

Interactive comment on “Regularisation model study for the least squares retrieval of aerosol extinction time series from UV/VIS MAX-DOAS observations for a ground layer profile parametrisation and westward viewing direction” by A. Hartl and M. O. Wenig

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Response to referee #2

We thank the reviewer for the very careful review of our manuscript and apologise for careless mistakes we could have spotted ourselves.

C1097

Response to general comments

We are aware of the fact that our manuscript contains technical details that may disrupt the flow of reading now and then, but we still like to include them in the vain hope that they might be helpful.

Response to specific comments

Page 2588, line 22: Absolutely correct, we therefore changed “cancel” to “approximately cancel”.

Page 2589, line 14: Remark in brackets has been changed to “(this wavelength λ_{fm} as parameter of the forward model (fm) will be specified in sec. ...)”.

Page 2591, equation (11): We have added brackets.

Page 2592, line 17: Changed from “It uses the fact, that...” to “This scheme uses the fact that, if...”.

Page 2592, equation (12): The criterion we employ refers to the unweighted least squares (LS) in the original context (Hansen, 1998, Sec. 7.5.3). We apply it to the weighted LS problem, where we have taken the expectation value of the data residual (first term in eq.(11)) to approximate its real value. We have changed the text before eq.(12) to make this clearer.

Page 2592, line 24: This is indeed nonsense and has been corrected to “... x_{RMS} being the RMS of x_{est} .”

Page 2593, line 6: Changed both as suggested.

Page 2593, line 9: Changed from “For least squares solutions” to “For unregularised least squares solutions”.

Page 2595, line 13: See response to Page 2589, line 14.

Page 2595, line 13: Correct, this is a grammatical mistake: “have” → “has”.

Page 2596, line 5 & line 7: The index k is now defined at the beginning of this paragraph.

Page 2601, line 3 & Page 2601, line 6: Corrected. (Following the suggestion of referee # 1 we rearranged fig. 2.)

C1098

Page 2602, line 10: Removed "at the minimum \hat{x} " in this line.

Page 2604, line 15: Changed the sentence from "Consequently d_s is considerably smaller for the profile with larger AOD $\tau \sim 1$ " to "For given σ_ϵ , the signal-to-noise ratio σ_i/σ_ϵ decreases and consequently ...".

Page 2604, line 18: Changed "DOFs" to "degrees of freedom (DOFs)".

Page 2604, line 20: The condition number was defined on page 2591, line 6. To help the reader we have inserted "(ratio of largest to smallest singular value)" after "condition number".

Caption Fig. 9: Absolutely correct. We changed the labels.

Page 2606, line 19: The lines "Comparing the 'optimal' regularisation parameters with the corresponding d_s in fig. 8 shows that, depending on the solar angles, for low $\tau \sim 0.1$ between 20–30% are not fixed by the measurement, for high $\tau \sim 1$ between 30–60%." were changed to "Comparing the 'optimal' regularisation parameters with the corresponding d_s in fig. 8 shows that, depending on the solar angles, for low $\tau \sim 0.1$ between 70–80% out of the maximally 3 degrees of freedom are given by the measurement itself; the remaining 20–30% are affected by noise, for high $\tau \sim 1$ between 30–60%".

Page 2608, line 2: Correct, this is a mistake: " ϕ_{rel} getting larger" was changed to " ϕ_{rel} getting smaller".

Page 2608, line 5: Correct, this is (again) a mistake. It has been changed.

Fig. 15: Caption has been changed correspondingly.

Page 2608, line 27 & Page 2608, last line: A measurement (as component of the fit vector) which can be more or less directly expressed in terms of the fit parameters mathematically acts more or less like the a priori, the only difference being that the a priori represents an *assumed* measurement of the fit parameters. Taking this point of view can help to understand the effect and possible interference of measurement and a priori/regularisation, especially in our case (fig. 14), where the errors of the intensities are modified.

In this sense, the paragraph p. 2608, lines 27ff. was meant to give an interpretation for the fact that the retrievals in fig. 14 behave so differently for different solar positions

C1099

and regularisation parameters. But since we do not substantiate the usefulness of this interpretation for our particular case and this comment confused more than it helped, we decided to delete this passage.

Caption Fig. 16, line 4: This is indeed negligent and was changed from "Lines show averages of random errors, shaded areas standard deviations as in previous figures." to "As in previous figures, lines represent averages, shaded areas standard deviations for 100 MC runs."

Page 2611, line 4: "While for all profile series so far starting point and sequence of the retrieval process co-incided with the chronological order of the time series..." → "While for all profile series so far the retrieval sequence of one day started with data in the morning..."

Typos etc.

Page 2594, line 23: Corrected.

Page 2595, line 16: Changed to "The optimisation problem presented in eq. (11) is solved..."

Page 2607, line 19: Changed from "The graphs are result ..." to "The graphs are the result ...".

Page 2609, line 8: Corrected.

Page 2616, line 9: Corrected.

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C1100