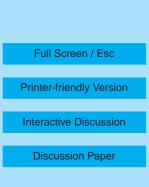**Atmospheric
Chemistry
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Interactive
Comment

Interactive comment on "A modified band approach for the accurate calculation of on-line photolysis rates in stratospheric-tropospheric Chemical Transport Models" *by* J. E. Williams et al.

Anonymous Referee #1

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This paper describes improvements to a previously-published method of calculating photolysis rates in chemical transport models, extending its applicability and reducing the errors introduced at high solar zenith angles. The development of fast and efficient solvers capable of calculating both tropospheric and stratospheric photolysis rates with temporally and spatially-varying clouds and aerosol is important for CTM and chemistry-climate model development, allowing more comprehensive feedbacks between gas, aerosol, and climate processes to be reliably modeled. Improvement of the band approach for this purpose is very valuable. The paper is appropriate for publication in ACP, but in its current form has a number of deficiencies, outlined below, which need to be addressed with appropriate revisions or clarification.

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General Comments:

The general layout of the paper is logical, but the text is confusing in places, due to forward-references to topics to be discussed in later sections, to unclear explanations (e.g., page 3522, lines 1-7) or to discussion of comparisons where it is not clear which reference the scheme is being compared with (e.g., section 4.3). These discussion sections should be tidied up.

It would have been very useful to have compared the various reference codes/cases described in the paper with the results of the DISORT scheme (as Landgraf and Crutzen 1998 did) or the full spherical reference model described in appendix A, to provide an integrated assessment of the errors due to the whole method. The current description focuses on errors due to separate effects (spherical treatment, band treatment, clouds and aerosol) and the reader isn't left with a clear picture of the overall errors involved compared with a full and accurate solution. Appendix B addresses this for zenith angles of 90 degrees or more, but figure A2 suggests that the errors are worse at (more important) smaller angles.

Potential users of the scheme will be interested in its ease of application. Section 6.2 addresses this and indicates that addition of new species is straightforward, but section 4.3 (page 3529, line 11) suggests that the application of the limits needs to be tested for each new species. How general is the approach?

The accuracy of the method is carefully assessed in the paper, but little is said about its computational efficiency. Computational requirements are generally highly problem- and system-dependent, but it would be helpful to give some measure of the fast the method is compared with other comparable schemes, with the unmodified scheme, or with more detailed schemes.

Specific Comments:

Page 3514: PIFM needs to be spelled out in the abstract.

Page 3527: How were the new values of lambda selected? Was this approached in a systematic way with some kind of optimization procedure, and if so, how was this done?

Page 3529, line 10: The limits are applied for some species and not for others; is there any justification for this, or will addition of any new species to the scheme require that the user runs these tests to check whether or not limits should be used?

Page 3533, section 5.1: Figure 12 shows the impact of aerosols on the profile of selected J values. J(NO2) is a dark pink line and exceeds 30%, not 20%. The impact of aerosol on the error in the J value calculated using the band method is of greater interest than the general impact of aerosol on J-values - the errors are dismissed in lines 24-26, but it would be more useful to show them here instead.

Page 3535, line 4: "Table 2" should read "Table 3".

Page 3540: Figure A2 provides important information on the accuracy of the PIFM model and associated high-angle treatments. This is critical for the accuracy of the scheme as a whole, and therefore it would be useful to see this figure (and associated description) in section 3 in the main text rather than stuck away in an appendix.

Page 3537, line 3: The accuracy is rather overstated in the conclusions: the error of 2% only applies for the middle and upper stratosphere at 90 degrees.

Figures:

The pale colors in the line-plots are difficult to see. Yellow and pale green lines should be darkened in figures 2, 3 and 4.

The noise occurring in many of the figures is stated to be a consequence of using a lookup table for temperature dependence, but it is very distracting, hides some of the features, and makes the figures more difficult to interpret. The figures would be much clearer if this noise was removed either by (a) choosing a more appropriate interpolation when using the lookup table, (b) plotting 2-km averaged data rather than

values every km, or (c) sampling, filtering or smoothing in some other way.

Figures 3 and 4 should be combined to allow a direct comparison of the errors with the standard and modified band schemes - there is no reason to keep them separate.

The caption of Figure 3 should indicate which reference model is used for the comparison here (reference B?), and/or make it clear that these are the errors due to the band approach only, not the total errors in the J values.

It would be helpful if figures 5-8 could be rearranged so that the standard and modified band methods could be seen side-by-side (as for Figs 3 and 4, see comment above).

The difference in the comparisons illustrated in Figures 10 and 11 is not clear from the captions or from the text. The errors at 90 degrees are different in the two figures: where do these differences arise?

Caption fig 13: contouring identical to Figs 6 and 8 (Fig 4 has no contours). It would be helpful if the same (or equivalent) color scheme could be used across all figures - figs 5 and 7 and figs 10 and 11 currently use quite different schemes. A simple dichromatic scheme based around red (positive) and blue (negative), with white at zero and magnitudes represented by the saturation level, would provide a more intuitive and consistent scheme than is used at present.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 3513, 2006.

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