

Interactive comment on “Iterative maximum a posteriori (IMAP)-DOAS for retrieval of strongly absorbing trace gases: Model studies for CH₄ and CO₂ retrieval from near infrared spectra of SCIAMACHY onboard ENVISAT” by C. Frankenberg et al.

A. Maurellis (Referee)

a.n.maurellis@sron.nl

Received and published: 8 November 2004

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

1. General comments

1.1. Summary of the publication

In summary, the authors provide a theoretical study using simulated retrievals of the IMAP-DOAS method. At first glance, IMAP-DOAS is simply an optimal estimation retrieval with a state vector consisting of column scaling factors, climatological indices and a polynomial baseline. Such an approach thus appears to be a highly-regularized profile retrieval with 100% correlation between all altitude levels and this can have its drawbacks since it is seldom difficult to fit a total column to a spectrum even though the outcome may be less sensitive to variations in the boundary layer than it is to the other layers. However, the authors have taken this problem into account by modifying their state vector to consist of three subcolumns per species, with the lowest altitude subcolumn (0-3 km) having much higher a priori variance than the upper two. They have also taken into account the possibility that the lowest column can be partially obscured in real retrievals by the presence of clouds or orographical features. As part of a fairly comprehensive sensitivity study they include a very innovative additional feature, namely, the use of a climatological index, or scaling factor, for the temperature derivative, which, the authors show, is vital for the retrieval of CO₂ and CH₄ in the near infrared.

1.2. Overall evaluation

This work presents a rigorous and thorough motivation for the adoption of yet another innovative DOAS-type method from the IUP/Heidelberg satellite group. Although IMAP-DOAS has yet to provide the scientific literature with measurements of atmospheric trace gases this paper does a very fine job of establishing the range of applicability of the method and fixing the method within a sound theoretical framework. This work also

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

provides a number of valuable insights into the general problems of retrieval in the near infrared. I therefore recommend its publication in this journal.

2. Specific comments

1. Spectral line shape problems, in particular line mixing and deviations from the Voigt profile for water vapour, are appropriately mentioned in section 2.2 but it is not clear how, if at all, this issue is dealt with in the retrievals that follow, ie. in the rest of the paper. Is section 2.2 just there to provide information to the reader and have the authors gone ahead with using the Voigt profile anyhow? Or has some special modification been made to the spectral line codes? There is also no estimate of the sensitivity of the retrievals to these problems, which I think is important to include in a work which is already as comprehensive as this paper.
2. Similarly the section on instrumental line shape problems (section 2.2) makes the point that smoothing the intensity spectrum is not the same as multiplying separately-smoothed solar and transmittance spectra. But the authors do not indicate at this point what they have done (although one might well believe that they have smoothed the intensity spectrum as they mention later in the paper). They have also assumed a fixed value for the instrumental point spread function FWHM. It is conceivable that this function may be incorrectly specified or even wrong (due to unforeseen effects such as growth of an ice layer in the optical path of the instrument) in which case it would be good to know how sensitive their retrievals are to uncertainties in the instrument FWHM.
3. The authors make an estimate of the sensitivity due to line-broadening parameter errors (section 4.2.2). The effect on the retrievals of errors in integrated line intensity is not explored. Water vapor spectroscopy, particularly in the near-infrared, has not been quite at the level of quality of water vapor in other spectral

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

- regions, and so it is likely that the effect of integrated line intensity uncertainties would be even greater than those of line-broadening uncertainties. It may also be interesting to note that HITRAN 2004 has just been released which contains considerably updated line parameter information in the near infrared. Perhaps the authors might consider taking this into account for future retrievals.
4. The Conclusions section (5) seems to be missing an overall summary of errors for all the parameter studies conducted in this work. I think it would be very useful to the retrieval community and future users of the data generated by this retrieval to have a table presenting the numbers as well a sentence or two in the text summarizing what total, formal error ranges would be for a realistic retrieval using the full IMAP-DOAS algorithm (method b). The table could consist of at least two columns, one with the parameter uncertainty, the other with the propagated retrieval error, and perhaps a third column for comments.
 5. I would like to see a sentence or two appended to the discussion on page 6078 (the paragraph covered by lines 11-17) which summarizes the main aspects of the following point. The one element missing from this discussion in this paragraph is that scattering has been totally avoided in this paper. A significant portion of the column would not be traversed by the light path in the presence of some kind of lower tropospheric aerosol load which may both enhance the reflectivity as well as introduce multiple scattering which increases the path length. This effect on the retrievals is extremely difficult to quantify. However, the question is whether or not a linearized model such as the one presented here would yield a good fit with wildly inappropriate column values, or would it simply fail to converge, in which case the retrieval could be safely ignored.

[Full Screen / Esc](#)[Print Version](#)[Interactive Discussion](#)[Discussion Paper](#)

3. Technical comments

I have only a few minor comments of a grammatical or typographical nature which should be addressed before publication:

Abstract, lines 18-20, sentence starting "For a quantitative test..." The subject of the sentence is unclear. I would suggest starting with "This new approach is applied to modelled spectra..."

Abstract and throughout the text. The definite article is frequently omitted before the word "measurement". In almost cases it really should be included, ie. "the measurement".

Page 6075, line 13. Replace "well applicable" with "really applicable".

Page 6080, sentence starting line 1. There is a reference to "this method" although it is still not clear what the method is. I would suggest rewriting the first part of the sentence as follows: "In the following, the use of optimal estimation with a state vector comprising column and temperature scaling factors for column retrieval purposes is referred to as IMAP-DOAS..."

Page 6080, line 15. "for" is missing; "Allowing for only small variances in S_d ".

Page 6080, sentence starting in line 20 is very unclear. "Since these variances (in the intensity space...". I would suggest starting with the main clause: "Each diagonal element of S_ϵ shows a different value since the variances (in intensity space) also depend on the intensity (via the shot-noise) transformed via the logarithm (Jahne 2002)."

Figures 1 and 3: the details of both the text and the graphics are extremely difficult to read and digest for these figure. For figure 1, I suggest spreading each of the

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper

four small frames across the page and placing them one underneath each other. Figure 3 is already in this format but should be made wider. In both cases much larger fonts are mandatory.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 6067, 2004.

Full Screen / Esc

Print Version

Interactive Discussion

Discussion Paper