

## ***Interactive comment on “Measuring FeO variation using astronomical spectroscopic observations” by Stefanie Unterguggenberger et al.***

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General comments:

This is an interesting manuscript dealing with ground-based observations of two terrestrial nightglow emission features, i.e. the FeO orange bands and the well-known Na D-lines. The spectral observations were carried out with the X-shooter spectrograph at the Very Large Telescope in Chile. The FeO and Na emissions show similar diurnal and seasonal variations. Comparisons with WACCM model simulations allow empirical estimation of the (effective) quantum yields for the two emissions, which are not well known. The paper is of interest to the aeronomy community and is in general very well written. A few paragraphs and sentences are difficult to follow (see specific comments below). I don't have any major objections against the publication of this manuscript

C1

and recommend publication subject to minor revisions. I ask the authors to consider the specific comments listed below.

Specific comments:

Page 3, line 20: "as A pseudo-continuum" ?

Page 7, line 9: "We tested our results with respect to the data distribution over the year by introducing equally spaced bins"

I don't fully understand what you mean here? How many bins were used? How wide/long were they? Do they have to be equally spaced?

Figure 2: I have some questions about this Figure:

(a) Is the ordinate label / unit correct? The plot shows the spectral intensity, so the unit should be  $R / (\text{wavelength unit})$ , e.g.  $R/\text{nm}$ , right? This applies to both panels.

(b) You write that the cyan line in the top panel corresponds to the FeO continuum, while the black line shows the raw spectrum. What is the origin of the offset between the two lines? Is it possible that the cyan line is offset by 100 R for better visibility? If yes, this is not mentioned, as far as I can tell.

Page 9, line 19: Evans et al. found a NiO/FeO ratio of 0.05 to 0.3 and Gattinger et al. a ratio of 2.3. Is the large difference between these results understood?

Page 9, line 26/27: "we find a maximum contribution of 31% to the mean peak"

I suggest adding "of the FeO emission" here (this is what you mean, right?)

Page 10, line 2: "Scaling the main peak emission from Gattinger et al. (2011) to the whole spectrum we obtain a value of 3.9%"

I think some pieces of information are missing here. What "value" do you mean? Even after reading the sentence several times, I'm not sure I interpret it correctly. Please clarify.

C2

Page 10, line 10: “where the main peak amounts to 3.3 +-0.8%”

3.3 % of what? This is related to the previous point. Please clarify.

Page 11, line 6: “In general, the Na and FeO emission show similar diurnal variation within their combined errors, i.e. Figs. 4a, c, and d.”

This statement is also true for 4b, and even more so than for, e.g. 4d or 4a.

Next sentence: “The intensities of FeO and Na decline at the beginning of the night and rise towards sunrise”

This is not true for 4b. I think you intend to only mean panels a, c d here, right? But this is not explicitly stated by this or the previous sentence (the phrase “i.e. Figs. 4a, c and d” does not imply that).

Page 11, last line: “The best fit approach ( $\chi^2_{\min}$ ) relies on the grid size and does not provide uncertainties”

After reading the entire paragraph I understand what you mean, but there are different “best-fit” approaches. You create arrays with possible fit parameters and then determine  $\chi^2$  for each set of possible combinations. One may also use – and I think this is generally done – numerical routines to find the optimum fit values in a least-squares sense. I suggest mentioning at the beginning that you don’t use a numerical scheme to minimize  $\chi^2$ . Otherwise, the reader has difficulties understanding what you mean by “relies on the grid size” – this is not correct for the numerical methods. Also the numerical methods will generally provide uncertainty estimates.

Page 12, line 8: “parameter” -> “parameter”

Page 12, line 22: “stronger .. amplitude” -> “larger .. amplitude” ?

Page 13, line 8: “at the end of May”

Isn’t it rather the end of April?

C3

Page 14, line 23: “by convolving”

Is this really a convolution in the mathematical sense? This may well be the case, but I’m not entirely sure.

Page 15, line 3: “convolving”

Same as above point.

Page 15, line 9: “Fig, 9” -> “Fig. 9”

Page 15, last sentence: I think it’s also worth mentioning that Clemesha et al. (1995) performed a minimization of the differences between the observed Na emission rates and model simulations, which resulted in a value of  $f = 0.093$ . Also, in our recent manuscript (von Savigny et al., First mesopause Na retrievals from satellite Na D-line nightglow observations, Geophys. Res. Lett., revised, 2016) we find an optimum value of  $f = 0.09$ , when comparing Na retrievals from SCIAMACHY Na nightglow observations with independent satellite observations (SCIAMACHY dayglow and GOMOS stellar occultation). I should point out that we varied  $f$  in steps of 0.01 to find the optimum value – an approach that can be refined. In any case, I find it encouraging that your results on the value of the effective quantum yield are in good overall agreement with the von Savigny et al. (2016) value and with Clemesha et al. (1995).

Fig. 4, caption, line 1: I Suggest replacing “with respect to season” by “for different seasons”. Same line: space in “.The” missing.

Figure 5: The symbols (squares) are hardly visible in the printout. Please increase the symbol size.

Page 16, line 2: “airglow emissionS” ?

Page 16, line 23: “None of the seasons showS”

Page 23, table caption, line 2: “the relative value of A1 ..”

C4

Suggest adding "in percent" to read "the relative value (in percent) .."

Reference list: the reference list contains a fair number of typos and inconsistencies. I probably didn't catch all of them. Please check the list again carefully. A general issue: periods are missing at the end of all references. In addition, the spacing between initials is not consistent between the references.

Page 17, line 24: "D.:Chemiluminescent"

Page 17, line 25: "..0 ,2006" -> "..0, 2006."

Page 18, line 1: "J. M. C. Plane, J. M. C."

Page 18, line 14: delete "&"

Page 18, lines 24, 27 and 30: "Phy." -> "Phys."

Page 18, line 30: "variation,J."

Page 19, lines 18 and 21: "Phy." -> "Phys."

Page 20, lines 1 and 2: semicolons used as separators between authors, rather than commas.

Page 20, line 9: "Res- Atmos."

Page 21, line 1: "Plane,J . M."

Page 21, line 10: "J. M. C. Plane, J."

Page 21, line 20: "Mlynzak" -> "Mlynczak"

Page 22, line 9: von Savigny (2012) is not cited in the manuscript, as far as I can tell (But I'm certainly happy if you cite it ..)

Page 22, line 14: "variationsof"

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