lines close to the considered emission line (partial blends) on the quality of the intensity measurement has been considered via the quality class. While 6% of all measured doublets show absorption of more than 10%, this percentage is only 3% for the best class 33.

Finally, I note that problems arising from the comparison of lines from the same upper level and with different delta-v, were also reported in Oliva et 2013 (2013A&A,..555A..78O). You may add a reference to this article.

We thank the reviewer for mentioning this paper with important results based on OH population comparisons. We have missed to consider it for the submitted manuscript, but we will discuss it in the revised version.

The corresponding text is entered at L. 381:
"… transition probabilities. Population comparisons for OH lines from near-infrared bands with low Δv mostly not covered by UVES were performed by Oliva et al. (2013) based on observations between 0.95 and 2.4 µm with the high-resolution echelle spectrograph GIANO at the Telescopio Nazionale Galileo at the La Palma Observatory in Spain. The results show clear discrepancies between populations derived from lines of bands with Δv = 2, 3 and 4 for the Einstein-A coefficients from van der Loo and Groenenboom (2007). Interestingly, the corresponding trend with wavelength displayed in Fig. 8 seems to be reversed for bands at longer wavelengths. In general, ..."

As a consequence, some text later in the paper will be redundant:
"which are not accessible by UVES" in L. 383 can be removed and the GIANO description in L. 528-530 can be shortened:
"Two-component fits were previously performed by Oliva et al. (2015) based on a near-infrared GIANO spectrum with a resolving power of 32,000 taken during 2 hours with the spectrograph directly pointing to the night sky at the La Palma Observatory. The investigated lines ..."