

Interactive comment on “Characterization of model errors in the calculation of tangent heights for atmospheric infrared limb measurements” by M. Ridolfi and L. Sgheri

Anonymous Referee #1

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Characterization of model errors in the calculation of tangent heights for atmospheric infrared limb measurements

Ridolfi & Sgheri.

REFeree COMMENTS

General Comments _____

The paper describes results from investigations of the impact of various aspects of ray-tracing for the MIPAS limb-viewing infrared radiometer. While I do not doubt the correctness of the results obtained I believe that, due to the methodology used, the

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results are not suitable for wider application and hence the current work is really more of an internal technical study rather than a scientific paper.

Section 2: Ray Tracing. It does not seem surprising that, given sufficiently small step-size, all three algorithms converge to the same solution. The difference appears to be in the efficiency but is the computing time spent on ray-tracing really a significant overhead in the retrieval of L2 products? Furthermore, since the Curtis-Godson integration is usually performed in parallel with the ray-tracing using a numerical integration along the ray-path, it is not clear that an algorithm which finds the tangent height with relatively few steps is any advantage since the CG integration will in any case have to sub-divide the steps.

Section 3: Refraction Model. The obvious way to analyse the impact of different refraction models is to use the fact that $[n r \sin(\theta)]$ is conserved along a circularly symmetric path (n =refractive index, r =radius from centre, θ =angle relative to local horizontal), from which it can be seen that $[n r]$ at the tangent point is a constant for any particular limb-view. This gives a much simpler analytical method of relating differences in refractive index models (n) to differences in tangent height (r) without any need for explicit ray-tracing. In any case, the difference in tangent height is only one aspect: perhaps more significant for L2 products is the difference in CG path amounts which are increased for a lower tangent point both by the increase in pressure and the additional length of the path (which does require ray-tracing), but there is no discussion of this.

Section 4: Atmospheric Model. It is of course to be expected that the atmospheric model will have the biggest impact on the tangent height: different models have different density v altitude profiles as well as horizontal structure. However the tests here just seem to be a not particularly representative sample and no attempt is made to isolate the two effects: it would have been better to use meteorological data to analyse the variation in density for a given altitude (the 1D effect) and also, perhaps sampled with MIPAS pole-to-pole orbital coverage, the variability in horizontal density gradients

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(the 2D effect), together with their impact on the L2 temperature and pressure profiles.

Specific Comments —————

p7702, I16: Since the early limb sounders on the Nimbus satellites in the 1970s it has been known that the on-board line-of-sight pointing is inadequate to define the tangent height to useful accuracy and that tangent pressure derived from the limb radiances themselves (with little a priori constraint on absolute altitude) have formed the vertical coordinate of the product. So, I disagree that good knowledge of the tangent height is of much benefit to the scientific L2 products except for the purposes of converting from pressure to absolute altitude, and even here may be more accurately performed by registration with (eg ECMWF) meteorological analyses.

p7702, I19: One of the biggest sources of uncertainty is the instrument pointing. It is of little benefit performing ray-tracing to 10m tangent height accuracy if the (geometric) instrument pointing is itself uncertain to 100m. What is the assumed absolute pointing uncertainty for MIPAS here?

p7704, I3: I couldn't find the reference to Stiller 2000, although on the KOPRA web-site I found a report by Hopfner & Hase dealing with ray-tracing. Perhaps this would be a better reference with an explicit link to this document in the bibliography?

p7704, I8: I don't think there's any problem in using Snell's Law to calculate refraction angle; the problem seems to be with the assumption that the angle is relative to an altitude surface when it should be relative to a refractivity/density surface?

p7707, I10: The RO refractivity measurements presumably only give the fine vertical structure of refractivity along the path without any horizontal information. To simulate the MIPAS observation with its finite FOV you would have to first smooth these data with the appropriate kernel, as well as assume no horizontal variation.

p7707, I18: It would have been simpler to start with the satellite location and viewing angle and avoid the back-calculation altogether. Perhaps these data were unavailable?

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p7715 (Fig caption): 'Error profiles ... T_L1b' - there should be some expansion of this to a proper sentence if it is to convey any more information than already given in the legend. What sort of errors?

Typographical errors: —————

p7708, I15: 'elaborate' rather than 'elaborated'.

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